Special Study Proposal: Support for Sediment Bioaccumulation Evaluations Part 2

Summary: The Dredged Material Management Office (DMMO) is responsible for approving millions of cubic yards of routine dredging projects in San Francisco Bay to maintain safe navigation. Dredged sediment as well as the remaining residual sediment are evaluated to ensure projects do not cause adverse environmental impacts. We propose to support sediment bioaccumulation testing evaluations through two targeted studies. The first is to review all the PCB bioaccumulation test results from San Francisco Bay to assess the performance of current bioaccumulation testing trigger thresholds. The results of this review may be used to support reassessing these thresholds. The second is to review and recommend a standard set of values for bioaccumulation modeling. This information would ensure that bioaccumulation modeling evaluations use the best available science and are consistent within the region. The recommendations from this study will save dredgers and regulators time and money by improving the efficiency and consistency of dredging project evaluations.

Estimated Cost: $48,000

Oversight Group: Sediment Workgroup, PCB Workgroup

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PROPOSED DELIVERABLES AND TIMELINE

Deliverable	**Due Date**
Task 1: Kickoff Meeting with DMMO Stakeholders	January 2019
Task 2: Compilation of Preliminary Results (PCB bioaccumulation test results and bioaccumulation model parameters)	March 2019
Task 3: Mid-Project Meeting with DMMO Stakeholders	June 2020
Task 4: Draft Report	July 2020
Task 5: Final Report	October 2020

Background

Every year, millions of cubic yards of sediment are dredged in and around San Francisco Bay to maintain safe navigation. The Dredged Material Management Office (DMMO) is an interagency group, led by the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency Region 9 (USEPA), San Francisco Bay Conservation and Development Commission, the San Francisco Bay Regional Water Quality Control Board, and the State Water Resources Control Board. It is responsible for approving routine dredging projects in an economically- and environmentally-sound manner. Both the dredged sediment and the remaining residual sediment (post-dredge surface sediment) are systematically evaluated for negative impacts to aquatic organisms or human health due to potentially bioaccumulative compounds. The evaluation process requires sequential assessment of bioaccumulation in sediment, benthic organisms, and fish. The potential for bioaccumulation in fish is evaluated using a model if sediment and benthic organism screening criteria are exceeded.

For bioaccumulative compounds, the regulatory evaluation process for routine dredging projects in the Bay is determined by the sediment concentration.

1. If sediment concentrations are below the bioaccumulation trigger (BT): in-Bay sediment disposal of dredged sediment is acceptable.[1]
2. If sediment concentrations are above BTs but below TMDL in-Bay disposal limits: detected compounds are evaluated using a risk assessment approach (Step 2) that requires sediment bioaccumulation tests and analyses to determine whether in-Bay disposal is acceptable.[2]
3. If sediment concentrations exceed TMDL in-Bay disposal limits: in-Bay disposal is not allowed. (However, additional evaluation may still be required to consider acceptability for ocean disposal.)[3]

In 2012, the DMMO eliminated Step 2 for evaluating exposures to mercury for navigational dredging that will be discharged back into the Bay at designated unconfined aquatic disposal sites. The decision was due to findings from an analysis (EFH Consultation, 2011) that found that the number of mercury bioaccumulation tests conducted for sediment concentrations between the BT and TMDL was negligible and that none of the tested sediment would have "failed" in-Bay placement tests (Ross, 2012). Post-2012, dredged sediment with mercury concentrations below the TMDL has been cleared for possible disposal at in-Bay locations and dredgers and the DMMO have not spent time and money on mercury bioaccumulation tests. To date, the DMMO Database includes approximately 30 studies that have conducted PCB bioaccumulation tests between 2011 to present. Similar to the process for mercury, analysis of these data is likely to provide the information needed to evaluate the efficacy of the PCB bioaccumulation testing threshold.

