DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, U.S. ARMY CORPS OF ENGINEERS
1455 MARKET STREET
SAN FRANCISCO, CALIFORNIA 94103-1398

AND

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 HAWTHORNE STREET
SAN FRANCISCO, CALIFORNIA 94105

Steven A. Edmondson
Northern California Habitat Conservation Manager
NOAA's National Marine Fisheries Service
Southwest Regional Office
777 Sonoma Ave, Rm 325
Santa Rosa, CA 95404

Subject: Modification to the 2011 "Agreement on Programmatic EFH Conservation Measures for Maintenance Dredging Conducted Under the LTMS Program (Tracking No. 2009/06769)" - Concerning Mercury Bioaccumulation and Residuals Testing

Dear Mr. Edmondson,

In June 9, 2011, the Environmental Protection Agency (EPA) Region 9, the US Army Corps of Engineers (USACE) San Francisco District, and your office completed a programmatic consultation under the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The completed consultation included a comprehensive suite of Conservation Measures designed to minimize impacts to EFH that may result from USACE and/or private maintenance dredging projects managed under the *Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region* (LTMS Program). We are pleased to be writing today to document our agreement to implement slight modifications to Conservation Measures 7 (Bioaccumulation Testing) and 8 (Residuals), specifically concerning mercury testing. We appreciate the close coordination we have enjoyed with your staff in reaching these agreed modifications.

Conservation Measure 7 established a method to systematically identify sediment concentrations for several potentially bioaccumulative compounds, including mercury. Above these "bioaccumulation trigger levels" the LTMS agencies would require bioaccumulation testing prior to reaching suitability determinations for dredged sediments proposed to be discharged at in-Bay disposal sites. Conservation Measure 8 established that residual samples (representing the new sediment surface exposed after dredging) would generally be chemically evaluated when the overlying sediment exceeded the bioaccumulation trigger levels. The bioaccumulation trigger level for mercury was based on San Francisco Bay ambient sediment concentrations.

When we began working on the LTMS Programmatic EFH consultation, we all realized that a mercury bioaccumulation trigger level based on Bay ambient sediment concentrations would probably be exceeded fairly often, especially in and around Central and San Pablo Bays, triggering expensive bioaccumulation testing for a number of small marinas with limited financial means. At the same time, the Dredge Material Management Office's (DMMO) experience suggested that bioavailability of mercury from maintenance dredging project sediments was extremely limited. As a result, we agreed that the LTMS agencies would amass and analyze mercury bioaccumulation data from San Francisco Bay dredging projects and, when the data were sufficient, present them to NMFS as a basis for reconsidering the mercury bioaccumulation testing requirement.

We have now collected a substantial mercury bioaccumulation data set comprised of San Francisco Bay dredging projects from 2001 through 2012. The results are analyzed in the attached report, which reaches the following major conclusions:

1. Mercury concentration in tissues of benthic organisms exposed to numerous sediments from San Francisco Bay dredging projects is consistently quite low, indicating little or no bioavailability of mercury from these sediments as tested.

2. There is no relationship between mercury concentration in the sediments as tested and mercury concentration in the tissues of the exposed organisms, indicating little or no increase in mercury bioavailability with increasing sediment concentration (particularly in the 0-0.5 ppm sediment mercury concentration range).

3. Since there was no significant net mercury uptake whatsoever by the test organisms, none of the projects or samples evaluated would have "failed" for in-Bay placement based on the mercury bioaccumulation results; to date this particular test has added no value to the regulatory decision making process.

These conclusions are directly applicable only to the scenario evaluated for the EFH consultation: namely, exposure to sediments that are dredged from navigation channels and discharged back into the Bay at designated unconfined aquatic disposal sites. Other dredged material placement scenarios, such as wetland or upland settings where quite different biogeochemical conditions may occur, and particularly where methylation may be likely, are outside the scope of this analysis. Also, our evaluation focused primarily on sediments containing less than 0.5 ppm total mercury, because under the existing TMDL any dredged material with mercury exceeding approximately 0.5 ppm is already prohibited from being discharged at the San Francisco Bay aquatic disposal sites.

However, we agree that the data support eliminating the mercury bioaccumulation trigger in the LTMS programmatic EFH consultation agreement for routine maintenance dredging projects proposing placement at the existing in-Bay sites. Retention of the existing requirement would result in several dredging projects unnecessarily incurring costs to collect data which will not help improve protection of Essential Fish Habitat in San Francisco Bay.

Specifically, LTMS (through DMMO) will immediately begin implementing the following modifications to the June 9, 2011, LTMS programmatic EFH agreement for San Francisco Bay maintenance dredging projects:

1. Dredged material with mercury above the TMDL limit remains prohibited from discharge at the in-Bay disposal sites. However, we will no longer generally require mercury bioaccumulation testing of dredged material proposed for discharge at the in-Bay disposal sites, when mercury levels in the material are below the TMDL limit.

2. We will continue to have the San Francisco Estuary Institute (SFEI) calculate the sediment mercury limit applicable each year under the existing TMDL, and post it on their web site. This remains the maximum mercury concentration allowable in dredged material discharged at the existing San Francisco Bay disposal sites.

3. All other bioaccumulation triggers remain in effect as described in the original June 9, 2011, EFH agreement, and we will continue to have SFEI calculate and post these triggers each year on their web site.

4. Residuals testing remains in effect as described in Conservation Measure 8, except that in the case of mercury we will generally require chemical evaluation of the relevant residuals samples only when the overlying sediment exceeds the TMDL limit.

Please note that mercury bioaccumulation testing will still be required as necessary in cases where ocean disposal is being considered as an option, and/or as called for under specific wetland or upland placement site plans or permits, these modifications to the EFH agreement notwithstanding.

Once again, we very much appreciate the close coordination with your staff in reaching agreement on these issues. If there are any questions about this or other aspects of the LTMS programmatic EFH agreement, please contact Brian Ross of EPA's Dredging and Sediment Management Team at 415-972-3475, or Robert Lawrence of USACE's Dredged Material Management Office at 415-503-6808.

Sincerely,

3/1/12

Thomas R. Kendall, PE Date
Chief, Planning Branch
USACE, San Francisco District

3/1/12

Jason Brush Date
Supervisor, Wetlands Regulatory Office
EPA, Region 9

Enclosure: LTMS Report, *"Summary and Evaluation of Bioaccumulation Tests for Total Mercury Conducted by San Francisco Bay Dredging Projects"*

A copy of this letter was sent electronically to Mr. Chris Yates, Mr. Bryant Chesney, and Mr. Dick Butler of the NMFS; Mr. Bruce Wolfe, Ms. Beth Christian, and Ms. Naomi Feger of the SFRWQCB; Mr. Steve Goldbeck and Ms. Brenda Goeden of BCDC; Ms. Susan Moore and Mr. Ryan Olah of the USFWS; Ms. Maria Vojkovich and Ms. Vicki Frey of the CDFG; and Mr. Cy Oggins and Mr. Donn Oetzel of the SLC.

