California Water Research

March 30, 2020 **Via email**

Delta Independent Science Board
980 9th Street, Suite 1500
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Re: Is Regime Change in the Delta Irreversible?

The Delta Independent Science Board produced a discussion paper on November 25, 2019, entitled, *Toward a Preemptive Ecology for Rapid, Global, and Increasingly Irreversible Environmental Change: A Discussion Paper with Implications for Research and Management in the Sacramento-San Joaquin Delta*.[1] The discussion paper states,

> The POD documents that ecologists were not equipped to foresee and address rapid, irreversible change. They did not have models that included tipping points and regime changes. It was appropriate to assure that the POD science was correct, but by the time ecologists were confident in their findings, there was little possibility for corrective management (though in this case correction may not have been possible).

The discussion paper cites the 2007 report of the Interagency Ecological Program's Pelagic Organism Decline Management Team (IEP POD Management Team) to support the conclusion that the ecologists did not have models that included tipping points and regime changes. But the discussion paper does not cite the IEP's 2010 *Pelagic Organism Decline Work Plan and Synthesis of Results* (2010 IEP POD Synthesis Report) (Baxter et al., 2010.)[2] The 2010 IEP POD Synthesis Report was comprehensive, citing hundreds of scientific studies. The IEP POD Management Team hypothesized that "drivers that changed slowly over decades (slow drivers) contributed to the slow erosion of ecological resilience of the system. This made the system more vulnerable to the effects of drivers that changed more rapidly around the time of the POD and/or have greater species specificity."[3] The IEP POD Management Team hypothesized that the slow drivers of the POD regime shift, in order of their hypothesized importance to the

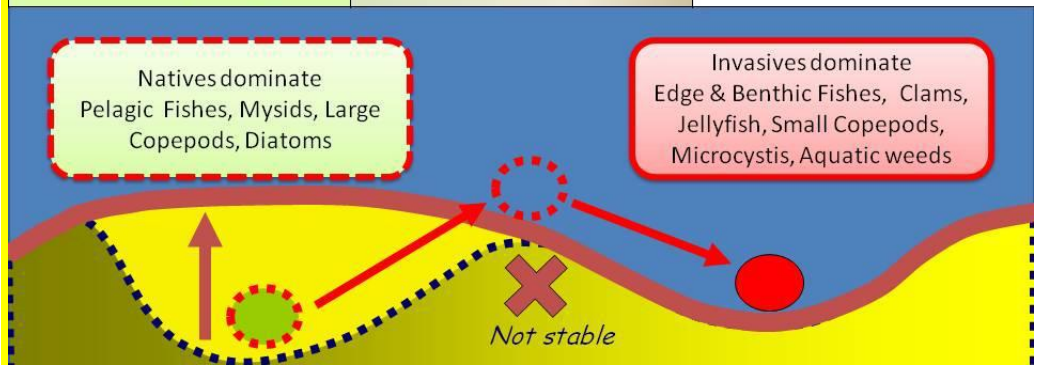
[1] Delta Independent Science Board, Toward a Preemptive Ecology for Rapid, Global, and Increasingly Irreversible Environmental Change: A Discussion Paper with Implications for Research and Management in the Sacramento-San Joaquin Delta, November 25, 2019. http://deltacouncil.ca.gov/pdf/isb/meeting-materials/2019-11-25-rapid-change.pdf.

[2] Baxter, R., R. Breuer, L. Brown, L. Conroy, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Mueller-Solger, T. Sommer, and K. Souza. 2010. Pelagic Organism Decline Work Plan and Synthesis of Results. Interagency Ecological Program for the San Francisco Estuary. Available at: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/FOTR/for_60.pdf.

[3] *Id*., p. 11 at 379.

resilience of the system and approximate rate of change were: 1) Delta outflow, 2) salinity, 3) landscape, 4) temperature, 5) turbidity, 6) nutrients, 7) contaminants, and 8) harvest.[4] The POD Management Team illustrated the regime shift and the drivers of this shift in the figure reproduced below.[5]

Old Regime	Environmental Drivers	New Regime
Variable, High	Outflow	*Variable, Lower*
To the west, Variable	Salinity gradient	*To the east, Constricted*
Complex, Variable	Landscape	*Simplified, Rigid*
Low, Variable	Temperature	*High, Uniform*
High, Variable	Turbidity	*Low, Less variable*
High P, low N	Nutrients	*Low P, High N (NH_4+)*
Few, Low	Contaminants	*Many, High*
Predation, Fishing	"Harvest"	*Predation and Entrainment*



The statement in the discussion paper that "by the time ecologists were confident in their findings, there was little possibility for corrective management" omits the management history. Pursuant to a mandate by the legislature in the Delta Reform Act of 2009, the State Water Resources Control Board held a proceeding in 2010 to develop instream flow criteria for the Delta that would restore fisheries. The Board appointed an expert panel to testify, and referenced 325 technical documents. Twenty-four parties to the proceeding provided 84 expert witnesses and 488 exhibits, plus exhibits from previous Bay-Delta hearings.[6]

The resulting State Water Resources Control Board report, titled *Development of Flow Criteria for the Sacramento- San Joaquin Delta Ecosystem*, found that "[t]he best available science suggests that current flows are insufficient to protect public trust resources" and that "recent Delta flows are insufficient to support native Delta fishes for today's habitats." The State

[4] *Id*., p. 11 at 383.
[5] IEP POD Synthesis Report, Figure 8, pdf p. 144.
[6] State Water Resources Control Board, Delta Flow Criteria Program website: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/.

