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MEMORANDUM

Date: January 28, 2022

To: Laurel Larsen, Delta Lead Scientist
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Delivered via email to SAA@deltacouncil.ca.gov

From: Delta Independent Science Board

Subject: Review of the Draft 2022-2026 Science Action Agenda

The Delta Independent Science Board (Delta ISB) is pleased to review the draft 2022-2026 Science Action Agenda (SAA) dated November 2021 as part of our legislative responsibility to "provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta through periodic reviews of each of those programs." As stated in the Foreword and Introduction, the SAA is part of the overall Delta Science Strategy to lay the foundation for achieving the vision of *One-Science – One Delta* and we applaud the Delta Science Program for leading the effort to move us closer to that goal. The SAA is designed to provide the 'roadmap' to foster collaboration and investment and specifically "is a four- to five- year focused science agenda that prioritizes and aligns science actions to inform management decisions, identifies major gaps in knowledge and promotes science collaboration."

This overall review of the SAA by the Delta ISB is designed to improve the value of this important document to the regional science and management community in the next revision and in the future to meet its stated goals. Our review is divided into three parts:

1) **Science agenda**. The questions that guided our review of the SAA included, but were not limited to: How well do the management needs, questions and science actions capture the pressing science needs in the Delta over the next 4 to 5 years? Is the case for those priorities well made?

2) **Process and documentation**. The questions that guided our review of the process included, but were not limited to: Was the process for setting priority science actions sound, robust, justifiable, and clearly documented? Does the SAA adequately document how progress on the 2017-2021 SAA informed the 2022-2026 SAA?

3) **Suggestions for future approaches.** We make specific suggestion to better align the SAA within the adaptive management framework and to improve the breadth, depth, and robustness of the priority-setting processes and accountability. We define adaptive management as a structured method to improve decision making by learning from implemented management decisions. The iterative process requires stakeholder engagement to explicitly define goals and targets, develop and implement a monitoring plan, analyze information to assess if objectives are achieved, and share what has been learned.

1 SCIENCE AGENDA

The SAA team is to be commended for producing a clearly written and succinct document that integrates a large quantity of diverse inputs. The overall 2022-2026 SAA effort shows rigor, timeliness, dedication, and thoroughness. The science needs that were identified will fill important knowledge gaps. Overall, the management themes are representative and provide high-level documentation supporting their place in the SAA. Management questions are generally well posed and timely. The mix of general and specific priorities, with associated management questions, provides for diverse uses of the document and enables multiple related research priorities to be succinctly summarized.

1.1 GENERAL COMMENTS

- The broader vision and goals for the Delta as established in the Delta Plan, the coequal goals, or components of the Delta Science Strategy are not clearly connected to the management needs and science action priorities as stated in the SAA. This makes it difficult to assess whether the prioritization in SAA is consistent with urgent needs.

    - We recommend articulating the specific goals that drove the selection of the management needs.
    - The strategic uses and the significance of the SAA could be greatly enhanced by providing direct linkages to the priorities in the Delta Science Plan and the Delta Plan. In addition, we recommend clarifying which of the science strategy documents offers planning for future needs, as complements to more immediate science needs.
    - We further recommend a section in the introduction specifically explaining the purpose of the SAA in the context of other reports and efforts that make up the Delta Science Strategy, as shown in the diagram on page 10. While this content is eventually covered in the report, it would be helpful to orient readers earlier. If not all the research topics raised by stakeholders fit within the existing report's context, it would be helpful to discuss why and any implications.

- The priority of the management needs was unclear. Are they all equal or are some paramount?

