A Response to Comments to the Independent Scientific Review Panel of the Report, “Mercury Imports and Exports of Four Tidal Wetlands in the Sacramento-San Joaquin Delta, Yolo Bypass, and Suisun Marsh for Delta Mercury Control Program Compliance”

April 2022

Prepared by Petra Lee, California Department of Water Resources

Introduction

We thank the Independent Scientific Review Panel (ISRP) for their time and efforts in reviewing our report, "*Mercury Imports and Exports of Four Tidal Wetlands in the Sacramento-San Joaquin Delta, Yolo Bypass, and Suisun Marsh for Delta Mercury Control Program Compliance*" submitted the Central Valley Regional Water Quality Board (Regional Board) in April 2020. The ISRP reviewed DWR's compliance report for the Delta Mercury Control Program (DMCP), promulgated through the Sacramento-San Joaquin Delta Mercury TMDL and Basin Plan Amendment.

After reading the review, we wanted to respond to some of the comments. This is by no means an exhaustive response to comments, but in the interest of brevity, clarity, and transparency, we chose and addressed comments that were representative within the document. Often, the same comment was mentioned several times throughout the document, so we generally addressed it once or perhaps twice, only. We hope this clarifies our work and as shown by our response to comments and initial report ***our conclusions are supported and that in this study, the data show that these four tidal wetlands are not net annual sources of MeHg in any form.***

Flow Data

Overall, the ISRP's comments were concerned about the accuracy and use of our flow data. Our methods followed what was approved by the Regional Board in our workplan, although we were not physically able to study back-to-back spring and neap tides as planned. The study was also partly modeled after Mitchell et al. (2012), who measured the hydrology, including the hydrodynamics, of one saline tidal wetland on the east coast. Our DWR study measured the tidal exchange of methylmercury (MeHg) and total mercury (THg) of four tidal wetlands more completely than other published studies, providing new information about tidal exchange.

Because of concerns about the validity and accuracy of the flow data, we want to reassure the ISRP and others that the flow measurements were made by professional engineers who are very experienced with measuring tidal flows. The Flow Section within DWR's North Central Region Office does extensive work throughout the Delta and Yolo Bypass, works with USGS, and follows strict measurement protocols as their data is regularly used for compliance. Flow measurement calculations follow Levesque and Oberg (2012) and in this report, they used their best professional judgment and statistical models to determine best fit of the rating equation to each set of flow data.

Because of the ISRP's concerns with flow, we had the Flow Section verify their measurements as well as review the least-squared regression models used to develop the rating equations. The Senior Engineer reviewed the data to determine whether the regression equations used for the rating equations were appropriate; in brief, an alternate rating equation was used for the last 6 months at Blacklock South, though it did not cause Blacklock to be a net annual source of MeHg or THg. Because this was such a novel type of measurement and thus the flow measurements were complicated, we agreed that it was appropriate to recheck the ratings and data because of concerns.

Additional Data

We will include additional data with this response to comments. We will provide 1) updated flow information for Blacklock, including tidally averaged flow for all four wetlands, the Yolo Bypass Tidal Wetland, Blacklock, North Lindsey Slough, and Westervelt Consumnes Tidal Wetland, 2) calculations for particulate mercury concentrations, and 3) updated loads for Blacklock.

Response to Comments

1. *"The main findings of this report are not in agreement with these published works."* The works cited are Bergamaschi et al. (2011), Mitchell et al. (2012), and Turner et al. (2018), pg 55, third paragraph.
    a. While those are valuable studies, there were differences in study design and/or location that may contribute or account for the different results. In fact, the ISRP noted earlier in the same paragraph that our study, which focused on freshwater and brackish tidal wetlands, might not be representative of other tidal wetlands due differences such as salinity.

       In addition, the other studies were of one wetland, or portion of wetland in the case of Turner et al. (2018), whereas in this study we were able to capture the hydrodynamic flow of four non-leaky tidal wetlands. Previous studies in the area such as Bergamaschi et al. (2011), were only able to *estimate* flow because of the lack of non-leaky wetlands with one to two breaches only (to place meters to measure flow). After our study, it is clear that *measuring* flow as completely as possible is essential for accurate load calculations.