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

Prepared by

Brian D. Ross
Dredging & Sediment Management Team
USEPA Region 9, San Francisco, CA

February 2, 2012

I. Introduction

In June 2011, the Environmental Protection Agency (EPA) Region 9, the US Army Corps of Engineers (USACE) San Francisco District, and the National Marine Fisheries Service Northern California Habitat Conservation Office completed a programmatic consultation under the Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The completed consultation (USACE and USEPA, June 9, 2011) included a comprehensive suite of conservation measures designed to minimize impacts to EFH that may result from USACE and/or private maintenance dredging projects managed under the *Long Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region* (LTMS Program). This report presents and analyzes sediment and tissue data from maintenance dredging projects in San Francisco Bay in support of modifying the terms of the LTMS programmatic EFH agreement concerning mercury bioaccumulation testing.

II. Background

Two of the conservation measures in the LTMS programmatic EFH agreement had provisions concerning mercury testing in dredged material. Conservation measure 7 (Bioaccumulation Testing) established a method to systematically identify "bioaccumulation triggers" for several potentially bioaccumulative compounds. Bioaccumulation triggers are sediment concentrations, including mercury, above which the LTMS agencies would require bioaccumulation testing prior to reaching suitability determinations for dredged sediments proposed to be discharged at in-Bay disposal sites. Conservation measure 8 (Residuals) established that residual samples (representing the new sediment surface exposed after dredging) should generally be chemically evaluated when the overlying sediment exceeds the bioaccumulation trigger levels. Depending on the compound, the bioaccumulation triggers either reflect levels already in use in dredged material management programs elsewhere (such as the Pacific Northwest) or, when more appropriate, are based on ambient concentrations in Bay area sediments. All the bioaccumulation trigger values are published on the web at

http://www.sfei.org/content/dmmo-ambient-sediment-conditions.

The bioaccumulation trigger level for mercury is one of those based on ambient Bay area sediment concentrations. It is also related to the existing Total Maximum Daily Load (TMDL) for mercury in San Francisco Bay.[1] The San Francisco mercury TMDL (RWQCB, 2006) established a long-term target of 0.2 parts per million (ppm) dry weight for total mercury in San Francisco Bay sediment overall, and also a maximum concentration of total mercury in dredged material discharged at designated disposal sites in at any time. That maximum level changes over time based on a rolling ten-year data set of mercury concentrations in sediment samples collected each year throughout San Francisco Bay by the Regional Monitoring Program (RMP), conducted by the San Francisco Estuary Research Institute (SFEI) and overseen by the San Francisco Regional Water Quality Control Board (RWQCB). Specifically, the TMDL maximum concentration is defined as the 90th upper tolerance limit of the 99th percentile of mercury data in the most recent ten-year RMP data set. The mercury bioaccumulation trigger under the EFH consultation was purposely set at a level between this maximum TMDL concentration and the long-term TMDL target concentration: the bioaccumulation trigger is the 90th upper tolerance limit of the 90th percentile of mercury data in the same ten-year RMP data set.

The various mercury values thus calculated by SFEI and used by the LTMS agencies' Dredged Material Management Office (DMMO) in 2011 were as follows:

Long-term TMDL sediment target	0.20 ppm dw
2011 EFH Bioaccumulation trigger	0.33 ppm dw
2011 TMDL maximum	0.472 ppm dw

The corresponding mercury values re-calculated for 2012 are:

Long-term TMDL sediment target	0.20 ppm dw
2012 EFH Bioaccumulation trigger	0.34 ppm dw
2012 TMDL maximum	0.471 ppm dw

[1] The RWQCB's 2006 TMDL for mercury in San Francisco Bay establishes water quality objectives protective of aquatic organisms and wildlife, and of human health. For the protection of aquatic organisms and wildlife, the TMDL objective is 0.03 mg mercury per kg fish (average ww concentration measured in whole fish 3–5 cm in length). For protection of human health, the TMDL objective is 0.2 mg mercury per kg fish tissue (average ww concentration measured in trophic level 4 fish). In general, San Francisco Bay fish currently do not meet these objectives. So the TMDL establishes *mass-based* limits on ("allocations" for) new mercury discharges into San Francisco Bay for various categories of discharger, in order that the overall mercury exposure will decrease over time. The dredged material category is not given a mass-based allocation. Instead, the TMDL limits the *concentration* of total mercury in dredged material discharged at San Francisco Bay aquatic disposal sites at any time. This concentration limit is based on the ambient concentration of mercury in Bay sediments overall and is designed to ensure that in-Bay dredged material discharges do not hinder the TMDL-driven reduction of mercury concentrations in the Bay over time (an "anti-degradation" approach).

During the time that the LTMS programmatic EFH consultation was in process, USEPA and USACE noted that sufficient bioaccumulation data should be available before long to assess the efficacy of and need for the mercury bioaccumulation trigger. This report presents and analyzes the results of a substantial number of mercury bioaccumulation tests using sediment from San Francisco Bay dredging projects, as a basis for reconsidering the EFH's mercury bioaccumulation testing requirement.

III. Bioaccumulation Data from San Francisco Bay Dredging Projects

Both before and during the programmatic EFH consultation process, EPA required evaluation of mercury bioaccumulation for several larger maintenance and new-work dredging projects that were considering ocean disposal as an option (including both USACE and private projects). In addition, since the EFH agreement was completed in 2011, DMMO has consistently required mercury bioaccumulation testing for any project proposing in-Bay disposal, where sediment mercury exceeded the new trigger level. In every case, the bioaccumulation testing was conducted in accordance with the joint EPA-USACE national sediment testing manuals: either the Ocean Testing Manual (EPA and USACE, 1991) or the Inland Testing Manual (EPA and USACE, 1998).

Overall, 16 San Francisco Bay dredging projects conducted mercury bioaccumulation testing between 2001 and early 2012 (14 of the 16 projects were tested since 2008). Figure 1 shows the general location of these 16 dredging projects. (Reports for each of the 16 projects are on file with DMMO.)

Taken together, these projects included 60 separate sediment sampling locations. Since two benthic organisms – a polychaete (either *Nephtys caecoides* or *Nereis virens*) and a deposit-feeding clam (*Macoma nasuta*) - were exposed to the sediment from each location, mercury bioaccumulation data from a total of 120 individual exposures are available. Table 1 lists the projects tested and the results of each test, including the sediment mercury concentration at each location and the corresponding tissue mercury concentration following exposure to that sediment, for each species. Control (or "time zero") tissue concentrations are also shown. Note that all evaluations in this report use the data in Table 1, including values listed as estimated (J-flagged) or as less than (<) a detection limit, at full face value.

Based on the data presented in Table 1, Figure 2 presents bioaccumulation results for the polychaetes, showing tissue mercury concentrations in relation to the sediment mercury concentration to which they were exposed. Figure 3 presents the same information for the clams. These figures include the full range of sediment mercury concentrations from all 60 sediment locations tested.

