Spencer Kenner (SBN 148930)
James E. Mizell (SBN 232698)
Emily Thor (SBN 303169)
DEPARTMENT OF WATER RESOURCES
Office of the Chief Counsel
1416 9th Street, Room 1104
Sacramento, CA 95814
Telephone: 916-653-5966
Email: jmizell@water.ca.gov

Attorneys for
CALIFORNIA DEPARTMENT OF WATER RESOURCES

BEFORE THE

CALIFORNIA STATE WATER RESOURCES CONTROL BOARD

HEARING IN THE MATTER OF CALIFORNIA DEPARTMENT OF WATER RESOURCES AND UNITED STATES BUREAU OF RECLAMATION REQUEST FOR A CHANGE IN POINT OF DIVERSION FOR CALIFORNIA WATER FIX	TESTIMONY OF MARIN GREENWOOD

I, Marin Greenwood, do hereby declare:

I. OVERVIEW

I have previously testified in this matter. A summary of my expertise is included in Exhibit DWR-1012 and a true and correct copy of my statement of qualifications has previously been submitted as Exhibit DWR-1001. There are no substantive changes.

This rebuttal testimony provides a response to issues raised by Protestants relating to the California WaterFix (CWF) and aquatic resources in the Delta[1]. I reviewed the written and oral testimonies of witnesses who discussed Delta aquatic resources related to the California WaterFix (CWF) and herein rebut aspects of these testimonies.

To summarize, my opinions are:

[1] As with my previous written testimony (Exhibit DWR-1012), I use the term 'Delta' to mean the legal Delta plus adjacent areas such as Suisun Bay and Suisun Marsh.

1. The CWF H3+ North Delta Diversions (NDD) will be designed and operated to reasonably protect fish.
2. Application of the Nobriga and Rosenfield (2016) population dynamics model suggests that CWF H3+ will reasonably protect Longfin Smelt.
3. CWF H3+ will reasonably protect fish from south Delta entrainment.
4. CWF H3+ will reasonably protect food web productivity in the Bay-Delta.
5. CWF H3+ will reasonably protect the Bay-Delta ecosystem.
6. CWF H3+ will reasonably protect juvenile and adult Mokelumne River salmonids.

II. THE CWF H3+ NDD WILL BE DESIGNED AND OPERATED TO REASONABLY PROTECT FISH

It is my opinion that the CWF H3+ NDD will be designed and operated to reasonably protect fish. As I described in my previous testimony, this reasonable protection includes screening, bypass flow criteria, real-time operational adjustments, pre- and post-construction studies, and mitigation such as habitat restoration (see Exhibit DWR-1012, in particular p. 17:17-22:24, 36:11-43:7). Protestant witnesses raised a number of issues related to the NDD that I address in the sections below.

A. Flow and Velocity

1. North Delta Reverse Flows and NDD Sweeping Velocity

CWF H3+ proposes and is required by its ITP (CWF ITP) to manage NDD operations at all times to avoid increasing the magnitude, frequency, or duration of flow reversals in the Sacramento River at the Georgiana Slough junction above pre-Project levels. (Exhibit SWRCB-107, p. 187). Both Dr. Rosenfield (NRDC-58, p. 41:15-26) and Mr. Cannon (CSPA-204, p. 11) proposed NDD bypass flow criteria to address the potential for greater flow reversals in the Sacramento River at Georgiana Slough or more generally in the north Delta; I consider these proposed criteria to be unnecessary because of the CWF ITP requirements to avoid increasing reverse flows. This also addresses the issue raised by Mr. Shutes regarding reverse flows (Exhibit CSPA-202, pp. 9-10).

Mr. Shutes acknowledged in oral testimony that there are sweeping velocity criteria for the NDD (Transcript Vol. 22, p.65, lines 4-18).[2] During his cross-examination of DWR's panel 2, Mr. Shutes asked whether DWR will operate to divert water at the NDD as long as the upstream sweeping velocity exceeds 0.4 feet per second, to which I responded that, although it may not be stated, it is safe to assume that sweeping velocity is in a downstream direction (Transcript Vol. 7, p. 32:3-21). To more fully address this issue, I add here that the operational criteria for the NDD require at least 5,000 cfs downstream bypass flow to remain in the river following diversions (Exhibit DWR-1142, Chapter 3, Table 3.3-1, p. 86), which would mean that sweeping velocity would have to be in a downstream direction; modeling for the NDD in DSM2 also reflected a requirement of 0.4 feet per second downstream velocity for diversions to be allowable (Exhibit SWRCB-102, Appendix 5.A, Section A, pp. 5A-A45-48). This information also rebuts Mr. Cannon's oral testimony suggesting that the CWF H3+ documentation does not preclude the possibility of diverting at the turning of the tides (i.e., when sweeping velocity is zero) during which time he felt there is the potential to negatively affect fish (Transcript Vol. 22, pp. 123:21 to 124:23). Again, based on Exhibit DWR-1142, Chapter 3, Table 3.3-1, p. 86, diversion would not occur with sweeping velocity less than or equal to zero because of the requirement for 5,000-cfs bypass flow remaining in the river.

In addition, as I noted in my previous testimony (Exhibit DWR-1012, p. 42:6-10), the CWF ITP requires listed juvenile salmonid through-Delta survival following commencement of CWF H3+ operations to be equal to or greater than baseline (Exhibit SWRCB-107, p. 172). This provides a biological criterion for reasonable protection in addition to the hydrodynamic and sweeping velocity criteria for reverse flows at Georgiana Slough.

2. <u>NDD Bypass Flows and Downstream Flows</u>

The written testimony of both Mr. Shutes (Exhibit CSPA-202-errata, p. 11: "The Biological Opinion for WaterFix evaluates greatly reduced use of the North Delta Diversions based on "Pulse Protection" when "winter-run-sized" or "spring-run-sized" fish are detected in rotary screw

[2] As I described in my previous testimony (Exhibit DWR-1012, p. 18:13-15), per the incidental take limit of the NMFS BO (Exhibit SWRCB-106, Table 2-290, p. 1159), the screen sweeping velocity would be twice the approach velocity, i.e., 0.4 feet per second at 0.2 feet per second approach velocity.

traps at Knights Landing, although the BiOp stops short of requiring even this minimal measure") and Mr. Cannon (Exhibit CSPA-204, p. 6: "Protecting the first winter flow pulse is commendable to help winter run salmon pass through the Delta, but would not protect fry, parr, and smolt spring and fall run salmon, or subsequent winter run emigration in later winter flow pulses") did not recognize that CWF H3+ is required to protect all pulses of winter-run and spring-run Chinook Salmon (CWF ITP, Exhibit SWRCB-107, p. 191). In oral testimony, Mr. Shutes acknowledged that unlimited pulse protection is included (Transcript Vol. 22, pp. 65:20 to 67:7).

Mr. Shutes claimed in his written testimony that CWF H3+ does not include Rio Vista flow compliance required under D-1641 (Exhibit CSPA-202-errata, p. 9:16-18), however, this is incorrect as it is included (e.g., see CWF ITP p. 181), which was acknowledged in oral testimony by Mr. Shutes (Transcript Vol. 22, pp. 62:8 to 63:8). Mr. Oppenheim proposed that Rio Vista flow criteria be required as a water right change condition for CWF H3+ (Exhibit PCFFA-130, p. 14:17-21). In my opinion these criteria are unnecessary to address CWF H3+ effects because, as I described in my previous testimony, factors already included in CWF H3+ such as bypass flow criteria, real-time operational adjustments, and mitigation including the nonphysical barrier at Georgiana Slough will reasonably protect juvenile salmonids. In addition, Mr. Oppenheim acknowledged that these criteria are not specific to CWF H3+ and that he had not done analysis of impacts of CWF H3+ that the criteria were supposed to address (Transcript Vol. 29, p. 70:8-19).

Mr. Cannon also raised a concern regarding the potential for bypass flows to affect Delta Smelt: "The Delta smelt spawning migration is dependent on tidal surfing. Reductions in Delta inflow at the NDD will affect the distribution of spawning and possibly increase the smelt run up the main channel of the lower Sacramento River into the area of the intakes. More adult smelt are likely to enter the lower San Joaquin channel of the Delta and become more susceptible to the SDD" (CSPA-204, p. 25). The BA specifically addressed the question of potential hydrodynamic effects on upstream-migrating adult Delta Smelt using DSM2 particle tracking modeling incorporating tidal surfing[3] and found no evidence that there would be greater movement potential into the NDD reach or risk of entrainment at the south Delta export facilities (Exhibit DWR-1142, Chapter 6, Table 6.1-7, p. 6.79). This also addresses the concern on a similar theme from Mr. Stroshane, who appeared to suggest that Delta Smelt could occur more frequently in the NDD reach (Exhibit RTD-12, p. 38:8-10).[4]

B. <u>Entrainment</u>

As I noted in my previous testimony (Exhibit DWR-1012, p. 18:6-10), the NDD would include fish screens with 1.75-mm openings, the NMFS standard for waters potentially including salmonid fry less than 60 mm in length, which I considered would reasonably protect juvenile salmonids (Exhibit DWR-1012, p. 36:21-24). Mr. Oppenheim opined that the NMFS CWF BO should have analyzed a longer time series of monitoring data than 2012-2016 in assessing that around 3% of fall-run Chinook Salmon fry could be vulnerable to entrainment at the NDD based on a threshold of 32 mm in size, because he felt that 2012-2016 included drought years that were not representative of the typical size of fry (Exhibit PCFFA-130, pp. 5:8 to 8:17). To address this concern, I summarized data from monitoring in the north Delta (Sacramento trawl and beach seines), which to me suggest that the NMFS BO's assumptions for the percentage of fish less than or equal to 32 mm are reasonable: the mean percentage of unmarked fall-run Chinook Salmon juveniles less than or equal to 32 mm from beach seines during 1992-2011[5] was just over 2% (Exhibit-DWR-1350), whereas the mean percentage from the Sacramento trawl during 1992-2011 was 0.63% (Exhibit-DWR-1351). Additionally, I considered the NMFS size threshold of 32 mm and under to be potentially conservative given that it was based on sampling of a

[3] To incorporate tidal surfing, particles were assumed to be in the upper third of the water column on flood tides, and lower third of the water column on ebb tides; the method is described in the BA (Exhibit DWR-1142, Appendix 5.B, Section 5.B.3.6, p .5.B-17).

[4] Mr. Stroshane also suggested that X2 could occur more frequently in the NDD reach by the time the NDD is built. However, in no month did X2 reach 100 km (just downstream of Rio Vista) in CalSim modeling representative of CWF H3+ (Exhibit DWR-1142, CWF BA, Appendix 5.A, Figure 5.A.6-29-7), illustrating that X2 would be well downstream of the NDD reach.

[5] I limited the summary to the years from 1992 onwards for both the beach seines and the Sacramento trawl in order to focus on a period that was consistently sampled with both gear types.

single 32-mm Chinook Salmon fry that may have grown following entrainment, given that the sampling location was far from the location of entrainment (Exhibit SWRCB-106, p. 578).