In Step 2, potential negative impacts on benthic organisms due to exposure to Bay sediment are first evaluated by comparing bioaccumulation test (using benthic organisms) results with toxicity reference values (TRVs) that are chosen based on published studies showing

[1] For all target bioaccumulating compounds: Mercury, Total PCBs, Total PAHs, Total DDTs, Total Chlordane, Dieldrin, Dioxins/Furans (https://www.sfei.org/projects/dmmo-ambient-sediment-conditions)
[2] For all target bioaccumulating compounds, except mercury
[3] For Mercury and Total PCBs

"effects" at particular concentrations. When bioaccumulation tests show TRVs may be exceeded in exposed invertebrates, biomagnification in the food chain is further evaluated using the Bioaccumulation Risk Assessment Modeling System (BRAMS) model, which contains two separate modules: the Trophic Trace model (TT) and the Bioaccumulation Evaluation Screening Tool (BEST). For organic compounds, the sediment-based food-web Trophic Trace model predicts fish concentrations using either user-specified sediment concentrations or tissue concentrations from bioaccumulation tests. For sediment dredging evaluations, the food web is typically modeled with the TT tool by specifying parameters for modeled fish, e.g., lipid content and weight, and their benthic diet.

The TMDL for PCBs includes a target tissue concentration for sport fish of 10 ppb (wet weight). However, ambient fish tissue concentrations in the Bay frequently exceed this target, so comparison to the TMDL target alone would "fail" much of the dredged sediment in the Bay even if they are cleaner than existing sediments. Instead, because PCB tissue concentrations in Bay-dwelling shiner surfperch and white croaker are the highest of all sport fish monitored in the Bay, dredging evaluations typically involve modeling biomagnification in these two species and comparing predicted tissue concentrations to reported ambient tissue concentrations. If conservative modeling indicates that exposure to a project's sediment would result in sport fish tissue concentrations that do not exceed current ambient levels, further evaluation is not needed. However, currently, certain steps in the modeling method and evaluation process are not standardized and need to be coordinated between dredgers and the DMMO on a case-by-case basis. Standardized Trophic Trace model inputs would make this evaluation process more efficient and consistent across the region.

This two-part study would be in support of the DMMO evaluation framework. First, this study will synthesize available PCB bioaccumulation test results in the DMMO database to evaluate the performance of the existing PCB bioaccumulation trigger as a tool for assessing the impact of dredged sediment. Second, this study would develop a recommended, standardized list of input data for Trophic Trace bioaccumulation modeling based on a literature review. These studies are related in that evaluating the PCB bioaccumulation trigger will necessarily involve conducting example modeling runs using parameters calculated herein, which will in turn help inform standardization of model inputs.

Evaluating the existing bioaccumulation trigger for PCBs and developing regionally standardized BRAMS model inputs should result in savings of time and money for dredgers and LTMS managers alike. These two studies would significantly streamline DMMO's evaluations, improving the consistency of decision-making across dredging projects.

Study Objectives and Applicable RMP Management Questions

This study will provide information and methods essential for evaluating bioaccumulation test results for dredging projects. This information is directly relevant to the following management questions for the RMP and the Sediment Workgroup (Table 1).

Overarching RMP Management Questions:

- 1: Are chemical concentrations in the Estuary potentially at levels of concern and are associated impacts likely?
  - 1.1: Which chemicals have the potential for impacts?
  - 1.2: What is the potential for impacts due to contamination?
  - 1.3: What are appropriate guidelines?

Table 1: Study objectives relevant to RMP Sediment Workgroup management questions

Management Question	Study Objective	Example Information Application
1) What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?	Develop targeted studies that: 1) assess the performance of current bioaccumulation testing trigger thresholds and the need for reassessment; and 2) recommend a standard set of values for bioaccumulation modeling that will ensure bioaccumulation modeling evaluations use the best available science and are consistent within the region	Provide key information that will result in cost savings for dredgers and permitting agencies by improving the efficiency and consistency of dredging project evaluations
2) Are there effects on fish, benthic species, and submerged habitats from dredging or placement of sediment?		
3) What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?		
4) How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?		
5) What are the concentrations of suspended sediment in the Estuary and its segments?		

Approach

We propose to support sediment bioaccumulation testing through two targeted studies. The first is to evaluate all the PCB bioaccumulation test results to assess the performance of current bioaccumulation trigger thresholds. The second is to recommend a standard set of values used for bioaccumulation modeling. The goal of this study is to make the evaluation process more efficient and consistent for dredgers and regulators.

