Evaluation of Sediment Condition Using California's Sediment Quality Objectives Assessment Framework

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Sediment quality has an important influence on the overall condition of a water body. Sediments act as a reservoir for contaminants that can be transferred to the water column through physical disturbance, diffusion, and biological activities. Also, sediments are a primary source of contaminant exposure for sediment-dwelling organisms and animals that feed on the bottom, such as crabs and flatfishes. This exposure can produce adverse impacts on benthic communities and can also lead to indirect effects on wildlife and human health due to the accumulation of contaminants from the food chain.

Sediment is a complex matrix of components and forms. Consequently, evaluating contaminant impacts on beneficial uses based on a single line of evidence is problematic. For example, bulk measures of chemical concentration fail to differentiate between the fraction of a contaminant that is tightly bound to sediment and that which is biologically available. Multiple mechanisms of contaminant exposure, including uptake of chemicals from interstitial water, sediment ingestion, and bioaccumulation through the food web further complicate interpretation of sediment chemistry data.

For these reasons, sediment quality assessment often involves simultaneously evaluating multiple lines of evidence (MLOEs) that measure both contaminant exposure and effects on organisms: an approach commonly known as the sediment quality triad (Long and Chapman 1985). Lines of evidence (LOEs), such as sediment chemistry, toxicity, and benthic community condition are often used. Virtually all of the ambient sediment quality monitoring programs in this country rely on more than one line of evidence (USEPA 1998, Crane *et al.* 2000, MacDonald and Ingersoll 2002, USEPA 2004). Such programs include the National Coastal Condition Assessment program (USEPA 2008), as well as numerous regional monitoring programs.

Historically, sediment quality assessment has been an important feature of many California monitoring programs. It was a major focus in the Bay Protection and Toxic Cleanup Program (BPTCP; Anderson *et al.* 1997), the California Environmental Mapping and Assessment Program (EMAP; USEPA 2005), the San Francisco Regional Monitoring Program (SFEI 2011), and the Southern California Bight 2008 Regional Monitoring Program (SCCWRP 2012). Comprehensive sediment quality information is needed for California's 305(b) and 303(d) programs to establish priorities for water quality programs at the State and Regional Boards. California became one of the first states in the U.S. to establish regulatory objectives for sediment quality when the State Water Resources Control Board adopted sediment quality objectives as part of its water quality control plan for bays and estuaries (SWRCB 2008). These objectives also included a new sediment quality assessment framework based on the evaluation of three lines of evidence (sediment quality triad): sediment chemistry, sediment toxicity, and benthic community condition.

The new California sediment quality assessment framework was used to conduct an integrated assessment of sediment quality using regional monitoring data collected between 1998 and 2005 (Barnett *et al.* 2007). That study found evidence of contaminant impacts on sediment quality in 83% of California bays and estuaries. However, data interpretation was limited by the

availability of relatively few data for San Francisco Bay, incomplete toxicity information, and inconsistencies in benthic indices.

This report presents a new assessment of sediment quality in bays and estuaries, using recent regional monitoring data and several modifications to improve upon previous assessments. Similar to previous studies, this assessment integrates data from multiple regional monitoring programs in order to provide an extensive and statistically robust evaluation of most of California's bays and estuaries. Study enhancements include the analysis of a greater number of samples from San Francisco Bay, incorporation of multiple toxicity tests, and the application of an additional benthic index for some habitats.

DATA SOURCES AND METHODS

Three levels of assessment were conducted. The first level evaluated statewide conditions. The purpose of this level was to determine the percentages of the State's embayments with various levels of impact from sediment contamination. At the second level, spatial assessments were conducted independently for three regions within the state in order to investigate patterns related to differences in size of embayments, land use, and hydrological characteristics. The northern region (North) included multiple small coastal embayments north of Point Conception to the Oregon border (Figure 1). The North embayments were characterized by low population density, where agricultural use is important and freshwater inputs are relatively high. The southern region (South) included multiple small coastal embayments south of Point Conception to the US-Mexico border. These southern embayments were often surrounded by high population density, extensive commercial/industrial use, and low freshwater inputs. The third assessment region was the San Francisco Bay and its contiguous marine embayment areas (SFB). The hydrology of the SFB is different from the North and South in that runoff into SFB is nearly continuous, tidal mixing is strong, and agricultural and industrial uses are relatively high. The third level of assessment examined five subregions within SFB. These subregions have been used in previous monitoring programs that reflect hydrological gradients (SFEI 2011): Lower South Bay, South Bay, Central Bay, San Pablo Bay, and Suisun Bay.

Data

The statewide and regional estimates of sediment condition were based on data collected from six stratified random surveys with probability-based designs, conducted over five years (Table 1). Probability-based designs were selected because the area represented by each site was known, allowing sampling results to be expressed as the percent area affected. In addition, each survey met the following criteria: (i) samples were collected within a 5 year period (2005-2010), (ii) site locations were subtidal areas within bays and estuaries, (iii) corresponding data for sediment chemistry, toxicity, and benthic macrofauna were available, and (iv) sampling and analysis methods were comparable to those specified in the proposed sediment quality assessment framework. All data for the SFB and South regions were collected subsequent to the previous evaluation (Barnett *et al.* 2007) in order to facilitate comparison of temporal changes. There was some overlap in studies for the North (WEMAP 2005 data used for both) in order to provide a larger sample size for analysis in this region.

Sample collection for each survey was conducted during June-September, with the exception of the 2010 survey by the Regional Monitoring Program (RMP) for Water Quality in the San Francisco Estuary, which was conducted in February. Comparable methods were used for each survey; however, the surveys encompassed different years and geographic regions. The WEMAP 2005 and National Coastal Assessment 2010 surveys examined embayments along the entire California coast. Data for San Francisco Bay were compiled from three surveys conducted in 2008-2010 by the RMP. Each RMP survey included 20 randomly selected stations distributed among the five subregions of interest, and an additional five historical stations (same location each survey). The Southern California Bight 2008 Regional Monitoring Program survey was the largest source of data overall (176 of 296 stations) and provided the majority of data for the South region. All surveys followed the USEPA's Generalized Random Tessellation Stratified

(GRTS) design with the intent of balancing samples spatially while allowing for intensification in certain areas of interest (http://www.epa.gov/nheerl/arm/designpages/design&analysis.htm).

The data from each survey were compiled into a single database, standardized with respect to format and units, and screened to verify they met quality control and inclusion criteria. Several stations from the WEMAP and NCA surveys were excluded from analysis because the sampling locations were not within enclosed bays and estuaries. Several additional stations from San Francisco Bay and other embayments were excluded from analysis because they did not meet salinity or sediment grain size criteria. The final data set used for analysis contained 296 samples.

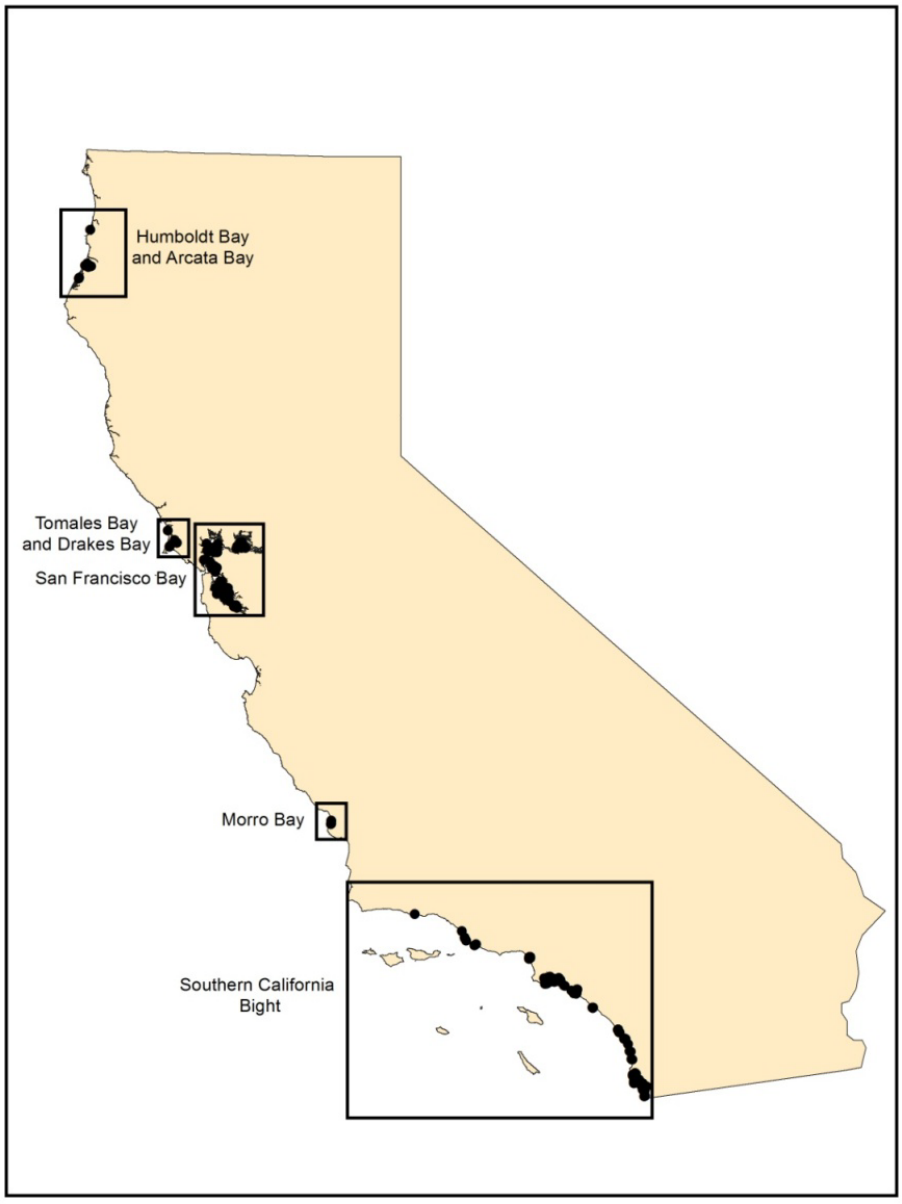

Figure 1. Distribution of sampling sites for the statewide sediment quality assessment.

Table 1. Probability-based surveys and number of sites per region for each survey.

Survey	Year	Area (km^2)	Number of Sites		
			North	SFB	South
Southern California Bight Regional Monitoring Program (Bight08)	2008	122	0	0	176
Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP)	2008	896	0	25	0
	2009	896	0	25	0
	2010	896	0	25	0
National Coastal Assessment (NCA)	2010	73	10	0	21
West Environmental Monitoring and Assessment Program (WEMAP)	2005	66	8	0	16
Total		1124[1]	18	75	213

[1] Total area evaluated by all studies combined, after correction for overlapping sample frames among individual surveys.

Determination of Sediment Condition

Three lines of evidence were evaluated at each site to assess sediment quality: sediment chemistry, toxicity, and benthic macrofaunal community condition (benthos). Each LOE was represented by a four-category response level that was based on the interpretation of multiple indicators (e.g., two toxicity tests, four benthic indices). Details of the specific measures and thresholds used for each LOE are provided in SWRCB (2008) and Bay and Weisberg (2012). The LOE responses were then integrated using the assessment framework to determine the level of impact, if any, with respect to sediment contamination for each site. A summary of each LOE and the integration process is provided below.

Lines of Evidence

Chemistry. A combination of two sediment chemistry indices was used to determine the magnitude of chemical exposure at each site: the California Logistic Regression Model (CA LRM) and the Chemical Score Index (CSI). The CA LRM was developed using a logistic regression modeling approach that estimates the probability of acute toxicity in sediments based on the chemical concentration (Field *et al.* 2002, USEPA 2005) calibrated using California data (Bay *et al.* 2012). The CSI was developed using California data and is based on the association of chemical concentration with benthic community disturbance (Ritter *et al.* 2012). Index-specific thresholds were then applied and resulting CA LRM and CSI exposure categories were averaged to determine an overall response for the chemistry LOE. The response-level categories used to define chemical exposure assessments were:

- **Minimal Exposure** - Sediment-associated contamination may be present, but exposure is unlikely to result in effects.
- **Low Exposure** - Small increase in contaminant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.
- **Moderate Exposure** - Clear evidence of sediment contaminant exposure at concentrations that are likely to result in biological effects.
- **High Exposure** - Contaminant exposure is highly likely to result in substantial biological effects.

