Statewide Assessment of Embayment Sediment Quality Using a Multiple Lines of Evidence Framework

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Background

- **Impacts of contaminants on sediment quality of California's bays and estuaries are poorly known**
  - Thousands of data, but incomplete integration or synthesis
  - Most assessments are region-specific
  - Often disagreements over data interpretation
  - Difficult to compare San Francisco Bay to other regions
- **California's proposed sediment quality objectives (SQO) program includes a statewide assessment approach**
  - SWRCB staff report on proposed policy recently released
  - Consistent methods and interpretation framework
  - Assesses contaminant impacts on benthic community
  - Developed with extensive scientific review and stakeholder input

Objectives

- **Apply new SQO assessment framework to California bays and estuaries**
  - **"Test drive" proposed policy**
  - **Evaluate potential changes in water body assessments**
- **Describe sediment condition on statewide basis**
  - **Percent area with unimpacted or impacted sediment quality**
  - **Update 305(b) report**

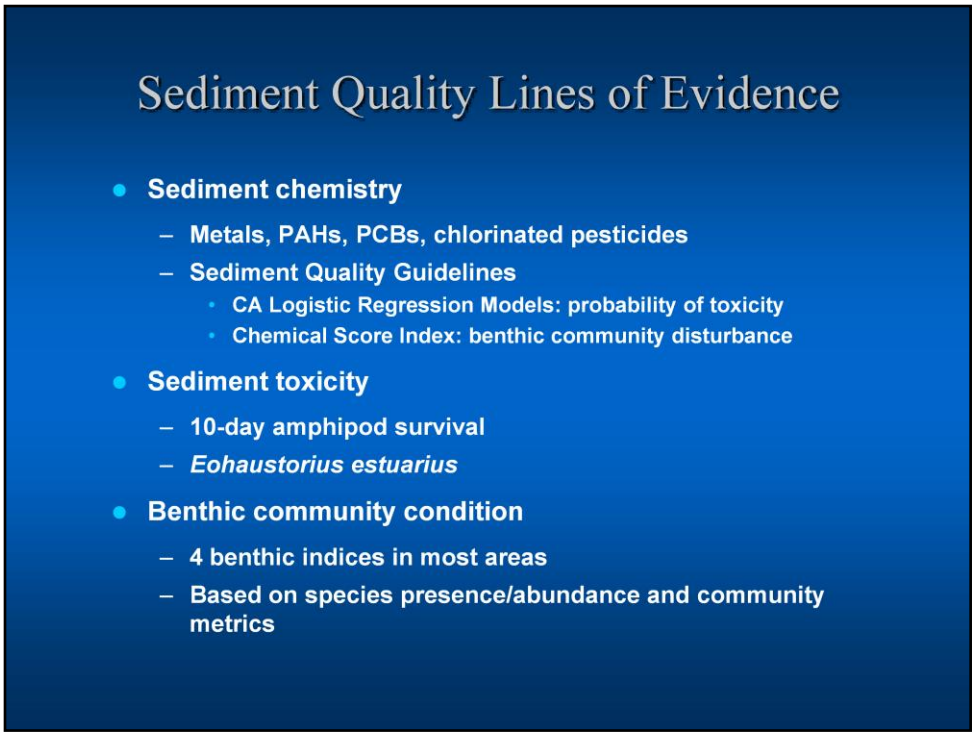
Study Design

- Select and compile suitable California data
  - Surveys with random stations
  - 3 lines of evidence (LOEs)
- Interpret LOE results
  - Multiple category responses
- Assess level of direct effects at each station
  - Integrate LOEs and determine station condition
- Determine % area impacted
  - Statewide
  - North Bays
  - South Bays
  - San Francisco Bay

Data

		Sample sizes		
Study	**Year**	**North**	**SFBay**	**South**
SoCal Bight	1998	0	0	113
	2003	0	0	102
WEMAP	1999	19	0	24
	2000	0	40	0
	2005	8	0	15
Huntington Harbor/ Anaheim Bay	2001	0	0	60
Total		27	40	314

Relatively few data were available for the north and San Francisco Bay, relative to the south. Only one randomized survey was available for San Francisco Bay, due to differences in toxicity test organisms or data quality.

