

PS: Margins Sediment Status & Trends Pilot

Estimated Cost:	\$5k margins frame definition, GRTS site selection \$135k sampling (~9 sites per segment, all segments) \$280k analyses (\$170k chem, 50k tox, 60k benthos) Sampling & analyses scalable (e.g., fewer sites/yr) \$25k RMP technical report
Oversight Group:	TRC
Proposed by:	Don Yee, SFEI

Background

The Bay margins are habitats that have been largely unsampled by the RMP, due to the RMP's historical focus on deep water locations, and even after the 2002 redesign, the limiting of sampling to areas accessible by a moderately large boat (~3 foot draft). Aside from the margins' importance as habitats in themselves, contamination in margins may contribute to the lack of decreasing trends in biota (e.g., fish tissue) concentrations of PCBs (and other persistent bioaccumulative contaminants), despite long-term changes in sediments of much of the open Bay. There are known hot spots in the margins associated with Superfund sites and other legacy sources, but the contamination and other characteristics of sites in the Bay margins are less known.

Within the RMP, there have been some efforts to collect sediment samples for mercury in margin areas where small fish sampling occurred, but site selection for that study was intentionally biased to characterize areas of known sources (e.g., mines and contaminated watersheds). The median mercury concentration for samples collected in 2008 for the small fish study was 0.39 mg/kg (avg±sd 0.46±0.25), as compared to the median for RMP S&T sampling for that year of 0.28 mg/kg (avg±sd 0.27±0.08). Concentrations for the sampled margin areas thus appear significantly higher, but may be due to the targeted inclusion of contaminated areas for the former (small fish) study.

Study Objective and Applicable RMP Management Questions

More widespread characterization of surficial sediment contamination and habitat ancillary characteristics (grainsize, species distributions and densities, etc.) in margin areas is proposed. These data are critical to any efforts to characterize or model contaminant risk, fate, and trends in the Bay margins. Otherwise, assessments of exposure and risks to margins biota would be estimated or extrapolated using data from deeper subtidal open water areas of the Bay, or from biased margin cleanup hotspots, which are likely unrepresentative of most locations the margins. Collection of representative margin data is the only real solution for testing of assumptions about contaminant distributions, characterizing exposure and risk, and populating and calibrating empirical or mechanistic food web and contaminant fate models. Ideally margins sampling should be included as an ongoing part of the RMP sediment S&T program, as it is characterizing a relevant, evolving, and presumed critical

portion of the ecosystem, which should be continually included in the sampling frame so long as the RMP S&T program continues.

Information needs related to finding sources, or measuring or predicting ecosystem response to management in specific locations should be addressed by monitoring schemes specifically designed to meet those needs and considered independently, even if many of those efforts can be logistically piggy-backed to a margins S&T characterization. Deterministic samples may be useful for case studies to illustrate process, but may be difficult to extrapolate beyond their locations without supporting information on the similarities (e.g., status) of the environments to which they are extended. The relative priority and effort assigned to monitoring Bay S&T, margins S&T, and deterministic sites in the Bay or margins needs to be considered in totality; what data is already available, and what could we safely assume without any additional data?

A margins S&T sampling plan would include areas previously excluded from the sampling frame in the RMP S&T redesign process: areas shallower than 1 foot at MLLW, and all the intertidal areas surrounding the Bay up to some limit to be determined: e.g., MTL, MHW, or MHHW. Areas included in the RMP sampling frame – 1 foot or deeper at MLLW – but skipped due to logistical reasons- e.g., surrounded by shallower water, or having a deeper draft boat in a given year- could potentially be picked up in a margins sampling effort. S&T sites within the margins would be picked via an unbiased GRTS method (similar to the selection for RMP S&T). Deterministic sites picked for other studies could be added on, or sampled independently, depending on the needs of each particular study (e.g., if seasonal or event data is needed on a different schedule from the margins S&T).

