DRAFT (DO NOT CITE)

Date: February 28, 2023

To: State Water Resources Control Board

From: Delta Independent Science Board

Subject: Comments on the Scientific Basis for Implementation of Voluntary Agreements in the California Delta

Temperature and flows are important and affect different fishes differently…

The State Water Resources Control Board (SWRCB), in collaboration with other California state agencies, recently released the *Draft Scientific Basis Report Supplement in Support of Proposed Voluntary Agreements for The Sacramento River, Delta, And Tributaries Update to The San Francisco Bay/Sacramento-San Joaquin Delta Water Quality Control Plan*, (hereafter the "Scientific Supplement," SWRCB et al. 2023). This document and the *Memorandum of Understanding Advancing a Term Sheet for the Voluntary Agreements to Update and Implement the Bay-Delta Water Quality Control Plan, and Other Related Actions* (MOU of 29 March 2022 and revised 10 November 2022; see Voluntary Agreements Parties 2022) support implementation of Voluntary Agreements (VAs) to partially address long-standing concerns over the balance between water for the environment and water for agriculture and other human-related uses, i.e. the Delta coequal goals.

The VAs propose a combination of flow and restoration assets to improve conditions for selected native species under the hypothesis that habitat restoration in combination with higher flows will provide enhanced benefits to fishes. The intent of the VAs is (MOU page 3): "*…. a comprehensive approach to managing habitat, flow, and other factors is required to protect native fish and wildlife species, while concurrently protecting water supply reliability, consistent with the legal requirement of providing reasonable protection for all beneficial uses.*" The VAs will establish a Governance Program to direct flows and habitat restoration, conduct assessments, develop strategic plans and annual reports, implement a science program, and hire staff and contractors.

The Delta Independent Science Board (Delta ISB) conducted an abbreviated review of these documents in accordance with our responsibilities to evaluate the broad range of scientific programs that support adaptive management of the Delta. Due to the short time frame for providing comments, we examined only selected parts of the Scientific Supplement and MOU. The Delta ISB previously reviewed the SWRCB's DRAFT *Scientific Basis Report in Support of New and Modified Requirements for Inflows from the Sacramento River and its Tributaries and Eastside Tributaries to the Delta, Delta Outflows, Cold Water Habitat, and Interior Delta Flows* at the request of the SWRCB. In that review (Delta ISB 2017), the Delta ISB was principally concerned with issues of unimpaired flow, cold-water management, non-flow stressors, climate change, and adaptive management. The Delta ISB noted that these issues and other public comments were discussed in the final scientific basis report. Yet there are some remaining concerns in the most recent MOU and Scientific Supplement (see below). Note that, while vitally important, legal and social issues are not addressed in this or previous Delta ISB reviews.

Building on our prior review, the Delta ISB addressed the central issue of determining if the science supporting the principles, responsibilities and potential goals, as outlined in the Scientific Supplement and the MOU, are sufficiently robust for guiding a successful program. While the agreements themselves are outside the expertise of the Delta ISB, we have evaluated some of the scientific underpinnings. Because time was insufficient for a full review, we primarily examined issues of the science supporting effects of restoration on fish communities, climate change, and other biophysical factors affecting environmental processes in the Scientific Supplement. We also considered the adequacy of the adaptive management plan, as outlined in the MOU.

The Delta ISB understands that the VAs are offered as a potential alternative to flow standards imposed by state agencies on water users to achieve goals specified in the Bay-Delta Plan. The agreements are voluntary commitments to both restore habitat and provide certain levels of flows in vulnerable waterways to support aquatic habitat and instream beneficial uses (see MOU). The recently released MOU outlines terms for an eight-year program that would provide flow and non-flow improvements to restore aquatic habitat and also provides details of the funding for implementation, monitoring, and water purchases.

An advantage of the present VAs is that they include a scientific review process and that there are quantitative targets for selected native fish. Organizations elsewhere have made significant efforts to craft VAs in ways that protect fish and other wildlife while balancing social and economic impacts. In practice, however, VAs have been generally contentious, and some question whether they can provide the benefits they promise (e.g., Diffley and O'Conner 2022). The Delta ISB understands that this will be a complex undertaking and offers the following commentary in an effort to improve implementation and execution.