Dr. Rosenfield claimed that "WaterFix assumes that no Longfin Smelt entrainment, impingement, or predation mortality will occur at the new North Delta diversions" (Exhibit NRDC-58, p. 32:11-12). This is incorrect. The CWF ITP Application's assessment of entrainment risk says that there is potential for CWF H3+ to take Longfin Smelt through entrainment by water diversions in the Delta, including the proposed NDD (Exhibit DWR-1036, Chapter 4.2, p. 4-265), while the following section goes on to describe the frequency of occurrence near the NDD as being very low but not zero. The analysis subsequently states in Section 4.2.6.3.1 that "Take at the NDD could occur as a result of entrainment, impingement/screen contact, and predation, as well as reduced access to upstream spawning habitat," with estimates for potential larval entrainment of 0.035% of longfin smelt larvae that could be entrained at the NDD in what the analysis describes as likely a worst case (Exhibit DWR-1036, Chapter 4.2, p. 4-282). Related to this issue, Dr. Rosenfield claimed that "Finally, none of the potential changes in entrainment rates has been incorporated into the overall assessment of potential population impacts to Longfin Smelt that may arise from WaterFix operations" (Exhibit NRDC-58, pp. 32:27 to 33:2). This is also incorrect. The CWF ITP application includes an analysis of the potential to jeopardize continued existence of the species, including a level of take analysis that discusses the percentage of Longfin Smelt that could be affected by entrainment loss at the south Delta export facilities, the NDD, and other facilities, as well as Delta outflow/X2 effects (Exhibit DWR-1036, Chapter 4.2, pp. 4-296 to 4-297). Similarly, for Delta Smelt, Mr. Stroshane opined that there was no detailed analysis of entrainment and impingement risk at the NDD (Exhibit RTD-12, p. 36:14-17). However, such analysis is included in the CWF BA (Exhibit DWR-1142, Chapter 6, Table 6.1-15, p. 6-107) and ITP application (Exhibit DWR-1036, Chapter 4.1, Table 4.1-17, p. 4-113).

With respect to smelt entrainment at the NDD, Mr. Shutes considered CWF H3+ operational criteria problematic because larval smelt are too small to detect (Exhibit CSPA-202-errata, p. 11:12-18). In fact, larval smelt can be detected. As I indicated in my previous testimony (Exhibit DWR-1012, pp. 19:27 to 20:28), CWF H3+ is required to conduct studies of abundance, distribution, and timing of all life stages of Delta Smelt and Longfin Smelt in the vicinity of the NDD (Exhibit SWRCB-107: Pre-Construction Study 11, pp. 165-166; Post-Construction Study 11, p. 170), to monitor entrainment (Exhibit SWRCB-107, Post-Construction Study 8, p. 169), and ultimately to assess effects of CWF H3+ on smelts from NDD operations (as well as other effects) in a life cycle model framework in order to establish population-level effects (Exhibit SWRCB-107, Post-Construction Studies 14 and 15) and the need for adaptive management. In order to meet these requirements, it is my opinion that typical small-meshed sampling nets would be used, as has been done in other entrainment monitoring and the DFW Smelt Larval Survey, for example, which would allow detection of larval smelts.

Mr. Stroshane opined that "Fish screen descriptions indicate they would exclude fish greater than 20 millimeters (mm) in length (nearly one inch) from being scooped up by diversions, but there is no mention in any of the intake descriptions of BDCP, the Draft EIR/EIS or the RDEIR/SDEIS what happens to fish, larvae and eggs that are 20 mm in size or smaller." (Exhibit RTD-12, pp. 32-33). As I indicated by the example analyses that I described above in rebuttal of Mr. Rosenfield, analysis for entrainment potential of smaller life stages was included in the effects analyses; another example is for Striped Bass in the FEIR/S (Exhibit SWRCB-102, Chapter 11, p. 3537:13-14).

In general, as I previously indicated in my written testimony, there is limited spatial overlap of Delta Smelt and Longfin Smelt with the NDD, so entrainment effects would be limited (Exhibit DWR-1012, p. 21:4-8 and p. 22:8-10). This is in agreement with smelt expert Mr. Baxter, who opined during cross-examination by Mr. Jackson that few, if any, Delta Smelt and Longfin Smelt larvae would be diverted from the Sacramento River into the Delta Cross Channel (Transcript Vol. 28, p. 133:24 to 134:3), which is around 10 river miles downstream of the NDD.

C. <u>Biological Modeling</u>

Dr. Rosenfield expressed several concerns related to modeling of salmonids as it pertained to effects of the NDD. For the Delta Passage Model (DPM), Dr. Rosenfield opined that the model is flawed and probably significantly underestimates probable reductions in juvenile salmonid survival because it does not account for near-field mortality (predation, entrainment, and impingement) and because it does not account for changes in flow affecting river depth or turbidity (Exhibit NRDC-58, p. 14:1-17). Regarding near-field mortality, these effects are uncertain[6] and so the model focused only on assessing potential changes related to changes in flow pattern. Regarding the second criticism for flow effects affecting depth and turbidity, these factors are implicitly captured through the flow-survival relationships that are included in the model; for example, as flow decreases, depth and turbidity tend to decrease, which presumably affected the observed survival of the acoustically tagged juvenile Chinook Salmon that were assessed in the studies providing the flow-survival relationships.[7] The DPM also did not include the effects of real-time operational adjustments to protect juvenile salmonids, nor the effects of the nonphysical barrier at Georgiana Slough, which is proposed to mitigate potential effects of the NDD, which would offset the negative effects suggested by the model. Dr. Rosenfield opined that assessment of the Unlimited Pulse Protection (UPP) scenario with the Perry Survival Model demonstrated that through-Delta survival of juvenile Chinook Salmon is likely to be lower under CWF H3+ than NAA (Exhibit NRDC-58, p. 15:2-8). As Dr. Rosenfield noted, this model also did not include consideration of near-field mortality (Exhibit NRDC-58, p. 15:19-25); I would also note that it did not include consideration of the nonphysical barrier at Georgiana Slough as mitigation for potential effects, which would reduce the estimated effect of CWF H3+ in a similar manner as I explained above with respect to the DPM.

Dr. Rosenfield noted that the NMFS winter-run Chinook Salmon life cycle model estimates that the NAA would lead to higher abundance of this species than under CWF H3+ (Exhibit NRDC-58, p. 18:1-5). This model included representation of potential near-field mortality effects and mitigation effects (e.g., the Georgiana Slough nonphysical barrier), however, as Dr. Rosenfield recognized (Exhibit NRDC-58, p. 15:27, fn. 2), this model did not include consideration of unlimited pulse protection and associated real-time operations. In addition, as I

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[6] For example, one study suggested that survival of juvenile Chinook Salmon along a large fish screen was similar to survival in the channel downstream of the screen, although there is uncertainty because of the release strategy (Exhibit SWRCB-102, Chapter 11, p. 11-3236, fn. 7); a laboratory study indicated high survival (considerably greater than 99%) and therefore minimal effects from entrainment/impingement along a simulated fish screen (see discussion of Swanson et al. 2004 in Section IID of this testimony).

[7] The same rationale also applies to the Perry Survival Model that Dr. Rosenfield cited results from.

noted in my previous testimony (Exhibit DWR-1012, p. 41:12-14), the winter-run life cycle model assumes most juvenile migration occurs at night (Exhibit SWRCB-106, Appendix H, Table 2, p. 25), which coincides with the greatest pumping period based on the simplified operations included in DSM2 modeling.[8] In contrast to the modelled pumping regime, actual NDD pumping levels are likely to vary across each day based on biological and hydrological conditions, and will be able to adjust for diurnal/nocturnal differences in migration tendency (Exhibit SWRCB-108, p. 157). The oversimplified operational assumption omits these factors and, as a result, overestimates impacts from NDD operations. Also, the greatest difference in through-Delta survival was in March of below normal years (Exhibit SWRCB-106, pp. 803-804); the life cycle model was applied to the BA H3+ operational scenario, whereas the CWF H3+ includes the additional spring outflow criteria and therefore has greater flow downstream of the NDD in March for below normal years (Exhibit SWRCB-107, Appendix 4.D, Table 4.D-4, p. 4.D-3), which would reduce the difference in estimated survival between NAA and CWF H3+ scenarios.

Overall, there is uncertainty in the estimates of the effects of the NDD on juvenile Chinook Salmon, as illustrated by the width of the predictions of Chinook Salmon escapement from the IOS model, for example (see discussion in Exhibit DWR-1142, Chapter 5, p. 5-177). During oral testimony, Dr. Rosenfield opined that the mean estimates from IOS are the best estimates (Transcript Vol. 32, p. 179:2-7); this is accurate, but in my opinion, it is important to recognize the variability in the estimates, which are wide and indicate uncertainty in the results. Dr. Rosenfield opined that “the Project Proponents presented this model, you know, knowing that no one else asked them to present this model” (Transcript Vol. 32, p. 179:10-12), but during development of the effects analyses and coordination with regulatory agencies about potential methods, this tool was selected because it is among the best available. The life cycle models employed in the effects analyses are consistent in suggesting the potential for negative effects

[8] At the time of the development of the operational modeling, it was not known that diel period (diurnal/nocturnal) was an assumption influencing survival estimates in the winter-run Chinook Salmon life cycle model. The following assumption was made to simplify modeling of the NDD: Given a daily target volume of water to divert at the NDD, the DSM2 model aimed to divert this volume as soon as possible on each day within operational constraints such as river channel velocity (see Appendix 5.B of the BA). This led to most diversion occurring during the night in the first few hours of a new day, which coincides with the main period of movement of juvenile Chinook Salmon in the life cycle model.

of CWF H3+ within the Delta (and not upstream) and specifically from the NDD. As I have indicated elsewhere in my previous testimony and this rebuttal testimony, it is my opinion that the various proposed and required measures (e.g., pre- and post-construction studies, bypass flow criteria, pulse protection flows, mitigation such as the Georgiana Slough barrier, and the requirement to meet biological criteria for through-Delta survival) are reasonably protective of juvenile salmonids, consistent with the overall conclusion from the NMFS BiOp that ESA-listed and non-listed juvenile Chinook Salmon would not be expected to have viability appreciably reduced by CWF H3+ (Exhibit SWRCB-106, p. 1110) and the issuance of the ITP indicating that effects to winter-run and spring-run Chinook Salmon will be minimized and fully mitigated.

D. <u>Screen Design</u>

As I indicated in my previous testimony, the CWF H3+ NDD will provide reasonable protection of species such as downstream migration juvenile salmonids because it will include a number of pre- and post-construction fish screen studies in order to inform final fish screen design and to assess fish screen performance in relation to operational and biological criteria (e.g., Exhibit DWR-1012, p.36 line 11 to p.38 line 23). The requirement for preconstruction studies to inform final design is in contrast to Mr. Stroshane's apparent opinion that the NDD would be built first, then studied (Exhibit RTD-12, p. 35:9-10). Mr. Cannon expressed several concerns regarding the NDD (Exhibit CSPA-204 pp. 2-3). First, he opined that the intake locations presented a risk to migrating juvenile fish, citing Exhibit CSPA-400, which does not appear to consider site-specific information beyond aerial photography. In contrast, an evaluation by the Fish Facilities Technical Team (FFTT) based on aerial photography and field-collected cross-sectional data categorized the sites in relation to water depth for screening and position of the site relative to river geometry (which affects fish protection factors such as sweeping velocity) as good (Intake 5), moderate to good (Intake 4), and marginal to moderate (Intake 2) (Exhibit DWR-219, pp. 57-59); none of the sites were characterized as poor by the FFTT, which included fish screen experts from a number of participating agencies including NMFS, DFW, Reclamation, and others. Among the preconstruction studies that I outlined in my previous testimony, studies 1, 2, 7, and 8 will inform protective final fish screen design given the hydraulics of the proposed NDD locations (Exhibit DWR-1012, p. 19:7-10, 19:19-24).