       Turner et al. (2018) had more uncertainty in capturing the entire flow of the wetland than our study did at any of our four wetlands, which was likely the best that could be done by Turner et al. (2018) at the time. The study authors made the helpful point that measuring the differences in MeHg in the adjacent water body, the Penobscot River, would not have detected minor differences in MeHg concentrations. They were able to measure four tidal cycles on the main channel and two tidal cycles on the side channel which represents a significant effort. However, in this study, we measured hundreds of tidal cycles which improved the accuracy of our estimates of mercury transport.

       Lastly, Mitchell et al. (2012) were able to measure the entire hydrology, including the hydrodynamics that we measured, and the accurate and complete measurement of flow was shown to be an important factor in calculating loads. Both Mitchell et al. (2012) and Turner et al. (2018) were studies of tidal wetlands on the east coast of the United States. Both studies were performed on more saline wetlands with a different dominant source of mercury than from our DWR study. These differences would likely affect the transformation of inorganic mercury to methylmercury. The Sacramento-San Joaquin River Delta and Suisun Marsh Hg sources are predominantly from historic mining rather than the aerial deposition which can dominate other watersheds (Wood et al., 2010). Other variables such as flora, salinity, carbon sources, temperature, etc., all make these two tidal systems different in ways that are not yet understood, but are likely significant, although the information derived has value.
2. *"More analysis could have been done with the ancillary measured variables. In our own analysis, we found that turbidity tended to most often peak on the ebb tide, sometime more closely to slack low tide. An example time series is given below. Over longer time periods, it appears quite clear that the Yolo marsh at least is a source of particles. Figures 12 and 20 of the report show that this marsh is almost always a sink for particulate MeHg and total Hg, respectively. This seems in contrast to one another. We suggest that further analysis could be done to take advantage of suspended solids and turbidity data, examining relationships with particulate Hg and MeHg separately for ebb and flood tides."* pg 56, second bullet.

a. We agree that more analysis could have been done, however it was out of scope for our Regional Board approved workplan. We also had tight timelines, so we did not do those analyses. We will do more analyses for an upcoming journal manuscript and appreciate the feedback.

   We address the difference between concentrations and loads in response number 12. This is an important distinction because tracking loads (sources and sinks) is only possible through load data. Our load data in Figures 12 and 20 do show that the tidal wetland is a sink of particles. However, because turbidity is not a concentration, but rather a measurement of the scattering of light by particles through water, there is no contrast. This means that turbidity cannot be used to determine whether the wetland is a source or sink of particles, and assuming it was a concentration, flow is still necessary to calculate the mass movement of the particles. The loads show that the wetland is a sink of particles, and as many tidal wetlands are depositional, this is not surprising.

3. *"There is a fairly substantial gap between the raw data provided and the much more summary data presentation/graphics in the report."* pg 55, last paragraph.

   a. It was challenging to judge what level of data to provide. DWR provided hundreds of thousands of data points as three data sheets that included the quality controlled continuous flow data, mercury concentration, organic carbon concentration, total suspended solids concentration, and chlorophyll concentration grab data, as well as the quality controlled continuous water quality sonde data that included temperature, specific conductance, total chlorophyll, dissolved oxygen, and turbidity data. These data were provided to the Central Valley Regional Water Quality Control Board along with the report; the rating equations were provided when asked. The exception was that we did not provide the velocity indexing data as that was unclear in the request though we would be more than happy to have provided it. We will provide tidally averaged flow data and updated flow data from Blacklock South, and will include our recalculated loads for Blacklock, including Blacklock South.

      In the end, DWR chose to provide the raw data, methodology, and calculated values along with charts to display the information. We will note the request for intermediate calculations in future publications. The methodology to duplicate our calculations from the raw was also provided in the report.

4. *"An opportunity to sample during major flooding in 2017 was missed."* pg 56, third bullet.

   a. The ISRP was correct that we did not collect samples during the 2017 flood. There were several reasons we did not sample during any flood flows, which includes during the 2017 flood. The main reason was that it was outside the scope of our Regional Board approved workplan. Additionally, sampling the wetlands while the area was flooding was dangerous. Staff was very limited for two reasons including, 1) staff were collecting data for the Yolo Bypass Open Water model, and 2) staff were deployed for the emergency response at the Oroville Spillway that DWR was leading.