- The temporal scope and purpose of the science action priorities do not appear to be fully consistent with the results. The introduction and charge suggest that the SAA's purpose is to prioritize science actions for the next 4 to 5 years, implying that the prioritized actions are intended to be achievable over this time period. However, much of the identified needs encompasses research that will only provide management-relevant results after many years of continued effort.
    - We recommend articulating more directly that the priorities identified in the SAA may include both short-term and longer-term management needs and science actions. Additionally, the document could clarify that the 4-to-5-year time frame is the period around which the Delta Science Plan evaluates and reassesses these priorities and, while progress is expected on these priorities during the period, the priorities may not be completed or fully achieved.
    - We recommend establishing clear goals to be addressed in the short term (3 to 5 years) and linking short-term goals to longer term (decadal) management needs and science actions as explored in the

Science Needs Assessment and elsewhere. Also, please clarify if the SAA is meant to provide flexibility to adapt to changing short-term needs.
    - The relationship between available funding and needs should be explained since the research needs well exceed the available budget.

- Some urgent science needs appear to be missing or did not receive sufficient emphasis. Given the role of the SAA in the science enterprise, we recommend that a larger component of the SAA be used to set specific science actions that require immediate attention. We note that these needs might have been identified if an adaptive management framework for tracking science needs were used (see Suggestions for Future).
    - We recommend increasing the emphasis on water supply, which is a vital element of Delta management and ought to permeate all management and science needs, not only in Needs 1, 2, and later in 6. Some recommendations from the Delta ISB's water supply reliability review (covering hydrologic/hydraulics) could be brought into 'existing gaps.'
    - Drought and other potential Delta crises are barely mentioned, despite evidence of accelerating change that could push systems over tipping points, marked by dramatic changes in system functioning. Although these issues are not readily resolvable by a short-term research agenda, neither should they be ignored. A useful step would be to specifically mention drought as an outcome of climate change, such as changing Management Need 6 to "Assess and anticipate impacts of drought and climate change impacts to support successful adaptation strategies."
    - Science synthesis and analysis is a major science gap. Making sense of the details available, discussing findings, and sharing knowledge are critical to creating and applying new knowledge. Mention of a modeling collaboratory (Management Need 1a) appears intended to address this need, but interim or highly focused efforts may be needed until such a platform is developed that will eventually contribute to development of the collaboratory.

    - Integrative modeling may need more emphasis: For example, estuarine programs with similar goals, such as the Louisiana Coastal Protection and Restoration Authority (see their Coastal Master Plan 2023), use integrative modeling as a key pillar of analysis, under which complex interactions of key ecosystem elements can be better understood (within uncertainty margins). The SAA rightfully takes pride in infusing more science into planning, but without a mix of science and technology, the impacts could be limited, especially over a 4-to-5-year time scale. The technology time scale is usually relatively short and shortens the time from science results to application. In Management Need 2, model interoperability and integration are mentioned, but they are buried in monitoring. It may be helpful, under Management Need 2, to clarify that integrated models can be used to prioritize the most critical data needs for decision making, including which improvements in system variables (e.g., characterizing temporal ranges and spatial heterogeneity) would improve risk assessments.
    - Managing under uncertainties deserves more emphasis. Investing in data acquisition, analysis, and decision support tools to help manage unavoidable uncertainties will complement new research. Risk analyses, strategic contingency planning, and adaptive management are common successful approaches to managing under uncertainties.

- The word “modeling” is used to encompass all types of data analysis, forecasting, and prediction. It would be helpful to be more precisely differentiate uses, particularly between models used for analysis and prediction.

- Although social science is integrated across many biophysical research needs and given a distinct category, many social science questions could be improved to better represent how social science researchers approach problems and to enable innovation. Some examples illustrate this point:
    - Good example (Need 6, page 31): “How and why are different human communities in the Delta currently adapting or not adapting to climate change, and what are the barriers communities face to adaptation?”

This question is useful because it seeks to identify problems and innovative solutions.