1. Sediment Bioaccumulation Evaluation

The first part of this study is to evaluate the PCB bioaccumulation trigger by collecting, synthesizing, and analyzing results from PCB bioaccumulation testing reported to the DMMO for projects from 2011-present. With guidance from the DMMO, we will identify all bioaccumulation testing projects and extract all relevant PCB data. Data will be extracted from the DMMO database, as well as from reports not currently included in the database. Results from these reports will be added to the DMMO database as part of this study's data compilation task. Initial data analysis will include calculating total PCB concentrations from congener data as well as evaluating quality of tissue data analyses (e.g., detection of PCBs in control samples, evaluate detection limits, and evaluating frequencies of detection of different congeners). Similar to Figure 1, we will compare these bioaccumulation testing results to the Regional Monitoring Program's ambient fish tissue concentrations for shiner surfperch and white croaker and relevant PCB thresholds. These thresholds include TRVs for benthic organisms and TMDL targets for aquatic resources and wildlife as well as TMDL targets for human health. We will input the bioaccumulation results to the BRAMS model (using standard model inputs recommended from the second part of this study described below) in order to estimate bioaccumulation of PCBs in fish. We will compare the resulting fish tissue concentration model outputs with the same list of thresholds, i.e., TMDL targets, and RMP ambient fish concentrations. This study will also summarize the most recent RMP data on ambient fish tissue concentration data for the Bay (Sun et al., 2017) to clarify the values to which modeled fish concentrations should be compared. Additionally, we will estimate the total mass of dredged material with PCB concentrations below the BT, between the BT and TMDL, and above the TMDL, in order to place the testing results in context.

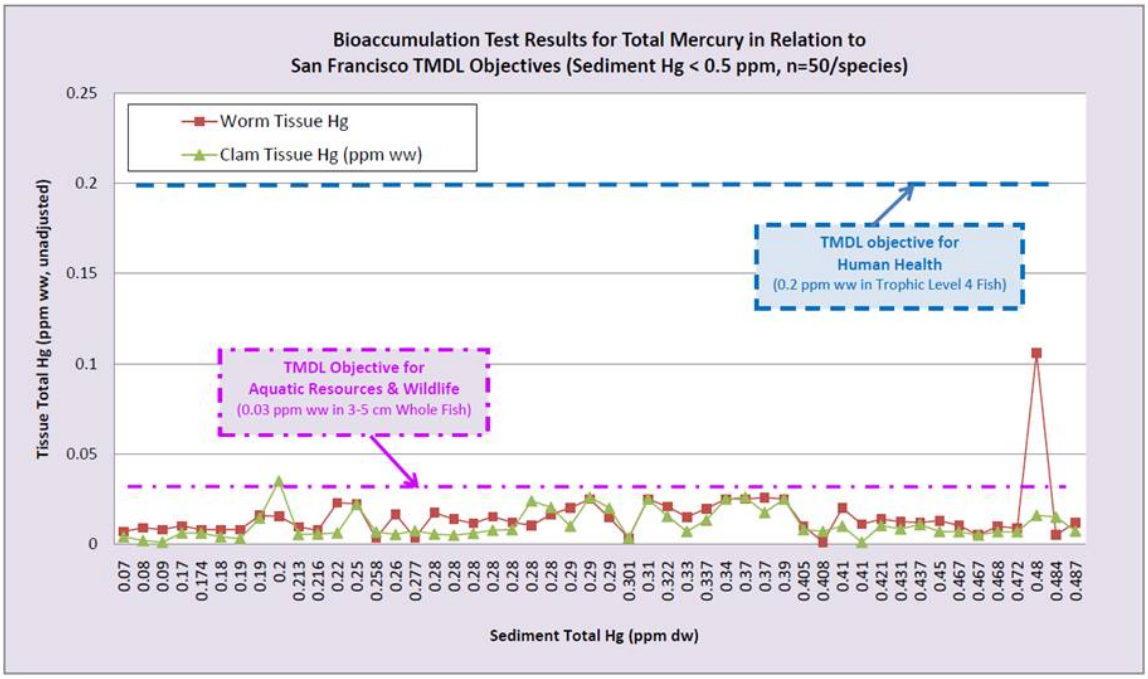

Figure 1 Findings from the mercury bioaccumulation-testing-analysis study mentioned in the background of this proposal (Ross, 2012).