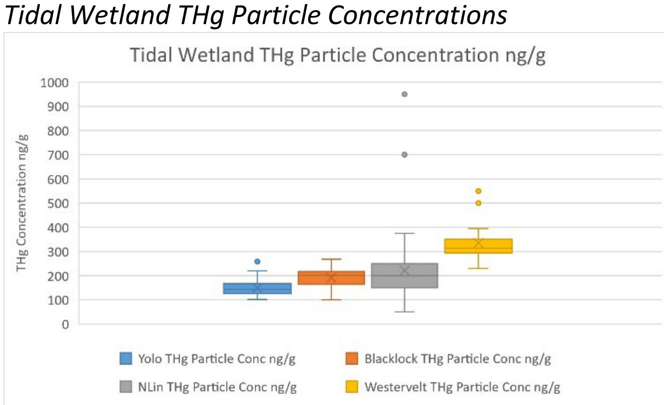
      We did not to collect concentration data without flow because 1) we stayed within scope of our Regional Board approved study design and therefore focused on load calculations, 2) the rating equation we developed did not account for flood flows, 3) developing a rating equation for flood flows is prohibitively dangerous and difficult, and 4) collecting concentration data during flood flows was an unacceptable risk to our staff.

To elaborate regarding the rating equation, DWR staff collected flow data for an approximately 25-hour tidal cycle to develop a rating equation during flows that would encompass the range of flows in the channel, meaning we needed high tides. Once developed, the rating equation was used to calculate flows from velocity and level data collected by the flow instrumentation (Acoustic Doppler Current Profiler, or ADCP) for the rest of the period. The rating equation was appropriate for the range of flows we used to develop it and flood flows exceeded that range.

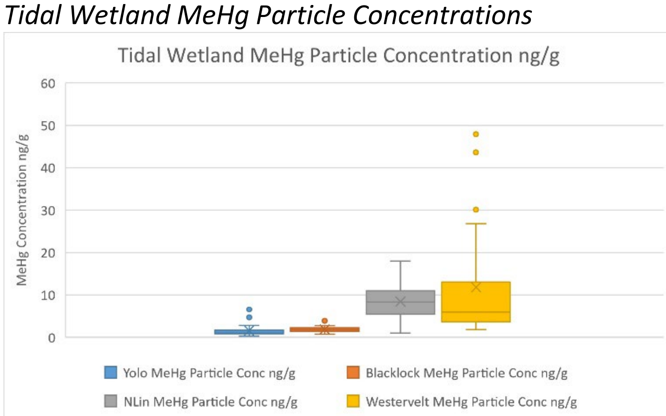
5. *"From the particulate numbers, it does not appear that any of the marshes were in Hg contaminated areas."* pg 56, sixth bullet.

    a. The DMCP was implemented in these areas because of the high concentrations in water, and while particulate concentrations in the water were not presented, particulate THg concentrations ranged from 50ng/g to 950 ng/g and particulate MeHg concentrations ranged from 0.28 to 48 ng/g (see below). We did these calculations after submitting the report in April 2020 for our own edification and will provide these calculations to the Regional Board, though the raw data we provided allows these values to be calculated. Below are two box plots of the particulate concentration data.

    Tidal Wetland THg Particle Concentrations



    Tidal Wetland MeHg Particle Concentrations



6. *"Though we understand that this may have been outside of the authors' control, we were struck somewhat that no wetlands were within the Central Delta, San Joaquin or Sacramento River areas."* pg 56, sixth bullet.

    a. Following our approved workplan and taking into consideration which wetlands we could accurately measure the hydrodynamic flow, no wetlands in the Central Delta, San

Joaquin or Sacramento River areas met our study parameters. These study parameters included having only 1-2 breaches through which water flowed, meaning they were not hydrodynamically leaky. DWR studied all the tidal wetlands within the TMDL areas that did fit the approved study criteria, and one outside the area. When developing our workplan, it appeared that more tidal wetlands would meet our study parameters, but upon examination, the wetlands such as Decker Island and Wildlands Liberty Island Conservation Bank did not meet our criteria.

7. *"There remains a disconnect between this study and the "open water" study."* pg 56, last paragraph.