Mr. Cannon's second concern is related to entrainment and impingement as a function of velocity, for which he cites Exhibit CSPA-401 as supporting information, and states that exposure beyond 60 seconds would lead to fatigue and fish succumbing to water flowing through the screens. However, a laboratory study[9] cited in the BO (e.g., Exhibit SWRCB-106, p. 581) of 2-hour exposure duration on small (4.4 cm) and larger (7.9 cm) juvenile Chinook Salmon did not find impingement or injury to be related to velocity (and injury rate was not different from control fish that were not exposed to the screen), and survival was high (5 of over 3,200 fish died). Exhibit CSPA-401, pp. 1-2, questions the ability to maintain uniform through-screen (approach) velocity along the entire length of each screen, citing difficulties in adjusting flow-control baffles, although without specific examples; however, based on my discussions with Mr. Valles, it is not anticipated that the flow control baffles will need frequent adjustment to maintain uniform approach velocity for fish protection. Term and Condition 4.a.iii of the NMFS BO requires velocity (and other factors) to be measured during test operations and thereafter in order to assess conformance with required NMFS criteria (Exhibit SWRCB-106, pp. 1185-1186), with this requirement being generally covered by required Post-Construction Studies 1-4 (see summary in my previous testimony, Exhibit DWR-1012, p. 20:5-16). The NMFS BO specifies incidental take limits for NDD approach and sweeping velocity and biological factors such as entrainment and injury in order to protect fish (Exhibit SWRCB-106, Section 2.9.1.2.5.1, pp. 1158-1160).

Mr. Cannon also opined that predation at the NDD is a serious concern (Exhibit CSPA-204, p.3). He cited Exhibit CSPA-402 as indicating that proposed fish refugia have a high probability of failure, although that exhibit does not provide any specific detail as to the reasoning behind this opinion. As I acknowledged in my previous testimony, there is uncertainty in the potential effects of the NDD on predation (Exhibit DWR-1012, p. 37:5-7), and so the pre-construction studies related to refugia that are required under the CWF ITP will be important to

[9] Swanson, C., P. S. Young, and J. J. Cech. 2004. Swimming in Two-Vector Flows: Performance and Behavior of Juvenile Chinook Salmon near a Simulated Screened Water Diversion. Transactions of the American Fisheries Society 133(2):265-278.

inform final design (see summary in my previous testimony, Exhibit DWR-1012, p. 19:10-15), with Post-Construction Study 5 requiring monitoring of the effectiveness of the refugia following commencement of operations (Exhibit DWR-1012, p. 20:16-19). Mr. Cannon opined, including citation to Exhibit CSPA-403, that in-water physical structures will provide predator habitat and that juvenile fish will become concentrated and continually exposed at the three NDD, with predators concentrated just downstream of each intake. The conceptual model for juvenile fish concentration presented in Exhibit CSPA-403's Figure 1 is an oversimplification, and does not recognize that there are river bends between the NDD that could change the overall distribution of fish, in particular between intake 3 and intake 5 (see Exhibit SWRCB-107, Appendix 1, Figures 2, 5, and 6), so that fish may move away from the NDD (left) side of the river before encountering subsequent intakes, if indeed they are more concentrated by the NDD (which is uncertain). The hydraulic influence of the intakes would be minimized during pulse protection flows during which many juvenile fish are migrating downstream. Recognizing the potential for increased predation risk at the NDD, CWF H3+ proposes and is required by the CWF ITP to undertake preconstruction study 5 (predator habitat locations) and Pre-and Post-Construction Study 9 (predator density and distribution) to inform protective final fish screen design and assess effects during testing and commencement of operations (see my previous testimony summary, Exhibit DWR-1012, p. 19:15-16, 19:24-27). Predatory fish relocation will also be considered as part of adaptive management following required pre- and post-construction studies of predatory fish density, habitat, and relocation methods (Exhibit DWR-1012, p. 49:13-17, 49:25-27). Ultimately, the effectiveness of fish screen protection will be assessed through attainment of Biological Criteria 1 (juvenile winter-run and spring-run Chinook Salmon NDD intake reach survival of 95% or more of pre-project survival) and 2 (juvenile winter-run and spring-run Chinook Salmon NDD through-Delta survival equal to or greater than preproject survival), which must be met as required by the CWF ITP's Condition of Approval 9.7 (Exhibit SWRCB-107, p. 172).

Mr. Stroshane also provided opinions related to NDD screen design. He expressed concern that the drawing shown in Exhibit RTD-1025, p. 3, is not to scale (Exhibit RTD-12, pp. 31:25 to 32:3). In fact, given that the graphic in RTD-1025 represents an example portion of a screen, it appears to me reasonably to scale given the relative size of the example fish and the screen openings. Mr. Stroshane opined that neither scaled illustrations nor engineered drawings of the NDD are provided in the DEIR/S or RDEIR/SDEIS (Exhibit RTD-12, p. 32:4-5). In fact, a rendering of an NDD intake (Exhibit DWR-212, Figure 6-2, p. 6-3), as well as preliminary engineering drawings (Exhibit DWR-1142, Appendix 3.C) have been provided as part of the project description. Mr. Stroshane opined that the NDD are experimental and have not been employed anywhere else (Exhibit RTD-12, p. 32:17-18). However, as described by Mr. Bednarski, the Glenn-Colusa Irrigation District intake is 3,000-cfs capacity with flat-plate screens, and the Red Bluff Intake[10] and Freeport intakes are two more examples with flat plate fish screens that would generally be similar to the NDD (Exhibit DWR-1022, p. 8:1-19). Mr. Stroshane cited Exhibit RTD-1023 as providing a comparison of DFW and NMFS fish screen design criteria (Exhibit RTD-12, p. 33:12-15) to those that he interpreted as being proposed under CWF H3+. Exhibit RTD-1023 suffers from some inaccuracies primarily as a result of relying on older sources: approach velocity for CWF H3+ is 0.2 feet per second at all times (rather than 0.2 feet per second only in the presence of Delta Smelt as RTD-1023 suggests; Exhibit DWR-1142, Chapter 3, p. 3-37) and the sweeping velocity must be at least double the approach velocity (Exhibit SWRCB-106, Table 2-290, p. 1159), which meets or exceeds both the DFW and NMFS criteria (rather than greater than the approach velocity [NMFS] and at least double the approach velocity [DFW], as RTD-1023 suggests), with screen cleaning apparatus being used to ensure the fish screens are kept clear of debris to meet the approach velocity criteria (Exhibit DWR-1142, Chapter 3, p. 3-38). Mr. Stroshane opined that there could be risk to fish because of temporary shutdowns of individual screens for cleaning (Exhibit RTD-12, p. 34:14-18). It is unclear what type of risk he is suggesting; regardless, there is flexibility in the NDD to allow partial shutdowns to occur by isolating screen bays as necessary (through closure

[10] Mr. Cannon incorrectly stated that the Red Bluff Intake fish screen “tries to push fish in a certain direction and collect them and put them in a certain place in the river out of danger. But this one [the NDD] is just a screen” (Transcript Vol. 22, p. 210:8-11). In fact, the Red Bluff Intake is similar to the NDD in consisting of an intake with on-bank flat plate fish screens, as summarized by Mr. Bednarski (Exhibit DWR-1022, p. 8:1-4).

of gates) as well as individual screens (through installation of stop logs), which would prevent entrainment of fish; see, for example, Exhibit DWR-216.

Citing Exhibit RTD-1020, Mr. Stroshane opined that “Fish screen options were considered at sites just a few miles downstream of the North Delta intakes and were rejected for natural diversions from the Sacramento River. Yet they are deemed acceptable or even necessary for the north Delta intakes associated with Petition Facilities”. (Exhibit RTD-12, p. 38:1-5). In my opinion, this comparison is unfounded. Exhibit RTD-1020 is a DWR report investigating the means of reducing juvenile salmonid entry into channels with relatively low survival. The locations assessed in RTD-1020 include the entrance to Georgiana Slough, which is at around Sacramento river mile 26 to 27, whereas the NDD are between around river mile 37 and 41 (SWRCB-107, Table 1.2, p.15). The entrance to Georgiana Slough is appreciably further downstream and more likely to be subject to tidal influence. Each NDD intake would have the capacity to divert 3,000 cfs, and the flow through the screens can be controlled and stopped as necessary (see additional discussion in Section IIE below related to the ability to shut down the intakes rapidly). In contrast, flow in Georgiana Slough can be appreciably greater than the proposed NDD (e.g., over 10,000 cfs; see Exhibit DWR-1142, Figure 5.B.5-5-7, pdf p. 140) and cannot be controlled, given that it is a natural channel. High flows going through the fish screens would have been a contributing factor in the RTD-1020, p. 37, working group decision to remove fish screens from further consideration based on the required large structure sizes and concerns over the ability to meet CDFW and NMFS screening criteria. Therefore, the comparison to the situation at the NDD is not appropriate.

Similar to Mr. Cannon, Mr. Stroshane had concerns regarding predation at the NDD: “112. The baseline of predation in the lower Sacramento River between Clarksburg and Courtland for each of the listed fish species is unknown and not disclosed in the RDEIR/SDEIS for its three sub-alternatives. Potential predation effects at the north Delta intakes for juvenile salmonids remaining in the Sacramento River (as opposed to entering the Yolo Bypass) could occur if predatory fish aggregated along the screens as has been observed at other long screens in the Central Valley [citation]. Baseline levels of predation are uncertain, however. (SWRCB-3, p.

4.3.7-65:36-39.) 113. The RDEIR/SDEIS indicated methodological problems with another fish predation study at the GCID fish screen in the Sacramento River near Hamilton City. (SWRCB-3, footnote 5, p. 4.3.7-66.)". (Exhibit RTD-12, p. 39:11-21). As I previously described with respect to the comments by Mr. Cannon, Pre- and Post-Construction Studies will aid final design and assessment of effects related to predation, and assessment of survival will be undertaken to address compliance with Biological Criteria 1 and 2 for juvenile Chinook Salmon. Footnote 5 that Mr. Stroshane refers to is the same footnote that appeared in the FEIR/S (Exhibit SWRCB-102, Chapter 11, p. 11-3236), and suggests that survival along the GCID screen was at least similar to survival in the portion of the channel without the screen, although the comparison was compromised by the release strategy of the fish. This is an example of the type of uncertainty that will be reduced through the various Pre- and Post-Construction Studies that I have previously referred to.