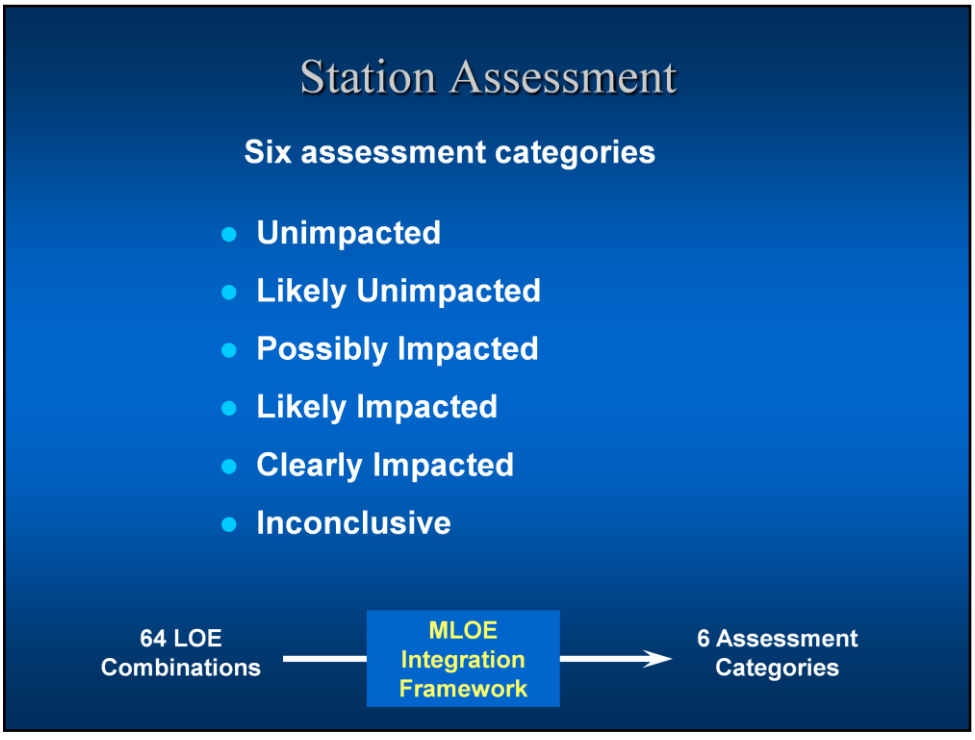


The data types for chemistry and the toxicity LOE were the same between regions. None of the samples were measured using more than one SQO-recommended toxicity test. The north and portions of SF Bay did not have the full suite of benthic indices available. The LOE response obtained using just the benthic index common to all samples (RBI) was calculated and compared to the full data set to examine the impact of tool variations.