   We agree that there is a disconnect between this study and the Delta model, but not the Yolo Bypass model. The data were not available in time for incorporating into either model, nor was data incorporation within either project's scope.

   The goals of the Yolo Bypass model development differed from the Delta model in that it was run for flood flows whereas the tidal wetlands were intended to be studied when the wetlands were not flooded. Because the Yolo Bypass model and the tidal wetland study were executed during different periods and flow regimes (flood plain versus tidal system), the data they produced were not compatible nor is it our understanding that they were intended to be comparable.

8. *"Alternatively, it is unclear from the presentation of data if any of the small wetlands tested here, outside of the Blacklock wetland, ever had water overtopping the marsh."* pg 57, first sentence.

   a. We only studied tidal wetlands where we could measure all the flow entering and exiting the wetland through surface water, the hydrodynamics. Because of that study constraint, none of the wetlands could be or ever were overtopped when we studied them. The Yolo wetland was incorporated as part of the flood plain when the Yolo Bypass flooded, and those two systems act very differently with mercury methylation and transport. Lastly, if the water was high enough to reach out of bank, the rating equation to calculate the flow data would not be applicable and accurate flow and load calculations would not be possible. Response number 4 in this document elaborates on the rating equations limitations during flood flows.

9. *"Possibly hydrological calculation errors: …We suspect that fluxes of water (and possibly Hg) were incorrectly calculated…we are not able to re-run all of the flux analyses to confirm."* pg 57, number 1.

   a. The ISRP suspected that we had miscalculated flow because of the order of magnitude difference in median sampled flow between Blacklock and two of the three other wetlands. ***<u>All calculations have been reviewed and are accurate.</u>***

      There are several variances in how we did our calculations in Tables 4 and 7 and how the ISRP did their calculations. First, the ISRP only calculated flow for one breach at Blacklock, the south breach, while we calculated flow at both north and south breaches to capture the entirety of the flow. Second, how we calculated median flow in tables 4 and 7 appears to be different than how the ISRP calculated mean flow.

      Tables 4 and 7 that the ISRP discussed show the Wilcoxon Signed-Rank Test and median results of the 25-hour events that we collected mercury data during. We used entirely non-parametric statistics, including median rather than average/mean that the ISRP calculated. In the example used for Blacklock, we analyzed the flows for the 11 (not 10) 25-hour events that we sampled, whereas it appears the ISRP analyzed 13 random tidal cycles; analyzing random data will not net the same outcome as our 11 25-hour sampling events. These reasons likely account for the differences in calculated results.

In addition to the calculated differences, it makes sense to us that Blacklock had an order of magnitude larger ebb and flood flows than two of the other wetlands. The differences were for several reasons. First, Blacklock has two breaches that have a larger amount of flow than the other wetlands. Second, Blacklock is physically larger than the other tidal wetlands studied. Third, the water velocity at Blacklock was far higher than at the other wetlands, which was why we could not install water quality sondes in the breaches as we did at the other three wetlands. The flow is higher at Blacklock than the other wetlands, by a significant volume, and that's apparent by the range of the continuous flow at Blacklock versus the other tidal wetlands; it must be noted that at Westervelt during January 2019, the flows were high thus there is a large negative flow into the wetland not seen at other times. The ranges of continuous flow are Blacklock north (-1070-784 cfs), Blacklock south (-891-898 cfs), Yolo (-362-250 cfs), North Lindsey (-274-198 cfs), and Westervelt (-1520-270 cfs).

Lastly, we provided the quality assured continuous flow data and the concentration data to the Regional Board, including the periods during which samples were collected which allow for a duplication of our calculations. These data are publicly available on DWR's Water Data Library, and we can provide it again upon request.

10. *"Hydrological/flow velocity measurement bias."* pg 57, number 2.

    a. We appreciate the ISRP's thorough review and will address the concerns, including clarifying terminology and the study intent. First, we want to clarify that we did not measure the full hydrology, we measured the hydrodynamics only, consistent with our Regional Board approved workplan. Measuring the full hydrology is a worthy pursuit but was outside of the scope of this study because of the cost and difficulty. We considered measuring the full hydrology, which would include evapotranspiration, groundwater, precipitation, and overland flow, but that would have made the study prohibitively expensive and difficult. Instead, the study was focused on developing hydrodynamics and load data needed to inform the DMCP regulation.

