

RMP Special Study Proposal: Update of Erosion and Deposition in San Francisco Bay

Summary: In 2014 and 2015 the Ocean Protection Council (OPC) contracted for bathymetric surveys of large portions of San Francisco Bay. This data along with recent NOAA, USGS, and California State University Monterey Bay surveys can now be combined to create a revised bathymetric Digital Elevation Model (DEM) of the whole of San Francisco Bay (South Bay, Central Bay, San Pablo Bay, and Suisun Bay). Analysis of these surveys and comparison with the USGS DEMs of earlier surveys will provide an update on the quantities and patterns of erosion and accretion in the Bay over the past 25 to 35 years. Such information can be used to assess how the Bay has responded to changes in sediment supply from the Delta and tributaries and provide managers with data for making decisions on a variety of issues including exposure of legacy contaminated sediment and strategies for beneficial dredge disposal.

Estimated Cost: \$77,000 for Year 1 (2019)
Another \$77,000 will be requested for Year 2 (2020)
Total project cost: \$154,000

Oversight Group: RMP Sediment Workgroup

Proposed by: Bruce Jaffe, USGS

Proposed Deliverables and Timeline

Deliverable	Due Date
Composite DEM of San Francisco Bay based on 2014-2015 OPC bathymetric surveys and other recent bathymetric data.	July 2020
Update on the quantities and patterns of erosion and accretion in the Bay over the past 25 to 35 years.	July 2020
Final report	July 2020 (draft) October 2020 (final)

Background

The USGS has spent just over a decade developing the historic bathymetric DEMs of San Francisco Bay from surveys conducted by NOAA's office of coast surveys beginning in the 1850s and ending in the 1990s. These DEMs have provided valuable insight to historic patterns of sediment deposition and erosion, pathways of sediment and sediment-bound contaminants within the Bay and subembayments, and sediment

budgets.

We expect that erosion and deposition has changed recently in response to a decrease in sediment supply from the Delta (Wright et al., 2004) and the corresponding increase in the relative importance of sediment supply from local tributaries (McKee et al., 2013). There is no comprehensive, bay-wide, documentation of the recent (25 to 35 years) erosion and deposition.

The record of historical erosion and deposition has proven to be valuable for interpreting the spatial distribution and concentrations of contaminants in the Bay (Hornberger et al., 1999; Yee et al., 2011; Nilsen et al., 2014). This update can further aid in the interpretation of contaminants in the Bay and subembayments. Another application of this type of research was shown by Higgins et al. (2007), who produced a map of the age of near-surface sediments in San Pablo Bay that may be useful for understanding the distribution of legacy contaminants. The proposed updated DEM would allow construction of a bay-wide version of that map. The proposed work will also have a strong influence on helping to understand sediment processes at the more local scale of operational landscape units (OLUs), recently defined in the Bay to assist adaptation planning (SFEI 2018) . The new DEMs created from this project will help us to better understand the morphology of mudflats adjacent to key margin areas, and to better define risk in relation to water depth, fetch, and wave energy.

Study Objectives and Applicable RMP Management Questions

The study will provide information essential to understanding sediment and sediment-bound contaminant pathways within San Francisco Bay and its subembayments. The objectives of the study and how the information will be used are shown in Table 1 relative to the management questions of the RMP Sediment Workgroup.

Table 1. Study objectives and questions relevant to RMP management questions.

Management Question	Study Objective	Example Information Application
MQ1: What are acceptable levels of chemicals in sediment for placement in the Bay, baylands, or restoration projects?		
MQ2: Are there effects on fish, benthic species, and submerged habitats from dredging or placement of dredged material sediment?		
MQ3: What are the sources, sinks, pathways, and loadings of sediment and sediment-bound contaminants to and within the Bay and subembayments?	<p>Update the distribution and quantities of erosion and deposition in the Bay and subembayments.</p> <p>Update mass balances for sediment in the Bay and subembayments.</p> <p><i>Potential scope expansion: Assess the age of near-surface sediment.</i></p>	<p>1) What are the present areas of erosion and accretion in San Francisco Bay?</p> <p>2) How have human activities affected the erosion and accretion in the Bay?</p> <p><i>What regions are erosional and may have older sediment with legacy contaminants near the sediment-water interface?</i></p>
MQ4: How much sediment is passively reaching tidal marshes and restoration projects and how could the amounts be increased by management actions?		
MQ5: What are the concentrations of suspended sediment in the Estuary and its segments?		