Toxicity. The 10-day amphipod survival test using *Eohaustorius estuarius* was used to determine the magnitude of sediment toxicity at each site (USEPA 1994). Toxicity was also evaluated using a mussel embyro (*Mytilus galloprovincialis*) sediment water interface test at most stations (Anderson *et al.* 1996). Mussel tests were not conducted during the WEMAP 2005 survey. Thresholds based on percentage survival and statistical significance were applied to assign test results to one of the following response-level categories:

- **Nontoxic** - Response not substantially different from that in uncontaminated control sediments.
- **Low Toxicity** - A low magnitude response that differs from control survival, but is within the variability typical for that test and thus may not be a reproducible effect.
- **Moderate Toxicity** - High confidence that a statistically significant toxic effect is present.
- **High Toxicity** - High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test.

Benthic Communities. Combinations of benthic community condition indices were used to determine the magnitude of disturbance to benthic communities at each site. The indices are based on different sets of species composition or community measures. The benthic indices used include:

Benthic Response Index (BRI). The BRI was originally developed for the southern California mainland shelf and extended into California's bays and estuaries (Smith *et al.* 2001, 2003). The BRI is the abundance-weighted average pollution tolerance score of organisms occurring in a sample.

Relative Benthic Index (RBI). The RBI was developed for California's Bay Protection and Toxic Cleanup Program (Hunt *et al.* 2001). The RBI is the weighted sum of: (i) several community metrics, (ii) the abundances of three positive indicator species, and (iii) the presence of two negative indicator species.

Index of Benthic Biotic Integrity (IBI). This index was developed for freshwater streams and adapted for California's bays and estuaries (Thompson and Lowe 2004, Ranasinghe *et al.* 2009). The IBI identifies community measures that have values outside reference ranges.

River Invertebrate Prediction and Classification System (RIVPACS). This index was originally developed for British freshwater streams (Wright *et al.* 1993, Van Sickle *et al.* 2006) and adapted for California's bays and estuaries. The RIVPACS index calculates the number of reference taxa present in the test sample and compares it to the number expected to be present in a reference sample from the same habitat.

AZTI Marine Biotic Index (AMBI). The AMBI was developed for soft bottom European coastal and estuarine environments (Borja *et al.* 2000) and subsequently applied in many areas worldwide, including southern California (Teixeira *et al.* 2012). The AMBI is based on the proportions of abundance in five ecological groups related to the sensitivity or tolerance of benthic organisms to environmental stress. Unlike habitat-specific benthic indices, it is based on general characteristics of benthic organisms and does not require calibration for application in novel systems. Therefore, the AMBI is especially useful in habitats where large quantities of calibration data are not available.

Thresholds specific to regional assemblages were applied to the results in order to classify each index result according to the level of disturbance, except for the AMBI, where thresholds are universal. The resulting disturbance categories were then combined to provide an overall benthic LOE category. The four response-level categories used to define benthic condition assessments were:

- **Reference -** A community composition equivalent to a "least affected" or "unaffected" site.
- **Low Disturbance -** A community that shows some indication of stress, but could be within measurement error of unaffected condition.
- **Moderate Disturbance -** Confident that the community shows evidence of physical, chemical, natural, or anthropogenic stress.
- **High Disturbance -** Changes in the benthos are substantial enough to limit community function.

Not all indices were used in each region, due to the lack of validation for some habitats. In southern California, and central and southern San Francisco Bay, where the combinations were validated during the initial development of the sediment quality assessment framework (Ranasinghe *et al.* 2009), the BRI, RIVPACS, RBI, and IBI were combined. Elsewhere, any available indices were combined. The RBI, IBI and AMBI were combined to evaluate the remainder of the SFB sites, while the RBI and AMBI were combined to evaluate the north coast sites.

Integration of LOE Response Levels

The response-level categories within each of the three LOEs resulted in 64 possible combinations of outcomes. Each combination was associated with one of six final site condition classes (Appendix A). The relationship between each LOE combination and site condition was established using a conceptual model that related the LOE classifications to the severity of biological effects and the potential for chemically mediated biological effects (Figure 2). These

intermediate classifications were then integrated to determine the final MLOE assessment of site condition. Development of these relationships is described in Bay and Weisberg (2012).

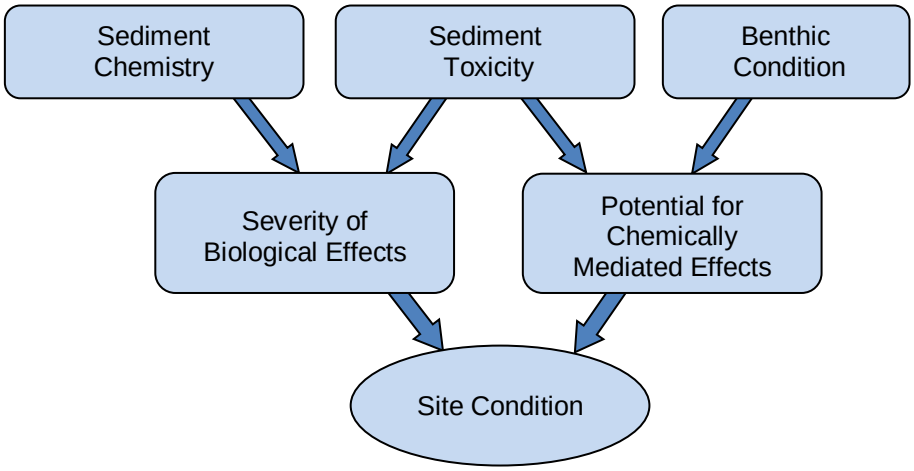

Figure 2. Conceptual model of MLOE integration for site assessment.

The final MLOE site condition categories were based on the severity level of biological effects and the potential for chemically mediated effects. Six assessment classes were developed to describe the contaminant impact in terms of level of certainty and magnitude:

- **Unimpacted.** Confident that chemical contamination is not causing significantly adverse impacts to aquatic life in the sediment.
- **Likely Unimpacted**. Chemical contamination is not expected to cause adverse impacts to aquatic life in the sediment, but some disagreement among the LOEs reduces certainty that the site is Unimpacted.
- **Possibly Impacted.** Chemical contamination at the site may be causing adverse impacts to aquatic life in the sediment, but the level of impacts is uncertain because of disagreement between LOEs.
- **Likely Impacted.** Evidence of contaminant-related impacts to aquatic life in the site sediment is persuasive, in spite of possible disagreement among LOEs.
- **Clearly Impacted.** Sediment chemical contamination at the site is causing clear and significantly adverse impacts to aquatic life in the sediment.
- **Inconclusive.** Disagreement among the LOEs suggests that either data are suspect or additional information is needed for classification.

Determination of Percent Area for Site Condition Categories

Each of the six surveys evaluated in this study used a random stratified sampling design that associated area weights with each site (survey station) and enabled the results to be expressed in a spatial context (e.g., percent of water body area affected). However, there were differences in level of stratification and sample frame (survey boundaries) among the surveys that prevented use of the original area weights for the integrated assessment. For example, some surveys included strata (e.g., ports, marinas), while no stratification was used in others. Different polygons (subregions within a stratum) were used to constrain sample point distribution or control sample density. Consequently, the area weights (proportional to the number of sites within a stratum) of individual sample points varied greatly between surveys.

In order to conduct a statewide assessment that was spatially representative, the survey designs were combined to produce a common sampling frame and level of stratification. Three strata (regions) were established: North, SFB, and South. Within each region, the survey-specific sampling frames and polygons were compared and a single set of polygons was created that included all of the combined area sampled. New area weights were calculated for the sites within each region by dividing the area of each final polygon by the number of sites within the area.

Estimates of the percent area representing various sediment condition classifications were calculated using the new area weights. The area of each region (or subregion within SFB) representing each MLOE condition category was calculated as the sum of the area weights of the samples that fell into that category divided by the sum of the area weights for all samples within the region. The percent area in each category was calculated by dividing by the area affected by the total area of the region evaluated. Statewide estimates of condition were calculated in the same manner used for the regional estimates.

RESULTS AND DISCUSSION

Statewide Assessment of Sediment Quality

Approximately 47% of the 1124 km^2 of California marine embayments included were classified as having some degree of impact related to sediment contamination (i.e., classified as Possibly Impacted, Likely Impacted, or Clearly Impacted). Chemical contamination of sediment in these areas is considered not to be protective of maintaining healthy benthic communities. Most of this area was classified as Possibly Impacted, the category having the highest uncertainty. Less than 1% of the area was classified as Clearly Impacted, the most severe impact category (Figure 3).

The greatest percentage of embayment area was classified as Likely Unimpacted, indicating that substantial effects were present for only one of the three LOEs. These areas likely represent sites where individual LOE indices are probably responding to factors that are not representative of contaminated sediment impacts, such as variation in salinity or sediment grain size. The statewide analysis results were dominated by the conditions present in SFB, which constituted nearly 80% of the embayment area evaluated.

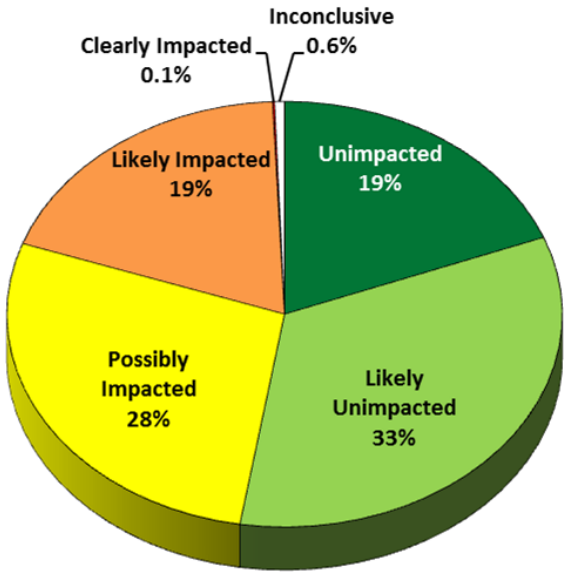

Figure 3. Percent area of California embayments in each sediment condition category, as classified by the MLOE assessment framework.

Regional Assessment of Sediment Quality

Large variations in sediment condition were present among the three geographic regions. The South region had the best overall sediment condition, with 51% of the area classified as Unimpacted and 23% Likely Unimpacted (Figure 4; Table 2). However, the South was the only region to contain Clearly Impacted sites (three stations in marinas). Slightly lower sediment quality was observed in the North, with 25% of the area classified as Unimpacted and 45% classified as Likely Unimpacted.

The worst sediment quality was present in San Francisco Bay, with slightly over half of the area classified as having impacts related to sediment contamination. The Possibly Impacted category accounted for most of the impacted area in each region, indicating that most of impacts were relatively low in severity or that there was inconsistency among lines of evidence.

All three regions were similar in that most of the impacted area was classified in the Possibly Impacted category. These results suggest that, while sediment contamination is prevalent in all regions, it is generally low in magnitude. This conclusion is consistent with the chemistry LOE results, which identified less than 0.1% of North or SFB embayments with moderate or high sediment chemistry and 30% with such levels in the South (Table 3).