Figure 1. General location of the 16 San Francisco Bay dredging projects that have conducted tests for mercury bioaccumulation. Together these 16 projects sampled and tested sediment samples from 60 different locations, with two species each, for a total of 120 bioaccumulation exposures. (Red dots = USACE dredging projects, yellow dots = other dredging projects.)

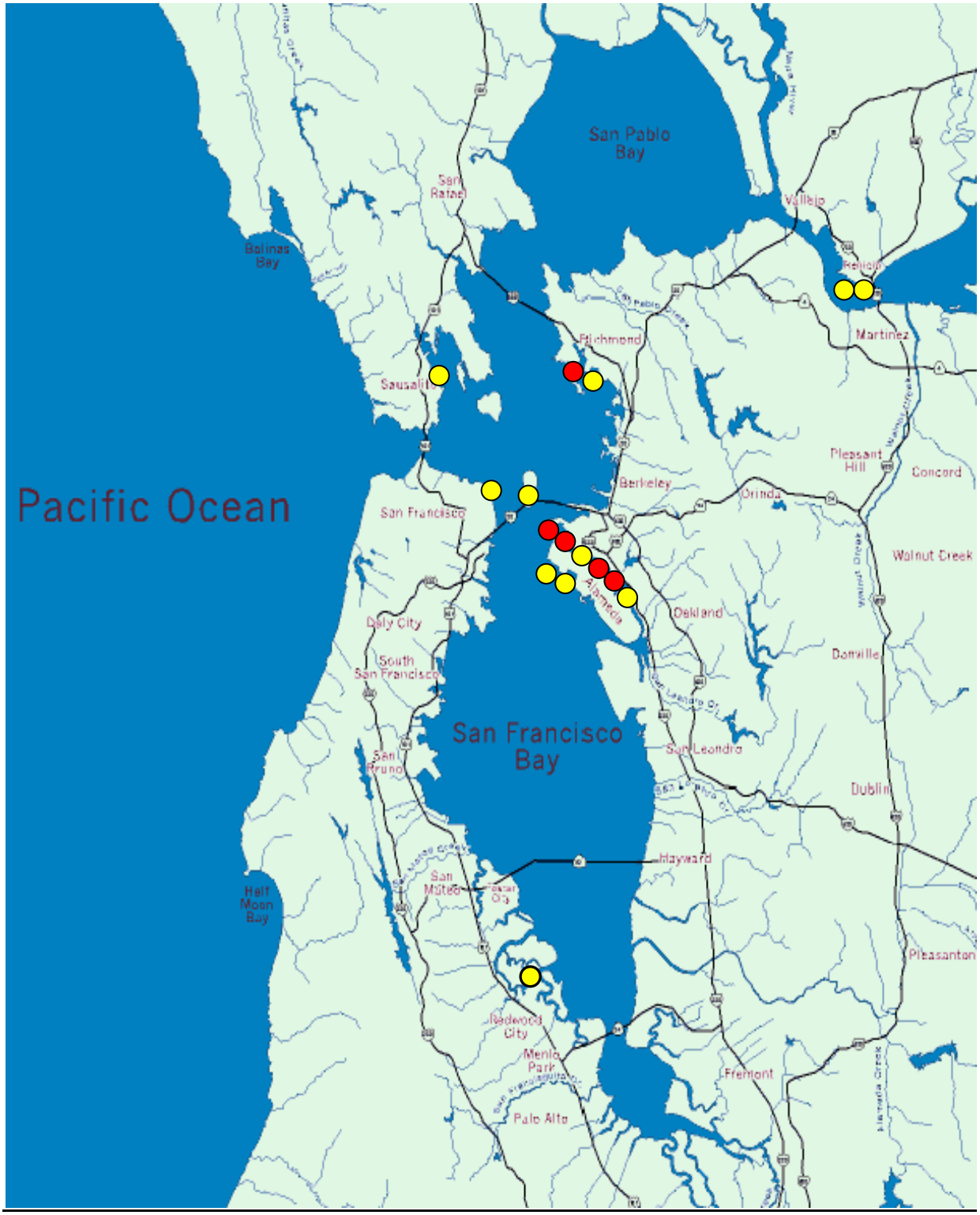


Table 1. Summary of total mercury concentrations in sediment samples from San Francisco Bay dredging projects, and in polychaete and clam tissue samples following laboratory exposure to the same sediments. Sixteen dredging projects conducted bioaccumulation tests with two benthic species on sediments from 60 separate locations, for a total of 120 sediment exposures. Of these, 102 reported sediment, test tissue, and control tissue concentrations. (Reports for each of the 16 projects are on file with DMMO.)

Project	Sediment Hg (PPM dw)	Polychaete Tissue Hg		Clam Tissue Hg	
		Control (PPM ww)	Exposed (PPM ww)	Control (PPM ww)	Exposed (PPM ww)
Oakland Inner Harbor Channel, 2001	0.41	0.008	<0.02	<0.005	0.01
	0.29	0.008	<0.02	<0.005	0.01
Oakland Inner Harbor Channel, 2003	0.48	0.097	0.106	0.035	0.016
Oakland Inner Harbor Channel, 2010	0.18	0.008	0.008	0.002	0.004
	0.19	0.008	0.008	0.002	0.003
	0.07	0.008	0.007	0.002	0.004
	0.09	0.008	0.008	0.002	0.001
	0.08	0.008	0.009	0.002	0.002
	0.41	0.008	0.011	0.002	0.001
Port of Oakland Berths, 2011	0.216	0.0052	0.0076	0.0052	0.0056
	0.174	0.0052	0.0079	0.0052	0.0061
	0.213	0.0052	0.0096	0.0052	0.0053
	0.17	0.0052	0.0101	0.0052	0.0062
Alameda Point Channel, 2008	0.31	<0.025	<0.025	<0.025	<0.025
	0.34	<0.025	<0.025	<0.025	<0.025
	0.37	<0.025	0.025	<0.025	0.026
	0.29	<0.025	<0.025	<0.025	0.026
	0.39	<0.025	<0.025	<0.025	<0.025
Alameda Point Channel, 2011	0.22	0.0213	0.0228	0.0082	0.0062
	0.26	0.0213	0.0165	0.0082	0.0053
	0.28	0.0213	0.0173	0.0082	0.0055
	0.28	0.0213	0.0138	0.0082	0.0049
	0.28	0.0213	0.0114	0.0082	0.006
	0.28	0.0213	0.0152	0.0082	0.0077
USCG Station San Francisco, 2011	0.258	0.0028	0.0033	0.0073	0.0067
	0.277	0.0028	0.0033	0.0073	0.0074
Port of San Francisco Pier 27, 2011	0.28	N/R	0.012	N/R	0.008
	0.33	N/R	0.015	N/R	0.007
	0.45	N/R	0.013	N/R	0.007
Marina Bay Yacht Harbor Entrance, 2010	0.408	0.001	0.0011	0.007	0.0071
	0.437	0.001	0.0119	0.007	0.0109
	0.421	0.001	0.0138	0.007	0.0103

Table 1, cont. Total mercury concentrations in sediment samples from San Francisco Bay dredging projects, and in polychaete and clam tissue samples following laboratory exposure to the same sediments.

