Hydrol. Earth Syst. Sci. Discuss., 12, C1709–C1714, 2015
www.hydrol-earth-syst-sci-discuss.net/12/C1709/2015/

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Reconstructing the natural hydrology of the San Francisco Bay-Delta watershed" *by* P. Fox et al.

P. Fox et al.

djhowes@calpoly.edu

Received and published: 23 May 2015

The authors appreciate the excellent review comments from the Referees. Our responses to each comment are shown below.

Comment 1. It would help if Figure 1 also showed where the flow into the Bay Delta where the "unimpaired flow" standard is being applied.

Response: We agree with the reviewer that the manuscript will be enhanced by identifying the location of Delta outflow on Figure 1. The enhancement will be accomplished by adding an inset map of San Francisco Bay and providing an arrow signifying Delta outflow leaving the Delta and entering the Bay and Pacific Ocean. For clarification, unimpaired flow standards are being contemplated but have yet to be applied to the

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

San Francisco Bay-Delta watershed.

Comment 2. While the argument is easy to follow, the results could be presented in a clearer manner. The endless tables get tedious. Please include some graphical representation of the three flows under Natural (Case I), Current and Unimpaired. This is the main point of the paper but not presented anywhere.

Response: We agree with the reviewer's comment and will prepare a new figure that compares long-term annual outflow under natural, current and unimpaired conditions. We propose to develop a simple bar chart to make such a comparison.

Comment 3. It is really striking how different the original and current land use of the region is in Figure 4 and Figure 5 – but it's made difficult to compare because the classification systems are totally different. Would it be possible to use a single classification system for Historical (natural) and Current land use and show them next to each other instead of two separate graphs? If this is not possible, another option would be to show the natural and current ET maps next to each other (using a single legend).

Response: We agree with the reviewer's comment that showing the maps in Figures 4 and 5 next to each other will allow readers to more effectively compare natural and current land use. We propose to replace Figures 4 and 5 with a single figure showing the maps side-by-side. Unfortunately, it is not possible to use a single classification system for both maps. Instead, we propose to simplify the legend associated with the current land use map by combining similar classifications.

Comment 4. While the analysis is simple – the implications are quite far reaching and therefore it's necessary to be sure that the core components are correct. The argument is contingent whether the base map used (the CSU Chico map) is correct and whether the correct ET values have been chosen for different vegetation types. Would it be possible to provide evidence that the CSU map is consistent with other estimates of land use particularly for the high ET species (wetlands and perennial grasslands)? E.g. a single table in an Appendix with the CSU area compared to area estimates by

HESSD

12, C1709–C1714, 2015

other scholars for each species.

Response: We agree with the reviewer's observation that our vegetation type and ET assumptions are critical to the analysis. As explained in the discussion manuscript, the CSU Chico map was only the starting point for our work. We used numerous other sources to confirm and modify the Chico map. Our analyses are documented in Fox and Sears (2014), which compares our estimates with those made by others where comparison was feasible. Direct comparison was not always feasible as others either used different geographic boundaries and/or different vegetation classifications. We propose adding the following narratives to the revised manuscript:

"We estimated about 0.40 million hectares of permanent wetlands. Others have estimated 0.40 (Fox 1987) to 0.53 million hectares (Hilgard 1884, Shelton 1987) for slightly different valley floor boundaries."

"We estimated about 1.62 million hectares of grasslands. Others have estimated 2.02 (TBI 1998) to 2.18 (Fox, 1987; Shelton 1987) million hectares for slightly different valley floor boundaries."

"We estimated about 0.77 million hectares of vernal pool habitat in the Valley Floor outside of the floodplain. Others have estimated about 0.97 million hectares of vernal pool habitat (Holland 1978, 1998; Holland and Hollander 2007) for slightly different valley floor boundaries."

"We estimated 0.29 million hectares of riparian forest based on CSU Chico's map, which is low compared to estimates by others including 0.35, 0.38, 0.37, 0.58, and 0.65 million hectares estimated by Shelton (1987), Roberts et al. (1977) , Katibah (1984) , Fox (1987), and Warner and Hendrix (1985), respectively, for slightly different valley floor boundaries."