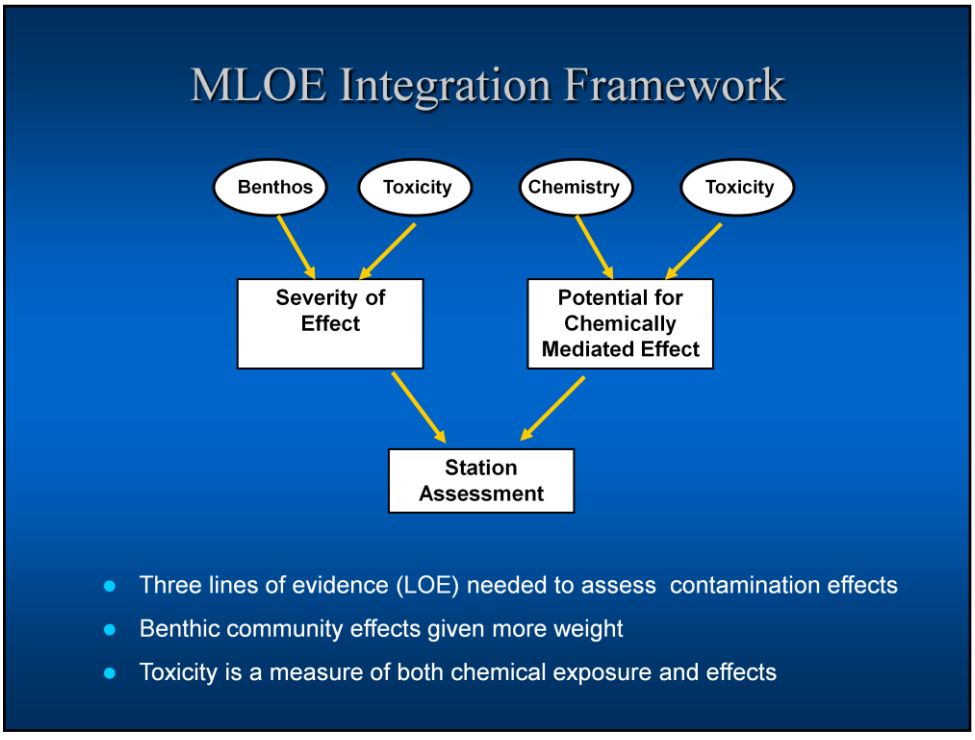
Interpretation of LOE Results

RESPONSE	CHEMISTRY (Exposure)	TOXICITY (Toxicity)	BENTHOS (Disturbance)
Equivalent to reference or control condition (1)	Minimal Exposure	Nontoxic	Reference
Slight change of uncertain statistical significance (2)	Low Exposure	Low Toxicity	Low Disturbance
Reliable difference generally regarded as significant (3)	Moderate Exposure	Moderate Toxicity	Moderate Disturbance
Highly reliable response of high magnitude (4)	High Exposure	High Toxicity	High Disturbance

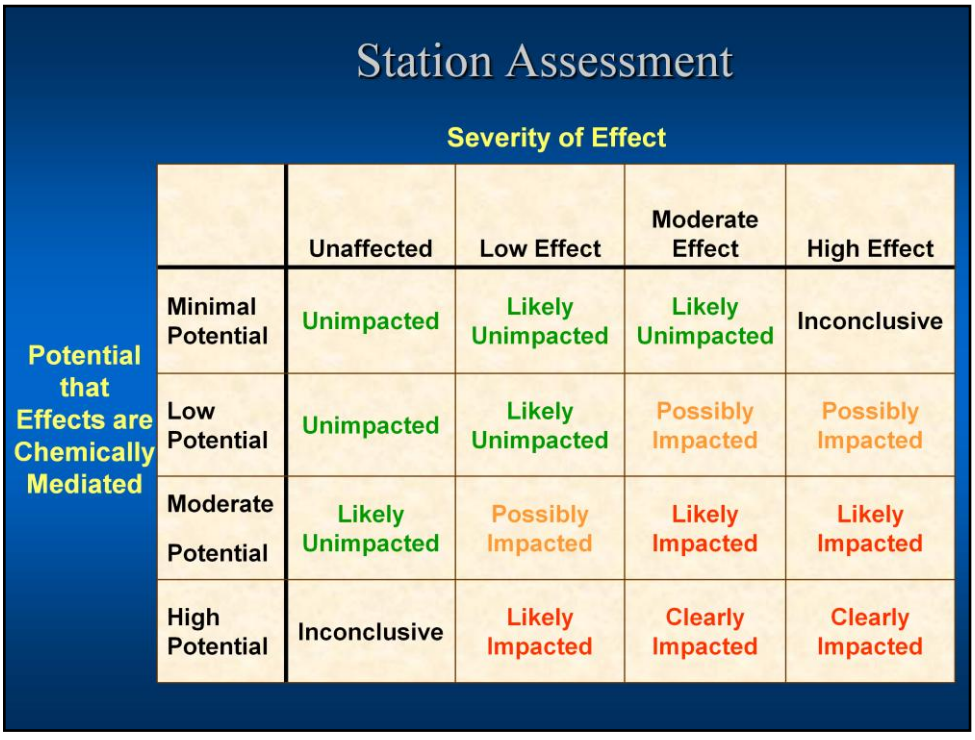
Summary of terms used to describe each line of evidence or classification. The results for each line of evidence are classified into one of four categories based on the magnitude of response and uncertainty in data interpretation.