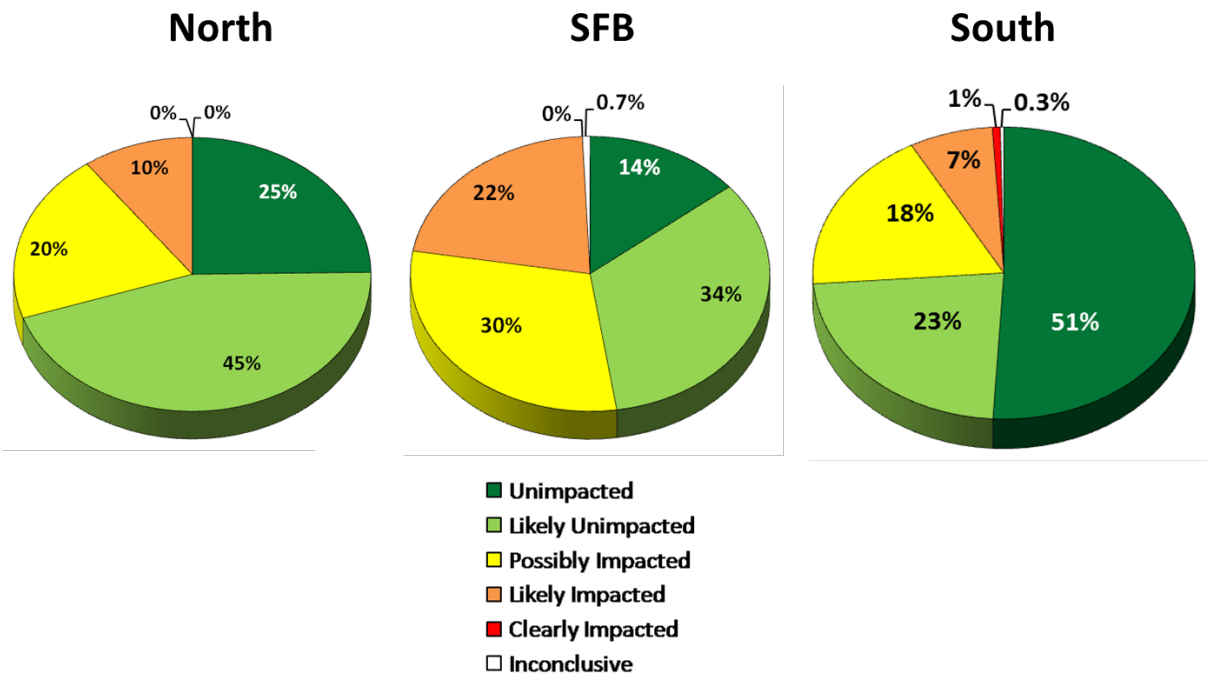

Figure 4. Percent area of sediment quality classification for regional MLOE assessments.

Table 2. Regional embayment sediment quality condition based on MLOE assessment. Assessment results for each station are included in Appendix B.

Condition Category	Number of Sites	Percent Area	95 Percent Confidence Interval
North			
Unimpacted	4	25	4 - 45%
Likely Unimpacted	8	45	25 - 65%
Possibly Impacted	4	20	2 - 38%
Likely Impacted	2	10	0 - 23%
Clearly Impacted	0	0	-
Inconclusive	0	0	-
Total	18	100	
SFB			
Unimpacted	5	14	4 - 24%
Likely Unimpacted	21	34	23 - 45%
Possibly Impacted	24	30	19 - 41%
Likely Impacted	14	22	12 - 31%
Clearly Impacted	0	0	-
Inconclusive	1	1	0 - 2%
Total	65	100	
South			
Unimpacted	84	51	44 - 58%
Likely Unimpacted	48	23	17 - 29%
Possibly Impacted	50	18	13 - 23%
Likely Impacted	26	6	4 - 9%
Clearly Impacted	3	1	0 - 2%
Inconclusive	2	0.3	0 - 1%
Total	213	100	

Table 3. Percent of area affected for each LOE. Area affected = sum of percent area classified in moderate and high response categories.

	Percent Area Affected Per LOE		
Region	**Benthos**	**Toxicity**	**Chemistry**
North	28	36	0
San Francisco Bay	39	59	0.1
Lower South Bay	8	69	8
South Bay	85	69	0
Central Bay	31	62	0
San Pablo Bay	0	46	0
Suisun Bay	85	54	0
South	18	8	30

Sediment Quality within San Francisco Bay

Large variations in sediment condition were present among the five SFB subregions (Figure 5). The best sediment quality was present in San Pablo Bay, where 85% of the subregion was classified as either Unimpacted or Likely Unimpacted. None of the San Pablo Bay sites were classified as Likely Impacted and benthic communities were in good condition at all stations sampled (Table 3). Relatively good sediment quality was also present in the Central Bay subregion, where 54% of the area was not impacted by sediment contamination. The Central Bay showed stronger evidence of sediment contamination impacts relative to San Pablo Bay, with 23% of the area classified as Likely Impacted.

The poorest sediment quality was present in the South Bay, where 100% of the area was classified as either Possibly or Likely Impacted (Figure 5). Suisun Bay had the second greatest extent of contaminant-impacted sediment (69%), with a similar area classified as Likely Impacted as was observed in the South Bay. Assessment results for one station, representing 8% of Suisun Bay's area, were inconclusive due to a large discrepancy among LOEs. This station had a highly disturbed benthic community, but low toxicity and minimal chemical contamination.

Sediments in the Lower South Bay also showed widespread evidence of possible sediment contamination impacts. Most of the sediments (54%) in this subregion were classified as Possibly Impacted, with 8% classified as Likely Impacted (Figure 5). The relatively high occurrence of uncertain sediment quality impacts was due to a high prevalence of sediment toxicity without corresponding occurrences of disturbed benthic communities or substantial chemical exposure (Table 3).

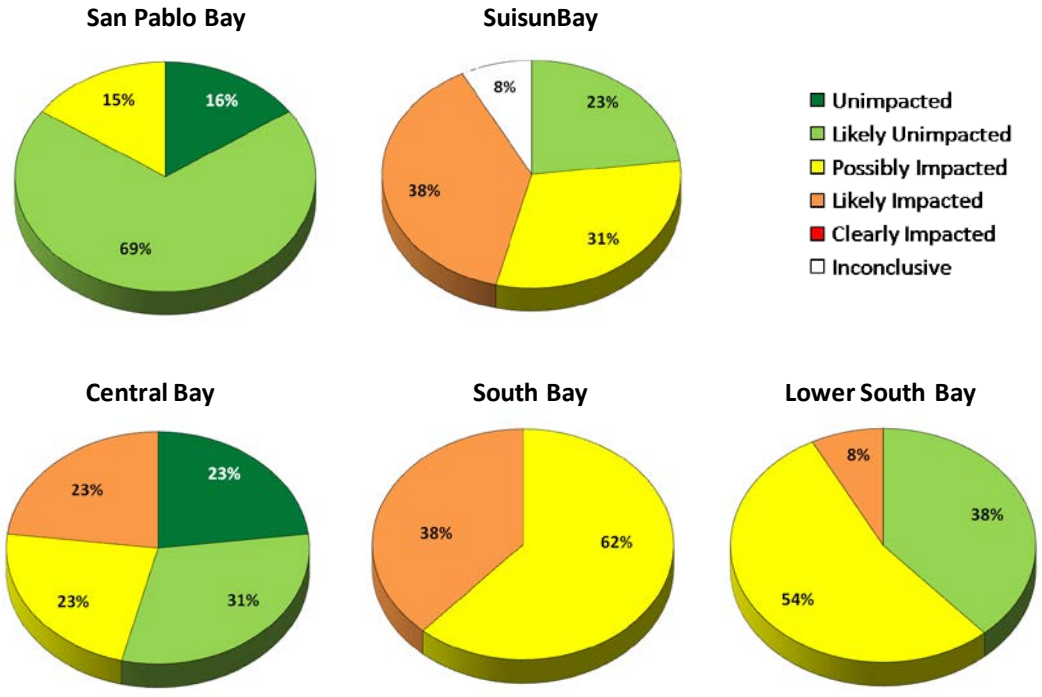

Figure 5. Percent area of sediment quality classifications for San Francisco Bay subregions.

Sediment Condition in Individual Embayments

Most of the sediment samples in the North region were located in four water bodies: Humboldt Bay/Arcata Bay, Tomales Bay, Drakes Estero, and Morro Bay (Figures 6 and 7). Density of sampling in these areas was too low to make a quantitative estimate of the spatial extent of impacts, but several trends are evident. First, the best sediment quality in the North appears to occur in Tomales Bay and Humboldt Bay. Both of these embayments did not contain any contaminant impacted stations and the results were consistent between the 2005 and 2010 surveys. Sediment sites that were classified as having impacted sediments were located in the southern portion of Morro Bay and in Arcata Bay, with similar results for both surveys. Most of the sites classified as Moderately Impacted or Possibly Impacted were located in very shallow areas that may be exposed at low tide or subject to extremes in water quality. It is possible that the elevated levels of benthic community disturbance at these sites were partly a reflection of harsh environmental conditions. However, sediment toxicity was also present at these sites, indicating the likely presence of chemical stressors in the sediments.

Sediment quality among individual sites in San Francisco Bay reflected the general patterns indicated by the subregion analysis summaries shown in Figure 5. There was little indication of trends in sediment quality related to location within each subregion. For example, impacted sites within the South Bay were located both near the margins and in the middle of the subregion (Figure 8). There also did not appear to be substantial temporal variation in the assessment results; impacted sites were present in all three RMP surveys analyzed (Appendix B).

Most of the sites in the South region were located in two water bodies: San Pedro Bay (including the ports of Los Angeles and Long Beach) and San Diego Bay. Moderately and Impacted sediments were located in both of these two bays, and were almost always located in marinas or areas of active port operations (Figure 9). Sites with Possibly Impacted condition were often located in marinas and ports as well, but were also distributed near the mouths of rivers and creeks entering the bays. Three other highly developed embayments also contained a relatively large number of stations: Marina del Rey, Newport Bay and Mission Bay. Of these three embayments, sediment quality showed the greatest impacts in Marina del Rey and Newport Bay; each of these bays had at least one site with the most severe impact category (Clearly Impacted). Similar to the larger bays, sediment quality was generally worse in marina areas that likely had limited water circulation. Of the larger embayments in the South, sediment quality was best overall in Mission Bay. All sites in Mission Bay were classified as either Unimpacted or Likely Unimpacted. The high quality of sediments in Mission Bay is likely related to the low intensity of commercial activities and limited stormwater inputs to the Bay. Mission Bay is primarily a recreational water body with relatively few marinas along the shoreline and no port activities. Sediment quality in the San Diego River, adjacent but separate from Mission Bay, was somewhat lower, with several stations classified as Possibly Impacted. Contaminant inputs from urban runoff may have contributed to potential sediment impacts in this river, as a moderate level of toxicity was observed at one location.

