Sediment Quality Objectives

For California Enclosed Bays and Estuaries

Statewide Assessment of Sediment Quality

July 10, 2007

OBJECTIVES

- **Estimate area of state with unimpacted/impacted sediment quality**

  – **EPA 305(b) Report**

- **Apply assessment framework and tools to available data**

  – **SQO "Test Drive"**

- **Compare waterbody condition with previous 303(d) assessments**

  – **SQO Economic Analysis**

Study Design

- **Select and Compile Data**
  - **Surveys with random stations**
  - **3 LOEs**

- **Determine LOE Category Responses**

- **Apply Direct Effects Assessment Framework**
  - **Integrate LOEs and determine station assessment**

- **Determine Area Impacted**
  - **Statewide**
  - **North Bays**
  - **South Bays**
  - **San Francisco Bay**

Data

Study	Year	Sample sizes		
		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

Sediment Chemistry Classification Steps

- **Compile Data**
  - **Calculate sums, estimate nondetects**

- **Calculate Chemistry Indicators (SQGs)**
  - **Chem-Tox: CA LRM (maximum probability of toxicity)**
  - **Chem-Benthos: CSI (weighted mean score)**

- **Combine Indicator Scores to Determine Chemistry LOE Category**

Toxicity Classification Steps

- **Compile Data**
  - **Normalize to control response**
  - **Statistical significance tests**

- **Apply Toxicity Classification Criteria**
  - **Amphipod survival (*Eohaustorius estuarius*)**

- **Determine Toxicity LOE Category**

Benthic Community Classification Steps

- **Compile Data**
  - Standardize taxonomy
  - Calculate abundance and other metrics

- **Calculate Benthic Indices**
  - Benthic Response Index (BRI)
  - Index of Biotic Integrity (IBI)
  - Relative Benthic Index (RBI)
  - River Invertebrate Prediction and Classification System (RIVPACS)

- **Combine Index Scores to Determine Benthos LOE Category**

Sediment Quality Lines of Evidence

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

Direct Effects Station Assessment
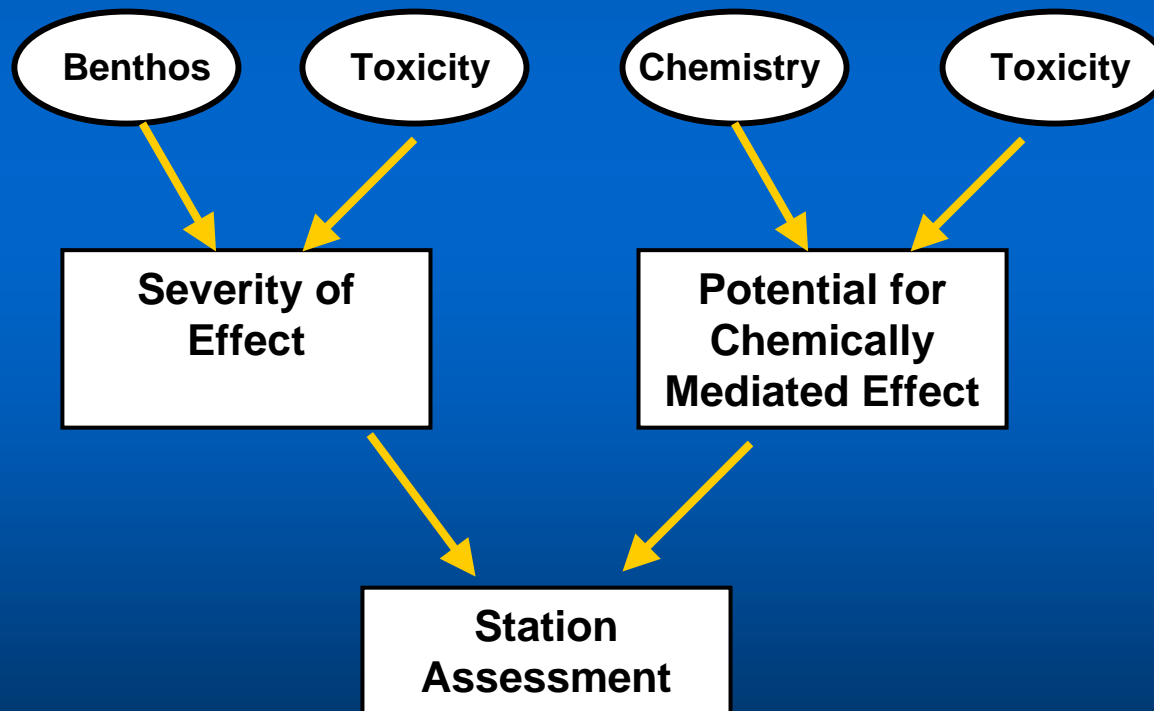
Six assessment categories