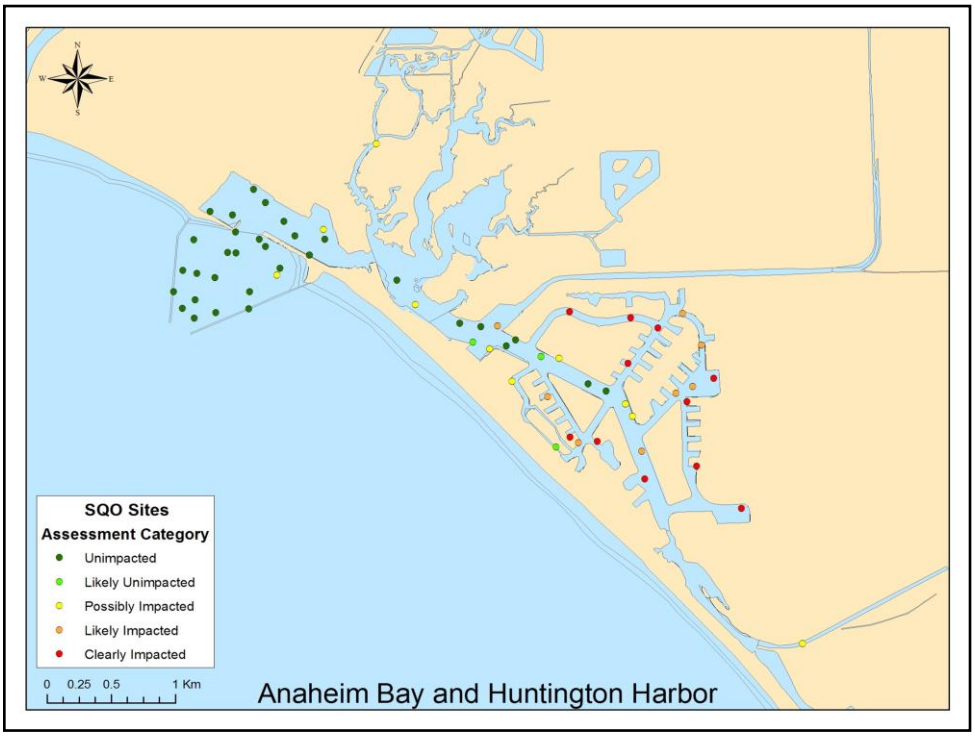
A multiple line of evidence integration framework was established to interpret the 64 possible combination of the 3 LOEs.



Schematic of the MLOE assessment framework proposed for use in California's SQO program. Data integrations follows a two-step process. (1) The three lines of evidence are used to determine the severity of biological effect (based on benthic impacts and toxicity) and the potential for chemically-mediated effects (based on sediment chemistry and toxicity). (2) The station assessment is based on a comparison of the severity of effect and potential for chemically-mediated effect. Note that the benthos is given greater weight for determining biological effects.