The management questions to be addressed are the same as those of the overall RMP S&T effort, localized to the margins, namely:

- 1) Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
- 2) What are the concentrations and masses of contaminants in the Estuary and its segments?
- 3) What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
- 4) Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?
- 5) What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?

Characterization of benthos would address parallel questions, albeit sometimes driven by factors not necessarily linked to contaminants, e.g., due to invasive species, or sediment supply and characteristics. This sampling effort would primarily address questions 1, 2, and 4, characterizing the margins spatially and temporally, while providing information that can guide investigations into 3 and 5 via special studies. For example, distributions of a contaminant found in margins sampling would inform decisions on locations to further investigate sources (e.g., at deterministic sites in a special study).

As more information is collected, these questions can be answered with greater certainty and statistical power. Throughout the progress however, the characteristics of the margins can

be tested against a null hypothesis assuming equivalence to the population of Bay open water areas; in early years with relatively little data, only very large differences will be statistically significant, but over time smaller differences can be discerned.

None of these questions can be addressed for margins using only data from open water areas of the Bay or a biased selection of hot spots or other deterministic sites. Similar to the need for data for open water sites provided in the current RMP S&T, no amount of modeling and other extrapolation methods can substitute for representative data. Overall, the margins should be sampled at a spatial density and temporal frequency at least proportional to their area in various Bay segments. In the short term, given their current relative lack of representative data, margins could be sampled more intensively than the rest of the Bay. Even in the longer term, if these areas are more productive and highly utilized by biota of interest (humans or wildlife), then they could continue to be characterized more intensely than other areas of the Bay.

Approach

Development of a margins component for the RMP S&T would entail the following steps:

- 1) Define a margin sampling frame, minimizing overlap with other efforts such as CRAM assessed wetland areas (e.g., <1 ft MLLW, but only unvegetated intertidal area) – this will be chosen in consultation with stakeholders, and internal and external wetland and Bay scientists.
- 2) Use a GRTS method to assign sampling locations for the foreseeable future (up to 200 per segment) to this frame in an unbiased manner – this will be done in consultation with an environmental statistician.
- 3) Select a synoptic or incremental approach for an initial effort (equivalent to one year of RMP S&T sediment covering the whole Bay). If an incremental approach is chosen, develop a sampling schedule based on budget/logistical/time critical question constraints.
 - a) Costs are not strictly proportional, e.g. \$3-4k additional mobilization costs are incurred in years or seasons without RMP S&T sediment sampling
 - b) Efforts are not fully scalable in all years, e.g., many RMP labs would not be able to handle both RMP S&T and synoptic margins samples from all segments in a given year (i.e., around double the usual number of samples)
 - c) Efforts can be scaled down by reducing the types of analyses run, number of samples per segment in a given year, or by sampling fewer segments per event
 - i) If the only concerns are bioaccumulative contaminants for example, toxicity testing and benthic characterization could be skipped. However, there is very little current data on the latter in the margins, so some data may be valuable as baseline indicators of state (i.e., are margins better, worse, or same as open Bay), even if not sufficient to diagnose causality.
 - ii) Sampling fewer segments is preferred if the characterization or significance of any differences between open water and margin areas needs to be established quickly for specific segments. This however introduces a biasing risk noted below.

- iii) Fewer samples per segment distributed among all segments reduces possible biasing introduced by episodic events, e.g., if all LSB samples are collected in a year with atypically high rainfall and sediment discharge, a bias could be introduced that is not seen for segments collected in other years.
- d) Given an expectation of possible seasonality in contaminant and sediment discharge (and possible resultant ecosystem effects) in the RMP S&T for open water sites, similar impacts are even more likely for margin sites nearer terrestrial sources. Wet and dry season sampling can be considered for the long term, and distributed sampling of fewer sites among all segments may be preferable especially for any wet season sampling, for reasons noted above.
 - i) If an incremental approach is initially selected, it may be especially beneficial to collect only dry season data until the whole Bay has been surveyed once, in order to somewhat reduce possible interannual variations, most likely to be driven by differences in wet season flows among years.
 - ii) Following that initial dry season survey, a wet season component could be implemented, for similar reasons to its current inclusion in S&T, and likely even more important for margin sites which are likely nearer terrestrial sources. E.g., A lack of toxicity in the dry season does not indicate its absence in the wet season, particularly for chemicals with half-lives of several months or less. This effort can either be interspersed with continued dry season margins sampling, or done exclusively until a wet season data set for the whole Bay is obtained. That decision can be made after review of wet season Bay S&T data to date; if major seasonal differences are seen, earlier collection of more margin wet season data may be helpful in characterizing and understanding contributing processes sooner.