General Comments on the Draft Scientific Basis Report

Overall, the methods and modeling approach are described well, with adequate detail and transparency. The authors analyzed the contributions of the proposed flow and restoration assets toward habitat and population increases for salmonids and selected estuarine fishes. Conclusions were reached by using quantitative modeling that coupled hydrodynamic and operations models to flow-dependent habitat and abundance models. A qualitative literature review was used where no quantitative models existed.

There are, however, several concerns about the structure and application of the proposed scientific approach, and these are described below. In general, they relate to having an effective adaptive management process, identifying and monitoring quantitative performance criteria, statistical design and the eventual programmatic evaluation, establishing a scientific team from the beginning, adjusting for changes in climate and important environmental drivers, as well as to several other issues important for a successful scientific program.

A key finding of the Scientific Supplement was that the magnitude of improvement to aquatic habitat varies with water year type and tributary such that not all habitat categories will have increases in all water year types.

The doubling of salmon abundance by 2065 is a key component of the Bay-Delta Plan. The combination of instream rearing and floodplain habitat needed to support 25% of the doubling goal for salmon populations is projected to be met in the Mokelumne (which currently meets the target) and Yuba Rivers, but not in the American, Feather, and Sacramento Rivers. Sacramento River rearing habitat would surpass the habitat needed to support 25% of the salmon doubling goal with the addition of 20,000 acres of floodplain restoration on the Sutter Bypass, provided that juvenile fish passage considerations can be addressed.

The VAs, if adopted, would include a set of implementation criteria and habitat suitability and utilization criteria for selected fish species, along with a monitoring program and an adaptive management process, to ascertain the actual benefits realized and incrementally improve overall program success. Nevertheless, the authors acknowledge that while the modeling and qualitative analyses described in the document indicate expected benefits from the VAs, the actual outcomes of the VAs are not certain at this time. As with all modeling analyses, the results have uncertainty arising from important assumptions and simplifications. For instance, the science used to support expected fish responses does not appear to take uncertainty into account.

General Comments on the MOU

The Delta ISB noted that additional details on the proposed science plan, and its components, were included in the MOU. The additional details provided a level of confidence that the VAs would be implemented and evaluated using established scientific processes. The authors are embarking on a complex adaptive management experiment that will need to be molded, adjusted, and evaluated over time.

Overall, the authors address the components of a potentially successful scientific program. General criteria in the appendices address flow measures (including refill criteria and other accounting provisions), habitat restoration measures, funding, and expected outcomes and metrics. There are provisions in the VA Science Program for implementing specific experiments, testing hypotheses, learning from experiments, designing experiments to test specific outcomes, facilitating a collaborative process with all parties, facilitating a transparent process through collaboration, reporting and open data, and conducting monitoring.

An additional positive aspect of the plan is the adaptive management component, which uses structured decision support processes to determine or adjust flow and non-flow measures, direct science efforts, and incorporate outcomes of the testable hypotheses to continue to inform decision-making, consistent with applicable provisions of the VA Governance Program. Funds are specifically allocated for adaptive management.

<u>Overarching Delta ISB Concerns on MOU</u>

1. Although the adaptive management plan outlined in the MOU contains most of the necessary elements for an effective plan, it lacks some desirable details for assuring a thorough and rigorous approach to promoting ecosystem benefits. For instance, Appendix 4 proposes that quantitative habitat suitability and utilization criteria will address the question, "*Are the constructed and restored habitats providing or likely to provide suitable habitat or food production for target species and life stages and are they being used as intended?*" The criteria, however, do not appear to address the potential for changing conditions due to climate or other environmental drivers, including changes in aquatic

species interactions. Importantly, the approach also does not establish quantitative Thresholds of Probable Concern or key decision triggers since the Green-Yellow-Red construct does not specify decision criteria. Defining the performance measures quantitatively and assessing the ability to measure these will be critical.

2. Another major concern is whether a sufficiently robust framework will be used to develop the quantitative metrics used to assess performance and inform adaptive management. While identifying tractable performance measures that represent desirable outcomes can be extremely challenging, once they are identified then Thresholds of Probable Concerned can be established and used in an effective Adaptive Management process. Another approach with a track record of success once performance metrics are established, is the use of SMART (specific, measurable, achievable, relevant, and time-bound) objectives. Nevertheless, the Delta ISB has concerns that metrics being proposed in the documents may not fulfill such criteria. For instance, Appendix 4 of the MOU states that quantitative measures will be developed at a future date for implementation criteria, for habitat suitability and utilization criteria, and for monitoring. An example is provided for a hypothesis about tributary spawning, but the objective is not quantitative, and therefore not scientifically useful. The Delta ISB strongly urges the authors to develop SMART objectives for all actions and hypotheses associated with site-specific MOUs before the MOUs are signed.