Project	Sediment Hg (PPM dw)	Polychaete Tissue Hg		Clam Tissue Hg	
		Control (PPM ww)	Exposed (PPM ww)	Control (PPM ww)	Exposed (PPM ww)
Brooklyn Basin S. Channel, 2011	0.405	0.0079	0.0099	0.0055	0.008
	0.431	0.0079	0.0124	0.0055	0.0084
	0.467	0.0079	0.0103	0.0055	0.0068
	0.487	0.0079	0.0119	0.0055	0.0072
	0.521	0.0079	0.0099	0.0055	0.0069
	0.472	0.0079	0.0087	0.0055	0.0068
	0.468	0.0079	0.0098	0.0055	0.0068
	1.1	0.0046	0.0057	0.0049	0.0103
	1.48	0.0046	0.0087	0.0049	0.0052
	1.16	0.0046	0.0081	0.0049	0.0074
	2.64	0.0046	0.0063	0.0049	0.0071
	2.17	0.0046	0.0081	0.0049	0.0084
Coast Guard Island, 2008	1.01	0.023	0.0065	<0.005	0.014
	0.722	0.023	0.0059	<0.005	0.007
Sausalito Boatyard, 2011	0.467	<0.005	<0.005	<0.005	<0.005
Richmond Inner Harbor Channel, 2008	0.2	N/R	0.0153 J	N/R	0.035
	0.28	N/R	0.0104 J	N/R	0.024
	0.19	N/R	0.0158 J	N/R	0.0144
	0.28	N/R	0.0164 J	N/R	0.0204
	0.25	N/R	0.0224 J	N/R	0.022
	0.29	N/R	0.0146 J	N/R	0.02
Port of Redwood City, 2010	0.301	0.0205	<0.0034	0.0205	<0.0034
Valero Refinery, 2008-2009	0.574	<0.013	0.017 J	0.011 J	0.012 J
	0.484	<0.013	<0.005	0.011 J	0.015 J
	0.54	<0.013	0.015 J	0.011 J	0.017 J
Valero Refinery, 2012	0.370	0.0176	0.0258	0.0164	0.0175
	0.322	0.0176	0.0270	0.0164	0.0155
	0.337	0.0176	0.0197	0.0164	0.0133

N/R = No Results reported
J = laboratory estimated value

Figure 2. Concentration of total mercury in 60 sediment samples from San Francisco Bay dredging projects, and in polychaete tissues following laboratory exposure to the same sediments. (All tests from Table 1, ranked in order of increasing sediment mercury concentration)

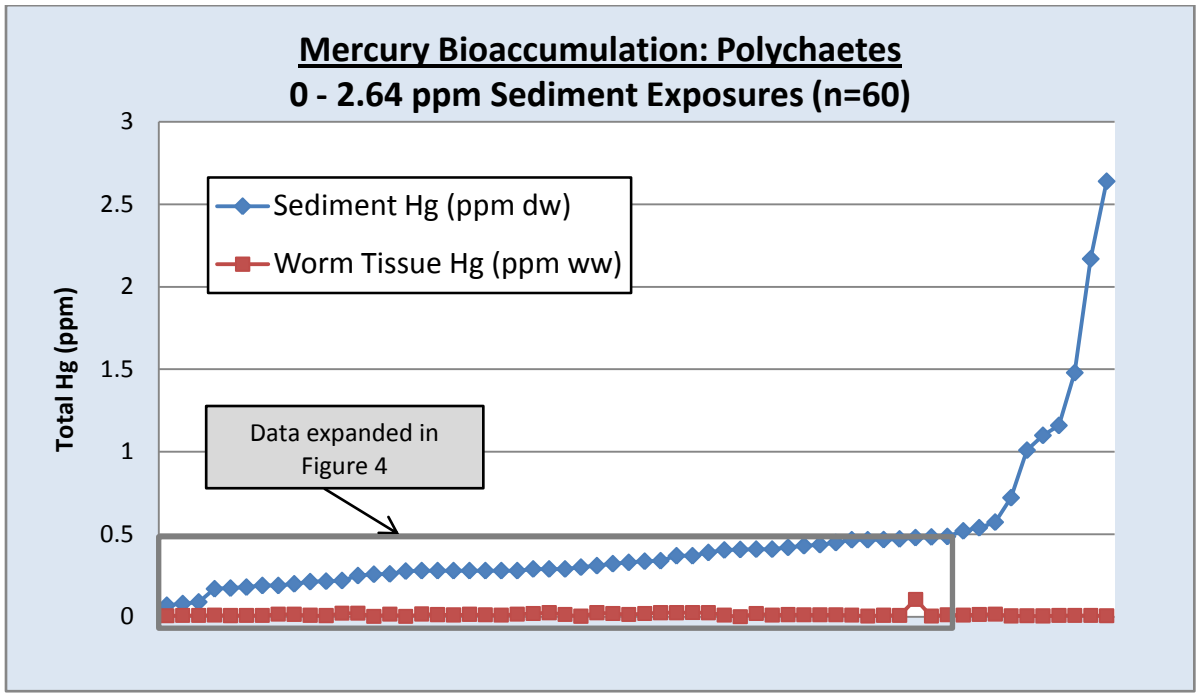
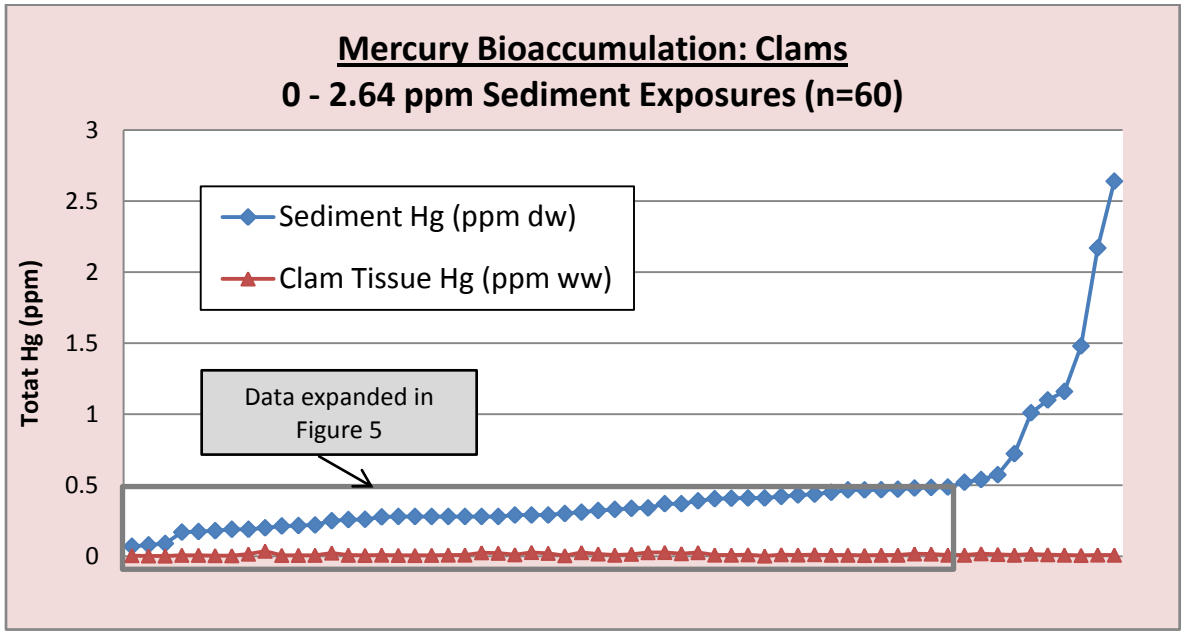