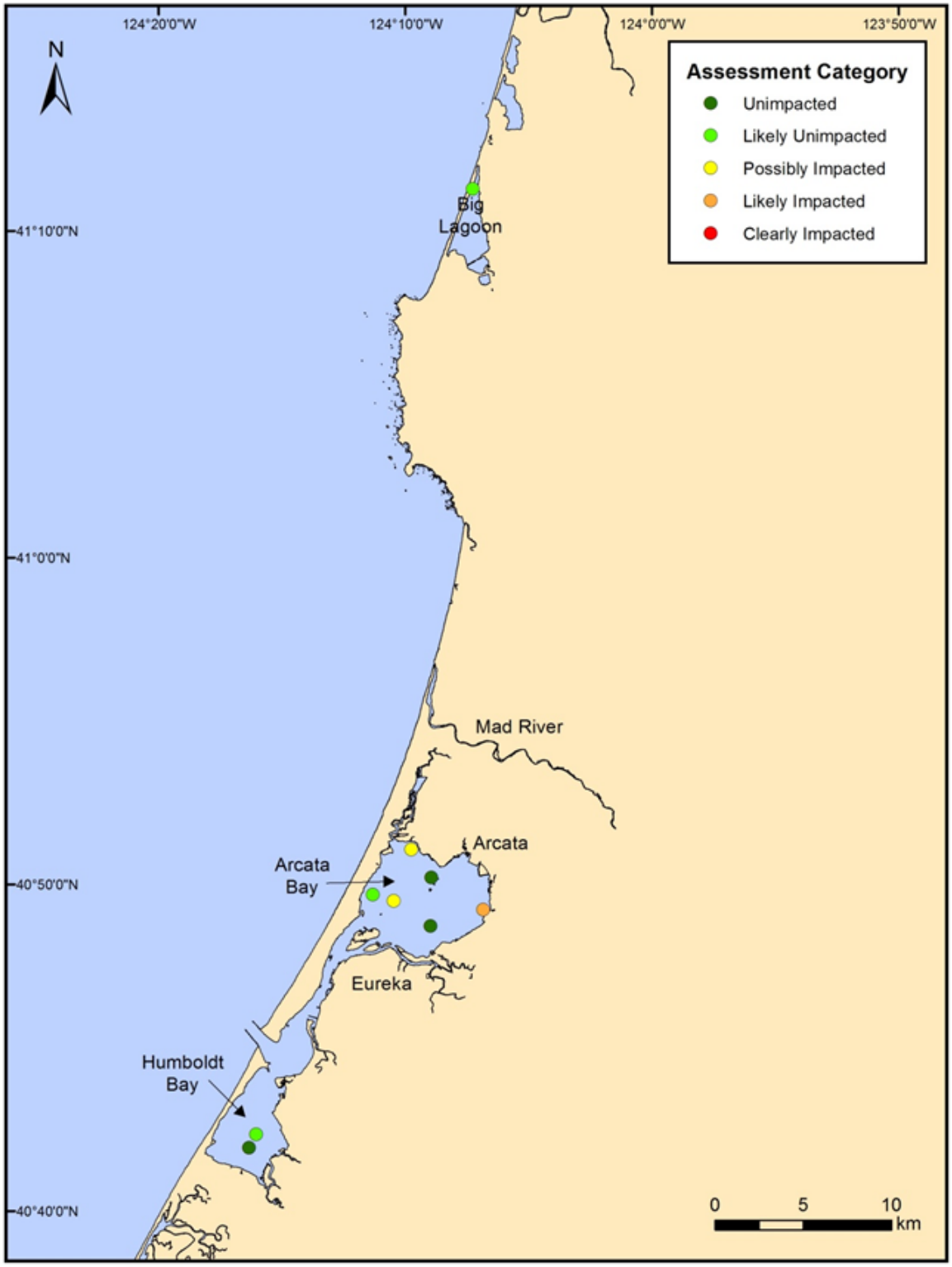

Figure 6. Sediment quality in North Coast embayments.

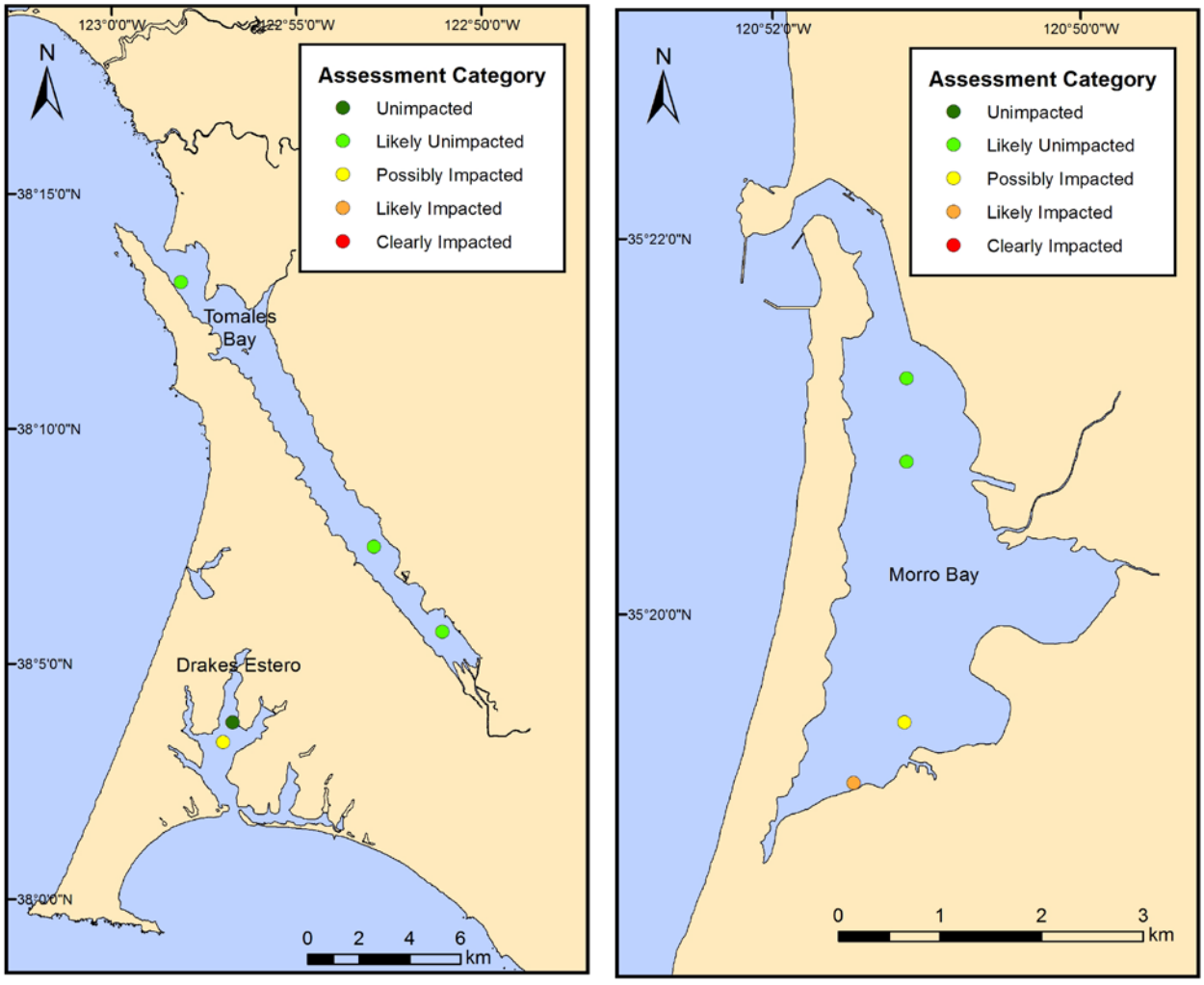

Figure 7. Sediment quality in Tomales Bay, Drakes Estero, and Morro Bay.

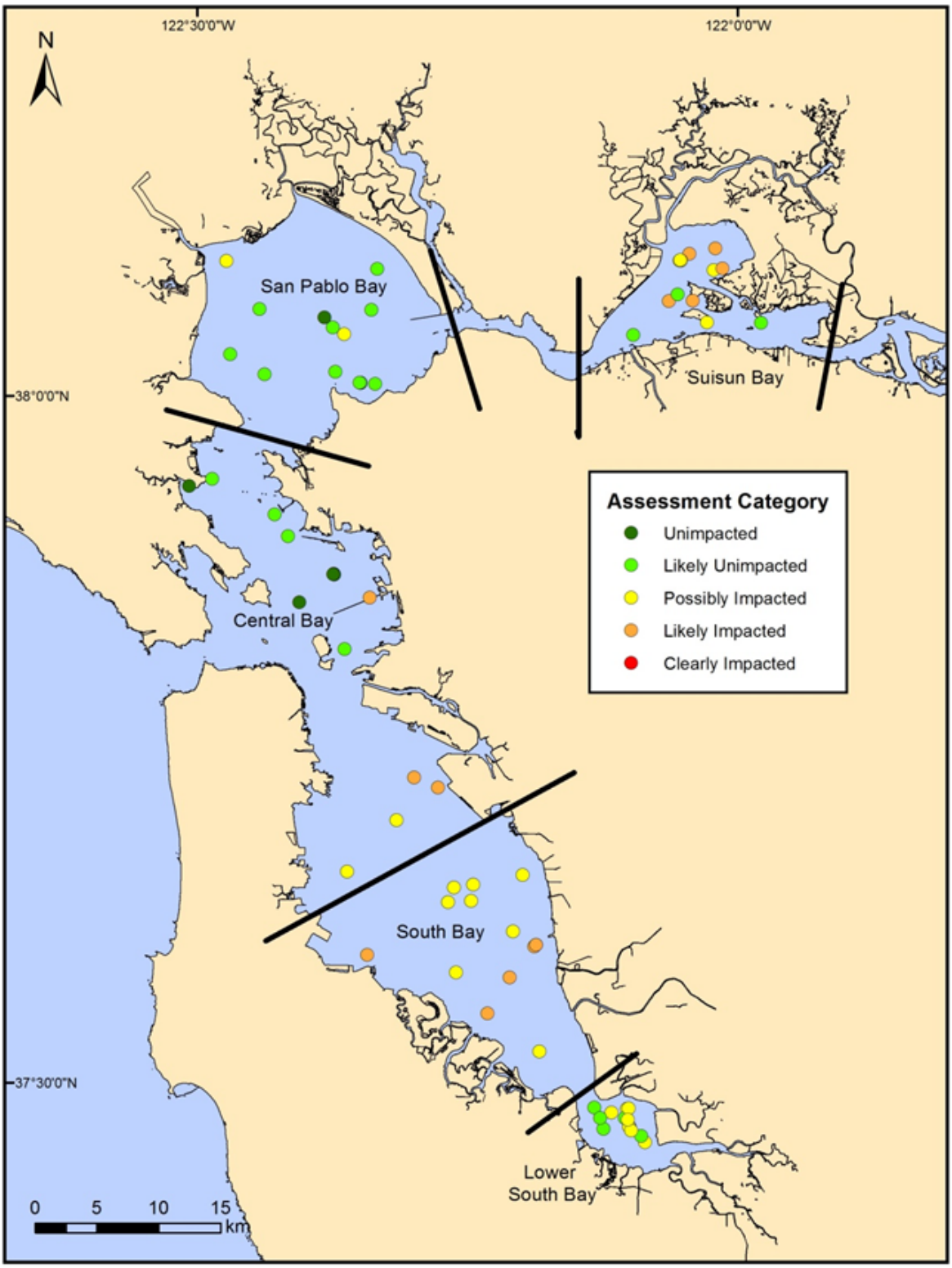

Figure 8. Sediment quality in San Francisco Bay subregions.

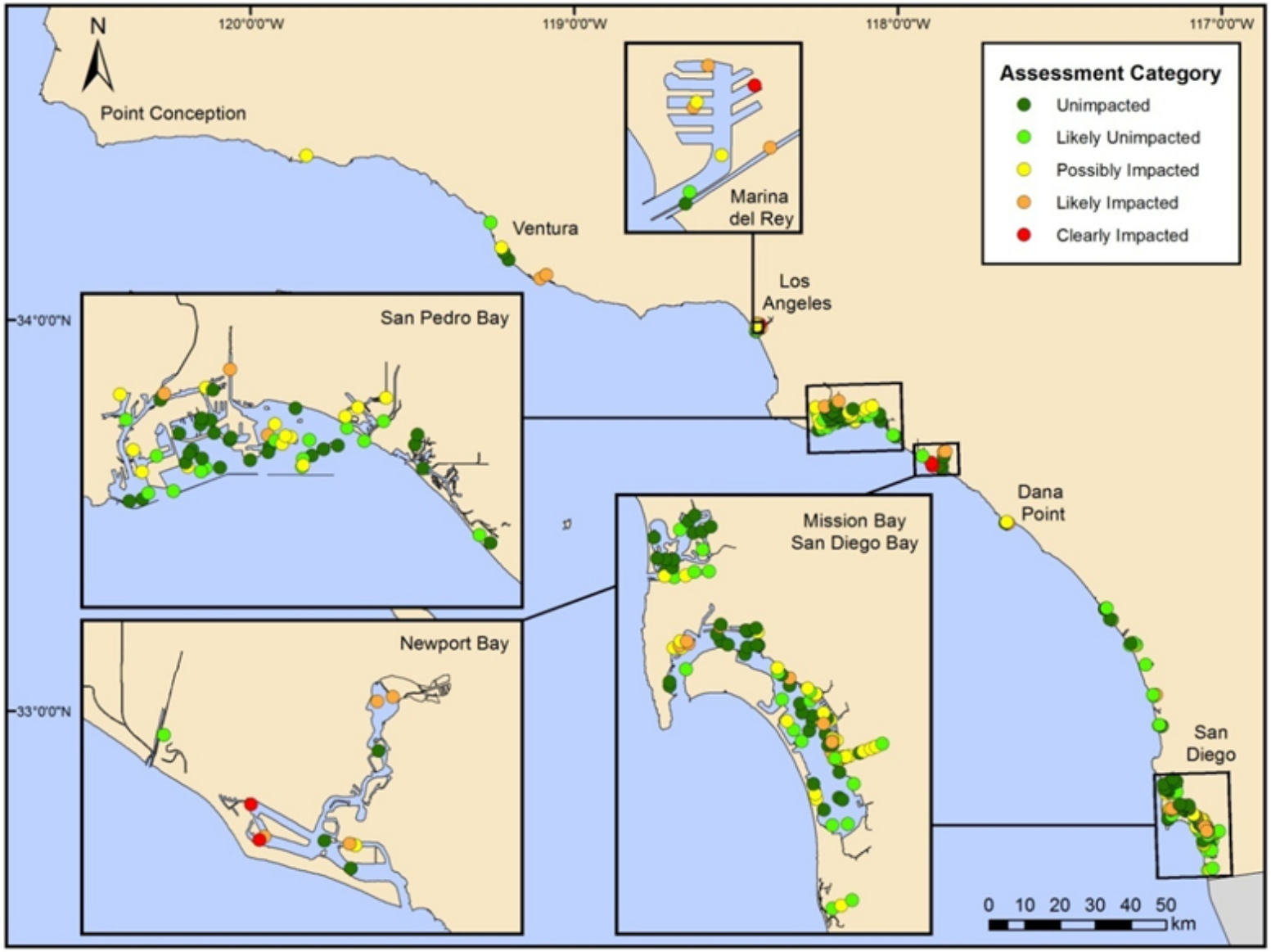

Figure 9. Sediment quality in southern California embayments.