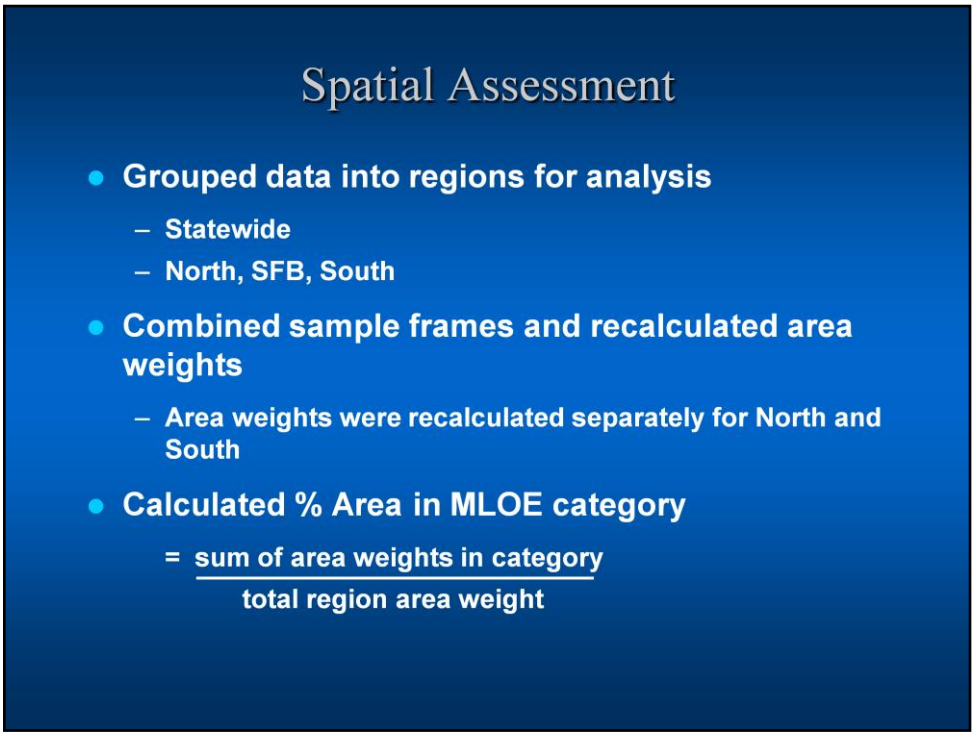


This matrix describes the relationship of the chemical potential and biological effect intermediate classifications to the the final MLOE assessment.

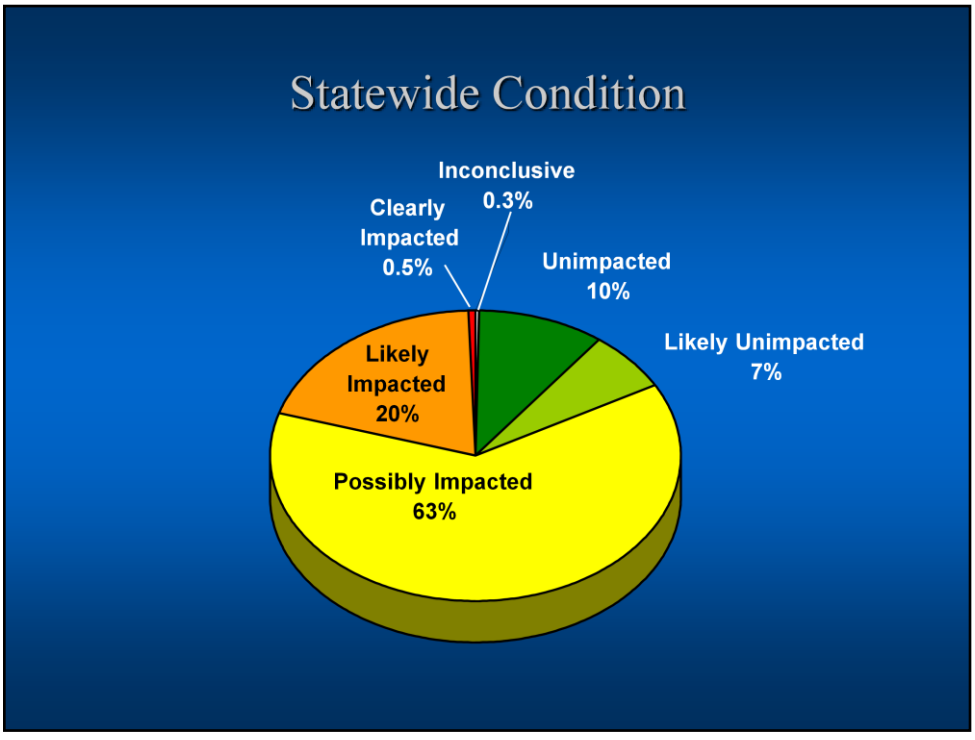


Data for Anaheim Bay and Huntington Harbor (Southern California) shows a gradient of greater response at inner harbor locations that is relatively consistent.