Figure 3. Concentration of total mercury in 60 sediment samples from San Francisco Bay dredging projects, and in clam tissues following laboratory exposure to the same sediments. (All tests from Table 1, ranked in order of increasing sediment mercury concentration)



IV. Evaluation of Mercury Bioaccumulation Data

TISSUE DATA AS REPORTED (UNADJUSTED)

It seems visually apparent from the absolute (unadjusted) measurements charted in Figures 2 and 3 that there is little if any increase in the concentration of total mercury in tissues of either polychaetes or clams as a result of standard laboratory bioaccumulation test exposures to the sediments samples from San Francisco Bay navigation dredging projects. As sediment total mercury concentrations increase, the tissue total mercury concentrations remain low. Specifically, 118 of the 120 individual (absolute) results were already below the most conservative TMDL objective (for protection of aquatic organisms and wildlife: 0.03 ppm total mercury, average wet weight concentration measured in whole fish 3–5 cm in length). The average tissue concentration for each species following exposure to the full range of sediment mercury concentrations (up to 2.64 ppm dw) was also below the TMDL objective, at 0.014 ppm ww for the polychaetes and 0.011 ppm ww for the clams.

However, relatively few of the sediments tested had high sediment total mercury concentrations. Only 10 of 60 sediment samples were above 0.5 ppm in total mercury, and only 6 sediment samples were above 1.0 ppm. So bioaccumulation testing data at the higher end of the concentration range are fairly sparse. On the other hand, 50 of the 60 sediment samples tested had total mercury in the narrow concentration range between 0 and 0.5 ppm, and can be discussed with more confidence. In addition, the TMDL does not allow any sediments containing total mercury above approximately 0.5 ppm to be discharged back into San Francisco Bay in any event. Therefore Figure 4 (for the polychaetes) and Figure 5 (for the clams) show only the data from the 50 locations where sediment mercury was below 0.5 ppm.

Within the narrow 0-0.5 ppm sediment mercury concentration range shown in Figures 4 and 5, it is similarly visually apparent that mercury in the tissues does not seem to increase with increasing mercury in the sediment. The absolute tissue concentrations in 98 of the 100 individual polychaete and clam exposures within this sediment concentration range were below the TMDL objective. The average tissue concentrations for each species also remained below the TMDL objective, and were similar to the averages for the full range of exposures at 0.015 ppm ww for the polychaetes and 0.011 ppm ww for the clams. Figure 6 shows the absolute polychaete and clam tissue mercury concentrations in relation to both TMDL objectives.

Of course, the TMDL objective for protection of fish and wildlife does not apply directly to the benthic organisms tested. Instead, it is meant to apply to small forage fish at least one trophic level higher in the food web. As such, some magnification of any mercury taken up from the sediments into the tissues of the benthic organisms tested might be presumed.

Figure 4. Concentration of total mercury in 50 sediment samples from San Francisco Bay dredging projects having less than 0.5 ppm total mercury, and in polychaete tissues following laboratory exposure to the same sediments. (Subset of data from Table 1, ranked in order of increasing sediment mercury concentration)

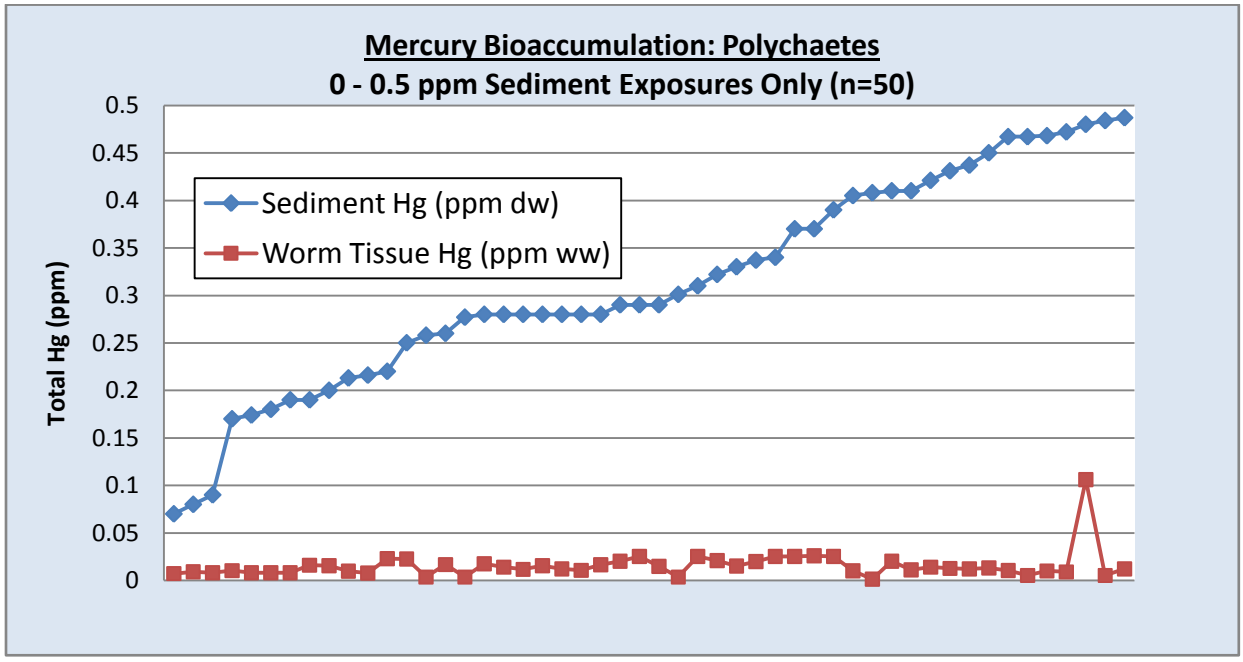


Figure 5. Concentration of total mercury in 50 sediment samples from San Francisco Bay dredging projects having less than 0.5 ppm total mercury, and in clam tissues following laboratory exposure to the same sediments. (Subset of data from Table 1, ranked in order of increasing sediment mercury concentration)