Relationships among LOEs

The factors influencing the regional differences in sediment quality were evaluated by analysis of the underlying lines of evidence (Chemistry, Toxicity, and Benthic Community). The percentage of area affected for each LOE was represented as the sum of the percentages for the moderate and high LOE response categories (e.g., Moderate Toxicity and High Toxicity). This analysis revealed two overall patterns of relative LOE influence among regions. Sediment condition category in the North and SFB was most strongly influenced by biological effects, either sediment toxicity or disturbed benthic communities. Both the North and SFB regions had much larger areas affected by sediment toxicity (36 - 59%) or disturbed benthic communities (28 - 39%), relative to sediment contamination (Table 3). There were no occurrences of moderate or high sediment contamination in the North, and only one occurrence in SFB. A different relationship among the LOEs was evident in the South. Approximately 30% of the area of South embayments was affected by sediment contamination, while the extent of sediment toxicity and disturbed benthos was much less (8 and 18%, respectively).

Variation in the sediment toxicity tests used among surveys did not appear to have a substantial influence on the results. The 2005 WEMAP survey (representing about half of the North stations) used only the amphipod survival test to measure toxicity, while all other surveys used both the amphipod and mussel embryo tests. Reanalysis of the North toxicity results using only the amphipod test for all stations produced less than a three percentage point reduction in the spatial extent of toxicity.

The varying relationship among LOEs suggests that different factors are influencing the biological results in each region. For the North and SFB regions, the sediment toxicity and benthic community indicators appear to be responding to factors that show little correspondence with traditional measures of sediment contamination. Biological responses in these two regions might be affected by noncontaminant stressors (e.g., salinity extremes, physical disturbance) or other types of contaminants that are not accurately represented by the sediment chemistry indices used in the assessment framework.

The LOE comparisons among the five subregions of SFB indicated varying biological responses that generally corresponded with the spatial extent of sediment quality impacts. Sediment toxicity was prevalent among all five subregions and of greater extent than the North or South, ranging from 46% of area in San Pablo Bay to 69% of area in the South Bay and Lower South Bay (Table 3). Only one station in the Lower South Bay was affected by elevated sediment contamination. The extent of benthic community disturbance varied widely among subregions. There were no stations with affected benthic communities in San Pablo Bay, while 85% of the communities in the South Bay and Suisun Bay had moderate or high levels of disturbance.

The cause of the wide variations in benthic community condition among SFB subregions is uncertain. While most of the subregions contain different benthic assemblages due to differences in salinity regime and other habitat factors (Ranasinghe *et al*. 2012), trends in benthic condition do not correspond. For example, the best benthic condition was present in San Pablo Bay, although this subregion has more of a variable salinity regime than the South Bay. Differences among the benthic condition indices used in each subregion also do not appear to explain the

variation in results. The same three benthic indices (RBI, IBI, and AMBI) were used in San Pablo Bay, Lower South Bay, and Suisun Bay, yet the results varied from 0 to 85% affected (Table 3).

Temporal Trends

The 2012 assessment results differ from those reported previously by Barnett *et al*. (2007) in several respects. Overall statewide sediment quality has improved. Surveys conducted in 1998-2005 indicated that 83% of California's bays and estuaries had contaminant-related impacts to sediment quality (condition categories of Possibly Impacted, Likely Impacted, or Clearly Impacted), whereas the new assessment of data from 2005-2010 indicates impacts to only 47% of the area. This overall improvement corresponded to improved sediment quality in San Francisco Bay, the state's largest estuary system (Figure 10). The extent of Possibly Impacted sediment in SFB declined by more than half since the 2008 assessment, with corresponding increases in the extent of better quality sediment (Likely Unimpacted and Unimpacted categories).

There was less of a temporal trend in sediment quality in the North and South regions (Figure 10). The percent of area of impacted sediment in the North increased in the 1995-2010 assessment period (18 - 30%), while there was a decrease in impacted area in the South (38 - 24%). As was the case for SFB, most of these changes were due to variation in the percent of area classified as Possibly Impacted, the category having the greatest uncertainty. There was also a shift in the relative proportion of North stations classified as Unimpacted or Likely Unimpacted, resulting in a reduction in area classified as Unimpacted in 2012.

The temporal trends in sediment quality appear to be the result of lower levels of chemical contamination and sediment toxicity in many of the embayments, relative to the previous assessment period (1998-2005). The extent of Moderate sediment chemistry declined from approximately 20% in the previous assessment to 3% (Figure 11). A much greater decline in the spatial extent of sediment toxicity between survey periods was observed, with the spatial extent of Moderate or High toxicity declining substantially between surveys (72 - 51%). Little change in benthic community condition was observed between surveys (Figure 11).

There were changes in the toxicity and benthic community indicators used between surveys that may have influenced the temporal comparison of results. Two toxicity tests were used in most of the recent surveys, while only one test was used in the 1998-2005 study. The influence of the toxicity test change was investigated by reanalyzing the statewide toxicity LOE results using only the amphipod test. The modified toxicity LOE results for 2012 show an even more pronounced reduction in toxicity extent, suggesting that this temporal trend was not unduly influenced by test method changes (Figure 11).

The assessment of benthic community condition varied between surveys in terms of the inclusion of an additional benthic index for some habitats. The AMBI, an index developed in Europe and adapted for application in the U.S., was applied in combination with the RBI for North sites and in combination with the RBI and IBI within portions of SFB (San Pablo Bay, Suisun Bay, Lower South Bay). This change was made to increase the reliability of benthic community assessments in these habitats, since the RBI and IBI have had limited calibration for use in some of these

habitats. Similar to the toxicity LOE, the influence of the changes in the benthic indices was investigated by recomputing the benthic LOE using only those indices applied in the previous assessment. Very little change in benthic LOE category distribution resulted from using the modified set of indices, indicating that benthic community condition was stable between surveys.

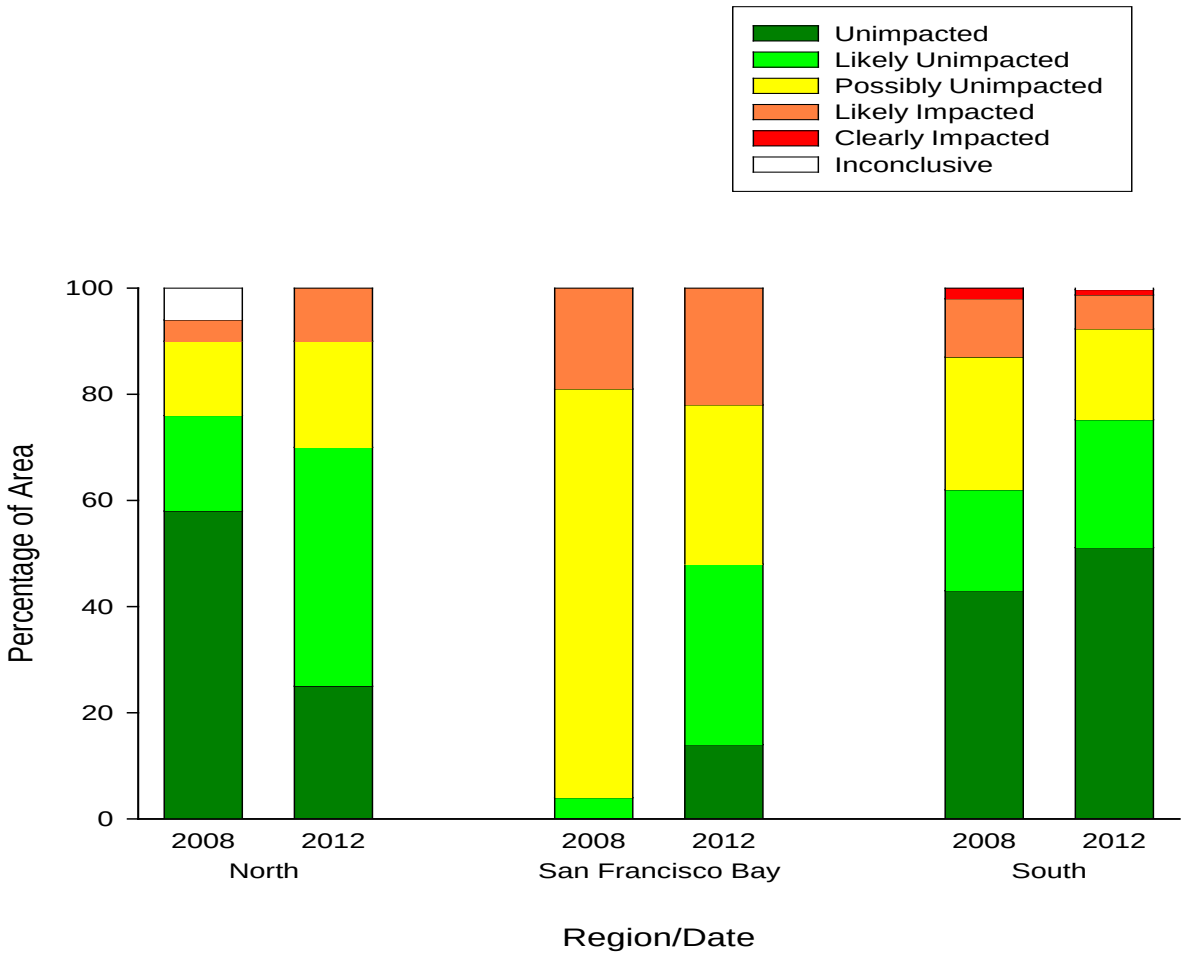

Figure 10. Comparison of spatial assessments from 2008 and 2012.

