Draft Memorandum: Summary of Discussion on Ecology During Rapid Environmental Change

For the Delta Independent Science Board's discussion at its March 20, 2020 meeting.

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To: Delta Stewardship Council Members and Delta Plan Interagency Implementation Committee Members

Sent via e-mail to Susan.Tatayon@deltacouncil.ca.gov

From: Delta Independent Science Board

Subject: Preparing for accelerating rapid and uncertain future environmental change

Ecology is the scientific foundation for the conservation and management of species, ecosystems, and natural resources in the Delta. An accumulation of past drivers compounded by the intensity with which climate change is arriving are changing the Delta more rapidly than ever before. *Our findings indicate that Delta science and management need to formally incorporate best available science and methodologies for looking ahead to anticipate changes and thresholds.*

The Delta Independent Science Board (Delta ISB) has been exploring how Delta science and management might better anticipate the environmental consequences and management implications of rapid and accelerating environmental change and growing uncertainty about the future. The Delta ISB's discussions have focused on the best available science to anticipate and manage how individual species might respond to more rapid change and how these responses might affect the character of ecosystems. These discussions have been taking place in parallel with the preparations for the Science Needs Assessment Workshop that is planned for later this year.

Summary of the Discussion Paper

The Delta ISB prepared a discussion paper during the latter months of 2019, titled: *Toward a Preemptive Ecology for Rapid, Global, and Increasingly Irreversible Environmental Change* (http://deltacouncil.ca.gov/pdf/isb/meeting-materials/2019-11-25-rapid-change.pdf). The paper was written to promote discussion of this important issue, and it should be stated that not all of the Delta ISB members endorsed all of the paper's content in its entirety.

The thesis of the paper is that although the Delta has experienced rapid human-driven environmental change ever since the Gold Rush of 1849 to 1850, the changes are now more rapid, more pervasive, and are accelerating. Historically, scientists have studied, and managers have responded to the changes after the fact—for example, by adjusting water flows and restoring habitats to enhance salmon migration toward historic levels. Scientific research and management responses have lagged behind the pace of environmental changes. Early response options were lost while populations of native species declined and non-natives better suited to the changed environment thrived.[1] With changes in underlying conditions projected to be more rapid and more uncertain in the future, such lags will make science and management increasingly less effective.

The Delta ISB's discussion paper identifies several ways in which Delta science could be more deliberately forward-looking, including:

- *Enhancing the resilience of systems* so that they adapt to change while retaining key system properties.
- Undertaking *scenario analyses* to organize thinking about possible future directions ecosystems might take.
- Undertaking *horizon scanning* by interdisciplinary teams to better foresee possible future directions.
- *Eliciting the judgement of experts from multiple disciplines* in a Delphi or similar process to better foresee and respond to possible futures.
- *Focusing science more directly on foreseeable management needs.*
- *Accelerating the synthesis, interpretation, and communication* of science for management.

Several of these approaches are already being used to some extent. Yet, the paper argues, they could be undertaken more formally and become a clearer, stronger part of Delta science.

[1] The pelagic organism decline (POD) in 2002 provides an example of not foreseeing potential changes and not being in a position to respond sooner. The causes of the POD were still deemed scientifically uncertain five years after the rapid decline happened. Had Delta science been more forward looking and possible changes due to different drivers projected, the drivers might have been spotted earlier and managed sooner and better. Scenario analysis was well developed by the late 20th century and used extensively in climate science. Invasive mollusks had been transforming food webs around the globe for decades. Delta science might have had a team dedicated to portraying possible futures through scenario analysis to aid in the early detection of such changes when they do occur.

Summary of the Commentaries by Invited Panelists

The Delta ISB invited seven scientists to prepare written commentaries on the discussion paper and to participate in a panel discussion with the Delta ISB. The panelists provided very insightful commentary and were generous in their responses (http://deltacouncil.ca.gov/pdf/isb/meeting-materials/2020-01-27-isb-panel-response-rapid-change.pdf). The written commentaries were made public prior to the Delta ISB's meeting on January 30, 2020, and the invited panelists had read each other's contributions.

The panelists agreed that environmental change will likely accelerate and become more uncertain, and that this presents new challenges to environmental science and to ecology in particular. Several panelists also noted that climate change is not the only driver of rapid change. The difficulties of managing Delta ecosystems are also due to historic human activities such as levee construction and the use of mercury in gold mining, as well as more recent drivers including enrichments and toxics from agriculture and urbanization. Climate change is a new and additional driver affecting already vulnerable ecosystems.

One discussant, however, felt the discussion paper was "a bit alarmist, grounded more in general ideas and global trends than in what is known about the Delta region …". Another also felt the discussion paper needed to be more specific with respect to the Delta. While the intent of the discussion paper was to raise a broad issue, some members of the Delta ISB are now drafting a paper with more Delta specificity for submission to San Francisco Estuary and Watershed Science.

Several panelists argued that adjusting to more rapid change will require changes in science and management that are inhibited, if not completely prohibited, by current institutions. Some institutional change will be needed to address the challenges of the future more effectively. One discussant proposed forming a "futures program" to address more rapid and uncertain change. Several argued that the disciplinary structure of universities still discourages academics from collaborating across disciplines and training graduate students in interdisciplinary collaboration, as well as engaging effectively in policy making and management.

While the discussion paper focused on the challenges of doing science under rapid change, several panelists noted that identifying public goals during more rapid change will also be a challenge. Ecologists are shifting their emphasis from maintaining ecosystem composition and structure to maintaining functions and processes. Particular stakeholders and the public generally will be faced with novel options and wholly new choices for which informed preferences will be needed. The interests of stakeholders are changing. Maintaining trust from science through management to policy and politics will be a greater challenge than it already is. Greater public participation in the process

of interpreting and synthesizing science would help the public realize how management options are changing.

Several panelists suggested building a conceptual coupled human-natural systems model and adjusting it as conditions and knowledge of feedbacks change, to help in thinking about longer term policy issues.

Several of the panelists elaborated on how improved monitoring and modeling can be used more effectively to understand and respond to the complex dynamics of more rapidly changing ecosystems. Dynamic models of ecosystems that go beyond replicating past changes in, for example, shifts in the spatial distribution of species, are needed. Progress is being made on how to anticipate critical thresholds or tipping points, although definitive indicators may remain elusive. New types of monitoring may be needed to measure tipping point indicators. Even if prediction remains elusive, dynamic models can help structure discussions of what seems to be understood well enough to be used in an anticipatory management process. Perhaps most importantly, anticipatory management using multiple possible scenarios can address the range of possible outcomes rather than single specified futures.

One discussant stressed that we need to learn from management interventions, treating them as experiments. This will entail monitoring for outcomes, both expected and unexpected, and doing so quickly as outcomes unfold. Learning from “management experiments” in other places will also become more important. This too will require breaking down the divisions between science and management.