       Because of the ISRP's comments, our senior flow engineer re-evaluated the rating equations and flow for all four wetlands, and we will provide the Regional Board with the updated flow data for Blacklock. For the second half of Blacklock south monitoring (north was not affected), from December 2015 through June 2016, we used a best-fit quadratic equation for the rating equation. However, after this review and considering the options, the flow engineer chose to use a linear equation rather than a quadratic equation for the rating equation. The quadratic equation fit the rating equation data better, but a linear equation was more consistent with the previous rating equations for the Blacklock flow monitoring. Additionally, quadratics can cause large extrapolation errors if the calibration data was not able to fully cover the range of velocities experienced over the study period. Using a quadratic equation did not change the overall MeHg load results; however, meaning that the wetland was still not a significant source or sink of MeHg in any form at Blacklock. Below are the new calculations for the 25-hour sampling events and only the flow is a significant sink, MeHg is neither a significant source nor sink. THg was a significant sink for both forms. Negative values mean the wetland is a sink, and positive values mean the wetland is a source.

Updated Blacklock methylmercury ebb flood concentration statistical analysis

Blacklock	**Flow (l/tide)**	**Unfiltered MeHg (g/tide)**	**Filtered MeHg (g/tide)**	**Particulate MeHg (g/tide)**
Wilcoxon statistic	5	12	10	15
Wilcoxon p-value	0.039	0.250	0.164	0.426
Median	-103,864,827	-0.0114	-0.0022	-0.0068

Updated Blacklock total mercury ebb flood concentration statistical analysis

Blacklock	**Flow (l/tide)**	**Unfiltered THg (g/tide)**	**Filtered THg (g/tide)**	**Particulate THg (g/tide)**
Wilcoxon statistic	5	0	4	0
Wilcoxon p-value	0.039	0.004	0.027	0.004
Median	-103,864,827	-2.7	-0.14	-2.5

Second, all four wetlands sometimes showed what the ISRP called a “bias” toward a negative flow value, meaning more water entered than left each tidal wetland. After submitting our report, we calculated net flow using a Godin filter. A Godin filter removes the tidal signal from continuous flow data to calculate a tidal average or “net flow”. The net flow showed that it was not the case that all the tidal wetlands were consistently sinks for water, North Lindsey had a median net flow of 2.1 cfs. Using the data without a Godin filter (see table below), all wetlands had a positive median except for Blacklock South (we calculated median for both breaches). A negative flow means the wetland is a sink of water and a positive flow means the wetland is a source of water

Median flow for four wetlands, both breaches at Blacklock

	Yolo	**Blacklock North**	**Blacklock South**	**North Lindsey**	**Westervelt**
Median Flow (cfs)	18	19	-26	0.8	5.2

As a conceptual fate and hydrodynamic model, when water enters the tidal wetlands, the water slows down and generally ends up in a shallower channel. Tidal wetlands tend to be depositional for this reason, and water would be more likely to infiltrate the ground or evaporate under these conditions. Additionally, the tidal wetlands also had more vegetation than the adjacent channels which would increase transpiration rates.

Third, it seems important to provide additional information about how the ADCPs were placed and how they measured the water movement. The ADCPs were bolted to heavy blocks and placed and replaced into the center of the channel until level (within 2 degrees in the X and Y direction). After the ADCPs were placed, they were allowed to settle for 1-2 weeks. During that time if the ADCP shifted more than 2 degrees from zero, the process was repeated until the ADCP was stable. After this stabilization process, a rating equation was developed to match this placement.

The rating equation was a least-squares regression equation that best fit the data and what initially fit the rating data was used. In the case of Blacklock, we initially used a quadratic equation based on the rating, but later chose to use a linear regression for the rating equation to calculate flow. Because we were measuring a range of water level and velocities to calculate the flow, we aimed for tides with more extreme high and low water levels to capture the broadest set of flows. The maximum water level measured during the rating was a boundary for how high of a flow we could calculate using the rating equation.