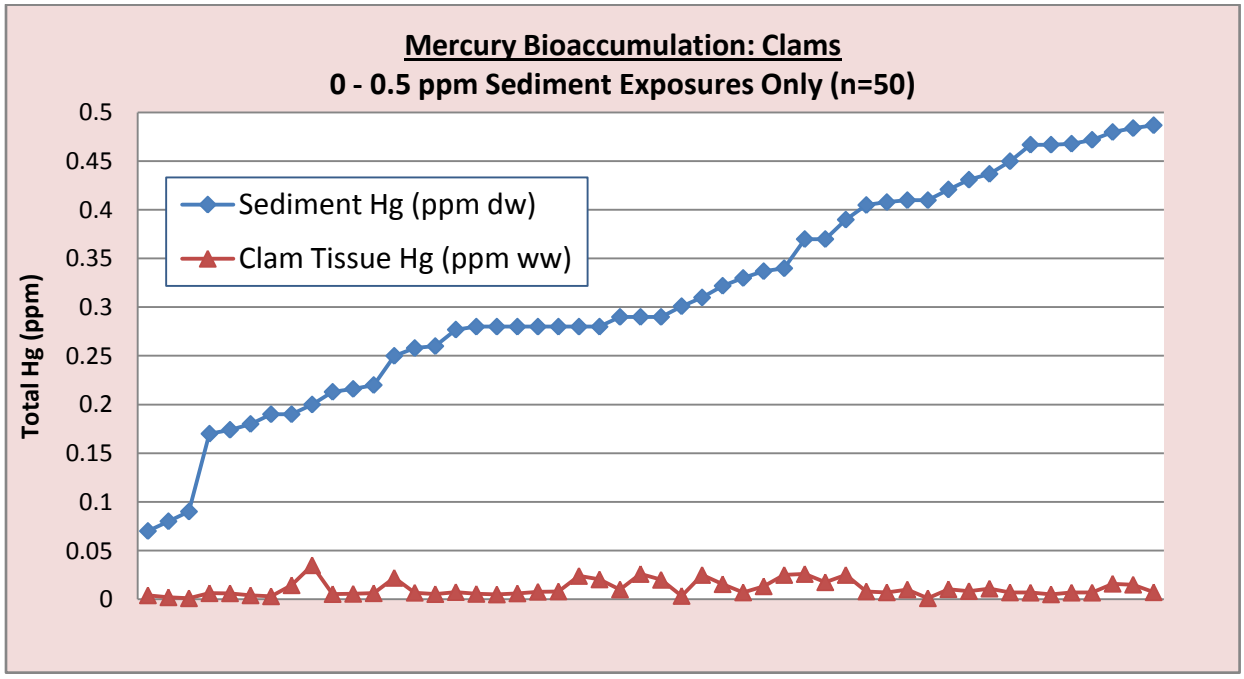
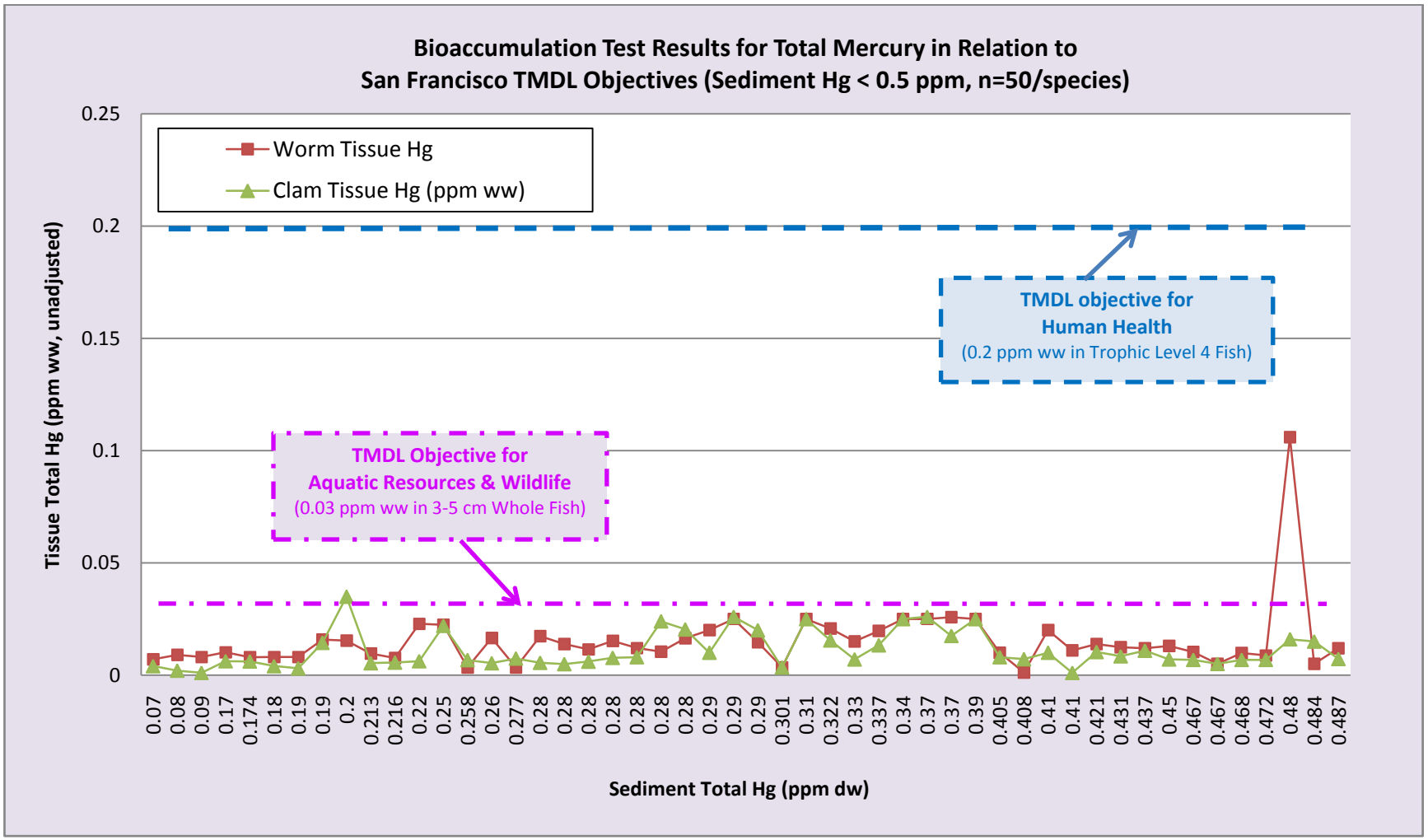


Figure 6. Reported concentrations of total mercury in tissues of polychaetes and clams following laboratory exposure to 50 sediment samples from San Francisco Bay dredging projects having less than 0.5 ppm total mercury, in relation to the San Francisco Bay mercury TMDL objectives for protection of human health, and for protection of aquatic resources and wildlife.