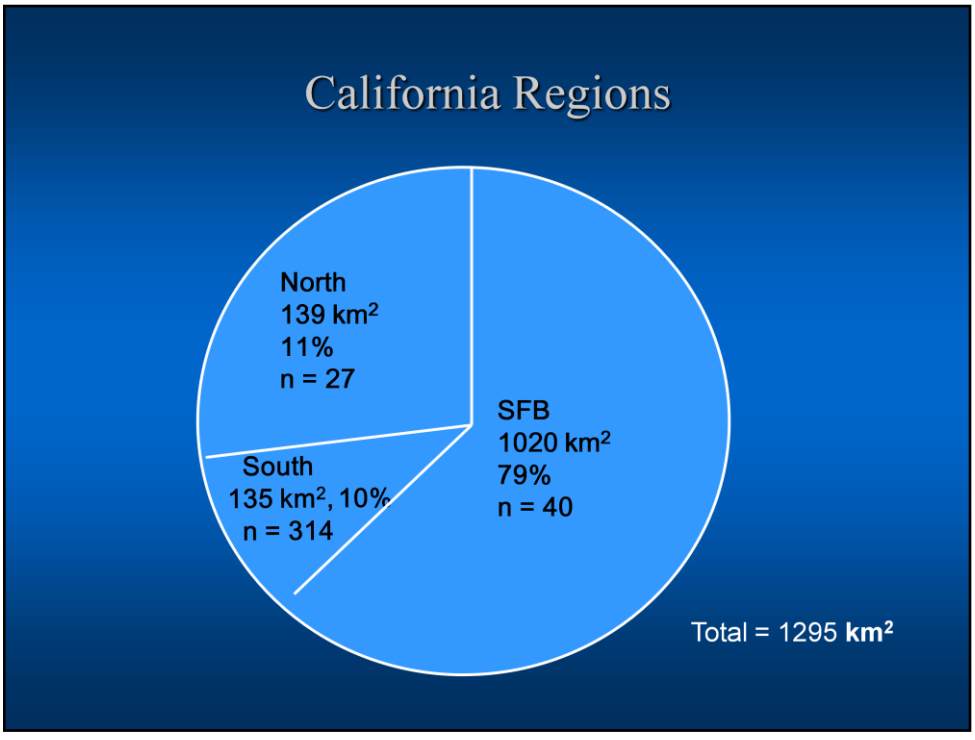
Most stations are possibly impacted, although greater impacts indicated near port/commercial areas.