- Less good example (Need 5): "What degree of control keeps invasive/non-native populations at a level that allows for desired and cost-effective management outcomes (e.g., boating access, fish habitat, food production)?" This question is narrow and prescriptive rather than promoting innovation to understand and possibly alter cost-effectiveness, as might be reflected in the question: "What types and levels of invasive species management produce the highest cost-effectiveness (e.g., in terms of goals for boating access, fish habitat and food production), with the least ancillary harms?"
- Could be improved (Need 4): "Measure and evaluate the effects of using co-production or community science approaches (in management and planning processes) on communities' perceptions of governance and decision-making processes." Perceptions are good to evaluate but why not also consider the contribution of co-production to improvements in program implementation or in generating innovative ideas? Meaningful co-production has benefits to communities and institutions.
- Missed opportunity for social science integration – Impacts of harmful algal blooms (HABs) on different communities (Need 5C).

1.2 SOME ADDITIONAL CONCERNS

- Reasons for the low survey response rate should be investigated. Also, it is not clear how representative the respondents were. Not all agency representatives attended some of the SAA meetings. Including information about the nature of responders (management experience, management advisory experience, science cognizance) would help explain the overall 'Delta-representativeness' of management questions.
- Assessing impacts on disadvantaged communities (DACs) is a valid research need. While thinking about the needs of specific communities, it would be helpful to add information about how science and management needs could respond to the White House Executive Order calling for a focus on meeting the needs of indigenous peoples. Further, goals to integrate local and

traditional ecological knowledge might be addressed by this federal focus. In addition, there is also a lack of understanding of management impacts across all communities, including diverse recreational users and small to large businesses. Therefore, a more systematic or holistic approach to impact assessment would also be desirable.

- Some questions need to be refined to generate the information most useful for management or to clarify the management application. (The use of an adaptive management framework in the future could prevent these issues.)
    - Example (Need 5): “Quantify spatial and temporal "hotspots" of chemical contaminants and evaluate ecosystem effects through monitoring, modeling, and laboratory studies.” This question could be improved by mentioning the need for upstream source tracking and in-situ burial rates to better understand how system dynamics influence management priorities.
    - Example (Need 3): “How do management actions (e.g., source control practices or managed flows) and habitat types influence nutrients, carbon, contaminants, and sediment fluxes in the Delta?” This management question appears to be a science question because it promotes basic science without stating an application or goal.

1.3 PROCESS AND DOCUMENTATION

The co-production process was ambitious and engaged many stakeholders with diverse backgrounds and interests. The process was open and transparent and showed a strong commitment to meaningful engagement with diverse stakeholders. The process promoted the inclusion of the concerns of the broad community working on Delta challenges and provided ample opportunity for public input. The approach is well organized and the document provides clear information about the processes used to identify the priority management needs. The summary in the “Co-Production by the Numbers” box is helpfully specific about the amount and sources of input. The SAA was also responsive to some of the prior Delta ISB recommendations about process, for example in documenting the public input process and providing information on the screening criteria used to guide the selection of management questions and science actions in the appendices.

- As stated in the Delta ISB review of the previous SAA, the overall process of selecting priorities is a consensus building effort that brought multiple agency personnel into communication and this is valuable and a major first step in coordination. We pointed out and still contend that "while the process used in identifying priorities for this document was good for assembling priorities across agencies, it may not be as useful for developing agenda items that address deeper and more synthetic research needs for the Delta. The SAA and Delta Science Plan processes are an opportunity to organize and coordinate the existing science agendas of agencies and agency programs, but they are also an opportunity to create a science agenda that is greater than the sum of these parts. Perhaps an expanded process could be used to broaden the range of science topics included in future plans." An expanded process might include facilitated discussions between managers, scientists, and key stakeholders to promote the identification of new approaches to current questions and strategic research to prepare for an uncertain future. A "cross-walk" with other science-priority - setting efforts (such as the Delta ISB review recommendations, State of the Bay Science papers and Delta Adapts) would be very useful. See also the adaptive management recommendations in the next section on suggestions for future approaches.
- It would be helpful if continuing recommendations were distinguished from new recommendations to highlight novel elements from the last SAA, as well as to show what priorities from the previous SAA remain.
- Although the report describes connections to the previous SAA, the process by which the SAA Progress Summary (as described in Appendix B) informed the prioritization of actions in the new SAA remains vague. We recommend adding clarification to address the question, how did the *level* of progress across different actions from the previous effort inform the need for new actions or ongoing actions?
- A simple discussion of the recognized strengths and weaknesses of the overall approach would be useful.