- **Unimpacted**

- **Likely Unimpacted**

- **Possibly Impacted**

- **Likely Impacted**

- **Clearly Impacted**

- **Inconclusive**

64 LOE Combinations → **MLOE Integration Framework** → **6 Assessment Categories**

MLOE Conceptual Framework Direct Effects

Three lines of evidence (LOE) needed to assess direct effects of sediment contamination

Severity of Effect

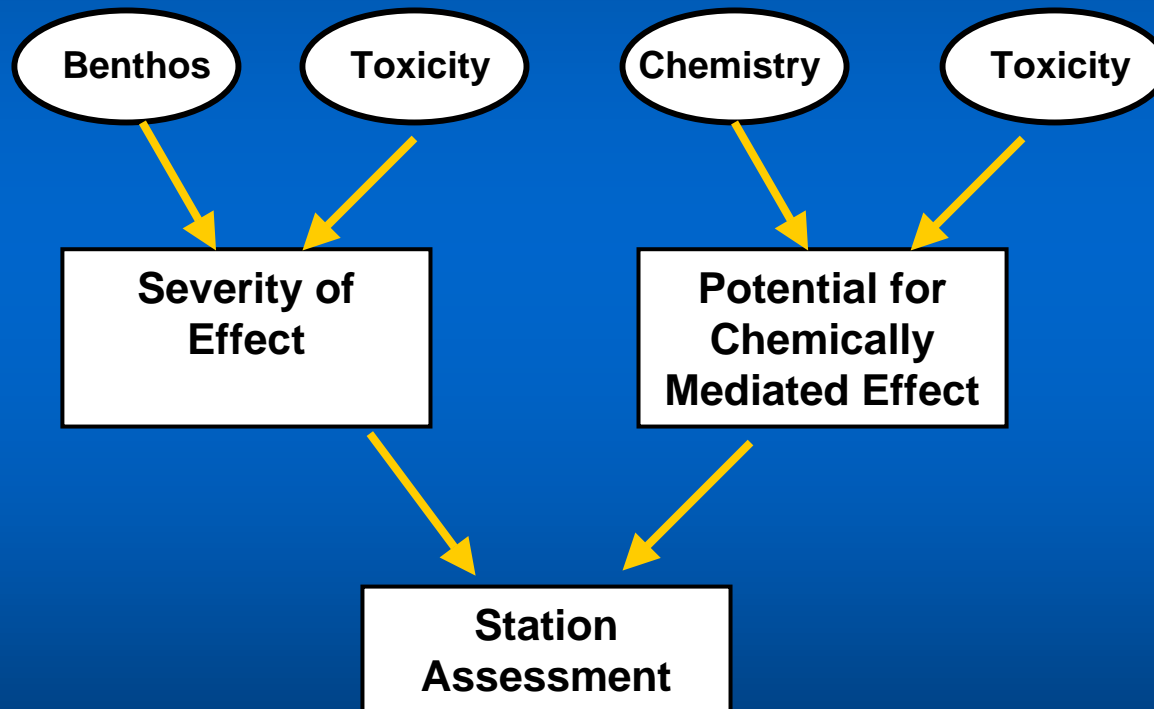| Benthos	Nontoxic	Low Toxicity	Moderate Toxicity	High Toxicity
Reference	Unaffected	Unaffected	Unaffected	Low Effect
Low Disturbance	Unaffected	Low Effect	Low Effect	Low Effect
Moderate Disturbance	Moderate Effect	Moderate Effect	Moderate Effect	Moderate Effect
High Disturbance	Moderate Effect	High Effect	High Effect	High Effect

Potential that Effects are Chemically Mediated

Toxicity

Chemistry	Nontoxic	Low Toxicity	Moderate Toxicity	High Toxicity
Minimal Exposure	Minimal Potential	Minimal Potential	Low Potential	Moderate Potential
Low Exposure	Minimal Potential	Low Potential	Moderate Potential	Moderate Potential
Moderate Exposure	Low Potential	Moderate Potential	Moderate Potential	Moderate Potential
High Exposure	Moderate Potential	Moderate Potential	High Potential	High Potential

Station Categories

- ## Unimpacted

  - Confident that sediment contamination is not causing significant adverse impacts.

- ## Likely Unimpacted

  - Sediment contamination at the site is not expected to cause adverse impacts to aquatic life. Some uncertainty from small disagreement among the LOE.

- ## Possibly Impacted

  - Sediment contamination at the site may be causing adverse impacts to aquatic life. Small impacts or LOE disagreement cause substantial uncertainty.