3. It is essential to have the scientific team—with the proper mix of expertise—in place from the beginning. Finding appropriate metrics is more likely if a scientific team is involved from the beginning in program design and has the appropriate mix of expertise (see below). The implementation of a scientifically based program and eventual evaluation requires thoughtful and effective planning, even before the MOUs are implemented. The statistical design, monitoring program and data management (see below) are especially critical components. The Delta ISB noted that the document included nearly all the right components and scientific processes (e.g., temperature, food supply, flows, statistical evaluation, adaptive management, and so forth). However, these need to be acted upon by a well-trained scientific team if they are to realize successful implementation.

4. Further, concrete plans for data management, analysis and synthesis are critical to successful adaptive management. A strong element of the plan is that the scientific team will conduct an ecological outcomes analysis of the VAs prior to Year 7, and a report from the VA Governance Program will be submitted to the SWRCB synthesizing the scientific data and information generated by the VA Science Program, primarily based on the Years 3 and 6. Given that these analyses are essential for evaluating outcomes from the VAs, it would be useful to know more about the details of data management and integrity, as well as statistical design. For instance, are reference sites used or will the VAs rely on before-after analyses? These are scientifically essential details that need to be established from the beginning if the VAs are to be adequately evaluated.

Suggestions on Major Topics

Monitoring (MOU)

The design and implementation of the monitoring plan requires improvement. Assurances are needed that individual projects will use current understanding of practices thought to promote success, including implementing features that anticipate potential problems and needed adaptations. The language about hypothesis-driven monitoring design is welcome but further specificity is needed to ensure an experimental design that could ultimately explain variability in restoration effectiveness. Such a design often requires monitoring potential confounding factors such as systemic stressors, non-native species abundances and species interactions. Further, the monitoring plan appears ambitious, and the funding plan does not include sources for contingent funding, if costs exceed expectations. Similarly, little information is provided to define priorities for monitoring which, if funds become limiting, could be important for ensuring sufficient data are generated to provide meaningful evidence of improvement.

More details on how to develop the monitoring plans using an adaptive management framework can be found in a prior Delta ISB's monitoring enterprise review (Delta ISB 2022). The Delta ISB feels that the periodic measures of flow changes, water quality and fish use may be insufficient to demonstrate benefits.

Conclusions and Uncertainties (Scientific Supplement)

1. The authors acknowledge (Chapter 7 and elsewhere) several key limitations with the analysis (e.g., habitat suitability of restored areas for salmon did not include water temperature, relationships of flow and habitat suitability for

other species were largely assumed, lack of modeling of more extreme hydrologic conditions that could likely be expected under climate change, quantitative connection between restored non-flow habitat and species abundance). The chapter could go further in making recommendations for 1) ongoing assessments of the VAs as the plans for implementation unfold, and 2) how the methods and modeling used in this supplement could be improved to inform adaptive management and potential VA benefits. Identifying data gaps that would improve the accuracy of the modeling and reduce uncertainty would be helpful guides as the program progresses.

2. The analysis makes a strong argument for the benefits to fish of stationary (non-flow) habitat, such as wetlands and floodplains, yet recognizes that additional restoration of these habitats is likely to be modest in terms of fish abundance. It seems that the conclusions about the benefits to fish populations should be tempered with an acknowledgment that achieving the benefits identified in the literature may require more substantial and diverse restoration efforts. Habitat restoration will impact different species to different degrees. Relatedly, at the bottom of page 5-1, the authors sound somewhat self-contradictory in stating that researchers haven't developed good quantitative relationships of fish populations and habitat restoration and that uncertainties remain, yet "*therefore an extensive review of the literature is included to describe the conceptual model for why the VA package will provide benefits to native species*". The uncertainty of benefits particularly in the context of other environmental drivers that affect fish abundances should be more clearly acknowledged and addressed within the adaptive management plan.

3. While the authors acknowledge some the limitations in assessing more extreme hydrologic conditions under climate change, they do not address sea level rise, temperature variations or modification to the growing season. Identifying the potential concerns associated with the effects of sea level rise, temperature and growing season on proposed non-flow habitat would be informative.