2. Bioaccumulation Model Inputs

The second part of this study is to provide direct support for evaluations of food web transfer associated with contaminants in dredged sediment. We will review the latest literature, DMMO testing data, and RMP data and evaluations to develop a recommended list of standard bioaccumulation model inputs for food web modeling in BRAMS. This list will include parameters for modeled fish, composition of diet (lipid content of benthic organisms), and the physical and chemical parameters listed in Table 2. We will evaluate the sensitivity of predicted fish tissue concentrations to uncertainties or potential ranges in model input parameters as a basis for recommending standard values that are appropriate for screening level evaluations of Bay sediment. The list of partition coefficients will include recommended values to represent total PCBs, total PAHs, total DDTs, total chlordanes, dieldrin, and dioxins/furans. Recommendations will be developed based on discussions with DMMO.

Table 2: Model input parameters

Modeled fish lipid content
Modeled fish weight
Modeled fish diet lipid content
Composition of diet (sums to 100%)
Sediment TOC concentration
Overlying water particulate organic carbon
Overlying water dissolved organic carbon
Overlying water temperature
Contaminant organic carbon-water partitioning coefficient
Contaminant octanol-water partition coefficient

Budget

The following budget represents estimated costs for this proposed special study (Table 3). Efforts and costs can be scaled back by reducing the number of compounds evaluated.

Table 3. Proposed Budget.

	Costs	Estimated Hours	Estimated Budget
Sediment Bioaccumulation Evaluation	Project Staff (SFEI)	215	$22,500
Bioaccumulation Model Inputs	Project Staff (SFEI)	185	$25,500
		Total	**$48,000**

Budget Justification:

Project staff costs are based on estimated time required to:

1. **Sediment Bioaccumulation Evaluation**
    - Compile complete DMMO PCB bioaccumulation testing results from DMMO database and add any missing studies from reports. (80 hrs)
    - Analyze and evaluate data: compare sediment, benthic tissue, and predicted fish tissue PCB concentrations with relevant thresholds and ambient fish concentrations; discuss with DMMO. (50 hrs)
    - Calculate mass of dredged material. (15 hrs)
2. **Bioaccumulation Model Inputs**
    - Review literature on bioaccumulation model parameters. (55 hrs)
    - Implement model to test sensitivity to uncertainties in model inputs. (30 hrs)
    - Recommend standard values for model inputs and summarize ambient fish concentrations. (30 hrs)
3. **Reporting and Meetings** (split between the two tasks in Table 3. Reporting costs will be a higher if the tasks are funded independently)
    - Kickoff and mid-project meetings with DMMO stakeholders (25 hrs)
    - Draft Report (75 hrs)
    - Finalize Report (40 hrs)

Reporting

The primary deliverable will be a final technical report due in October 2020. A draft report will be prepared by July 2020.

References

Kendall, T. and Brush, J. EFH Consultation Letter to NOAA's National Marine Fisheries Service. San Francisco, CA. 12 March 2012.

Ross, B. 2012. Summary and Evaluation of Bioaccumulation Tests for Total Mercury Conducted by San Francisco Bay Dredging Projects Prepared in Support of Modifying the June 9, 2011 Programmatic Essential Fish Habitat (EFH) Consultation Agreement for San Francisco Bay Maintenance Dredging Projects. Long-Term Management Strategy. (http://www.sfei.org/sites/default/files/project/EFH%20Hg%20modification%20agreement%20%26%20report%2003-06-2012.PDF)

Sun, J.; Davis, J. A.; Bezalel, S. N.; Ross, J. R. M.; Wong, A.; Fairey, R.; Bonnema, A.; Crane, D. B.; Grace, R.; Mayfield, R. 2017. Contaminant Concentrations in Sport Fish from San Francisco Bay, 2014. SFEI Contribution No. 806.