Because of multiple instrument failures, flooding, and other unexpected events, we had to repeat the ADCP installation and stabilization process, often several times, during each year at each wetland. As noted above, we did adjust our rating equation for the second half of collection at Blacklock. Ideally, we would have been able to collect flow data after one ADCP placement and rating equation. Unfortunately, natural tidal systems are challenging to measure, and as with most field studies, did not entirely follow our whims.

We welcome ISRP feedback on the organic carbon data comment we received in the review. The dissolved organic carbon (DOC) loads were calculated using the same method as the MeHg and THg loads. The DOC loads were seen as credible using the flow data; however, the ISRP seemed to be concerned with the MeHg and THg loads because of the same flow data. Further clarification on this issue would be appreciated.

11. *"Water budget issues likely impact estimated sink/source function of wetlands for Hg and MeHg."* pg 58, number 3

    a. DWR disagrees that the water budget has the significant issues as outlined by the ISRP. We never expected the water budget to be net zero as that does not seem likely in a natural system, especially over an approximately 25-hour tidal cycle. For example, Bergamaschi et al. (2011) also showed that Brown's Island was a net sink of water, though they were not able to measure all water flow due to the leakiness of the tidal wetland. As mentioned above, after calculating net flows, we did not see that the wetlands were net sinks for water; sometimes they were sinks, sometimes sources and we attempted to capture that in our monthly estimates of mercury.

       Of note, the ISRP mentioned, *"Problematically for example, the wetlands acting as the strongest net sinks for MeHg are also those with the strongest net imbalance of flows, such that much more water is coming into those wetlands than going out."* We disagree with this statement for two reasons. First, we outlined that these wetlands varied in whether they were net sources and sinks for flow; they certainly were not all net sinks (see the previous response, number 9). Second, loads = flow x concentration, meaning flow is 50% of the input of the equation. In this study, we were able to measure flow at a higher resolution at four tidal wetlands, which was more than other studies have been able to do.

"Finally, specific conductance data could be used to help support or refute the water budget estimations." We are unsure of how this will work in a freshwater system as other freshwater inputs are unlikely to change the specific conductance very much. However, we are going to work with flow engineers to calculate dispersive and advective flow using our flow and continuous specific conductance data in the near future. We can provide this data to the Regional Board and will consider adding it to future publications.

12. The ISRP favored analyzing concentrations over loads. *"An example from the Yolo wetland that illustrates the above point."* pg 58, number 4.

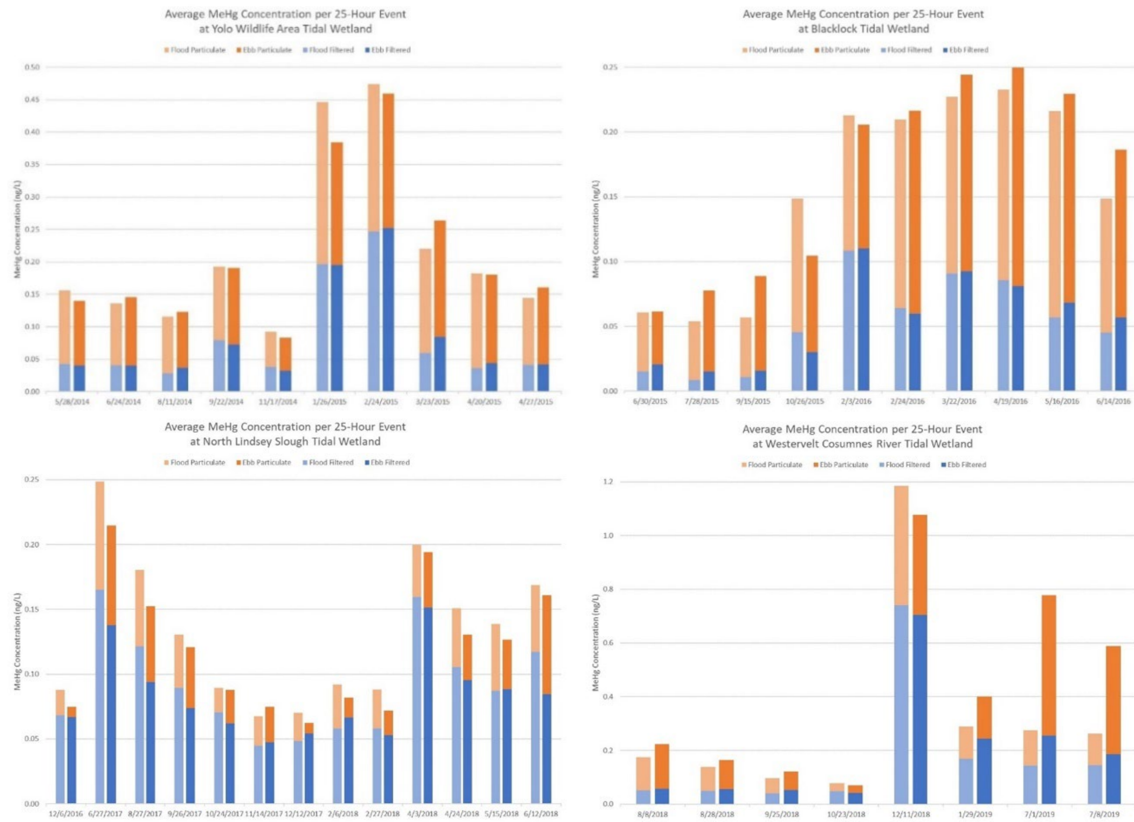
    a. Throughout the document, the ISRP focused on concentration rather than loads. While we recognize that biologically, concentration is very important, we deferred to loads because we were measuring the masses of water and Hg, which is the *only* way to measure whether a tidal wetland is a source or sink of MeHg and THg. Concentrations are only a part of the load calculation (see response number 11). Because this is the most thorough dataset of its kind, this study confirmed the conclusions of Mitchell et al. (2012) identifying the importance of accurate flow measurements in determining transport of Hg.