E. <u>Monitoring</u>

As I indicated in my previous testimony, real-time operational adjustments in response to fish presence are one component informing my opinion that CWF H3+ will reasonably protect juvenile listed salmonids (e.g., Exhibit DWR-1012, pp. 39:1 to 43:7). Protestant witnesses raised concerns related to monitoring. Mr. Shutes opined that pulse protection of fish depends on detection, which he considered to be unreliable, giving as an example (without specific citation) smolt-sized salmon swimming out of rotary screw traps (Exhibit CSPA-202-errata, p. 11). Given that rotary screw trap monitoring forms an important basis for existing real-time adjustments, for example, with respect to Delta Cross Channel operations,[11] I believe, as I indicated during cross-examination, that this form of monitoring is a good indicator of relative abundance in order to ascertain when pulses of fish are occurring (Transcript Vol. 6, p. 120:1-20). Mr. Cannon essentially provided similar testimony during cross-examination by Ms. Meserve (Transcript Vol. 22, pp. 213:19 to 214:21).

[11] See Exhibit SWRCB-84, pp. 635-640.

Dr. Rosenfield noted that analysis of UPP criteria in the NMFS CWF BO relies on real-time detection of salmonids to inform adjustment of operations and opined that the BO "admits that existing monitoring programs are inadequate for these purposes, and that the reliance on existing monitoring programs could underestimate both abundance and temporal extent of winter and spring run Chinook salmon (NMFS BiOp at 772)." (Exhibit NRDC-58, p. 16:7-12). However, the NMFS BiOp further states "When real-time operations are implemented, new/additional monitoring locations and information from baseline studies are expected to allow a better characterization of the typical travel time and, therefore, lag time, from monitoring stations closer to the diversion locations. This would allow better resolution of fish presence and abundance to coordinate operations." (Exhibit SWRCB-106, p. 773). CWF H3+ is required to consider the installation of additional monitoring stations and the development of new monitoring techniques in order ensure that biological criteria 1 and 2 for through-Delta survival are being achieved (Exhibit SWRCB-107, p. 191), which in my opinion will allow adjustments to monitoring as necessary in order to effectively conduct real-time operations and provide reasonable protection.

During cross-examination by Ms. Meserve, Mr. Cannon opined that assessment of the through-Delta biological criteria would be undertaken with large, hatchery-origin fall-run or late fall-run Chinook Salmon with radio tags (e.g., Transcript Vol. 22, pp. 217:3-11 and 219:7-14). While that description of test fish is somewhat representative of fish that have been used in recent studies that I am familiar with, CWF H3+ is required to assess survival rates for all juvenile life stages as part of Pre-Construction and Post-Construction Study 10 (Exhibit SWRCB-107, pp. 165 and 169-170). Therefore, survival rates must be assessed not only for larger juveniles, but also smaller juveniles.

Dr. Rosenfield opined that there is evidence that protective triggers based on real-time monitoring results are unlikely to actually occur and are not reasonably certain to occur, citing the NMFS (2009) SWP/CVP BO generally as an example (Exhibit NRDC-58, p. 17:1-8), but without providing specific details. CWF H3+ real-time pulse protective criteria are required to be implemented as part of permitting conditions of approval, and must occur within 24 hours of detection of a fish pulse (e.g., Exhibit SWRCB-107, p. 191), which is feasible given that the diversions can be shut down within 20 minutes or so, as indicated by the CER's Hydraulic Analysis (Exhibit DWR-1142, Appendix H).

F. Mitigation

As I described in my previous testimony, it is my opinion that mitigation including the nonphysical barrier proposed to reduce juvenile salmonid entry into Georgiana Slough will contribute to reasonable protection from NDD effects (e.g., Exhibit DWR-1012, pp. 39:1 to 43:7). In addition, as I previously described with respect to screen design in Section IID above, predatory fish relocation will also be considered as part of adaptive management following required pre- and post-construction studies of predatory fish density, habitat, and relocation methods. Mr. Cannon opined, without citing any sources, that "Neither predator removal nor non-physical barriers have proven feasible or effective." (Exhibit CSPA-204, p .8). Regarding predatory fish relocation, the BA acknowledges uncertainty in the effectiveness of this measure but also provides citations to two peer-reviewed studies describing increases in juvenile salmonid survival at two locations within the Delta following predator reduction (Exhibit DWR-1142, Chapter 5, pp. 5-107-5-108). Regarding nonphysical barrier effectiveness, testing of a BioAcoustic Fish Fence-design barrier during 2011 and 2012 found significant reductions (12-15 percentage points, or 50-67% in relative terms) in entry of acoustically tagged late fall-run Chinook Salmon and steelhead into Georgiana Slough when the barrier was turned on, with results from the first year of the study being published in a peer-reviewed journal (Exhibit DWR-1142, Chapter 3, Section 3.4.3.1.1.1, pp. 3-142-3-144). As described in the BA, additional testing will be required to determine effectiveness for smaller, wild-origin fish. Construction of this barrier is required to occur before NDD operations begin (Exhibit SWRCB-104, p. 1181).

G. Protection of Unlisted Fish

1. Unlisted Salmonids

Various protestant witnesses expressed concerns that unlisted salmonids would not be protected by the NDD as a result of factors such as pulse protection criteria being focused on listed winter-run and spring-run Chinook Salmon (e.g., Mr. Shutes, Exhibit CSPA-202-errata, p. 11:14-15; Mr. Cannon, Exhibit CSPA-204, p .6:7-8; Mr. Oppenheim, Exhibit PCFFA-130, pp. 8:22 to 9:14). As I described in my previous testimony, I consider that there will be reasonable protection for unlisted salmonids from CWF H3+ because of the various operational criteria and environmental commitments, for example (Exhibit DWR-1012, pp. 48:7 to 50:22), which is consistent with the conclusion from the NMFS BO (p. 1110): "…we have concluded in this Integration and Synthesis that the PA [proposed action, i.e., CWF H3+] is not expected to appreciably reduce the viability of the population of ESA-listed Chinook salmon populations in the Central Valley. Although a similar ESA determination has not been made for the non-ESA listed fall-run and late fall-run Chinook salmon, the relative benefits from the revised PA elements and commitments underlying the determinations for ESA-listed Chinook are generally applicable to all Central Valley Chinook salmon populations. As a result, we expect that the overall magnitude of the reduction in Chinook abundance in the ocean available for Southern Resident [killer whale] foraging will also be minimized."[12] As I indicated in my oral testimony, the temporal overlap of unlisted and listed salmonids means that operational criteria focused on the latter also will also be protective of the former (Transcript Vol. 4, p. 151:5-10).

2. <u>Other Native Fish Species</u>

Mr. Cannon opined that sturgeon and Pacific Lamprey would be affected by the NDD (Exhibit CSPA-204, pp. 22-23). As I indicated in my previous testimony (Exhibit DWR-1012, p. 52:3-7), analysis in the FEIR/S concluded that operational impacts would be less than significant for White Sturgeon[13] and Pacific Lamprey.

Mr. Cannon also opined that a number of other native Delta fish species will pass the NDD and many have larvae and juvenile life stages that will be lost to the intakes and associated predators (Exhibit CSPA-204, p. 27)[14]. Of the species named by Mr. Cannon, the FEIR/S did

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[12] Both Mr. Shutes (Transcript Vol. 22, pp. 67:8 to 69:17) and Mr. Oppenheim (Transcript Vol. 29 pp. 69:14 to 70:2) acknowledged that the NMFS BO made this conclusion during cross-examination by Ms. Morris and Ms. Ansley.

[13] My previous testimony also addressed Green Sturgeon, a listed species, to inform my opinion that this species would be reasonably protected by the NDD (Exhibit DWR-1012, pp. 36:11 to 38:23).

[14] Mr. Cannon also opined that "Many of these native species were previously devastated from the interior Delta by the SDD." (Exhibit CSPA-204, p. 27). No source is given for this statement.

not find significant impacts from NDD entrainment for Sacramento Splittail because the bulk of reproduction occurs on inundated floodplains, particularly the Yolo Bypass, which discharges downstream of the NDD and will result in larvae and small juveniles avoiding the NDD; larval entrainment in lower flow years when the Yolo Bypass is not inundated would be limited because bypass flow criteria would limit operations of the NDD in these years (Exhibit SWRCB-102, pp. 11-3426:9 to 11-3427:5). As described in the FEIR/S, Hardhead are largely distributed upstream of the NDD and so effects would be less than significant (Exhibit SWRCB-102, p. 11-682:35-41). Tule perch are viviparous and so offspring are born sufficiently large to avoid entrainment risk at the NDD, resulting in a less than significant impact conclusion in the FEIR/S (Exhibit SWRCB-102, p. 11-682:9-26). As described in the BA, Starry Flounder would have little spatial overlap with the NDD based on their distribution in more downstream areas, and therefore the potential for adverse effects is limited (Exhibit DWR-1141, Appendix 5.E, Figure 5.E-3 [p. 5.E-10] and Section 5.E.5.2.1.1.1 [p. 5.E-25]). It is my opinion that although larval Prickly Sculpin could be entrained by the NDD, the species would be reasonably protected because it is widespread throughout the Central Valley[15] (as indicated by its low status as a species of special concern)[16], spawns upstream (including well upstream) and downstream of the NDD,[15] and the larval period is primarily in the spring months,[15] during which time NDD operations are constrained because of the CWF H3+ spring outflow criteria, for example. Based on my understanding from reading a recent review of the species' biology,[16] it is my opinion that there is limited potential for negative effects of the NDD on Sacramento Hitch because spawning takes place mostly in stream riffles rather than the main stem river and juveniles do not move into open water until 50-mm fork length, at which point they would be too large to be entrained by NDD; in addition, abundance is relatively low in the Delta and the species is widespread upstream of the Delta in the Sacramento River. Based on my review of the literature,[17] Sacramento Blackfish,

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[15] Moyle, P.B. 2002. Inland Fishes of California. 2nd ed., University of California Press, Berkeley, CA, pp. 346-349.

[16] Moyle, P. B., R. M. Quiñones, J. V. Katz, and J. Weaver. 2015. Fish Species of Special Concern in California. California Department of Fish and Wildlife, Sacramento, CA.

[17] Sacramento Blackfish: Moyle (2002, pp. 144-146); Sacramento Pikeminnow: Moyle (2002, pp. 154-158); Sacramento Sucker: Moyle (2002, pp. 185-188).

Sacramento Pikeminnow, and Sacramento Sucker are all species of low conservation concern[18] that are widespread upstream of the Delta and therefore would be expected to have limited spatial overlap with the NDD at small enough sizes to be entrained; the larval period is during spring, which as I previously noted coincides with constraints on NDD operations because of the CWF H3+ spring outflow criteria, for example. Sacramento Perch is extinct from its native range and therefore no longer occurs near where the NDD would be sited.[19]

3. **Other Fish Species**

Mr. Cannon noted the potential for negative effects to Striped Bass from the NDD (Exhibit CSPA-24, pp. 23-24). This potential was acknowledged in my previous testimony, principally reflecting possible egg and larval entrainment at the NDD (Exhibit DWR-1012, pp. 52:17 to 53:18). My previous testimony also illustrated that the overlap of larval Striped Bass with the period covered by the spring outflow criteria would restrict NDD operations in April-May and therefore provide some protection for Striped Bass early life stages. As described further in the FEIR/S, population-level effects from entrainment of the early life stages of Striped Bass may be dampened because of density-dependence in the subsequent life stages (Exhibit SWRCB-102, p. 11-678:22-31).