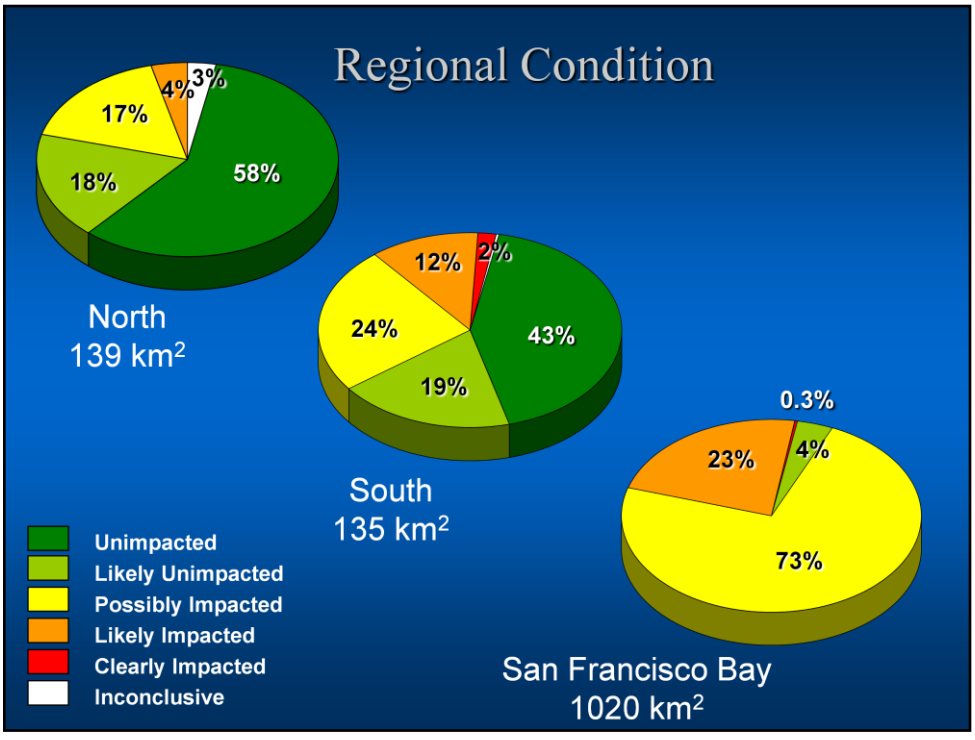
The spatial assessment followed methods used in previous EMAP studies. It was a challenge to combine multiple surveys that had differing levels of intensification.



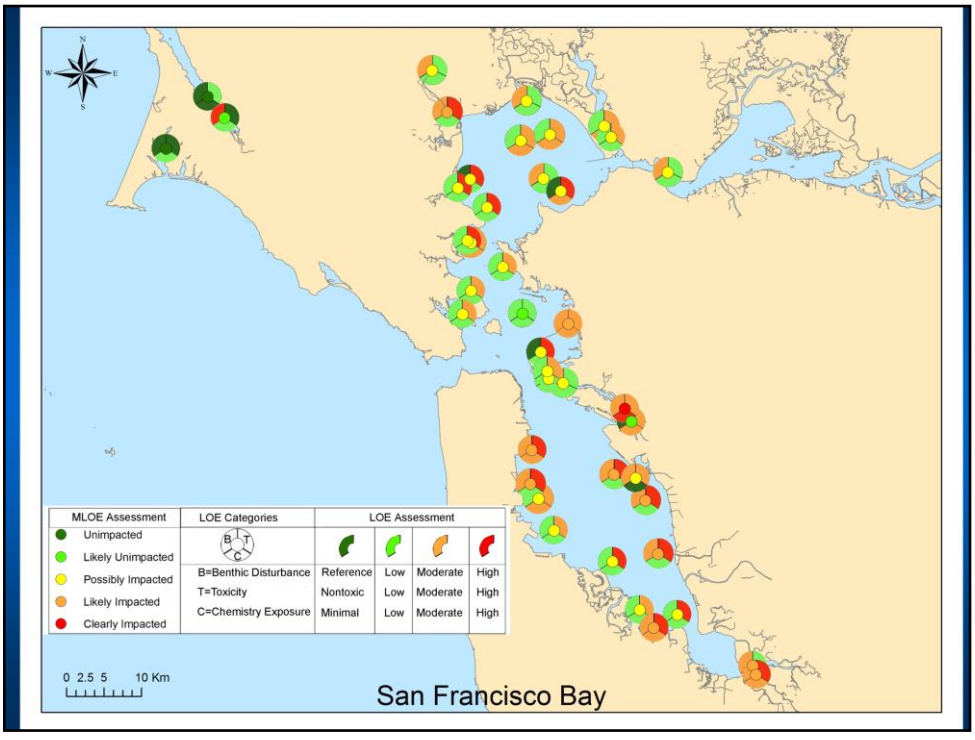
Statewide results were surprising in that a relatively large portion of the state was classified in one of the three impacted categories.