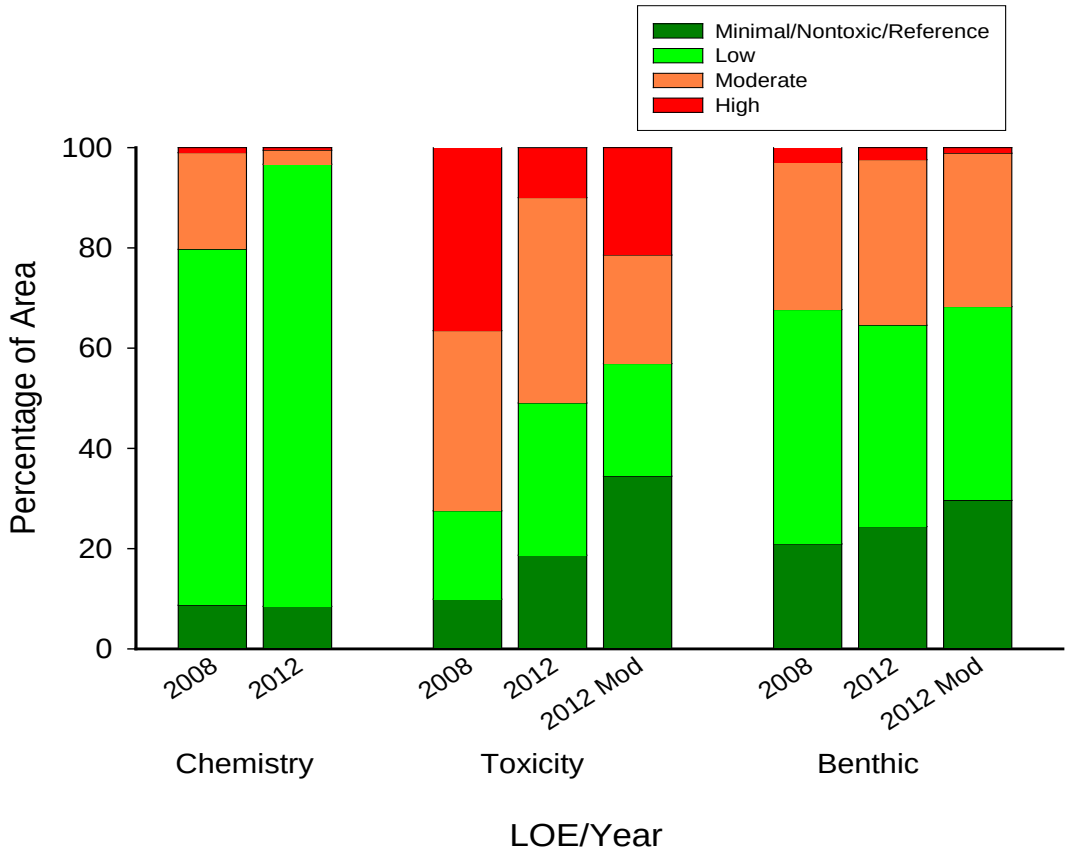

Figure 11. Comparison of statewide LOE response categories from 2008 and 2012. The 2012 Mod bar shows results using the same indicators for each LOE that were used for the 2008 assessment.

SUMMARY

This study is the second statewide application of California's standardized multiple line of evidence assessment framework. The development of this framework and its application to a comprehensive set of regional monitoring survey data enables comparisons among regions, lines of evidence, and time periods. Such comparisons are useful for assessing the effectiveness of environmental management actions and identifying priority areas for further investigation.

Sediment quality varied regionally among California's marine and estuarine embayments. The greatest extent of contaminant-impacted sediments was present in San Francisco Bay (52% of area), while conditions were best in southern California (26% of area impacted). Overall, 47% of California's bays and estuaries had evidence of contaminant- related impacts in 2005-2010.

Comparisons with a previous statewide assessment indicate some improvement in sediment quality, particularly in San Francisco Bay. A reduction in the extent and magnitude of sediment toxicity between assessment periods appears to be the major driver for these temporal changes. There is insufficient information available to identify the factors responsible for the reduction in sediment toxicity, however. The change may be associated with reduced chemical contaminant inputs, as there was an indication of reduced contaminant exposure in San Francisco Bay, but such a relationship is difficult to establish given the generally low level of correspondence between the sediment chemistry and biological response data observed in this study.

Sediment toxicity is still prevalent in California's bays and estuaries, despite the temporal trend of improvement. The widespread toxicity reported here for San Francisco Bay has been observed since the 1980s (Anderson *et al.* 2007) and other studies have associated sediment contamination with benthic community degradation in portions of San Francisco Bay (Thompson *et al.* 2007). The cause of such adverse impacts in San Francisco Bay remains elusive, without clear spatial gradients, and may be due to multiple factors. Additional studies to identify the stressors responsible for these biological responses are needed to help inform environmental management agencies regarding strategies to improve sediment quality in the future.

LITERATURE CITED

Anderson, B.S., J.W. Hunt, M. Hester and B.M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. pp. 609-624 *in*: G.K. Ostrander (ed.), Techniques in Aquatic Toxicology. CRC Press Inc. Boca Raton, FL.

Anderson, B., J.W. Hunt, B. Phillips, B. Thompson, S. Lowe, K.M. Taberski and R.S. Carr. 2007. Patterns and trends in sediment toxicity in the San Francisco Estuary. *Environmental Research* 105:145-155.

Anderson, B.S., J.W. Hunt, S. Tudor, J. Newman, R.S. Tjeerdema, R. Fairey, J.M. Oakden, C. Bretz, C.J. Wilson, F. LaCaro, G. Kapahi, M. Stephenson, H.M. Puckett, J.W. Anderson, E.R. Long, T. Fleming and J.K. Summers. 1997. Chemistry, Toxicity and Benthic Community Conditions in Sediments of Selected Southern California Bays and Estuaries. California State Water Resources Control Board. Sacramento, CA.

Barnett, A.M., S.M. Bay, K.J. Ritter, S.L. Moore and S.B. Weisberg. 2007. Sediment quality in California bays and estuaries. Techinical Report 522. Southern California Coastal Water Research Project. Costa Mesa, CA.

Bay, S.M., K.J. Ritter, D.E. Vidal-Dorsch, and L.J. Field. 2012. Comparison of national and regional sediment quality guidelines for classifying sediment toxicity in California. *Integrated Environmental Assessment and Management* 8:597-609.

Bay, S.M, and S.B. Weisberg. 2012. Framework for interpreting sediment quality triad data. *Integrated Environmental Assessment and Management* 8:589-596.

Borja, Á., J. Franco and V. Perez. 2000. A marine biotic index to establish the ecological quality of soft-bottom benthos within european estuarine and coastal environments. *Marine Pollution Bulletin* 40:1100-1114.

Crane, J.L., D.D. MacDonald, C.G. Ingersoll, D. Smorong, C.G. Lindskoog, C.G. Severn, T.A. Berger and L.J. Field. 2000. Development of a Framework for Evaluating Numerical Sediment Quality Targets and Sediment Contamination in the St. Louis River Area of Concern. U.S. Environmental Protection Agency, Great Lakes National Program Office. Chicago, IL.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G. Ingersoll, C.G. Severn, D. Smorong and R. Lindskoog. 2002. Predicting amphipod toxicity from sediment chemistry using logistic regression models. *Environmental Toxicology and Chemistry* 21:1993-2005.

Hunt, J.W., B.S. Anderson, B.M. Phillips, R.S. Tjeerdema, K.M. Taberski, C.J. Wilson, H.M. Puckett, M. Stephenson, R. Fairey and J. Oakden. 2001. A large-scale categorization of sites in San Francisco Bay, USA, based on the sediment quality triad, toxicity identification evaluations, and gradient studies. *Environmental Toxicology and Chemistry* 20:1252-1265.

Long, E.R. and P.M. Chapman. 1985. A sediment quality triad - measures of sediment contamination, toxicity and infaunal community composition in Puget-Sound. *Marine Pollution Bulletin* 16:405-415.

MacDonald, D.D. and C.G. Ingersoll. 2002. A Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater Ecosystems - Volume I: An Ecosystem-Based Framework for Assessing and Managing Contaminated Sediments. USEPA Great Lakes National Program Office. Chicago, IL.

Ranasinghe, J.A., S.B. Weisberg, R.W. Smith, D.E. Montagne, B. Thompson, J.M. Oakden, D.D. Huff, D.B. Cadien, R.G. Velarde and K.J. Ritter. 2009. Calibration and evaluation of five indicators of benthic community condition in two California bay and estuary habitats. *Marine Pollution Bulletin* 59:5-13.

Ranasinghe, J.A., K.I. Welch, P.N. Slattery, D.E. Montagne, D.D. Huff, H.L. II, J.L. Hyland, B. Thompson, S.B. Weisberg, J.M. Oakden, D.B. Cadien and R.G. Velarde. 2012. Habitat-related benthic macrofaunal assemblages of bays and estuaries of the western United States. *Integrated Environmental Assessment and Management* 8:638-648.

Ritter, K.J., S.M. Bay, R.W. Smith, D.E. Vidal-Dorsch and L.J. Field. 2012. Development and evaluation of sediment quality guidelines based on benthic macrofauna responses. *Integrated Environmental Assessment and Management* 8:610-624.

San Francisco Estuary Institute (SFEI). 2011. 2009 Annual Monitoring Results. The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP). San Francisco Estuary Institute. Oakland, CA.

Smith, R.W., M. Bergen, S.B. Weisberg, D.B. Cadien, A. Dalkey, D.E. Montagne, J.K. Stull and R.G. Velarde. 2001. Benthic response index for assessing infaunal communities on the southern California mainland shelf. *Ecological Applications* 11:1073-1087.

Smith, R.W., J.A. Ranasinghe, S.B. Weisberg, D.E. Montagne, D.B. Cadien, T.K. Mikel, R.G. Velarde and A. Dalkey. 2003. Extending the Southern California Benthic Response Index to Assess Benthic Condition in Bays. Technical Report 410. Southern California Coastal Water Research Project. Westminster, CA.

Southern California Coastal Water Research Project (SCCWRP). 2012. Southern California Bight 2008 Regional Monitoring Program Coastal Ecology Committee: Coastal Ecology Synthesis Report. SCCWRP. Costa Mesa, CA.

State Water Resources Control Board (SWRCB). 2008. Water Quality Control Plan for Enclosed Bays and Estuaries - Part 1: Sediment Quality. SWRCB. Sacramento, CA.

Teixeira, H., S.B. Weisberg, A. Borja, J.A. Ranasinghe, D.B. Cadien, R.G. Velarde, L.L. Lovell, D. Pasko, C.A. Phillips, D.E. Montagne, K.J. Ritter, F. Salas and J.C. Marques. 2012.

Calibration and validation of the AZTI's Marine Biotic Index (AMBI) for Southern California marine bays. *Ecological Indicators* 12:84-95.

Thompson, B., T. Adelsbach, C. Brown, J. Hunt, J. Kuwabara, J. Neale, H. Ohlendorf, S. Schwarzbach, R. Spies and K.M. Taberski. 2007. Biological effects of anthropogenic contaminants in the San Francisco Estuary. *Environmental Research* 105:156-174.

Thompson, B. and S. Lowe. 2004. Assessment of macrobenthos response to sediment contamination in the San Francisco Estuary, California, USA. *Environmental Toxicology and Chemistry* 23:2178-2187.

United States Environmental Protection Agency (USEPA). 1994. Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. EPA 600-R94-025. USEPA, Office of Research and Development. Washington, DC.

USEPA. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F. USEPA. Washington, DC.

USEPA. 2004. National Coastal Condition Report II. EPA-620/R-03/002. USEPA, Office of Water. Washington, DC.

USEPA. 2005. Condition of Estuaries of California for 1999: A Statistical Summary. USEPA, Office of Research and Development. Washington, DC.

USEPA. 2008. National Coastal Condition Report III. EPA/842-R-08-002. USEPA. Washington, DC.

Van Sickle, J., D.D. Huff and C.P. Hawkins. 2006. Selecting discriminant function models for predicting the expected richness of aquatic macroinvertebrates. *Freshwater Biology* 51:359-372.

Wright, J.F., M.T. Furse and P.D. Armitage. 1993. RIVPACS: a technique for evaluating the biological water quality of rivers in the UK. *European Water Pollution Control* 3:15-25.

APPENDIX A - LOE CATEGORY RELATIONSHIPS

Table A-1. Station assessment categories resulting from each possible MLOE combination.