Water Resources Control Board's 2017 Final Scientific Basis Report[7] summarized the Delta Flow Criteria Report's findings as follows:

> With respect to specific flow criteria, the Delta Flow Criteria Report found that flow criteria should reflect the frequency, duration, timing, and rate of change of flows, and not just volumes or magnitudes and proposed criteria based on a percentage of the unimpaired hydrograph as a way of achieving these attributes. The Delta Flow Criteria Report specifically identified a Delta outflow criterion of 75 percent of unimpaired Delta outflow from January through June and an inflow criterion of 75 percent of unimpaired Sacramento River inflow from November through June. The report also identified criteria for increased fall Delta outflow in wet and above normal years; fall pulse flows on the Sacramento River; and interior Delta flows.
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> The Delta Flow Criteria Report further found that inflows should generally be provided from tributaries to the Delta watershed in proportion to their contribution to unimpaired flow and that studies and demonstration projects for, and implementation of, floodplain restoration, improved connectivity and passage, and other habitat improvements should proceed to provide additional protection of public trust uses and potentially allow for the reduction of flows otherwise needed to protect public trust resources in the Delta. (p. 1-8.)

The 2017 report also stated:

> Recent Delta flows are insufficient to support native Delta fishes for today's habitats. Flow modification is one of the immediate actions available although the links between flows and fish response are often indirect and are not fully resolved. Flow and physical habitat interact in many ways, but they are not interchangeable. (p. 1-8.)

The flow criteria recommended by the State Water Resources Control Board in 2010 and 2017 generated fierce opposition from the water user community. Since increased Delta flows have not been implemented, it remains an unanswered question as to whether the changes to the Delta ecosystem are irreversible.

Impacts of climate change complicate the question of whether the changes to Delta ecosystem are reversible. Droughts are expected to be more severe. Temperatures will increase. Sea level rise will increase salinity intrusion.

The ISB's March 15, 2020 draft memorandum[8] states,

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[7] State Water Resources Control Board, Final 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, 2017. https://www.waterboards.ca.gov/water_issues/programs/peer_review/docs/scientific_basis_phase_ii/201710_bdphaseII_sciencereport.pdf.

[8] Delta Independent Science Board, Draft Memorandum: Summary of Discussion on Ecology During Rapid Environmental Change, March 25, 2020. Available at https://deltacouncil.ca.gov/pdf/isb/meeting-materials/2020-03-15-isb-draft-rapid-change-discussion-summary.pdf

> … 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.

However, since experiments with significantly increased flows have not been done, it seems premature to assume that such changes will not help maintain the Delta ecosystem composition and structure. Doing such experiments would also be important in understanding the Delta as a dynamical system, which is essential in making informed management decisions.

Providing a more natural flow regime is strongly supported by studies of other estuaries. As explained by Julie Zimmerman, Jeanette Howard, Jon Rosenfield, and Rene Heneryin an Op Ed entitled, Ecologists See Little Difference Between Unimpaired and (Truly) Functional Approaches to Flow[9],

> From an ecologist's perspective, river habitat and species population sizes and life histories were shaped by unimpaired flow patterns (including volume and natural variability) across seasons and years. Science from across the world, other regions in the US, and right here in California suggests that we can take some of that flow for other uses, but must preserve adequate volume and natural patterns of variation if we want native species to survive. Whenever we decide to significantly deviate from those natural patterns, we are making trade-offs between human needs and ecological outcomes. In some cases, those trade-offs may be necessary to balance demands on existing water supplies. Without information about unimpaired flow, however, the nature of those trade-offs is unknown, and the results are much less likely to achieve the maximum benefit. It's true that climate change is altering the unimpaired baseline in California, but base seasonality, river processes, and the needs of native species will not change. Climate change only makes the articulation of trade-offs more important and building in resilient water supplies for native species even more crucial, to protect our aquatic ecosystems.
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> In the world of river ecology and environmental flows, the concept of maintaining flows as a proportion of unimpaired has not been replaced by the creation of novel flows. Quite the opposite; decades of application of novel (or highly engineered) flows have demonstrated that they are ineffective at maintaining even the single species they are often designed around — much less supporting a thriving aquatic ecosystem. Novel flows may be necessary in heavily altered, novel ecosystems, in which unimpaired flows can no longer provide benefits to native species because humans have so greatly modified the landscape. Even in these systems, however, novel flows are most often effective for a given native species because they mimic a portion of the unimpaired hydrograph and/ or the effect of some portion of the unimpaired hydrograph on habitat conditions. As such, understanding the unimpaired hydrograph and the way species have adapted in response,

[9] Zimmerman, J., \Howard, J., Rosenfield, J., and \Henery, R., Ecologists See Little Difference Between Unimpaired and (Truly) Functional Approaches to Flow, Maven's Notebook, February 4, 2020. https://mavensnotebook.com/2020/02/04/guest-commentary-rebuttal-ecologists-see-little-difference-between-unimpaired-and-truly-functional-approaches-to-flow/

also informs how best to structure a novel flow and to understand its potential to be effective. Even in California's most heavily altered landscapes, rivers that are so changed that they require novel flows are the rare exception. In most rivers, environmental flows that provide the functions of a natural hydrograph are the best hope to allow native species to persist and thrive.

In conclusion, it is currently unknown whether the changes to the Delta are irreversible. While we are heading to a period of rapid change, it is also unknown what benefits the restoration of a more natural hydrograph would provide to the Delta ecosystem. As argued by leading ecologists, those benefits may be substantial, and could buffer the effects of climate change.

Thank you for your consideration of these comments,

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