TISSUE DATA ADJUSTED BY CONTROL RESULTS

To determine the concentration of mercury actually accumulated from the sediments into the tissues of the benthic test organisms, the reported absolute tissue mercury concentrations were adjusted for their corresponding control (or time zero) values. The control tissue mercury concentration indicates the mercury already present in the test organisms (which may vary from test to test based on such factors as the organisms' origin, or pre-test holding or handling conditions) in the absence of any exposure to dredging project sediments. Adjusting the sediment-exposed results for the control results provides a more precise measure of actual (net) mercury uptake from the sediments. The adjustment itself was made by simple subtraction of the mercury concentration measured in the control tissue, from the mercury concentration measured in the corresponding tissue at the end of the bioaccumulation test (following exposure to the sediment).

Figures 7 and 8 present the control-adjusted tissue concentrations for the polychaetes and clams, respectively, exposed to sediment with 0.5 ppm or less total mercury. (In these figures, n=41 rather than 50 for each species because some projects did not report control tissue results. See Table 1.)

As shown in Figures 7 and 8, the control-adjusted tissue mercury values are variously both positive (above zero) and negative (below zero). Thus, while some individual tests appear to show some minor net mercury uptake, others appear to show a minor net loss of mercury. Linear regression on the adjusted (net uptake) data confirms that, within the 0-0.5 ppm sediment mercury concentration range, there was no statistically significant relationship between sediment total mercury concentration and tissue total mercury concentration, for either test species. The correlation coefficients are extremely low ($R^2 = 0.04$ for the polychaetes and effectively 0.00 for the clams), and the slopes of the regression lines are essentially flat. Taken together, these minor positive and negative values are more likely an indication of the variability in the chemistry laboratories' mercury measurements than of any real mercury uptake or loss.

The net uptake values are also much lower than the reported absolute results depicted in Figures 4 through 6. Across the 0-0.5 ppm sediment range, the net mercury uptake by polychaetes averaged 0.001 ppm ww, while the net uptake by the clams averaged -0.0003 ppm ww (negative, indicating on average a slight loss of mercury). These net uptake averages, at worst, are more than an order of magnitude below the San Francisco Bay mercury TMDL objective for protection of aquatic resources and wildlife of 0.03 ppm ww.

Figure 7. Net (control-adjusted) uptake of total mercury in polychaete tissues following laboratory exposure to 41 San Francisco Bay sediment samples having less than 0.5 ppm total mercury. (No statistically significant corellation.)

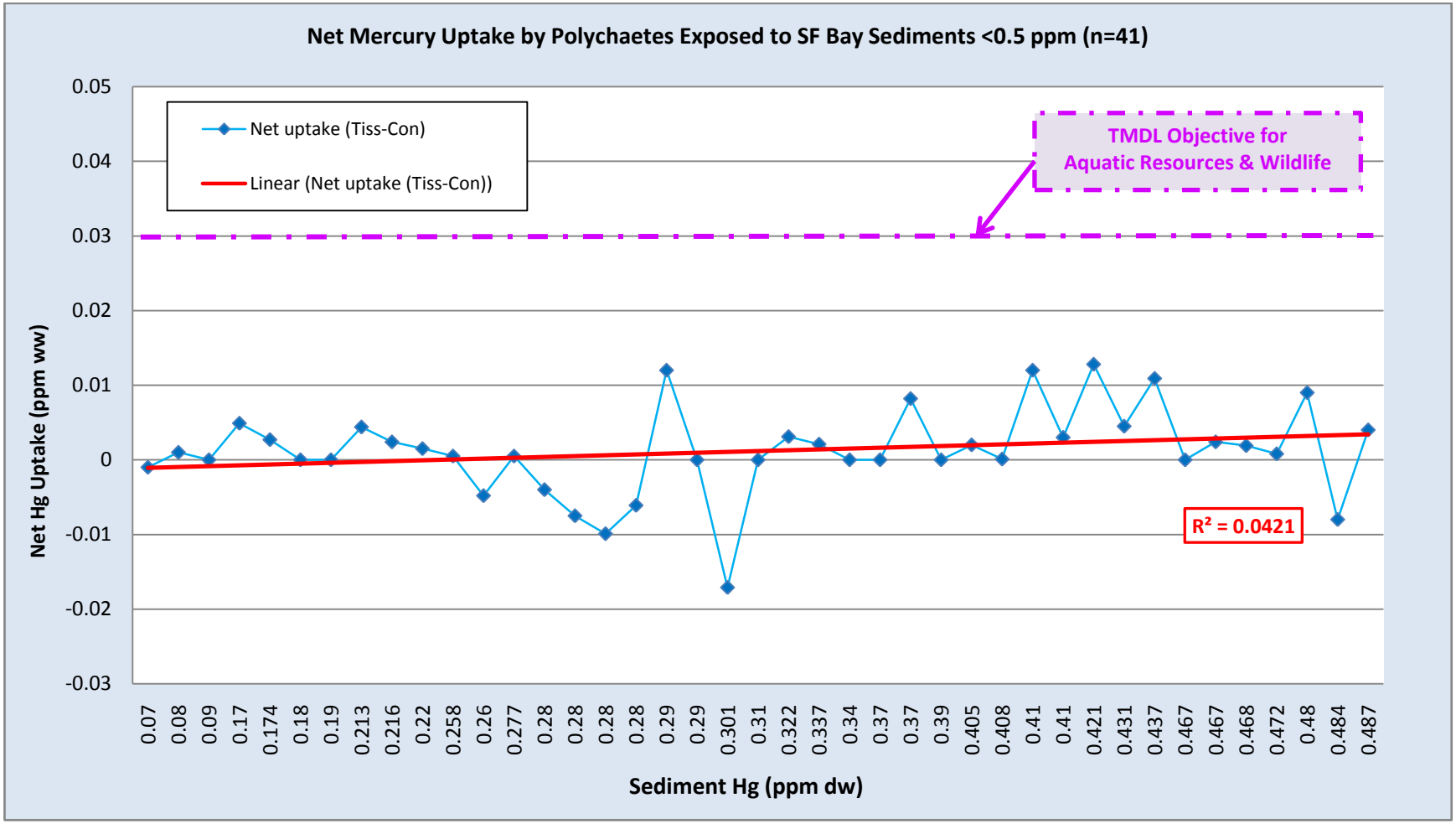
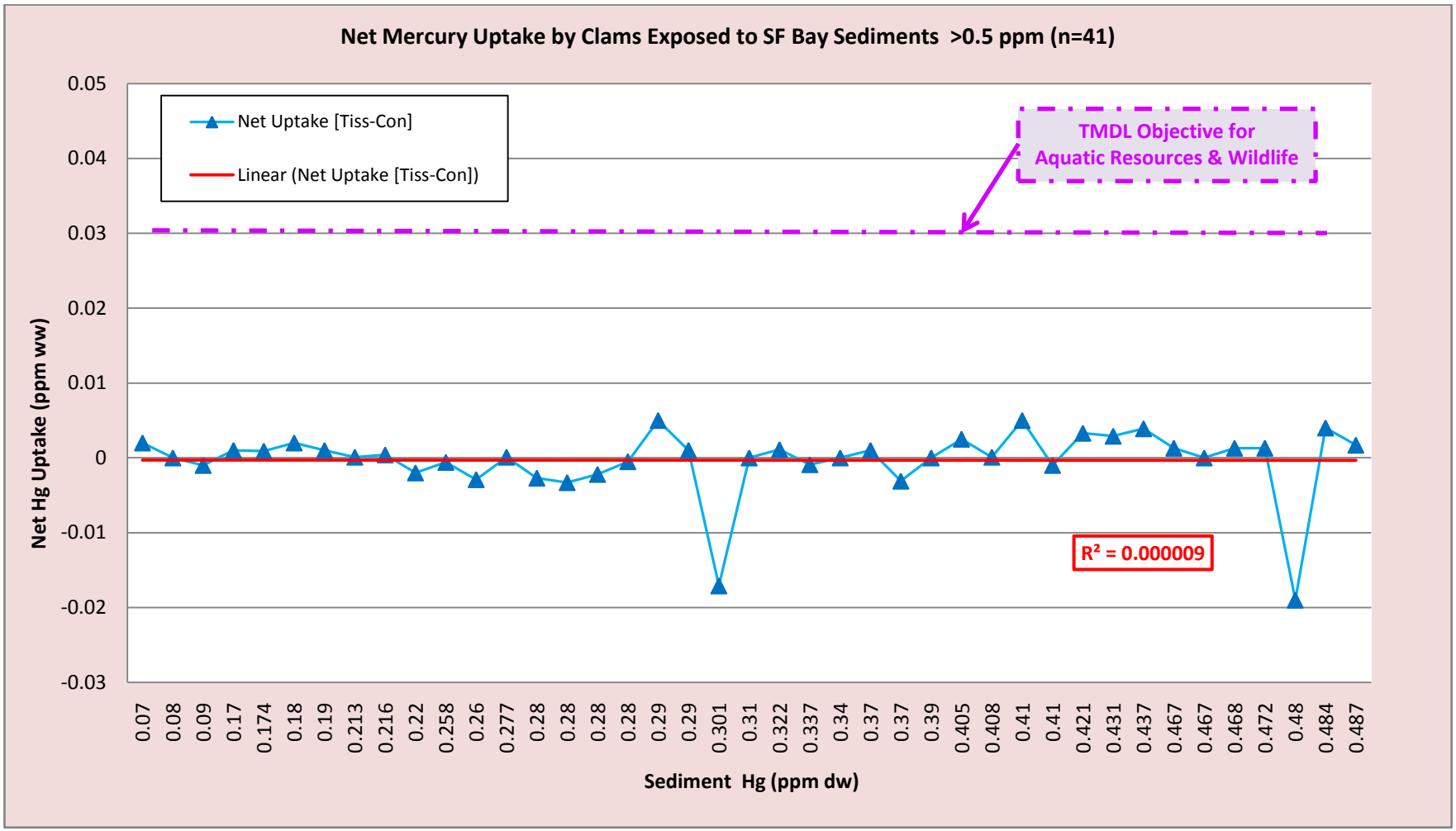