2 SUGGESTIONS FOR FUTURE APPROACHES

We make specific suggestion to better align the SAA within the adaptive management framework and to improve the breadth, depth, and robustness of the priority-setting processes and accountability.

2.1 SCIENCE AGENDA

- Scientific research can effectively support management when it is embedded in an adaptive management framework that takes a holistic view of the Delta system and integrates all aspects of planning for environmental, social, and economic considerations. Adaptive management requires an assessment of the expected consequences of management actions that are subsequently monitored and that provide triggers for changes in management actions. Science drives that assessment. The adaptive management framework often involves having structured conversations with stakeholders about science priorities and measurement approaches, which provides an opportunity to promote public input and gain common understanding. An adaptive management approach would necessitate consideration of goals for the Delta, metrics to evaluate progress toward reaching those goals, progress achieved thus far, and the need to revisit and/or revise goals, metrics, and ways to assess progress. On page 11 of the SAA, the definition of Science Actions includes adaptive management as part of science action yet it is broader than that, for adaptive management includes management issues and questions.
    - The Delta ISB recommends future versions of the SAA seek to 1) systematically identify research that supports adaptive management components, 2) apply that framework to track how science output are used in adaptive management, and 3) make recommendations for future research that respond to shortfalls or emerging needs, as identified in adaptive management. This approach could avoid concerns about whether the recommendations are most representative of the urgent needs, based on a thorough examination across agencies, scientists, and stakeholders.

- To support an adaptive management approach, measurable indicators should be used to motivate and improve tracking of progress towards the subset of management needs and science actions that can be enhanced through such methods. SMART metrics (often defined as "specific, measurable, achievable, relevant, and time-bound) or Key Performance Indicators (KPI) used to track intended results, or other types of performance indicators, could be identified for specific science actions. However, complementary and needed research that is less amenable to tracking may not benefit from such metrics if they limit innovation or if the feasible (measurable) metrics are only weakly aligned with the primary research goals.
- Engaging more social scientists in the future, including as reviewers on draft final products, would improve the framing of social science questions and integration of social science across diverse management needs.
- The separate climate change section appears repetitive. It could be better in future rounds to recognize that climate change effects need to be integrated across all research questions. Also, the Delta science enterprise can leverage existing institutions to generate some of the basic climate change projections needed and thereby narrow their focus to Delta - or California-specific questions that would not otherwise be addressed.
- It could be valuable to discuss how external partnerships (e.g., National Center for Atmospheric Research, NOAA Regional Integrated Sciences and Assessments) could support the SAA and management needs. E.g., address the concern: Are you trying to do too much solely within California agencies vs taking advantage of external expertise through partnerships?

2.2 PROCESS AND DOCUMENTATION

- The draft was generally clear in explaining how progress was made on the current SAA and how this progress informed development of the new SAA. The measurement of progress, however, was subjective, and a statement of performance benchmarks for the 2022-2026 science actions would add more rigor for future evaluation. The discussion of various projects that used the SAA as a guide was helpful, but most of those projects were funded by or

with the science program that used the SAA as a criterion for funding. Therefore, this result seems to be a confounded experiment. Assessment of progress could be improved by evaluating which actions are completed at the end of 4 years and by identifying other meaningful metrics of progress in an adaptive management framework (see Section 2.1).