Limiting Factors, Water Quality and Other Environmental Drivers (Both Documents)

1. Elevated water temperature is one of the most important stressors in the Sacramento-San Joaquin watershed as well as in the bypasses and side channels, as it is elsewhere in the Pacific Northwest (e.g., see Department of

Environmental Quality 2008). It impairs water quality in several tributary watersheds, but the connection between increased/modified flows and water temperature is only described briefly in a few sections, most notably in Conclusion #4 (see Chapter 7, page 7-2: "*VA proposed spawning and rearing habitat was all assumed to be suitable from expert opinion and commitments from the VA Parties, and it was not informed by water temperature. If the habitat is not all suitable, that would reduce the VA habitat contributions.*"). Further, climate change will likely exacerbate temperature stress. A near-term climate change scenario should be included in modeling of suitable rearing and spawning habitat gains due to VAs.

2. Little attention is given to the need for creating, preserving, or expanding cold water habitat. Doing so is especially important in the autumn when flows are low and air temperatures high. Flow in tributaries is key to managing such cold-water pools. However, several tributaries are already impaired due to high water temperatures: lower American River, Mokelumne River, Putah Creek, bypasses and side channels. Thus, it will be important to articulate how increased flows can or cannot reduce temperature stress during fish-critical times of the year, especially since the authors acknowledge that "*Optimal ranges for temperature and dissolved oxygen for salmonids (State Water Board 2017) are regularly exceeded when salmonids are present in the bypasses* (see page 2-16)."

3. The projections regarding gains in suitable habitat for Delta smelt and salmon created by the VAs appears to be overly optimistic. In reality, only two fish species are the focus of the VAs and the abundance of one of them (i.e., Delta smelt) is impossible to measure.

   a. For Delta smelt, the model uses a temperature threshold of 77°F (25^{o}C, page 5-23). The authors state that "*Delta smelt experience optimal conditions, but it does provide an upper limit for habitat suitability.*" The logic behind this statement and choice of the temperature threshold are not entirely clear. Damon et al (2016) write: "*The spawning season of Delta smelt appears to be linked to water temperature (Bennett 2005; IEP 2015), and has been reported to occur when temperature ranges from 7-22°C based on the presence of larval fish in field surveys (Wang 2007). Delta smelt eggs ripen following a rise in water temperature in late winter, and spawning success decreases in the spring when water temperature exceeds 20°C (e.g., Bennett 2005; IEP 2015).*" And "*… roughly 95% of the ripe females (n=521) occurred between 9.2 and 17.9 degrees. Therefore,* *we determined that 9-18°C approximates the range when most spawning takes place."* According to Komoroske et al. (2014), the majority of juvenile and adult Delta smelt were caught in the field at temperatures of 20°C and below. The use of 25°C, therefore, needs revision or a better justification.

b. For salmon, based on a number of scientific studies, the model used to project gains in suitable habitat created by the VAs uses a temperature threshold of 73°F (22.8°C, page 5-24). However, the authors also state (page 2-23) that: "*..., and when temperatures exceed 68°F, juvenile Chinook salmon survival in the Delta declines rapidly (Nobriga et al. 2021).*" Would it not be prudent to use 68°F (20°C), especially given the fact that these are average temperatures and temperature ranges and maxima are ignored? The authors rightfully conclude in Chapter 7: "*...VA proposed spawning and rearing habitat was all assumed to be suitable from expert opinion and commitments from the VA Parties, and it was not informed by water temperature. If the habitat is not all suitable, that would reduce the VA habitat contributions".* Therefore, for better clarity, it would be helpful if model boundary conditions and criteria, especially those applied to define "*suitable*" habitat for each species and season, were summarized in a table.

4. Chemical contaminants are mentioned sparingly throughout the report. Contaminants may impair primary and secondary production of fish food organisms (Scholz et al. 2012; Fong et al. 2016), especially in small channels and wetlands important to fish species of concern (see page 6-26). Concentrations of pesticides and other contaminants tend to be higher in smaller and shallower water bodies than in the main river channel (e.g., Werner et al. 2000, 2010). Information on the impact of VAs on exposure and toxicity to native fish and "fish food" organisms is scarce or vague (Table 2-1 and corresponding text) and speculative (e.g., page 6-27). Fish food organisms, in particular crustaceans and insects, are more sensitive to contaminants than fish, therefore indirect impacts on fish resulting from contaminants may play an important role, especially in the low-flow or no-flow habitats created by the VAs where contaminants tend to be most concentrated. Further, the documents seem to imply that the abundance and availability of "fish food" organisms are equal across all habitats, which is not the case. These topics require careful inspection and more detailed information in the document.