Additional Reference to be Added Hilgard, E.W., Report on the Physical and Agricultural Features of the State of California, U.S. Census Office, Government Printing

HESSD

12, C1709–C1714, 2015

Office, Washington, D.C., Tenth Census, v. 6, 649 -796, 1884.

Comment 5. Just because annual natural flows are in the range of current flows, it doesn't mean that human alterations have not impacted the delta in terms of the fluctuations and timings of flows. It's possible that humans have either increased or decreased inter-annual and intra-annual variability (will need dam operation data for this). I think presenting monthly analyses as a graph may help – considering that the analyses was actually done at a sub-annual scale.

Response: We agree with the reviewer's comment that human alterations have likely changed the fluctuations and timing of flows relative to natural conditions and recognize the importance of characterizing intra-annual variability of natural outflow. Our manuscript recommends that future work be conducted in this area. We have been engaged in modeling work to explore seasonal variability of natural outflow. However, due to the complexity of the subject matter and issues of excessive manuscript length, we determined that this subject would best be addressed in a future separate manuscript.

Comment 6. The effect of GW is clearly important and missing as the authors acknowledge. If GW depletion has occurred should this be considered a net addition of "water supply" into the basin just as inter-basin transfers from the Trinity River are considered inputs?

Response: We agree with the reviewer's comment that groundwater is an important element of the analysis. The analysis assumes that under natural conditions: (1) there is no significant groundwater inflow from the 'rim' watersheds to the valley floor, (2) the groundwater aquifer is approximately coincident with the valley floor, and (3) there is no long-term change in groundwater storage. Changes in groundwater storage must be considered at seasonal and inter-annual time scales to correctly characterize streamflows. At these shorter timescales, groundwater may act alternately as a source and then a sink. At longer time scales, the net gain or net loss in groundwater storage translates into a net loss or net gain in water supply. A long-term reduction in ground-

HESSD
12, C1709–C1714, 2015

water storage has been included in the historical water balance as a net water supply. However, under the natural condition assumptions, there is no long-term change in groundwater storage and no associated net water supply. We do not propose any changes to the manuscript on this issue but invite suggestions.

Comment 7. I am assuming urban uses are considered to be net of return sewage flows – this isn't clearly specified anywhere.

Response: The analysis presented in the manuscript considers the depletion (or consumption) of surface water and groundwater by different land uses. For agriculture and natural landscapes, depletion is equal to evapotranspiration. For urban land use, depletion is assumed equal to a fraction of the outdoor water use. All indoor water use is assumed to be non-consumptive, i.e,. all indoor water use is assumed to return to either surface water or groundwater. We do not propose any changes to the manuscript on this issue but invite suggestions.

Comment 8. The paper ends with a call for more research, which is fine but not sure that will help the immediate problem of declining fish. I am reasonably convinced by the author's central argument that "unimpaired flows" are an inappropriate standard to manage the Bay Delta and "natural flows" are a better standard. However, it is an indisputable fact that species in the Bay Delta are declining. Early on, the authors suggest the causes may lie elsewhere with sedimentation, nutrients, flow timing, temperature changes etc.). Thus, the analysis does not help actually solve the Bay Delta problem and sadly makes it much more complicated. There is a tendency among agencies to fixate on a single parameter because it is so much easier to track and communicate to the public and policy makers – but sometimes it's simply wrong. It would help sharpen the paper if this point is made more clearly at the end and also offer some alternatives if the objective is to save endangered fish species.

Response: This is an insightful comment by the reviewer. We agree that (1) there is a tendency among agencies to fixate on a single parameter and that (2) this work in

HESSD
12, C1709–C1714, 2015

isolation will not solve the Bay Delta problem. The authors refrained from discussion of other potential ecological stressors in this manuscript to focus on the hypothesized Delta outflow stressor. We believe that our criticism of the literature on the outflow stressor and the results of this focused study will be quite controversial. If we were to dilute the focus of this paper through examination (and possible criticism) of other potential stressors, we believe such a change would invite undue controversy and detract from the main point of the study.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 3847, 2015.