LOE Combination	Chemistry LOE: Sediment Chemistry Exposure	Benthic LOE: Benthic Community Condition	Toxicity LOE: Sediment Toxicity	Station Assessment (Site Condition)
1	Minimal	Reference	Nontoxic	Unimpacted
2	Minimal	Reference	Low	Unimpacted
3	Minimal	Reference	Moderate	Unimpacted
4	Minimal	Reference	High	Inconclusive
5	Minimal	Low	Nontoxic	Unimpacted
6	Minimal	Low	Low	Likely unimpacted
7	Minimal	Low	Moderate	Likely unimpacted
8	Minimal	Low	High	Possibly impacted
9	Minimal	Moderate	Nontoxic	Likely unimpacted
10	Minimal	Moderate	Low	Likely unimpacted
11	Minimal	Moderate	Moderate	Possibly impacted
12	Minimal	Moderate	High	Likely impacted
13	Minimal	High	Nontoxic	Likely unimpacted
14	Minimal	High	Low	Inconclusive
15	Minimal	High	Moderate	Possibly impacted
16	Minimal	High	High	Likely impacted
17	Low	Reference	Nontoxic	Unimpacted
18	Low	Reference	Low	Unimpacted
19	Low	Reference	Moderate	Likely unimpacted
20	Low	Reference	High	Possibly impacted
21	Low	Low	Nontoxic	Unimpacted
22	Low	Low	Low	Likely unimpacted
23	Low	Low	Moderate	Possibly impacted
24	Low	Low	High	Possibly impacted
25	Low	Moderate	Nontoxic	Likely unimpacted
26	Low	Moderate	Low	Possibly impacted
27	Low	Moderate	Moderate	Likely impacted
28	Low	Moderate	High	Likely impacted
29	Low	High	Nontoxic	Likely unimpacted
30	Low	High	Low	Possibly impacted
31	Low	High	Moderate	Likely impacted
32	Low	High	High	Likely impacted
33	Moderate	Reference	Nontoxic	Unimpacted
34	Moderate	Reference	Low	Likely unimpacted
35	Moderate	Reference	Moderate	Likely unimpacted
36	Moderate	Reference	High	Possibly impacted
37	Moderate	Low	Nontoxic	Unimpacted
38	Moderate	Low	Low	Possibly impacted
39	Moderate	Low	Moderate	Possibly impacted
40	Moderate	Low	High	Possibly impacted
41	Moderate	Moderate	Nontoxic	Possibly impacted
42	Moderate	Moderate	Low	Likely impacted
43	Moderate	Moderate	Moderate	Likely impacted
44	Moderate	Moderate	High	Likely impacted
45	Moderate	High	Nontoxic	Possibly impacted

Table A-1. Continued.

LOE Combination	Chemistry LOE: Sediment Chemistry Exposure	Benthic LOE: Benthic Community Condition	Toxicity LOE: Sediment Toxicity	Station Assessment (Site Condition)
46	Moderate	High	Low	Likely Impacted
47	Moderate	High	Moderate	Likely Impacted
48	Moderate	High	High	Likely Impacted
49	High	Reference	Nontoxic	Likely Unimpacted
50	High	Reference	Low	Likely Unimpacted
51	High	Reference	Moderate	Inconclusive
52	High	Reference	High	Likely impacted
53	High	Low	Nontoxic	Likely Unimpacted
54	High	Low	Low	Possibly Impacted
55	High	Low	Moderate	Likely Impacted
56	High	Low	High	Likely Impacted
57	High	Moderate	Nontoxic	Likely Impacted
58	High	Moderate	Low	Likely Impacted
59	High	Moderate	Moderate	Clearly Impacted
60	High	Moderate	High	Clearly Impacted
61	High	High	Nontoxic	Likely Impacted
62	High	High	Low	Likely Impacted
63	High	High	Moderate	Clearly Impacted
64	High	High	High	Clearly Impacted