5. Similarly, potential additive and/or synergistic effects of multiple stressors and ranges of environmental drivers acting on aquatic species (e.g., high temperatures, contaminants and diseases), which are often present simultaneously in aquatic environments are rarely mentioned (see pages 2-26, 6-8). They should be considered within the site-specific MOUs.

Climate Change Implications (Scientific Supplement)

1. The authors clearly state the potential impacts of climate change on both the assets (Table ES-1) and the habitat. Table 2-1 describes few limiting factors associated with climate change that may impact the performance of VAs and, as well, how dissolved oxygen conditions may be worse as a result of climate change. Specifically, this table summarizes how flow regimes are important for maintaining desirable conditions for temperature, counter sea level rise, and salinity intrusion. Section 2.4.3 provides a concise summary of the implications of climate change.

2. Despite the recognition of the climate change impacts, there is no clear indication that the modeling accounted for future hydrologic conditions that may result from climate change. It appears that selected versions of CalSim were used to provide "boundary conditions" of inflows for detailed, in-Delta modeling, using models such as RMA and DSM (Figure 5-4). However, there is no clear description of how the hydrology of future conditions was used for operations modeling. In this document, it appears that the treatment of future conditions associated with climate change is not adequately robust. While the description of climate change impacts on the performance of VAs is mentioned, there is no evidence that quantitative modeling of future conditions was included. In fact, the Conclusion and Uncertainties in Chapter 7 identify this as a limitation (see #6 on page 7-2): *"Current and future hydrologic conditions will likely be more extreme than the modeling periods used, which were limited by computational demands. While the modeling periods did include past extreme events (e.g., the DSM2 modeling period of 1975–1991 included an extreme drought and wet year), they may not be fully reflective of the current conditions (e.g., extended dry periods) and those expected in the future (e.g., climate whiplash [Swain et al. 2018])"*

Editorial Suggestions (Scientific Supplement)

1. The report would be more clear if one term were used for the following:
   - Objective
   - Narrative objective
   - Narrative viability objective

   All are used in the Executive Summary (page ES-3) and elsewhere. Alternatively, the report could define these terms if they have different meanings.

2. Box ES-1, which provides a summary of the assumptions and simplifications, should (at least) refer to Section 7 (page 7.2), where the assumptions and simplifications are listed. However, it would help the reader if these assumptions were listed in the Executive Summary. Further, the last paragraph in the Executive Summary (page ES-7) says, "*As with all modeling analyses, the quantitative results have uncertainty arising from assumptions and simplifications*" but should add "*and also from unexpected events, unanticipated consequences, and unknown unknowns in the system.*"

3. Section 2.3.3 Water Quality, page 2-21: This section starts with a general description of the importance of suitable water quality, which should be included in the Introduction rather than in this section. However, this is the level of detail that would benefit other chapters.

Additional Technical Comments (Scientific Supplement)

1. High prey abundance (based on high nutrient and organic matter concentrations), lower water velocities, and higher temperatures have been shown to be attributes favorable for salmon rearing (page 6-8). Nevertheless, the same factors can foster HABs, increase susceptibility to disease and favor invasive species when water temperatures are high. The authors may wish to establish thresholds of probable concern so not to exceed critical boundaries.

2. The authors cite Roni et al. (2008, 2014) to support the assumption that increases in habitat will produce more fish. However, Roni and colleagues were following up on the placement of *in-stream* structures to *improve* habitat, finding that fish abundances increased in only 60% of the cases. As well, the mechanisms for those increases could not be established. This is

not the same as proposed by the authors to use VAs to create wetlands, which is a positive—but different—step on its own.

3. The basis for the conclusions in Table 2-1 should clearly state if they are based on literature, expert judgment, or something else.

4. Page 5-18, the discussion of floodplain/wetland geometry (page 5-18) included notes that "*Other sites may result in slightly different changes to appropriate habitat area (e.g., salinity, turbidity), but not enough to impact overall effectiveness of the VA package.*" The basis for this conclusion should be clearly articulated.

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