III. APPLICATION OF THE NOBRIGA AND ROSENFIELD (2016) POPULATION DYNAMICS MODEL SUGGESTS THAT CWF H3+ WILL REASONABLY PROTECT LONGFIN SMELT

As I described in my previous testimony, I considered that CWF H3+ will reasonably protect Longfin Smelt by implementing spring outflow criteria developed in coordination with the California Department of Fish and Wildlife (Exhibit DWR-1012, pp. 24:16 to 26:9). My testimony explicitly referenced quantitative modeling using the X2-abundance regression method, as applied in the FEIR/S, CWF ITP Application, and CWF ITP. Dr. Rosenfield opined that use of the X2-abundance method is overly simplistic (Exhibit NRDC-58, p. 28:3-5) and that use of the method based on the Nobriga and Rosenfield (2016) population dynamics model would have

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[18] Moyle, P. B., R. M. Quiñones, J. V. Katz, and J. Weaver. 2015. Fish Species of Special Concern in California. California Department of Fish and Wildlife, Sacramento, CA.

[19] Id.

been an improvement (Transcript Vol. 33, p. 216:20-22). Without applying the latter model, Dr. Rosenfield stated that CWF H3+ would reduce winter-spring Delta outflow and negatively affect Longfin Smelt abundance and productivity (Exhibit NRDC-58, p. 25:23-25). Although the Nobriga and Rosenfield (2016) model was not used quantitatively in the CWF ITP Application, it was considered qualitatively in terms of interpreting potential effects of CWF H3+ (Exhibit DWR-1036, pp. 4-264-4-265). To support this rebuttal testimony, Dr. Corey Phillis and I reproduced the Nobriga and Rosenfield (2016) population dynamics model and applied it to the CalSim scenarios for CWF H3+ and NAA (Exhibit DWR-1352). This gave small differences (3% or less) in predicted fall midwater trawl abundance index between the CWF H3+ and NAA scenarios (Table 1).[20] The magnitude of difference is similar to the analyses based on the X2-abundance regression that I previously discussed and provides additional support for my opinion that Delta outflows under CWF H3+ are reasonably protective of Longfin Smelt. This also addresses the concern of other protestant witnesses raising the issue of potential outflow effects to Longfin Smelt, including Mr. Cannon, who stated “The WaterFix will take more of the limited uncontrolled winter freshwater flow to the detriment of longfin smelt…Population abundance and recovery depend on good winter-spring Delta outflow; WaterFix will reduce outflow to the Bay.” (Exhibit CSPA-204, pp. 26-27).

Dr. Rosenfield stated that the CWF ITP found that the Longfin Smelt population is still projected to decline further as a result of reduced Delta outflow (NRDC-58, p.26, lines 1-3). However, my understanding is that the analysis cited by the CWF ITP is based on the X2-abundance regression method applied to the NAA with existing climate and sea level in relation to CWF H3+ with 2030 climate and sea level, and as such the CWF H3+ scenario reflects sea level rise effects on X2 that are independent of CWF H3+. As described in Exhibit DWR-1352, comparison to existing conditions based on Delta outflow (as opposed to X2) with the Nobriga

[20] As described in Exhibit DWR-1352, there is appreciable variability predicted in the estimates of Longfin Smelt relative abundance indices (differences between scenarios are much less than the range of estimates for each scenario, as shown with 95% intervals, i.e., the central 95% of the range of midwater trawl abundance indices generated from randomly resampling the model coefficients based on their standard errors).

and Rosenfield (2016) method predicts that Longfin Smelt relative abundance would be similar or slightly greater under CWF H3+ than existing conditions (Table 1).[21]

Table 1. Longfin Smelt Fall Midwater Trawl Index: Water Year Type Mean of Median Index Predicted for CWF H3+, NAA, and Existing Conditions Operational Scenarios, Based on Simulation Reproducing Nobriga and Rosenfield (2016) Model (Exhibit DWR-1352).

Water Year Type	Existing	NAA	CWF H3+	CWF H3+ vs. Existing	CWF H3+ vs. NAA
Wet	1,832	2,038	1,974	141 (8%)	-64 (-3%)
Above Normal	1,786	1,960	1,939	153 (9%)	-21 (-1%)
Below Normal	829	843	840	11 (1%)	-3 (0%)
Dry	466	473	458	-8 (-2%)	-15 (-3%)
Critical	187	188	184	-4 (-2%)	-5 (-3%)

IV. CWF H3+ WILL REASONABLY PROTECT FISH FROM SOUTH DELTA ENTRAINMENT

In my previous testimony I described my opinion that south Delta operations of CWF H3+ will be reasonably protective with respect to entrainment risk for fish (Exhibit DWR-1012, pp. 14:21 to 17:16, pp. 34:14 to 36:10, 52:3-7). Dr. Rosenfield opined that analyses indicated that entrainment of Longfin Smelt juveniles may increase dramatically under CWF H3+, based on modeling (Exhibit NRDC-58, p. 30:9-18). His opinion is based on analysis of modelling that uses simplified assumptions regarding Head of Old River (HOR) Gate operations. However, as I described in my previous testimony, actual HOR operations will include real-time adjustments of south Delta exports and Old and Middle River flows to minimize effects to listed species. Thus my opinion is that the modeled increases in entrainment that Dr. Rosenfield describes are unlikely to occur (Exhibit DWR-1012, p. 17:2-8). Dr. Rosenfield indicated in his oral testimony that he did not recall that the HOR gate operations were the main cause of the estimated differences in entrainment (Transcript Vol. 32, p. 242:1-4). The issue of greater modeled entrainment as a result of HOR gate operations is also relevant to analyses for larval/juvenile

[21] As previously noted, there is appreciable variability in the estimates.

Delta Smelt cited by Dr. Rosenfield (Exhibit NRDC-58, p. 35:4-23); the modeled increases in entrainment in April/May reflect HOR gate operations, whereas in reality entrainment risk would be minimized through consideration of HOR gate operations as part of real-time operations.

Dr. Rosenfield also opined that assessment of Longfin Smelt larval entrainment in the CWF ITP Application was flawed for a number of methodological reasons. He considered that the particle tracking period of 45 days was inappropriate because he claimed that the CWF ITP Application acknowledged that larvae can manipulate their water column position much earlier than 45 days after hatching (Exhibit NRDC-58, p. 31:10-15). In fact, the 45-day tracking period was specifically informed by consideration of the lower limit of hatching size (4 mm) and the number of days it would take to reach 12 mm in length given a growth rate of 0.18 mm per day (see DFG 2009[22] and references therein). Other analyses have used considerably longer tracking periods (e.g., 90 days for the DFW 2009 SWP/CVP ITP; Exhibit SWRCB-65), which was felt to be inappropriate for the CWF ITP Application because it was too long in duration. Dr. Rosenfield also considered that the particle tracking modeling was flawed because the same geographic distribution of larvae was used for all years, as opposed to changing based on hydrological conditions (Exhibit NRDC-58, p. 31:15-120). However, as described in the CWF ITP Application, the Smelt Larval Survey (SLS) data did not support differing distributions for different hydrological conditions, while acknowledging that this did not preclude the possibility of a considerable proportion of the population occurring downstream of the SLS sampling area during wet years (Exhibit DWR-1036, Appendix 4.A, pp. 4.A.1-16). Dr. Rosenfield considered the analyses based on this method to be misleading because in his opinion larvae would be less susceptible to entrainment mortality in wet years (Exhibit NRDC-58, p. 32:1-10). Regardless of whether more larvae would be downstream in wetter years, the results for particle tracking modeling show similar or less entrainment of particles under CWF H3+ than NAA across all water year types individually (Table 2), which forms part of the basis for my opinion regarding reasonable protection.

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[22] California Department of Fish and Game (DFG). 2009. A Status Review of the Longfin Smelt (*Spirinchus thaleichthys*) in California. Report to the Fish and Game Commission. January 23. California Department of Fish and Game.

Table 2. Mean Entrainment of Particles Representative of Larval Longfin Smelt Entrained at the State Water Project and Central Valley Project South Delta Export Facilities, from DSM2-PTM Analysis of January-March 1922-2003.[23]

Month	Water Year Type	State Water Project			Central Valley Project		
		NAA	CWF H3+	CWF H3+ minus NAA	NAA	CWF H3+	CWF H3+ minus NAA
January	Wet	1.03	0.30	-0.73 (-71%)	0.45	0.21	-0.24 (-53%)
	Above Normal	1.23	0.58	-0.65 (-53%)	0.63	0.24	-0.39 (-62%)
	Below Normal	2.47	1.05	-1.42 (-57%)	1.52	0.47	-1.05 (-69%)
	Dry	2.82	1.50	-1.32 (-47%)	1.71	1.07	-0.64 (-37%)
	Critical	2.75	2.27	-0.47 (-17%)	1.54	1.41	-0.14 (-9%)
February	Wet	0.66	0.01	-0.64 (-98%)	0.27	0.02	-0.25 (-94%)
	Above Normal	1.23	0.61	-0.62 (-51%)	0.60	0.10	-0.49 (-83%)
	Below Normal	1.43	0.92	-0.51 (-35%)	0.75	0.41	-0.34 (-46%)
	Dry	1.67	0.99	-0.68 (-41%)	0.91	0.63	-0.28 (-31%)
	Critical	1.35	1.11	-0.24 (-18%)	0.59	0.47	-0.12 (-21%)
March	Wet	0.73	0.01	-0.72 (-99%)	0.32	0.00	-0.32 (-100%)
	Above Normal	0.93	0.00	-0.93 (-100%)	0.42	0.00	-0.42 (-100%)
	Below Normal	1.13	0.31	-0.82 (-72%)	0.53	0.30	-0.24 (-45%)
	Dry	0.96	0.36	-0.60 (-62%)	0.50	0.29	-0.21 (-43%)
	Critical	0.62	0.29	-0.33 (-53%)	0.25	0.22	-0.03 (-12%)

Mr. Cannon opined that "Risk from continued operation of the south Delta diversions would not be alleviated with moving some of diversions to the NDD. Continuing south Delta diversion risks would potentially increase without the freshwater inflow diverted at the NDD. Existing rules governing SDD are to be unchanged. Yet with the added burden of NDD, all the conditions used in setting SDD export restrictions (e.g., OMR limits, export to inflow ratios, water temperatures, Delta outflow, etc.) could change." (Exhibit CSPA-204, p.4). It is incorrect that the south Delta export rules are to be unchanged; see discussion by Mr. Reyes (Exhibit DWR-1226) and Exhibit DWR-1143, for examples. As I indicated in my prior testimony, analysis of entrainment risk for juvenile winter-run Chinook Salmon that accounted for changes in Sacramento River flow and south Delta exports indicated the potential for entrainment loss under CWF H3+ to be less than NAA (Exhibit DWR-1012, pp. 35:14 to 36:2). Further on in his testimony, Mr. Cannon opined that "Massive fish losses at the south Delta pumps would continue" and cites Exhibit CSPA-412 as evidence (Exhibit CSPA-204, p. 11). However, Exhibit CSPA-412 is an administrative draft of the BDCP from 2012, which is based on a different project and operational scenario than CWF

[23] These data are summarized from DWR-1347_lfs_PTM_07052018.xlsx, with the calculations from PTM outputs made in DWR-1348_lfs_PTM_calcs_07052018.xlsx. Reference to description of the method is provided in my previous testimony, Exhibit DWR-1012, p. 56:1-3).