Approach

This research uses approaches developed by the USGS that documented erosion and accretion in San Francisco Bay from the mid-1800s to 1990s (Jaffe et al., 1998; Capiella et al., 1999; Foxgrover et al., 2004; Jaffe and Foxgrover, 2006; Jaffe et al., 2007; Fregoso et al., 2008). Details of the development of data, phasing of research, and dissemination of study results are below.

1. Data Development

- A. The 2014-15 OPC survey will be gridded using GIS surface modeling software to create a continuous bathymetric DEM. Gridding of the OPC surveys is time intensive because there are 93 surveys comprising a patchwork of surveys collected using either multibeam or interferometric sidescan sonar systems with varying spatial coverage. Some regions have continuous bathymetric coverage while others consist of striped trackline patterns with various spacing (Figure 1). Of the 93 surveys, 75 consist of swaths of bathymetry ranging from 18 to just over 100 meters wide. These swaths are collected along tracklines with spacings of 10 to just over 300 meters that will have to be interpolated across to create a continuous bathymetric surface DEM. The OPC data will support 1 m grid cells in regions with continuous coverage; larger grid cells may be necessary to accurately represent the bathymetry in regions where the bathymetry is only narrow swaths with larger gaps between adjacent tracklines.
- B. Gaps in the OPC survey will be filled with the most recent bathymetric data from other sources, NOAA, USGS, CSUMB, and others, to allow a more complete comparison with earlier surveys (Figure 2). There are approximately 40 non-OPC surveys that will be used for gap filling.
- C. All surveys will be resampled to a common resolution and mosaicked, with careful attention paid to edges, and possible discontinuities, between surveys.
- D. After correcting to common vertical and horizontal datums, the bathymetric DEM of recent bathymetry will be differenced from existing 25 and 50 m resolution bathymetric DEMs of the 1970s-1990s to create a change DEM. This change DEM will be analyzed using GIS tools to document the quantities and patterns of erosion and accretion with South, Central, and San Pablo Bays during the past 25 to 35 years. These analyses will be conducted on both Bay segments and OLU's.

2. Phasing of Research

In the first year of the study we will refine methodology for creating an accurate modern DEM from bathymetric surveys with differing sounding densities and produce a DEM for Central Bay north of Tiburon, San Pablo Bay, and Suisun Bay. A DEM will be produced for the remainder of Central Bay and for South Bay in the second year of the study. The data release and final report will be prepared in the second year of the study as well.

3. Presentation of Results at Local Scientific Meeting

Results of this study will be presented at either the State of the Estuary or Bay-Delta Science Conference.

4. Report and Data Release

The final report will be published as a USGS Open-File Report. Contents will include the methodology for creation of the modern bathymetric DEM and analyses of the updated erosion and deposition. Analyses of erosion and accretion will be conducted on both Bay segments and OLU's. The modern bathymetric and change DEMs will be distributed as a USGS data release. Timeline for products is 18-24 months from start of the work. A draft of the report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee.

Budget

The following budget represents estimated costs for this proposed study (Table 2).

Table 2. Proposed Budget.

Expense	Estimated Cost
Year 1 Labor	\$49,500
Year 1 Overhead	\$27,500
Year 1 Total	\$77,000
Year 2 Labor	\$49,500
Year 2 Overhead	\$27,500
Year 2 Total	\$77,000
Grand Total	\$154,000

Budget Justification

Labor Costs

Theresa Fregoso (11 months labor) will create a whole bay modern DEM from the 2014-2015 OPC surveys and other recent bathymetric data, conduct analyses of change DEM to quantify update erosion and accretion in the Bay and subembayments, compile data releases for modern and change DEMS, prepare final report. Amy Foxgrover (1/2 month labor) will assist Fregoso in the analyses.

\$10,000 of funding for Bruce Jaffe's involvement with the project is being contributed by the USGS. Jaffe's primary contribution is to the final report.

Note: At the request of the Sediment Workgroup, USGS contacted the California Ocean Protection Council (OPC) to inquire whether they were already funding related work or if they would co-fund this proposal. OPC stated that related work was not underway and matching funds were not available.

Reporting

The final report will be published as an USGS Open-File Report. A draft of the report will be reviewed by the RMP Sediment Workgroup and Technical Review Committee.