- We recommend that the process of reducing the number of management needs and science actions from the initial large list be re-evaluated to identify the level of specificity that is most useful for spurring action. The process of lumping a number of related 'actions' into more general categories makes them largely undoable in 4 years. Evaluation of management needs using a modified Delphi or similar process (as discussed below) would be inclusive of diverse perspectives.
- The document could be structured to make the science suggestions more actionable. A 1 to 2 page description and action plan for each science action would describe a) who is responsible, b) who else is involved, c) who is funding, d) what scientific approach(es) are to be taken, e) what has been done so far, and f) what kinds of products and time lines are expected. This kind of appendix material could essentially become a contract for accomplishment.
- The co-production process needs to be constructed in a way that is less sensitive to the participation rates. The process was clearly challenged by Covid-19 restrictions that limited the time for both informational presentations and group discussions. As a result, small group discussions could have been more effective at identifying key concerns and characterizing the degree of consensus on concerns.
    - An alternative structure to conducting prioritization, such as a Delphi technique, might be preferable for prioritizing concerns in the future through a facilitated process and systematic combination of surveys and discussions that 1) organize research priorities by goals, 2) promote deep thinking by individuals, and 3) enable group refinement of ideas. (See Section 3 and Wolfe et al. 2017 for more detail).
- The co-production process used emphasized a highly "inductive" approach to developing management needs and science action priorities. However, the

process could also be balanced with some additional "deductive" guidance from the Delta Science Plan and State of Bay-Delta Science, alongside the Progress Summary from the previous SAA. The contributions of these documents to establishing goals and criteria for guiding the prioritization process could be made more explicit in the future, including using them as part of adaptive management.

- One of the highlights is the planned availability of a cyber tool – Delta Science Tracker – to help science-based planning. We appreciate the inclusion of this vision, which is responsive to SAA, Action 1A of the 2017-2021 SAA.
- We recommend the SAA developers conduct a "post mortem" of this SAA. This first effort to assess progress on the prior SAA is impressive. Future efforts could seek to systematically identify and address weaknesses and potential improvements in terms of process and scientific results.

3 CLARIFICATIONS, MINOR ISSUES AND QUESTIONS

- The Executive Summary gives the impression that ecological and social sciences are being conducted separately and could better reflect the integration that is evident in the body of the recommendations.
- The modeling collaboratory is an interesting proposal but requires some thoughtful deliberation and negotiation before launching. Its description in Table 1 is only part of the science and governance concept that was discussed at the Science Needs Assessment workshop. Is it wise to use the word collaboratory in Table 1, given the premature status of the idea? We also recommend that the highlight on page 19 be deleted.
- Additional details on a potential modified Delphi process that includes direct, facilitated negotiation are (from Wolfe et al. 2017):
    - Have a facilitator work initially with the resource managers, scientists, and key stakeholders in the Delta to design an effective engagement process.
    - Have that group create a tangible, though interim and "living," product (e.g., a preliminary integration framework or conceptual model of the

Delta systems that can be used in an adaptive management approach to identify priority science actions).

- Elicit input first from resource managers and key stakeholders on the framework (or its necessary dimensions and components) and then from the scientists. Have the scientists propose indicators that, collectively, provide comprehensive and useful metrics that serve as a basis for improved environmental management.
- Use direct, facilitated negotiation: Have a meeting (or meetings) that includes both groups to discuss and finalize framework.

- Representative photos and captions providing context are needed: Each of the photographs located side by side of the management needs can include a quick reference to enhance its relevance. For example, how Regional San's wastewater treatment upgrades represent integration of large (plant) scale experiments, data collection, and evaluations? It is unclear if low water level in Shasta Lake water on a given day is a representation of climate change impacts; a better plot on climate problems would be an eye-catching graph showing suitably averaged water level variation over several decades.
- In the tables that show the existing gaps relative to each of the science actions (starting on page 20), there are several references to building on "progress made" from the past SAA. To some degree, this leaves the reader with the impression that many current science actions are focused on areas where progress has already been made, rather than areas where there has been limited progress. Is there any way to differentiate the level of progress that these "progress made" tags are associated with?

4 REFERENCES

Wolfe AK, VH Dale, T Arthur and L Baskaran. 2017. Ensuring that ecological science contributes to natural resource management using a Delphi-derived approach**.** Chapter 6 in (MJ Paolisso, Ed.) *Participatory Modeling in environmental decision-making: Methods, tools, and applications*. Springer: New York, pages 103 to 124.