Figure 8. Net (control-adjusted) uptake of total mercury in clam tissues following laboratory exposure to 41 San Francisco Bay sediment samples having less than 0.5 ppm total mercury. (No statistically significant corellation.)



V. Conclusions and Discussion

Bioaccumulation testing data from 16 different San Francisco Bay navigation dredging projects were analyzed to evaluate the need for continued routine mercury bioaccumulation testing under the terms of the June, 2011 LTMS programmatic EFH consultation agreement. These projects included sediment samples from 60 different locations around San Francisco Bay. Two different classes of benthic organisms were exposed to each of the sediments in standardized laboratory bioaccumulation tests, resulting in 120 individual bioaccumulation exposures that were evaluated in this report.

The results indicate there was effectively no net uptake of mercury from the San Francisco Bay dredging project sediments tested, by any of the species tested. This is particularly true for sediments with total mercury concentrations below 0.5 ppm. (Dredged material with total mercury above that approximate sediment concentration is already excluded from being discharged at San Francisco Bay aquatic disposal sites, under terms of the existing mercury TMDL.) In all cases, the net uptake of mercury into benthic test organism tissues was well below the San Francisco Bay TMDL objective for the protection of aquatic organisms and wildlife, and more than an order of magnitude below the TMDL objective for protection of human health.

It is important to note that the mercury TMDL objective for the protection of aquatic organisms and wildlife in San Francisco Bay applies to whole fish 3-5 cm in length, or at least one trophic level higher than the benthic organisms used in the bioaccumulation tests. Therefore formal comparison to the long-term TMDL target cannot be made without estimating the mercury concentrations that would result after any transfer higher up through the food web. Appropriate models exist to predict this phenomenon. However, since there was no statistically significant net uptake of mercury from these sediments whatsoever, further evaluation of potential trophic transfer and biomagnification is unwarranted.

In summary, the following conclusions are reached concerning mercury bioaccumulation testing under the existing LTMS programmatic EFH consultation:

1. Mercury concentration in tissues of benthic organisms exposed to numerous sediments from San Francisco Bay dredging projects is consistently quite low, indicating little or no bioavailability of mercury from these sediments as tested.

2. There is no relationship between mercury concentration in the sediments as tested and mercury concentration in the tissues of the exposed organisms, indicating little or no increase in mercury bioavailability with increasing sediment concentration (particularly in the 0-0.5 ppm sediment mercury concentration range).

3. Since there was no significant net mercury uptake whatsoever by the test organisms, none of the projects or samples evaluated would have "failed" for in-Bay disposal based on the mercury bioaccumulation results; to date this particular test has added no value to the regulatory decision making process.

These conclusions are directly applicable only to the scenario evaluated for the EFH consultation: namely, exposure to sediments that are dredged from navigation channels and discharged back into the Bay at designated unconfined aquatic disposal sites. Other dredged material placement scenarios, such as wetland or upland settings where quite different biogeochemical conditions may occur, and particularly where methylation may be likely, are outside the scope of this analysis.

Also, this evaluation has focused primarily on sediments containing less than 0.5 ppm total mercury (100 of the 120 bioaccumulation exposures, or 83 percent of the available results). Substantially fewer data are available to address potential bioaccumulation from San Francisco Bay dredged material containing significantly higher total mercury concentrations, and this evaluation does not address such sediments. This constraint is not considered to be a problem for present purposes, since under the existing mercury TMDL any dredged material with a mercury concentration exceeding approximately 0.5 ppm is already prohibited from being discharged at the San Francisco Bay disposal sites.

However, for in-Bay disposal of dredged material containing mercury at concentrations below the TMDL sediment limit, the data support eliminating the general requirement in the LTMS programmatic EFH consultation agreement that routine maintenance dredging projects must conduct expensive mercury bioaccumulation testing whenever the EFH bioaccumulation trigger for mercury is exceeded. Retention of the existing requirement will result in several dredging projects unnecessarily incurring costs to collect data which will not help improve protection of Essential Fish Habitat in San Francisco Bay.

Of course, modification of the EFH agreement will not affect mercury bioaccumulation testing that may be required in cases where ocean disposal is being considered as an option, and/or as called for under specific wetland or upland placement site plans or permits.

VI. References

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