H3+. As illustrated in the CWF ITP Application, entrainment losses in recent years have been considerably limited as a result of more restrictive operating criteria from the USFWS (2008) and NMFS (2009) SWP/CVP BOs (e.g., Exhibit DWR-1036, Table 4.1-49, p. 4-187), and as I previously indicated, it is my opinion that CWF H3+ will maintain or potentially increase this level of protection because the implementation of dual conveyance will allow diversions to be switched from the south Delta export facilities and reduce south Delta exports (e.g., Exhibit DWR-1012, pp. 34:14 to 36:10). As I indicated during oral testimony, factors such as Old and Middle River flows as well as fish distribution are considered for protection of fish from south Delta entrainment (Transcript Vol. 7, p. 236:4-7), and these factors would continue being considered through the work of real-time operations groups such as the Smelt Working Group (Exhibit DWR-1142, Chapter 3, pp. 3-2 and 3-18).

V. <u>CWF H3+ WILL REASONABLY PROTECT FOOD WEB PRODUCTIVITY IN THE BAY-DELTA</u>

In my opinion, CWF H3+ will reasonably protect food web productivity in the Bay-Delta. In my previous testimony I described that the assessment of food web material entrainment (specifically phytoplankton carbon) at the NDD suggested little, if any, effects from CWF H3+, especially when interpreting the modeling results in consideration of factors such as decreased south Delta pumping offsetting NDD losses and potentially increasing phytoplankton loading as a result of higher contributions from the food web material-rich San Joaquin River (Exhibit DWR-1012, pp. 27:18 to 28:5). Although that analysis considered phytoplankton, I believe that its conclusions are also generally applicable to zooplankton, which also tend to be more abundant on the San Joaquin River/southern side of the Delta (Orsi and Mecum 1986).[24]. Therefore, potential negative effects of entrainment of phytoplankton and zooplankton at the NDD as suggested by Dr. Rosenfield (Exhibit NRDC-58, p. 39:11-13) would not occur in my opinion. Related to this issue is the comment from Mr. Cannon that changes in Delta hydrodynamics could affect Delta Smelt food supply (Exhibit CSPA-204, p. 255). The USFWS (2009) BiOp

[24] Orsi, J. J., and W. L. Mecum. 1986. Zooplankton distribution and abundance in the Sacramento-San Joaquin delta in relation to certain environmental factors. Estuaries 9(4):326-339.

assessed that summer/fall south Delta entrainment of the important Delta Smelt zooplankton prey *Pseudodiaptomus forbesi* occurs (Exhibit SWRCB-87, p. 228). In my opinion changes in Delta hydrodynamics under CWF H3+ may reduce south Delta entrainment of *P. forbesi* because of improved south Delta hydrodynamics, as indexed by QWEST[25] flow, for example (Table 3). QWEST provides an indication of south Delta entrainment risk as it shows the net movement of water in the lower San Joaquin River, reflecting the hydrodynamic influence of the south Delta export facilities acting against river flow. As shown in Table 3, under NAA, mean QWEST is negative in all water year types, indicating net upstream movement of water, whereas under CWF H3+, QWEST generally is positive or close to zero and appreciably greater than NAA, suggesting greater potential for food web productivity from the lower San Joaquin River to move downstream out of the Delta under CWF H3+.

Table 3. Water Year Type Mean of July-September QWEST Flow (Cubic Feet Per Second) from DSM2-HYDRO Modeling for California WaterFix H3+ and No Action Alternative Operational Scenarios (Exhibits DWR-500 and DWR-1078).

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	-2,628	3,212	5,840 (222%)
Above Normal	-2,898	1,969	4,867 (168%)
Below Normal	-3,599	272	3,871 (108%)
Dry	-2,001	-238	1,763 (88%)
Critical	-399	-23	376 (94%)

Dr. Rosenfield also opined that reductions in freshwater flows caused by CWF H3+ operations are likely to reduce productivity and abundance of important zooplankton prey species in the Delta that have relationships with spring Delta outflows, citing *Crangon* (Bay Shrimp) and the copepod *Eurytemora* as examples (Exhibit NRDC-58, p. 39:11-13). However, as I show in Exhibit DWR-1349, applying X2-abundance regression relationships indicates little difference in predicted relative abundance of these species between CWF H3+ and NAA

[25] I calculated QWEST in the same manner as the US Bureau of Reclamation OCAP BA (2008, pp. 9-80 to 9-81; https://www.usbr.gov/mp/cvo/OCAP/sep08_docs/OCAP_BA_Aug08.pdf), i.e., from DSM2-HYDRO modeling, the sum of flows at San Joaquin River at Blind Point (RSAN014), Three Mile Slough (SLTRM004), and Dutch Slough (SLDUT004).

scenarios (Tables 4 and 5).[26] This reflects the spring outflow criteria included in CWF H3+ that I described in my previous testimony (Exhibit DWR-1012, p. 25:9-13).

Table 4. Bay Shrimp: Water Year Type Mean of Relative Abundance Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios (Exhibit DWR-1349).

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	397	395	-2 (-1%)
Above Normal	320	325	5 (1%)
Below Normal	204	209	5 (2%)
Dry	209	209	1 (0%)
Critical	138	139	0 (0%)

Table 5. *Eurytemora affinis*: Water Year Type Mean Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios (Exhibit DWR-1349).

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	196	195	-1 (0%)
Above Normal	165	167	2 (1%)
Below Normal	114	117	2 (2%)
Dry	116	116	0 (0%)
Critical	83	83	0 (0%)

VI. CWF H3+ WILL REASONABLY PROTECT THE BAY-DELTA ECOSYSTEM

It is my opinion that CWF H3+ will reasonably protect the Bay-Delta ecosystem. Below I rebut a number of points raised by protestants' witnesses as to potential effects of CWF H3+ on the Bay-Delta ecosystem.

A. Turbidity/Sediment

Dr. Rosenfield opined that sediment removal at the NDD will reduce habitat availability and degrade remaining habitats (Exhibit NRDC-58, pp. 37:5 to 38:7). His opinion was informed by his interpretation of a memorandum stating that less than 10% of sediments captured at the

[26] I included specific analysis for Bay Shrimp in my previous testimony based on the FEIR/S analysis for the H3 and H4 scenarios (Exhibit DWR-1012, p. 52:8-15); Exhibit DWR-1349 updates the analysis for the CWF H3+ scenario, confirming the applicability of the H3 and H4 scenarios in bracketing the CWF H3+ scenario effects.

NDD could be reused (Exhibit NRDC-63, p.3). Notwithstanding that this memorandum is not specific to CWF H3+, the memorandum incorrectly interpreted its reference source for the estimate that it provided,[27] resulting in an overestimate in the annual amount of sediment that would be entrained by the NDD. As described in Exhibit DWR-1142, Appendix 3.B (Sections 6.1.2.2 and 6.1.2.4), the sedimentation basins and sediment drying lagoons at the NDD are sized to process the anticipated annual load of sediment entrained at the NDD. As I described in my previous testimony (Exhibit DWR-1012, p. 27:3-9), the CWF proposes and is required by CWF ITP Condition of Approval 9.6.9, to prepare and implement a sediment reintroduction plan, which will minimize the potential effects of sediment removal by the NDD. Dr. Rosenfield proposed a water right change petition condition for CWF H3+ related to sediment entrainment by the NDD, specifically to limit WaterFix-induced reduction of sediment inputs to the Delta to less than 5% (Exhibit NRDC-58, p.43, lines 3 to 10). In my opinion this condition is unnecessary because of the sediment reintroduction plan already required under the CWF ITP, and because there is no specific justification provided by Dr. Rosenfield as to why the limit should be 5% (Transcript Vol. 33, p. 55: “There’s no analysis that says 5 percent is a magic number.”)

B. _*Microcystis*_

Dr. Rosenfield opined that operational effects of CWF H3+ are likely to increase the frequency of harmful algal blooms, including *Microcystis* (Exhibit NRDC-58, pp. 38:8 to 39:9). However, as I noted in my previous testimony (Exhibit DWR-1012, p. 27:13-14), the testimony provided by Dr. Michael Bryan indicates little potential for *Microcystis* increase from CWF H3+ operations (Exhibit DWR-81).

C. Outflow Effects

In addition to zooplankton species with Delta outflow-relative abundance correlations that I discussed earlier in Section V, Dr. Rosenfield opined that various fish species would be adversely affected by reduced spring Delta outflow under CWF H3+ (Exhibit NRDC-58, pp. 39:22 to 40:39). I presented information in Section III suggesting that this would not be the case for

[27] Specifically, the memorandum interpreted estimated sediment entrainment for a 12-year period (1991-2002) as an annual amount.

Longfin Smelt as a result of the spring Delta outflow criteria included in CWF H3+. My previous testimony also indicated that this would not be the case for American Shad (Exhibit DWR-1012, p. 52:8 to 15) or for White Sturgeon (Exhibit DWR-1012, pp. 47:12 to 48:15, line 3), two other species explicitly mentioned by Dr. Rosenfield; I have updated these analyses for the CWF H3+ scenario to emphasize this point (Tables 6-9). The spring Delta outflow criteria generally would be expected to be protective of Delta Smelt as well, given the small differences in predicted relative abundance for the other species I have discussed, which reflect the overall similarity of Delta outflow and X2 during the spring months; my previous testimony noted that the USFWS BO included late spring in the consideration of rearing habitat for Delta Smelt and found that the frequency of years for which the low salinity zone would be upstream generally would be similar between CWF H3+ and NAA (Exhibit DWR-1012, p.23, lines 10-16)[28]. As I also described in my previous testimony, uncertainty regarding Delta Smelt rearing habitat during other seasons such as summer[29] will be addressed through CWF adaptive management, including investigations of factors driving population outcomes, with study of rearing habitat from July to November being considered in this context, for example (Exhibit DWR-1012). Therefore, I do not consider the various Delta outflow water right change petition conditions proposed by Dr. Rosenfield to be necessary for CWF H3+, particularly in light of the ongoing updates to the Bay-Delta Water Quality Control Plan, as well as additional processes such as the Delta Smelt Resiliency Strategy and re-initiation of consultation on the 2009-2009 BiOps. This is also relevant to Mr. Cannon's proposed water right change petition condition requiring exports to be restricted to the minimum diversion when Emmaton and Jersey Point gages exceed a daily average 500 EC (Exhibit CSPA-204, p. 11). In support of this proposed condition, Mr. Cannon cites Exhibit CSPA-414, which seems to consider electrical conductivity of 500-2000 as being low salinity habitat for Delta Smelt. However, this range is narrower than has been observed, e.g., Sommer and Mejia

[28] Note, however, that Dr. Acuña's written testimony (Exhibit DWR-1211) describes that there is little evidence for winter-spring outflow (X2) effects on Delta Smelt.

[29] For example, Dr. Acuña's written testimony (Exhibit DWR-1211) explains how the Collaborative Adaptive Management Team was not able to reach consensus on the validity of analyses linking Delta Smelt abundance and summer outflow (X2).

(2013[30]Figure 4B), which shows high probability of occurrence of conductivity from near zero to around 4,000. Exhibit CSPA-414 also is confusing in the manner in which it considers Delta Smelt distribution, e.g., the lower graph on page 11 has a notation indicating 'most smelt' that does not correspond with the actual survey data (Figure 1). Therefore, I do not consider this proposed change petition condition to be well supported by the testimony of Mr. Cannon or Exhibit CSPA-414, upon which he relies.In any case, the condition is not necessary given the CWF H3+ proposed spring Delta outflow criteria and adaptive management to address Delta Smelt rearing habitat needs in relation to summer habitat, for example.