The statewide results are dominated by San Francisco Bay, which accounted for nearly 80% of area studied.



Different proportions of station categories were present within each region.



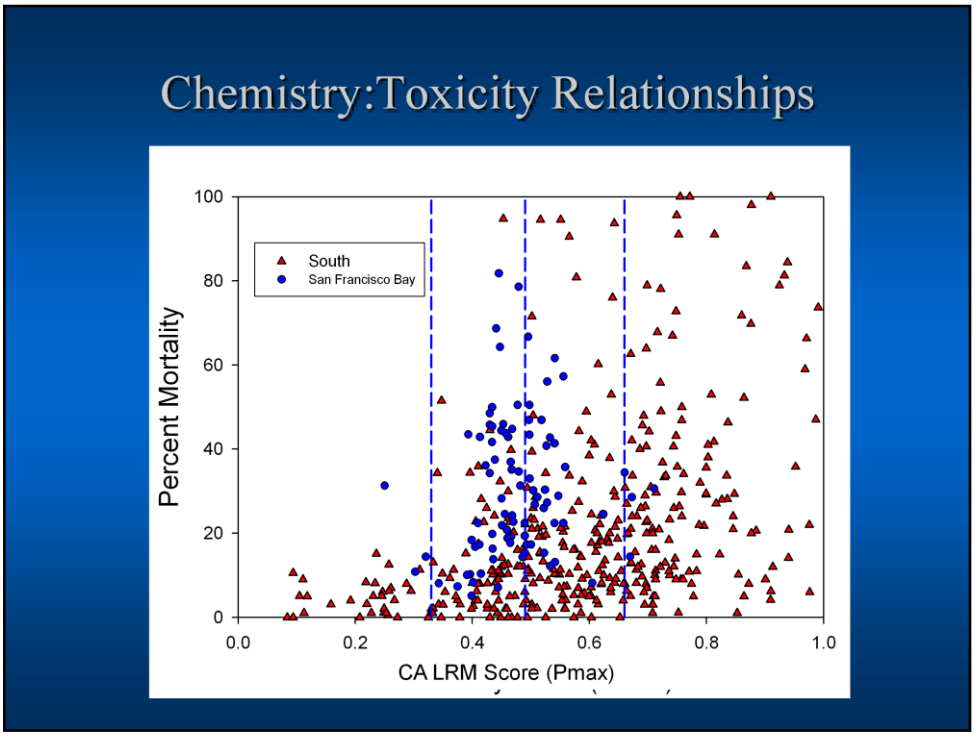
Map of the individual LOE results (perimeter of symbol) and final station category (center) for the San Francisco Bay stations. Almost every station showed evidence of moderate to high effects in the toxicity and/or benthic community LOEs that resulted in a station classification of Possibly Impacted or greater when combined with a low to moderate chemistry LOE value.

LOE Responses (% Area)

Region	Response	Benthos	Toxicity	Chemistry
North	Affected	27	17	1
SFB	Affected	38	85	24
South	Affected	23	28	43

Affected: Moderate or High response

Different patterns of relative LOE responses were found in each region, consistent with the overall % area results. The north had the lowest level of chemistry, as expected. San Francisco Bay had high incidences of impacted benthos and toxicity, relative to the south.



The data suggests that a higher level of toxicity is present at similar levels of chemical contamination in San Francisco Bay. The causes of toxicity in the south and San Francisco Bay have not been identified.

Summary

- SQO assessment framework successfully applied throughout state
  - Integrated data from 6 surveys and 381 stations
- Regional differences in sediment condition observed
  - Greater area of impacts in SFB due to higher prevalence of both sediment toxicity and benthic community disturbance
  - Cause of impacts uncertain
- Results provide a focus for research and management actions
  - Stressor identification studies in SF Bay and other areas
  - Increase monitoring in North and SFB with MLOE indicators
  - Improve chemistry evaluation tools