APPENDIX B - ASSESSMENT RESULTS BY STATION

Table B-1. Statewide embayment individual line of evidence and condition category summary.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6004	Bight08	7/16/2008	South		Moderate Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6009	Bight08	7/16/2008	South		Moderate Disturbance	Moderate Toxicity	Minimal Exposure	Possibly Unimpacted
6010	Bight08	7/16/2008	South		High Disturbance	Low Toxicity	Minimal Exposure	Inconclusive
6012	Bight08	7/16/2008	South		High Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6015	Bight08	8/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6017	Bight08	8/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6025	Bight08	8/22/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6027	Bight08	8/22/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6031	Bight08	8/22/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6039	Bight08	8/21/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6040	Bight08	8/21/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6041	Bight08	8/22/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6042	Bight08	8/21/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6044	Bight08	8/22/2008	South		Moderate Disturbance	Moderate Toxicity	Moderate Exposure	Likely Impacted
6045	Bight08	8/22/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6046	Bight08	8/22/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6047	Bight08	8/22/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6049	Bight08	8/21/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6052	Bight08	7/10/2008	South		Reference	Low Toxicity	Moderate Exposure	Likely Unimpacted
6054	Bight08	8/21/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6057	Bight08	7/10/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6060	Bight08	7/10/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6065	Bight08	7/10/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6068	Bight08	8/21/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6069	Bight08	7/10/2008	South		High Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6071	Bight08	8/21/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6072	Bight08	8/19/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6075	Bight08	8/19/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6080	Bight08	8/21/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6083	Bight08	8/21/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6084	Bight08	8/19/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6085	Bight08	8/19/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6086	Bight08	8/18/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6087	Bight08	8/19/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6090	Bight08	8/19/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6093	Bight08	8/19/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6094	Bight08	8/19/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6106	Bight08	8/18/2008	South		Reference	Low Toxicity	Minimal Exposure	Unimpacted
6110	Bight08	8/18/2008	South		Reference	Low Toxicity	Moderate Exposure	Likely Unimpacted
6116	Bight08	8/18/2008	South		Moderate Disturbance	Nontoxic	High Exposure	Likely Impacted
6119	Bight08	8/18/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6120	Bight08	8/18/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6125	Bight08	8/18/2008	South		Low Disturbance	Nontoxic	High Exposure	Likely Unimpacted
6127	Bight08	8/18/2008	South		Low Disturbance	Low Toxicity	High Exposure	Possibly Unimpacted
6128	Bight08	8/20/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6129	Bight08	8/21/2008	South		Reference	Low Toxicity	Minimal Exposure	Unimpacted
6130	Bight08	8/20/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6133	Bight08	8/8/2008	South		Moderate Disturbance	Moderate Toxicity	Moderate Exposure	Likely Impacted
6134	Bight08	8/8/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6136	Bight08	8/8/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6138	Bight08	8/21/2008	South		Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
6140	Bight08	8/8/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6151	Bight08	8/6/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6152	Bight08	8/7/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6153	Bight08	8/6/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6154	Bight08	8/7/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6155	Bight08	8/7/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6156	Bight08	8/8/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6157	Bight08	8/6/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6159	Bight08	8/6/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6161	Bight08	8/6/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6168	Bight08	8/8/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6172	Bight08	8/7/2008	South		Reference	Low Toxicity	Low Exposure	Unimpacted
6173	Bight08	8/7/2008	South		Reference	Low Toxicity	Low Exposure	Unimpacted
6174	Bight08	8/8/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6177	Bight08	8/7/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6180	Bight08	8/7/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6181	Bight08	7/11/2008	South		Moderate Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
6189	Bight08	7/11/2008	South		High Disturbance	Moderate Toxicity	Minimal Exposure	Possibly Unimpacted
6192	Bight08	7/11/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6197	Bight08	7/11/2008	South		Low Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6200	Bight08	7/11/2008	South		Moderate Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
6204	Bight08	8/5/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6211	Bight08	8/5/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6212	Bight08	8/5/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted
6213	Bight08	8/5/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted
6216	Bight08	8/5/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted
6217	Bight08	8/5/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6219	Bight08	8/5/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6223	Bight08	8/5/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6228	Bight08	7/17/2008	South		Low Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6229	Bight08	7/17/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6230	Bight08	7/17/2008	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
6232	Bight08	7/17/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6236	Bight08	7/17/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6239	Bight08	7/15/2008	South		High Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6242	Bight08	7/22/2008	South		High Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
6243	Bight08	7/15/2008	South		Moderate Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6245	Bight08	7/15/2008	South		High Disturbance	Low Toxicity	Minimal Exposure	Inconclusive
6269	Bight08	7/8/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6270	Bight08	7/8/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6271	Bight08	7/8/2008	South		High Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6280	Bight08	7/8/2008	South		Moderate Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6282	Bight08	7/8/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted
6288	Bight08	8/4/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6291	Bight08	8/4/2008	South		High Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6294	Bight08	8/4/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6308	Bight08	8/29/2008	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
6311	Bight08	8/29/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6314	Bight08	8/29/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6317	Bight08	8/29/2008	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
6320	Bight08	8/4/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6325	Bight08	8/4/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6327	Bight08	8/4/2008	South		Moderate Disturbance	Moderate Toxicity	Moderate Exposure	Likely Impacted
6328	Bight08	8/4/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6335	Bight08	7/14/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6343	Bight08	7/14/2008	South		Reference	Nontoxic	Moderate Exposure	Unimpacted
6344	Bight08	7/14/2008	South		Moderate Disturbance	Moderate Toxicity	Moderate Exposure	Likely Impacted
6350	Bight08	7/14/2008	South		Moderate Disturbance	Moderate Toxicity	High Exposure	Clearly Impacted
6354	Bight08	8/8/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6355	Bight08	8/12/2008	South		Moderate Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
6362	Bight08	8/8/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6363	Bight08	8/8/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6372	Bight08	8/8/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted
6375	Bight08	9/26/2008	South		Moderate Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
6383	Bight08	7/23/2008	South		Reference	Low Toxicity	Minimal Exposure	Unimpacted
6384	Bight08	9/22/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6386	Bight08	7/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6387	Bight08	9/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6402	Bight08	9/22/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6404	Bight08	7/24/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6405	Bight08	7/17/2008	South		Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
6406	Bight08	7/14/2008	South		Reference	Nontoxic	Minimal Exposure	Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6407	Bight08	9/11/2008	South		Reference	Low Toxicity	Moderate Exposure	Likely Unimpacted
6411	Bight08	9/11/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6413	Bight08	7/17/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6416	Bight08	7/24/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6419	Bight08	7/31/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6424	Bight08	7/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6428	Bight08	7/24/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6432	Bight08	9/9/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6436	Bight08	9/11/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6437	Bight08	9/9/2008	South		Low Disturbance	Low Toxicity	High Exposure	Possibly Unimpacted
6438	Bight08	9/25/2008	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
6442	Bight08	7/23/2008	South		Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
6443	Bight08	7/31/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6444	Bight08	9/9/2008	South		Reference	Low Toxicity	Moderate Exposure	Likely Unimpacted
6446	Bight08	7/31/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6447	Bight08	9/9/2008	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
6448	Bight08	9/9/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6449	Bight08	7/29/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6450	Bight08	9/22/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6451	Bight08	9/25/2008	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
6460	Bight08	7/29/2008	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
6462	Bight08	9/10/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6466	Bight08	7/29/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6467	Bight08	7/29/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6468	Bight08	7/14/2008	South		Low Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
6472	Bight08	7/23/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6478	Bight08	9/10/2008	South		Reference	Nontoxic	Low Exposure	Unimpacted
6479	Bight08	7/23/2008	South		Low Disturbance	High Toxicity	Moderate Exposure	Possibly Unimpacted
6482	Bight08	7/30/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6485	Bight08	7/14/2008	South		Low Disturbance	Moderate Toxicity	Moderate Exposure	Possibly Unimpacted
6487	Bight08	7/30/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
6489	Bight08	7/30/2008	South		Moderate Disturbance	Low Toxicity	High Exposure	Likely Impacted
6493	Bight08	7/31/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6500	Bight08	7/14/2008	South		High Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6508	Bight08	9/29/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6513	Bight08	9/29/2008	South		Low Disturbance	Nontoxic	High Exposure	Likely Unimpacted
6518	Bight08	9/29/2008	South		Low Disturbance	Low Toxicity	High Exposure	Possibly Unimpacted
6520	Bight08	9/11/2008	South		Moderate Disturbance	High Toxicity	Low Exposure	Likely Impacted
6527	Bight08	9/29/2008	South		Moderate Disturbance	Moderate Toxicity	High Exposure	Clearly Impacted
6530	Bight08	9/29/2008	South		Moderate Disturbance	Nontoxic	High Exposure	Likely Impacted
6539	Bight08	8/19/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6543	Bight08	8/21/2008	South		High Disturbance	High Toxicity	Moderate Exposure	Likely Impacted
6546	Bight08	9/4/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6549	Bight08	9/3/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6553	Bight08	9/3/2008	South		Low Disturbance	Low Toxicity	High Exposure	Possibly Unimpacted
6560	Bight08	9/3/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6562	Bight08	9/10/2008	South		Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
6570	Bight08	8/19/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6572	Bight08	8/18/2008	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
6649	Bight08	9/17/2008	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
6659	Bight08	8/22/2008	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
6660	Bight08	8/21/2008	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
6661	Bight08	8/21/2008	South		Moderate Disturbance	Moderate Toxicity	Moderate Exposure	Likely Impacted
BA10	08RMP2ST	7/24/2008	SFB	Lower South Bay	Reference	Low Toxicity	Low Exposure	Unimpacted
BA41	08RMP2ST	7/28/2008	SFB	South Bay	Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
BC11	08RMP2ST	7/28/2008	SFB	Central Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
BD31	08RMP2ST	7/29/2008	SFB	San Pablo Bay	Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
BF21	08RMP2ST	7/31/2008	SFB	Suisun Bay	High Disturbance	High Toxicity	Low Exposure	Likely Impacted
CB037S	08RMP2ST	7/28/2008	SFB	Central Bay	Moderate Disturbance	High Toxicity	Low Exposure	Likely Impacted
CB038S	08RMP2ST	7/28/2008	SFB	Central Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
CB039S	08RMP2ST	7/29/2008	SFB	Central Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
CB040S	08RMP2ST	7/25/2008	SFB	Central Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
LSB037S	08RMP2ST	7/23/2008	SFB	Lower South Bay	Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
LSB038S	08RMP2ST	7/24/2008	SFB	Lower South Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
LSB039S	08RMP2ST	7/23/2008	SFB	Lower South Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
LSB040S	08RMP2ST	7/24/2008	SFB	Lower South Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
SB037S	08RMP2ST	7/25/2008	SFB	South Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SB038S	08RMP2ST	7/24/2008	SFB	South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
SB039S	08RMP2ST	7/25/2008	SFB	South Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SB040S	08RMP2ST	7/25/2008	SFB	South Bay	Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
SPB037S	08RMP2ST	8/1/2008	SFB	San Pablo Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
SPB038S	08RMP2ST	8/1/2008	SFB	San Pablo Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
SPB039S	08RMP2ST	7/29/2008	SFB	San Pablo Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
SPB040S	08RMP2ST	7/29/2008	SFB	San Pablo Bay	Reference	High Toxicity	Low Exposure	Possibly Unimpacted
SU037S	08RMP2ST	7/30/2008	SFB	Suisun Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SU039S	08RMP2ST	7/30/2008	SFB	Suisun Bay	High Disturbance	Low Toxicity	Minimal Exposure	Inconclusive
SU040S	08RMP2ST	7/30/2008	SFB	Suisun Bay	High Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SU080S	08RMP2ST	7/31/2008	SFB	Suisun Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
BA10	09RMP2ST	9/15/2009	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
BA41	09RMP2ST	9/16/2009	SFB	South Bay	Moderate Disturbance	High Toxicity	Low Exposure	Likely Impacted
BC11	09RMP2ST	9/17/2009	SFB	Central Bay	Reference	Low Toxicity	Low Exposure	Unimpacted
BD31	09RMP2ST	9/18/2009	SFB	San Pablo Bay	Low Disturbance	Nontoxic	Low Exposure	Unimpacted
BF21	09RMP2ST	9/22/2009	SFB	Suisun Bay	Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
CB001S	09RMP2ST	9/18/2009	SFB	Central Bay	Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CB043S	09RMP2ST	9/18/2009	SFB	Central Bay	Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CB075S	09RMP2ST	9/18/2009	SFB	Central Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
CB121S	09RMP2ST	9/18/2009	SFB	Central Bay	Reference	Nontoxic	Low Exposure	Unimpacted
LSB002S	09RMP2ST	9/15/2009	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
LSB016S	09RMP2ST	9/15/2009	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
LSB082S	09RMP2ST	9/15/2009	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
LSB108S	09RMP2ST	9/15/2009	SFB	Lower South Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
SB002S	09RMP2ST	9/16/2009	SFB	South Bay	Moderate Disturbance	High Toxicity	Low Exposure	Likely Impacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
SB016S	09RMP2ST	9/17/2009	SFB	South Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SB060S	09RMP2ST	9/16/2009	SFB	South Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SB106S	09RMP2ST	9/16/2009	SFB	South Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SPB002S	09RMP2ST	9/18/2009	SFB	San Pablo Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
SPB016S	09RMP2ST	9/21/2009	SFB	San Pablo Bay	Reference	Low Toxicity	Low Exposure	Unimpacted
SPB080S	09RMP2ST	9/21/2009	SFB	San Pablo Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
SPB135S	09RMP2ST	9/18/2009	SFB	San Pablo Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
SU016S	09RMP2ST	9/22/2009	SFB	Suisun Bay	Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
SU073S	09RMP2ST	9/22/2009	SFB	Suisun Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
SU085S	09RMP2ST	9/23/2009	SFB	Suisun Bay	High Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
SU090S	09RMP2ST	9/23/2009	SFB	Suisun Bay	High Disturbance	Nontoxic	Low Exposure	Likely Unimpacted
BA10	10RMP2ST	2/2/2010	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Minimal Exposure	Likely Unimpacted
BA41	10RMP2ST	2/3/2010	SFB	South Bay	High Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
BC11	10RMP2ST	2/4/2010	SFB	Central Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
BD31	10RMP2ST	2/8/2010	SFB	San Pablo Bay	Reference	Low Toxicity	Low Exposure	Unimpacted
BF21	10RMP2ST	2/9/2010	SFB	Suisun Bay	Moderate Disturbance	High Toxicity	Low Exposure	Likely Impacted
CB001S	10RMP2ST	2/4/2010	SFB	Central Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
CB042S	10RMP2ST	2/4/2010	SFB	Central Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
CB055S	10RMP2ST	2/4/2010	SFB	Central Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
CB122S	10RMP2ST	2/4/2010	SFB	Central Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
LSB002S	10RMP2ST	2/2/2010	SFB	Lower South Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
LSB072S	10RMP2ST	2/2/2010	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
LSB109S	10RMP2ST	2/2/2010	SFB	Lower South Bay	Reference	Moderate Toxicity	Low Exposure	Likely Unimpacted
LSB140S	10RMP2ST	2/2/2010	SFB	Lower South Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
SB002S	10RMP2ST	2/3/2010	SFB	South Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SB087S	10RMP2ST	2/3/2010	SFB	South Bay	Moderate Disturbance	Moderate Toxicity	Minimal Exposure	Possibly Unimpacted
SB091S	10RMP2ST	2/3/2010	SFB	South Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SB095S	10RMP2ST	2/3/2010	SFB	South Bay	Moderate Disturbance	Moderate Toxicity	Minimal Exposure	Possibly Unimpacted
SPB002S	10RMP2ST	2/8/2010	SFB	San Pablo Bay	Reference	Low Toxicity	Low Exposure	Unimpacted
SPB043S	10RMP2ST	2/8/2010	SFB	San Pablo Bay	Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
SPB051S	10RMP2ST	2/8/2010	SFB	San Pablo Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
SPB120S	10RMP2ST	2/8/2010	SFB	San Pablo Bay	Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
SU060S	10RMP2ST	2/9/2010	SFB	Suisun Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SU073S	10RMP2ST	2/9/2010	SFB	Suisun Bay	Moderate Disturbance	Low Toxicity	Low Exposure	Possibly Unimpacted
SU084S	10RMP2ST	2/9/2010	SFB	Suisun Bay	Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
SU109S	10RMP2ST	2/9/2010	SFB	Suisun Bay	Moderate Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
NCA10-1107	NCCA2010	6/29/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1108	NCCA2010	6/29/2010	South		Reference	Low Toxicity	Low Exposure	Unimpacted
NCA10-1109	NCCA2010	7/14/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1111	NCCA2010	7/1/2010	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
NCA10-1112	NCCA2010	6/30/2010	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
NCA10-1113	NCCA2010	7/14/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1114	NCCA2010	7/26/2010	North		Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
NCA10-1115	NCCA2010	6/29/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1116	NCCA2010	6/30/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1117	NCCA2010	7/15/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1119	NCCA2010	7/1/2010	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
NCA10-1120	NCCA2010	7/13/2010	South		Low Disturbance	Nontoxic	Minimal Exposure	Unimpacted
NCA10-1123	NCCA2010	7/1/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-1127	NCCA2010	7/1/2010	South		Reference	Nontoxic	Low Exposure	Unimpacted
NCA10-1128	NCCA2010	7/15/2010	South		Moderate Disturbance	Nontoxic	Moderate Exposure	Possibly Unimpacted
NCA10-1130	NCCA2010	7/26/2010	North		Low Disturbance	Moderate Toxicity	Minimal Exposure	Likely Unimpacted
NCA10-1131	NCCA2010	7/15/2010	South		Low Disturbance	Low Toxicity	Moderate Exposure	Possibly Unimpacted
NCA10-1132	NCCA2010	8/11/2010	North		Low Disturbance	Moderate Toxicity	Low Exposure	Possibly Unimpacted
NCA10-1254	NCCA2010	8/9/2010	North		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
NCA10-1266	NCCA2010	8/10/2010	North		Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
NCA10-1274	NCCA2010	8/12/2010	North		Low Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
NCA10-1278	NCCA2010	8/10/2010	North		Low Disturbance	Moderate Toxicity	Minimal Exposure	Likely Unimpacted
NCA10-2110	NCCA2010	6/30/2010	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
NCA10-2111	NCCA2010	7/1/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
NCA10-2112	NCCA2010	7/14/2010	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
NCA10-2114	NCCA2010	6/30/2010	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted

Table B-1. Continued.

Station ID	Study	Date	Region	Stratum	Benthic Category	Toxicity Category	Chemistry Category	Condition Category
NCA10-2116	NCCA2010	7/14/2010	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
NCA10-2117	NCCA2010	7/26/2010	North		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
NCA10-2120	NCCA2010	7/13/2010	South		Moderate Disturbance	Low Toxicity	Moderate Exposure	Likely Impacted
NCA10-2278	NCCA2010	8/12/2010	North		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
NCA10-2290	NCCA2010	8/10/2010	North		Moderate Disturbance	Moderate Toxicity	Minimal Exposure	Possibly Unimpacted
CAN05-0004	EMAP05	8/4/2005	North		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAN05-0006	EMAP05	8/3/2005	North		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAN05-0007	EMAP05	8/2/2005	North		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
CAN05-0012	EMAP05	8/4/2005	North		Low Disturbance	Low Toxicity	Minimal Exposure	Likely Unimpacted
CAN05-0014	EMAP05	8/3/2005	North		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAN05-0015	EMAP05	8/3/2005	North		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAN05-0017	EMAP05	8/29/2005	North		Moderate Disturbance	Moderate Toxicity	Low Exposure	Likely Impacted
CAN05-0018	EMAP05	8/2/2005	North		Low Disturbance	High Toxicity	Low Exposure	Possibly Unimpacted
CAS05-0001	EMAP05	8/18/2005	South		Low Disturbance	High Toxicity	Moderate Exposure	Possibly Unimpacted
CAS05-0002	EMAP05	8/17/2005	South		Reference	Nontoxic	Low Exposure	Unimpacted
CAS05-0003	EMAP05	8/16/2005	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
CAS05-0004	EMAP05	8/16/2005	South		Low Disturbance	Nontoxic	Moderate Exposure	Unimpacted
CAS05-0006	EMAP05	8/31/2005	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAS05-0007	EMAP05	8/30/2005	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted
CAS05-0008	EMAP05	8/19/2005	South		Moderate Disturbance	Nontoxic	High Exposure	Likely Impacted
CAS05-0009	EMAP05	8/18/2005	South		Moderate Disturbance	High Toxicity	Moderate Exposure	Likely Impacted
CAS05-0010	EMAP05	8/17/2005	South		Low Disturbance	Low Toxicity	Low Exposure	Likely Unimpacted
CAS05-0011	EMAP05	8/18/2005	South		Moderate Disturbance	Nontoxic	Minimal Exposure	Likely Unimpacted
CAS05-0012	EMAP05	8/16/2005	South		Low Disturbance	Nontoxic	Low Exposure	Unimpacted