Again, this effort is intended to provide ambient characterization of margins habitat, an equivalent to or spatial expansion of the RMP S&T sediment effort. So long as representative sampling occurs in the Bay, the margins must be included due to their importance as part of the habitat.

Budget

The total budget indicated at the start of this proposal is for a whole-Bay synoptic sampling effort with around 8-10 sites per segment (~45 total sites). Annual costs for an incremental approach (e.g. fewer sites per segment, spread over several years) are proportional to the number of sites sampled for the analytical costs, and slightly more than proportional (\$3-4k per year for additional mobilization costs) for sampling logistics.

Example alternatives:

One year synoptic, whole Bay: \$420k. This would have to be done in a non RMP S&T sediment year, be a substitute for Bay S&T, or at the least be in the season opposite the S&T to minimize lab overload. \$25k for RMP tech report 2nd year comparing results to Bay ambient.

Two sampling years, 40% in a RMP S&T year, 60% the other (next or previous) year:

\$5k design 1st year, \$166k in S&T sediment year, \$249k + \$4k mobilization other year. Lower effort to reduce lab overload in S&T year. \$25k for RMP tech report 3rd year comparing results to Bay ambient.

Five sampling years, 20% in any year. \$5k design 1st year, + \$4k mobilization any non-S&T years/seasons, \$83k sampling & analysis each year. A variant of this, e.g., with sampling years and seasons coincident with RMP S&T sediment, would be an option for a longer term plan and would not strain current lab capabilities. \$25k for RMP tech report 6th year comparing results to Bay ambient. Analysis and report can be done earlier and/or the initial round truncated (with fewer samples/lower statistical power) if this timeline is too long.

The last option is probably not ideal for an initial survey as it would take 10 years to cover the Bay (S&T sediment every 2 years) and would produce a mix of wet and dry season data; if distributed among all segments in a given year this would not conflate temporal for spatial variability, but it still could introduce seasonal variability with very low power to distinguish seasonal differences until many years later. Five consecutive years is also not ideal, as it incurs added mobilization costs in each year, and would be beneficial only for budget but not lab logistical considerations.

Hybrids of the above can also be considered, e.g. 20%/60%/20% effort in sequential years to spread the budget and lab effort without extending the timeline of the initial survey too long. Other alternatives for budget considerations include 1:1 trades for Bay fixed or S&T sites in various years. Regardless, any level of effort (even the 20% per year level), despite the very low power in initial years, is a vast improvement over the status quo, with zero power to characterize margins relative to the open Bay. With even such a small effort, we can eventually get to a point where the margins are at least spatially proportionally represented in the mid-term (sub-decadal) dataset.

Deliverables

Data from this sampling effort would be reported via RMP web tools on an ongoing basis along with other S&T data, and the cumulative margins data to date at any point can be compared to open Bay data. Significant differences are not likely to be found in early years due to the small sample size, but over time it will become apparent if the distributions in the margins are likely to be significantly different or not for various contaminants and other characteristics (e.g., grainsize, TOC, benthic species, toxicity).

After the completion of the scheduled first round of samples (minimum 6 per segment) this comparison will be formalized in an RMP technical report. This can be done even with a mixed wet+dry season data set so long as the comparisons are not unrepresentatively biased (e.g. wet vs wet and dry vs dry only, or both seasons in the same proportions for both Bay and margins sets).