       If the net flow was zero, meaning the ebb and flood tides were equal, the concentrations would be the main driver of the mass load in the equation. However, the Hg concentration data still did not show any of the tidal wetlands to be a net source of MeHg over the year. During some periods, the wetlands could be sources of MeHg; however, our data showed these wetlands not to be net sources on an annual basis.

13. "*We found that average concentrations (both arithmetic averages and flow weighted averages) of nearly all constituents measured - uMeHg, PMeHg, and PTHg – as well as TOC and POC - were higher in ebb tide waters.*" pg 57, number 4

    a. We did not see the pattern for Hg that the ISRP noted other than for *THg*, not MeHg, at Westervelt and North Lindsey, which was confirmed by the statistics. **<u>MeHg was not at consistently higher concentrations during ebb tides.</u>** The data show a mixture of higher and lower concentrations in the ebb tides, which was confirmed by the statistics. We used a Wilcoxon Signed Rank test to test differences between ebb and flood tide concentrations and MeHg was not significantly higher in ebb floods ($\alpha = 0.05$). We are including the figures from the report that show the data to show the variations among Yolo ($p = 0.84$), Blacklock ($p = 0.15$), North Lindsey ($p = 0.00$, ebb tides had a significantly lower concentration than flood tides), and Westervelt ($p = 0.11$); it's worth noting the magnitude of concentration differences. We used a flow weighted concentration, which was important because these concentrations are representative of portion of the 25-hour tidal cycle.

MeHg flow-weighted average concentrations per 25-hour event at four wetlands



14. "*However, the report shows PMeHg efflux from the marsh for this event in Figure 9, but net influx for the monthly loads in Figure 12. How does that possibly come about? We suggest that this is most likely driven by issues with tidal water flux calculations.*" pg 58, number 4.

    a. We would like to clarify these data as it seems the ISRP did not interpret the data as intended. The calculations in Figure 9 are for the measured 25-hour events, whereas Figure 12 shows the estimated monthly loads. Because loads are a calculation including mercury concentration and flow, the flow has a very real and significant effect on loads. These two figures show different loads because the durations are 25 hours (Figure 9) vs a month (Figure 12). **The difference in results shows how significant flow is when calculating loads.**

15. *"Lack of uncertainty analysis… We point the report authors to Ganju et al. (2005), which is a helpful reference for examining errors and uncertainty for mass fluxes in tidal wetland systems."* pg 59, number 5.

    a. We agree with the ISRP that an uncertainty analysis would be beneficial. However, an uncertainty analysis cannot be done with the data we collected. We consulted engineers who work with tidal flow measurements who informed us that **there is not currently a method to calculate uncertainty in a tidal system without continuous mercury data.**

    The only uncertainty analyses that we have come across for similar studies are 1) using an error for a gravity flow, not tidal flow that was likely biased low (Mitchell et al., 2012) or 2) using advective and dispersive flow calculations which we cannot do as we do not have continuous mercury data (Ganju et al., 2005). We hope that continuous mercury monitoring becomes a reality in the future because understanding advective and dispersive mercury flux is likely important in understanding transport and sources.