Table 6. American Shad: Water Year Type Mean of Relative Abundance (Fall Midwater Trawl Index) Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios[31].

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	3,195	3,186	-9 (0%)
Above Normal	2,812	2,824	12 (0%)
Below Normal	2,110	2,143	32 (2%)
Dry	2,067	2,067	1 (0%)
Critical	1,602	1,593	-9 (-1%)

Table 7. American Shad: Water Year Type Mean of Relative Abundance (Bay Midwater Trawl Index) Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios[31].

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	8,418	8,385	-33 (0%)
Above Normal	7,051	7,089	38 (1%)
Below Normal	4,750	4,844	95 (2%)
Dry	4,613	4,614	0 (0%)
Critical	3,231	3,206	-25 (-1%)

[30] Sommer, T., and F. Mejia. 2013. A Place to Call Home: A Synthesis of Delta Smelt Habitat in the Upper San Francisco Estuary. San Francisco Estuary and Watershed Science 11(2).
[31] The method is outlined in the FEIR/S, Exhibit SWRCB-102, Section 11.3.4.2, p. 11-714, with regression coefficients provided by Kimmerer et al. (2009; Exhibit DWR-1091). Modeling is provided in DWR-1355.

Table 8. White Sturgeon: Water Year Type Mean of Year Class Strength Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios, Based on April-May Regression[32].

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	148	141	-6 (-4%)
Above Normal	59	59	0 (0%)
Below Normal	16	16	1 (4%)
Dry	14	14	0 (-1%)
Critical	0	0	0 (21%)

Table 9. White Sturgeon: Water Year Type Mean of Year Class Strength Predicted for California WaterFix H3+ and No Action Alternative Operational Scenarios, Based on March-July Regression[30].

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	117	113	-4 (-3%)
Above Normal	46	46	0 (0%)
Below Normal	3	3	0 (-1%)
Dry	5	5	0 (-8%)
Critical	0	0	0 (0%)

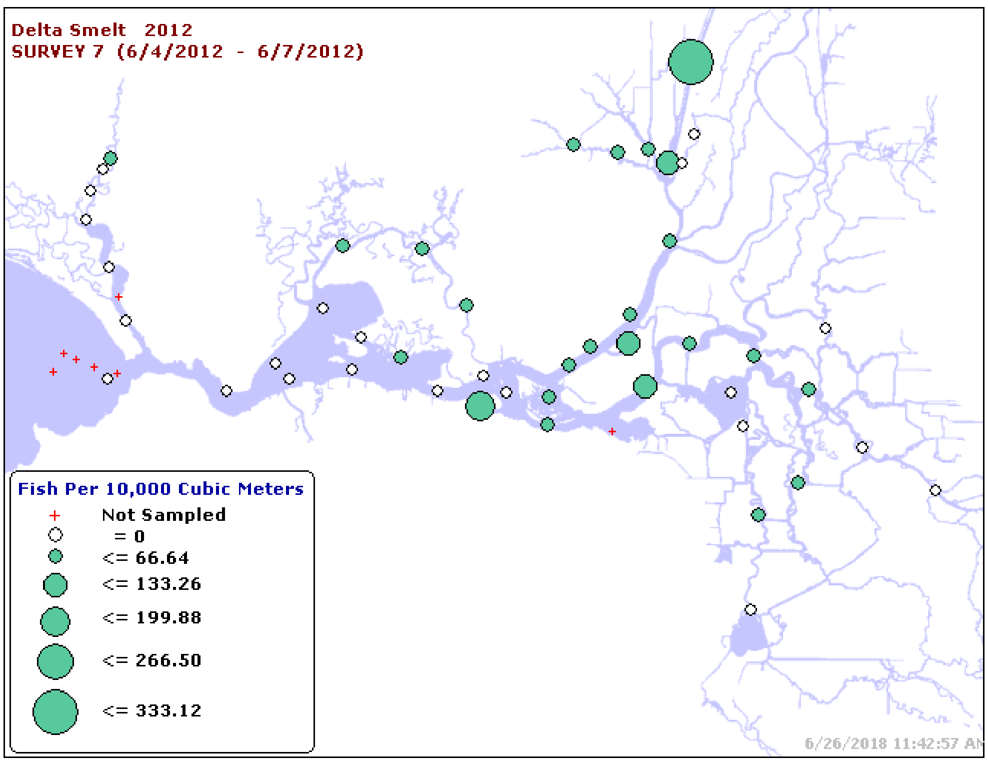

Figure 1. Density of Delta Smelt During 20-mm Survey 7, June 4-7, 2012 (from http://www.dfg.ca.gov/delta/data/20mm/CPUE_map.asp).

[32]A description of the method is provided in the BA (Exhibit SWRCB-104) Chapter 5, pp. 5-197 - 5-198. Modeling is provided in Exhibit DWR-1356.

D. Selenium

As I described in my previous testimony, analyses conducted for Delta Smelt (Exhibit DWR-1012, p. 27:14-17) and other fish species (Exhibit DWR-1012, p. 45:21-25) support my opinion that CWF H3+ effects on selenium would be limited and therefore reasonably protective of these species. Mr. Stroshane opined that selenium loading and bioaccumulation could increase as a result of CWF H3+, considering factors such as the distribution of the clam *Potamocorbula amurensis* and selenium loading from the San Joaquin River (Exhibit RTD-12, pp. 13:1 to 25:6). In opining that changes in flow caused by CWF H3+ could affect *P. amurensis*, however, Mr. Stroshane relied on documentation of the H3 scenario that only considered Sacramento River flow, not Delta outflow (i.e., Exhibits RTD-149 and RTD-150). Based on the conceptual model for *P. amurensis* included in the description by Mr. Stroshane (Exhibit RTD-190, p.40, Figure 5), the main larval periods for *P. amurensis* are spring (March/April), and late summer/fall (early/mid-August to mid-September), during which time Delta outflow for CWF H3+ is similar or slightly greater (spring) or similar or slightly less (late summer/fall) than the NAA (Exhibit SWRCB-108, p. 152, Figure 26). In my opinion this indicates that *P. amurensis* distribution and abundance would not be greatly affected by CWF H3+.

Mr. Stroshane proposed water right change petition conditions of extensive, permanent monitoring for selenium loading and concentrations (Exhibit RTD-12, pp. 24:16 to 25:17). In my opinion these conditions are not necessary for CWF H3+ because, as stated in the Staff Report for the proposed basin plan amendment related to North San Francisco Bay Total Maximum Daily Load (TMDL), monitoring is already ongoing or should be required as Delta outflow objectives are adopted by SWRCB as part of the Bay-Delta Water Quality Control Plan updates (Exhibit SWRCB-45, Appendix C, p. 113). In addition, the most recent data for selenium concentrations inflowing to the Delta from the San Joaquin River indicate that selenium is generally below the 0.5-microgram-per-liter (µg/l) water column target included in the TMDL[33] for protection against long-term chronic effects on fish, with a downward trend in selenium

[33] See Exhibit SWRCB-45, p. 36.

concentration (Figure 2).[34] Selenium concentration in the lower San Joaquin River is well below the target (Figure 3). Both of these monitoring locations provide evidence that a greater San Joaquin River contribution to the composition of water in the Bay-Delta as a result of CWF H3+ would not exceed the protective water column selenium target.

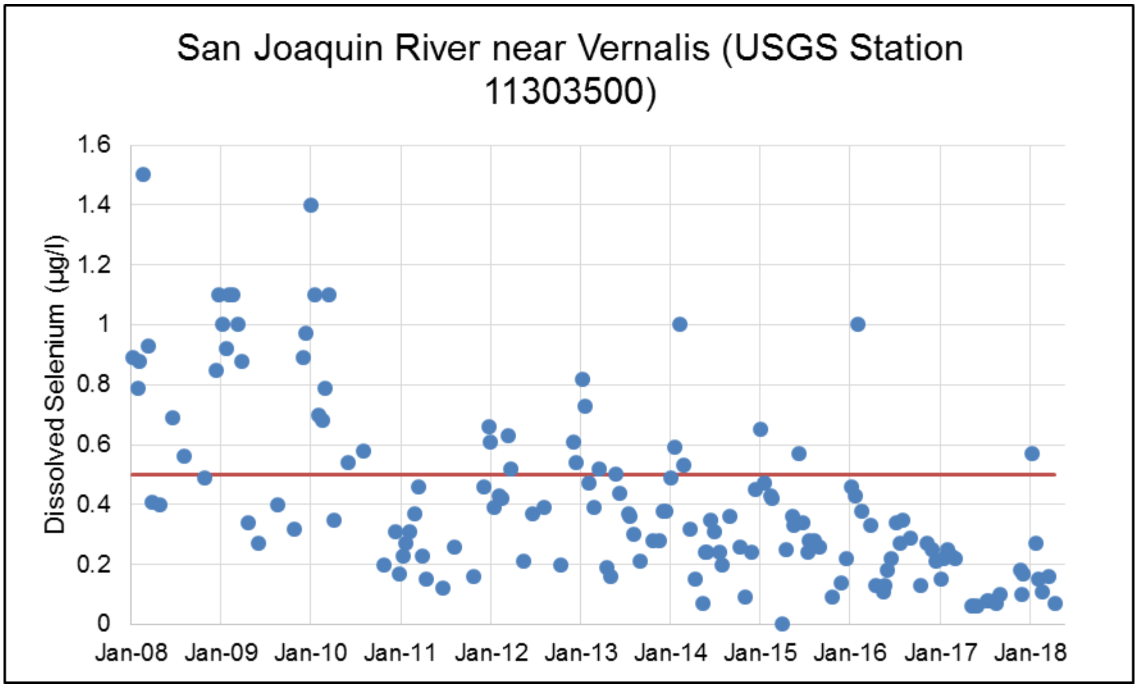

Figure 2. Dissolved Selenium Concentration in the San Joaquin River at Vernalis, with Red Line Indicating Water Column Target for Protection Against Long-Term Chronic Effects of Selenium in Fish (Exhibit DWR-1357).

[34] Data for this location and the lower San Joaquin River are provided in Exhibit DWR-1357.