References

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Figure 1- Coverage of the Ocean Protection Council 2014-2015 bathymetric surveys. Inset shows regions with continuous (solid colors) and striped (colored lines with no data between lines) coverage.

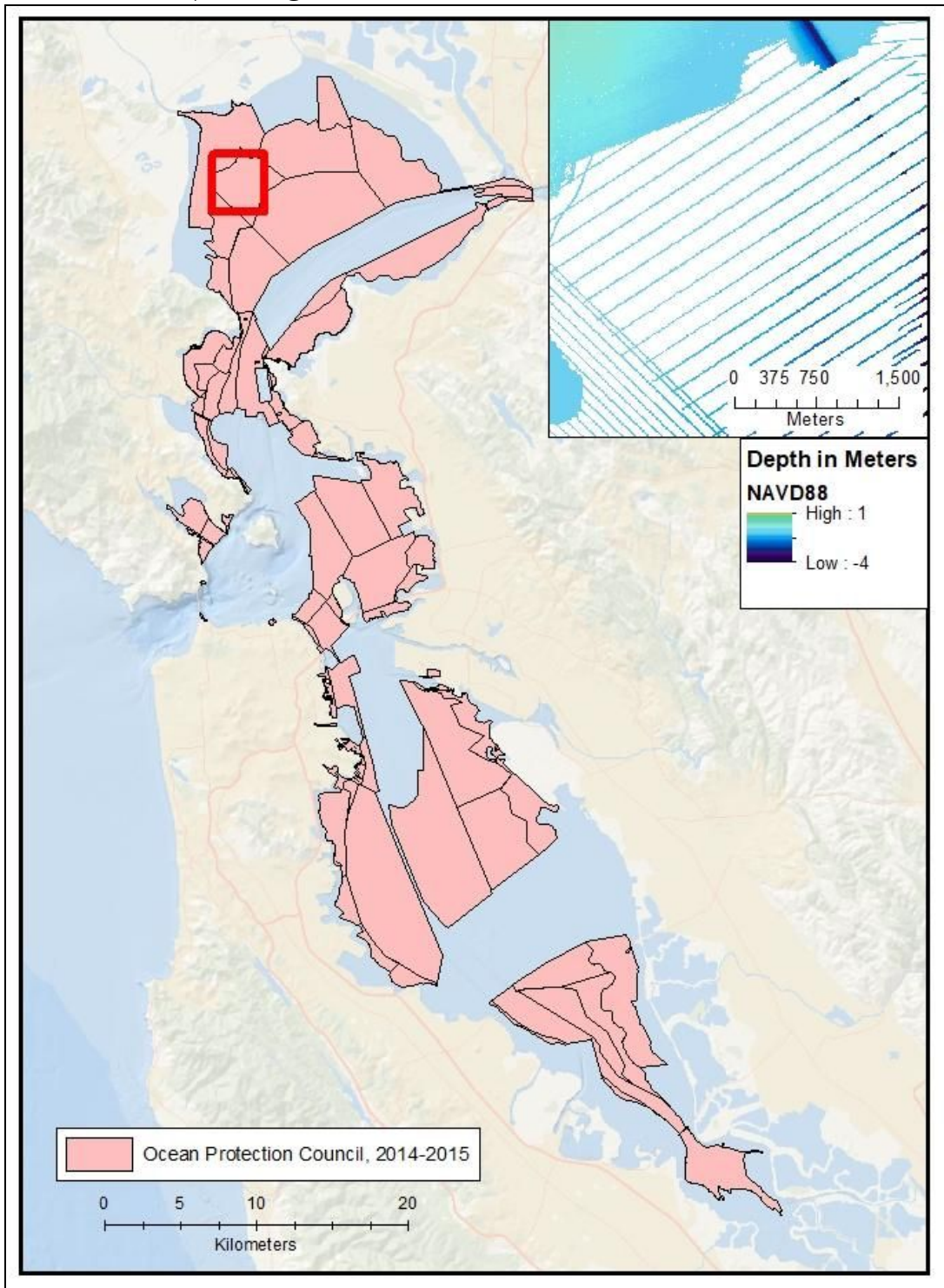


Figure 2- Coverage of Ocean Protection Council 2014-2015 and other recent surveys. The combination of surveys allows updated estimates of erosion and accretion in the majority of South, Central and San Pablo Bays and the main channel of Suisun Bay.