16. "*A further examination of the data specific for times when some flooding of the wetlands' surfaces would have occurred.*" pg 59, number 6

    a. We agree this would have been a worthy endeavor had it been within the scope of the study. The area of the wetland that was wet at any given time may have provided a better estimate of loads per area, but unfortunately, we were not able to collect that data. All the tidal wetlands stayed wet or moist within and around the channels, including Blacklock. If the tidal wetland had dried out, that would have increased mercury methylation, however all wetlands stayed wet and moist from our observations.

17. "*If most flows are sustained only within channels, this would also bias low the net outputs of MeHg from these systems if the rest of the wetland systems themselves are not substantially flooded/interacting with tidal flows.*" pg 59, number 6.

    a. We do not understand this comment and would welcome a chance for clarification.

18. "*These additional measurements which would help to resolve differences between this study and observations of the YBP mass balance in the Open Water report.*" pg 60, response to a.

    a. As explained in the response number 7, the Yolo Bypass model operates during flood flows only. The tidal wetlands study did **not** calculate loads nor measure flow when the Yolo Bypass was flooded. When the Yolo Bypass flooded, the tidal wetland was also flooded and acting as part of the flood plain.

19. "*Currently, however, the main findings are somewhat contrary to finding from other studies that generally find tidal wetlands to be sources of MeHg and are seemingly in contrast to the Yolo Bypass mass balance findings in the Open Water report.*" pg 60, response to a.

    a. We addressed the concern of our results versus those of other studies in response number 1. Additionally, we have found few studies that measured flow at a hydrodynamically bounded tidal wetland. The flow and mercury data collected for this DWR study is more comprehensive than any other tidal wetland study in this region, thus it provides more accurate measures of flow. Other studies in the region did not have hydrodynamically bounded tidal wetlands available to study as we did, so they did their best to estimate flows and provided initial information that we can now build upon. Because of the availability of newly restored tidal wetlands for our DWR study, we were able to do a more comprehensive study of this type than has been possible before.

       To address the concerns about the Yolo Bypass mass balance and the tidal wetlands study, please see the previous response, number 18.

Conclusion

Once again, we'd like to thank the Independent Science Review Panel for their efforts in reviewing our study. We hope that by addressing the comments and confirming and updating the flow and other calculations, we have clarified our work. The data show our conclusions are supported, and we hope this document makes that more apparent. We welcome discussions about this work and are more than happy to discuss this further.

Work Cited

Bergamaschi, B. A., Fleck, J. A., Downing, B. D., Boss, E., Pellerin, B., Ganju, N. K., Schoellhamer, D. H., Bytington, A. A., Heim, W. A., Stephenson, M., and Fuji, R. (2011). Methyl mercury dynamics in a tidal wetland quantified using in situ optical measurements. *Limnology and Oceanography, 56*(4), pp 1355-1371.

Mitchell, C. P., Jordan, T. E., Heyes, A., and Gilmour, C. C. (2012). Tidal exchange of total mercury and methylmercury between a salt marsh and a Chesapeake Bay sub-estuary. *Biogeochemistry*. doi:10.1007/s10533-011-9691-y

Turner, R. R., Mitchell, C. P. J., Kopec, A. D., Bodaly, R.A. (2018). Tidal fluxes of mercury and methylmercury for Mendall Marsh Penobscot River estuary, Maine. *Science of the Total Environment,* 637-638, pp 145-154

Wood, M. L., Foe, C. G., Cooke, J., and Louie, S. J. (2010). *Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury.* Staff Report, California Regional Water Quality Control Board - Central Valley Region, Rancho Cordova.