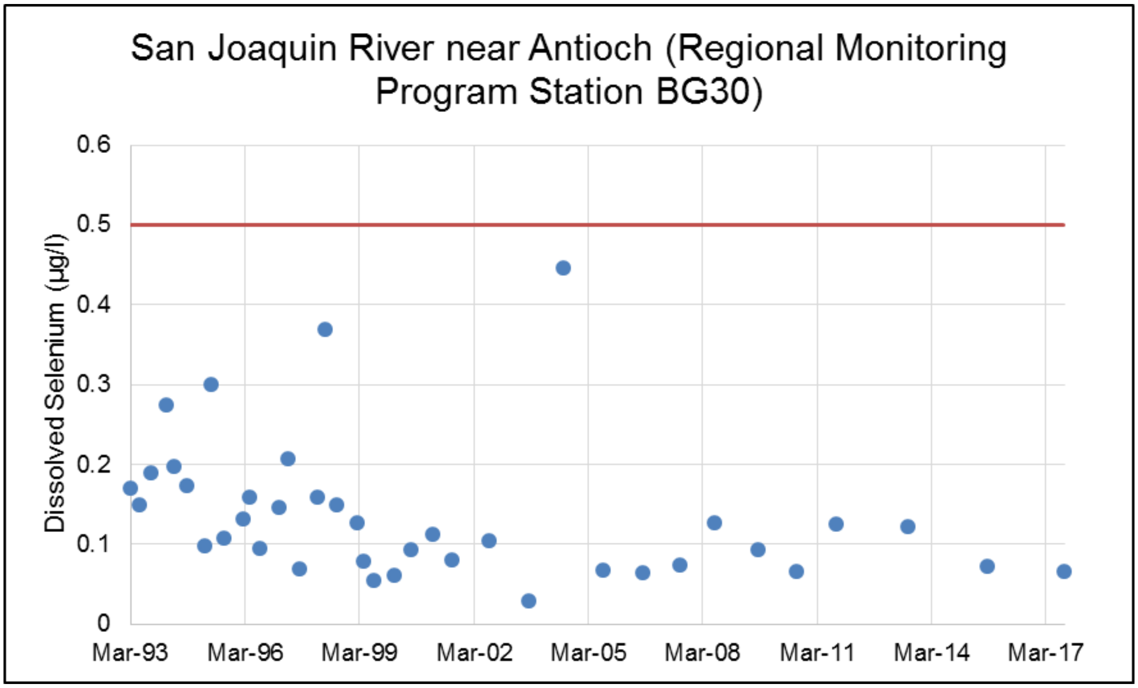

Figure 3. Dissolved Selenium Concentration in the San Joaquin River near Antioch, with Red Line Indicating Water Column Target for Protection Against Long-Term Chronic Effects of Selenium in Fish (Exhibit DWR-1357).

E. <u>Yolo Bypass Inundation</u>

CWF H3+ does not propose changes to Yolo Bypass inundation. I do not consider the water right change petition condition for CWF H3+ proposed by Dr. Rosenfield (Exhibit NRDC-58, p. 43:16-20) to be necessary given that the former is already a requirement of the NMFS (2009) BiOp (Exhibit SWRCB-84, p. 608-609),[35] is reasonably certain to occur, and was assumed to occur for both the NAA and CWF H3+ scenarios, so that effects to fish have already been accounted for.[36] Given the operational criteria and mitigation provided by CWF H3+ overall, I also do not consider the additional Yolo Bypass inundation water right change petition condition proposed by Mr. Oppenheim (Exhibit PCFFA-130, pp. 12:4 to 13:13) to be necessary.

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[35] Note also that as a term of the NMFS CWF BO, this action must be completed before the NDD commence operation (Exhibit SWRCB-106, p.1181).

[36] A draft EIR/EIS was issued in December 2017 (http://resources.ca.gov/ecorestore/2017/12/dwr-and-reclamation-release-environmental-documents-for-the-proposed-yolo-bypass-salmonid-habitat-restoration-and-fish-passage-project-for-public-review-and-comment/).

Mr. Cannon stated that “WaterFix documents discuss increasing Yolo Bypass flows to increase Delta productivity below the NDD. However, higher inflow from Yolo Bypass inflow will add warm water in the north Delta below the NDD. Exhibit CSPA-416 describes this phenomenon.” (Exhibit CSPA-204, pp. 12-13). It is unclear which “WaterFix documents” Mr. Cannon is referring to and whether he is implying that the warm water is a negative effect, given that Exhibit CSPA-416 does not address this issue; regardless, as I stated previously, CWF H3+ does not propose changes to Yolo Bypass inundation, as illustrated with flows at Fremont Weir (Exhibit SWRCB-108, p. 146, Figure 20).

VII. CWF H3+ WILL REASONABLY PROTECT JUVENILE AND ADULT MOKELUMNE RIVER SALMONIDS

A. Juvenile Salmonids

Based on the available information, it is my opinion that CWF H3+ will reasonably protect juvenile Mokelumne River salmonids. Ms. Workman suggested that she considered existing operational impacts of the south Delta export facilities to be significant, noting that 332 coded-wire tagged juvenile Chinook Salmon were collected at the south Delta export facilities between 1992 and 2006 (Exhibit EBMUD-156, p. 156:21-24); applying a loss expansion factor of 4.33, which is similar to that typically used for the SWP to account for salvage loss (e.g., due to predation),[37] 332 salvaged fish would represent approximately 1,438 lost fish, or 0.06% of the total number of coded-wire-tagged fish released in the Mokelumne River (as stated by Ms. Workman: the total release was approximately 26 million fish, of which 9% were coded-wire-tagged; Transcript Vol. 20, pp. 180:25 to 181:11). The 0.06% estimate is considerably lower than the 2% incidental take limit authorized for juvenile winter-run Chinook Salmon entering the Delta under the NMFS 2009 SWP/CVP BiOp (Exhibit SWRCB-84, p. 775), and to me does not seem significant. In forming her opinion, Ms. Workman did not specifically consider CWF H3+, focusing instead on south Delta exports in the B1, B2, H3, and H4 scenarios for April and May (e.g., Exhibit EBMUD-156, Figures 12-15). The CWF H3+ operating criteria have lower south Delta exports for April and May than the NAA, based on the modeling shown in DWR-1142, Appendix

[37] See, for example, loss calculations applied for Steelhead (https://www.usbr.gov/mp/cvo/fishrpt html).

5.A (Figure 5.A-6-27.7) for the BA H3+ scenario, and as shown for CWF H3+ by Dr. Chilmakuri (Exhibit DWR-1217). Ms. Workman described her concern that under the B1 scenario, south Delta exports could be higher than NAA, based on the available modeling. However, I would expect that the adaptive management process would only consider changes to south Delta operational criteria that remain protective of juvenile salmonids in the Delta, including runs that pass along the same interior Delta migration pathways as Mokelumne River juvenile salmonids, e.g., San Joaquin River steelhead and spring-run Chinook Salmon.

Ms. Workman stated that she did not consider the Delta Passage Model (DPM) as doing an adequate job of representing through-Delta survival of Mokelumne River salmonids, with her main points being that release of larger acoustically tagged juvenile Chinook Salmon in the Sacramento River during winter would not be representative of juvenile Chinook Salmon in the spring and that sample size was limited (Transcript Vol. 20, pp.190:6 to 191:7). In fact, the main relationship of importance to Mokelumne River fall-run Chinook Salmon in the DPM is based on fish released in the interior Delta over a considerably greater sample size (Exhibit DWR-1142, Appendix 5.E, Section 5.D.1.2.2.2.5.6 and literature cited therein). Ms. Workman noted in her testimony that Mokelumne fish are not using Georgiana Slough, which would indicate that the main influence on survival would be flows in the forks of the Mokelumne River until it meets the San Joaquin River. I consider the export-survival relationship represented in the DPM to provide useful representation of potential survival effects on Mokelumne River fish upon reaching the San Joaquin River. Although critical of the DPM, Ms. Workman did not suggest any alternative biological models for assessment of Mokelumne River salmonids. The DPM has been run for the CWF H3+ scenario and, consistent with the analysis presented in the CWF BA,[38] shows similar or greater predicted through-Delta survival under CWF H3+ as NAA (Table 10).

[38] See Exhibit DWR-1142, Appendix 5.E, Table 5.E-12 (p. 5.E-57).

Table 10. Mean Proportional Through-Delta Survival of Juvenile Mokelumne River Fall-Run Chinook Salmon from the Delta Passage Model By Water Year Type.

Water Year Type	NAA	CWF H3+	CWF H3+ minus NAA
Wet	0.18	0.20	0.02 (14%)
Above Normal	0.16	0.17	0.01 (5%)
Below Normal	0.15	0.16	0.00 (2%)
Dry	0.15	0.15	0.00 (2%)
Critically Dry	0.15	0.15	0.00 (0%)

Ms. Workman proposed a water right change petition condition for CWF H3+ as follows: "To protect outmigrating juvenile salmonids affected by changes in the direction of flows, exports from the Jones and Banks Pumping Plants shall be reduced as necessary to maintain Old and Middle River (OMR) flows between April 1 and May 31 that are not more negative than the OMR flow criteria specified for April and May in Table 3.3-1 on page 3-84 of Appendix A2 of the California WaterFix Biological Opinion issued by the National Marine Fisheries Service on June 16, 2017." (Exhibit EBMUD-156, p. 20:6-11). In my opinion this proposed condition is unnecessary because these criteria are already part of CWF H3+ and are included in CWF ITP Condition of Approval 9.9.4 (Exhibit SWRCB-107, pp. 179-180). Related to this, Ms. Workman proposed monitoring of juvenile salmonids as another water right change petition condition (EBMUD-156, p. 20:13-20). In my opinion this proposed condition also is unnecessary because based on the available information summarized above, effects on Mokelumne River juvenile salmonids under CWF H3+ would not be greater than the NAA.

B. <u>Adult Salmonids</u>

It is my opinion that CWF H3+ will reasonably protect adult salmonids returning to the Mokelumne River because based on my understanding modeled increases in Delta Cross Channel gate closures are not likely to occur during actual operations, and opportunities for additional DCC closures would exist under CWF H3+ just as they would under the NAA. Mr Setka (Exhibit EBMUD-155) opined that straying of adult Mokelumne River fall-run Chinook Salmon could increase under CWF H3+, based on modeling results showing greater frequency of Delta Cross Channel (DCC) gate opening under CWF H3+ than NAA during the species' main upstream migration period. Mr. Setka acknowledged that DCC operational criteria would remain the same under CWF H3+ as currently exist (Transcript Vol. 23, p. 162:6-7). As Dr. Chilmakuri (Exhibit DWR-1217) describes in his rebuttal testimony, DCC openings are expected to be the same between CWF H3+ and NAA because the differences seen in modeling would not occur under actual real-time operations.

Mr. Setka proposed a water right change petition condition for CWF H3+ as follows: "The DCC closure plan (daily or based on tidal cycles) shall be modified to include the following closure periods during the months of October and November: The DCC shall be closed for 15 days per month during the months of October and November, with said closures to be coordinated, to the extent feasible, with October-November pulse flows from the Lower Mokelumne River." (Exhibit EBMUD-155, p. 17:10-15). In my opinion this proposed condition is unnecessary because CWF H3+ would not preclude additional closures of the DCC of the type that were planned in 2012, as noted in the BA (Exhibit DWR-1142, Appendix 5.E, p. 5.E-87); as I previously described, DCC openings are expected to be the same between CWF H3+ and NAA.

VIII. CONCLUSION

On the basis of the rebuttal testimony that I have provided, I reiterate my opinions:

1. The CWF H3+ North Delta Diversions (NDD) will be designed and operated to reasonably protect fish.
2. Application of the Nobriga and Rosenfield (2016) population dynamics model suggests that CWF H3+ will reasonably protect Longfin Smelt.
3. CWF H3+ will reasonably protect fish from south Delta entrainment.
4. CWF H3+ will reasonably protect food web productivity in the Bay-Delta.
5. CWF H3+ will reasonably protect the Bay-Delta ecosystem
6. CWF H3+ will reasonably protect juvenile and adult Mokelumne River salmonids.

Executed on this 9th day of July, 2018 in Santa Cruz, California.

Marin Greenwood