Station Categories

- **Likely Impacted**
  - **Evidence for a contaminant-related impact to aquatic life at the site is persuasive, even if there is some disagreement among LOE.**

- **Clearly Impacted**
  - **Sediment contamination at the site is causing clear and severe adverse impacts to aquatic life.**

- **Inconclusive**
  - **Large disagreement among the LOE suggests that either the data are suspect or that additional information is needed before a classification can be made.**

Station Assessment

Severity of Effect

	Unaffected	Low Effect	Moderate Effect	High Effect
Minimal Potential	Unimpacted	Likely Unimpacted	Likely Unimpacted	Likely Unimpacted or Inconclusive
Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
Moderate Potential	Likely Unimpacted	Possibly Impacted or Inconclusive	Likely Impacted	Likely Impacted
High Potential	Likely Unimpacted or Inconclusive	Likely Impacted	Clearly Impacted	Clearly Impacted
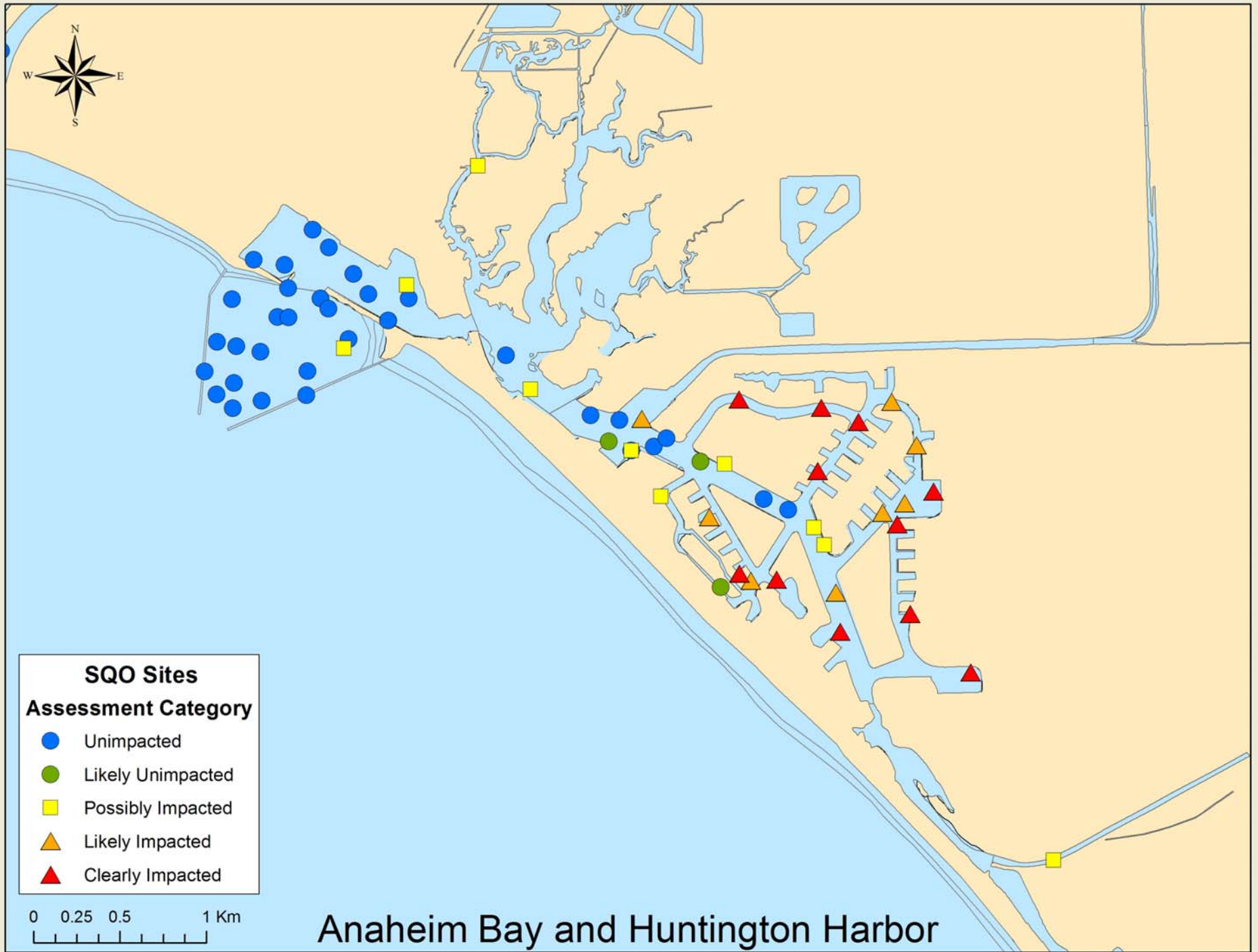
Potential that Effects are Chemically Mediated

N
W E
S

SQO Sites
Assessment Category

- 🔵 Unimpacted
- 🟢 Likely Unimpacted
- 🟨 Possibly Impacted
- 🔺 Likely Impacted
- 🔺 Clearly Impacted

0   0.25   0.5   1 Km

Anaheim Bay and Huntington Harbor

SQO Sites
Assessment Category

- Unimpacted
- Likely Unimpacted
- Possibly Impacted
- Likely Impacted
- Clearly Impacted
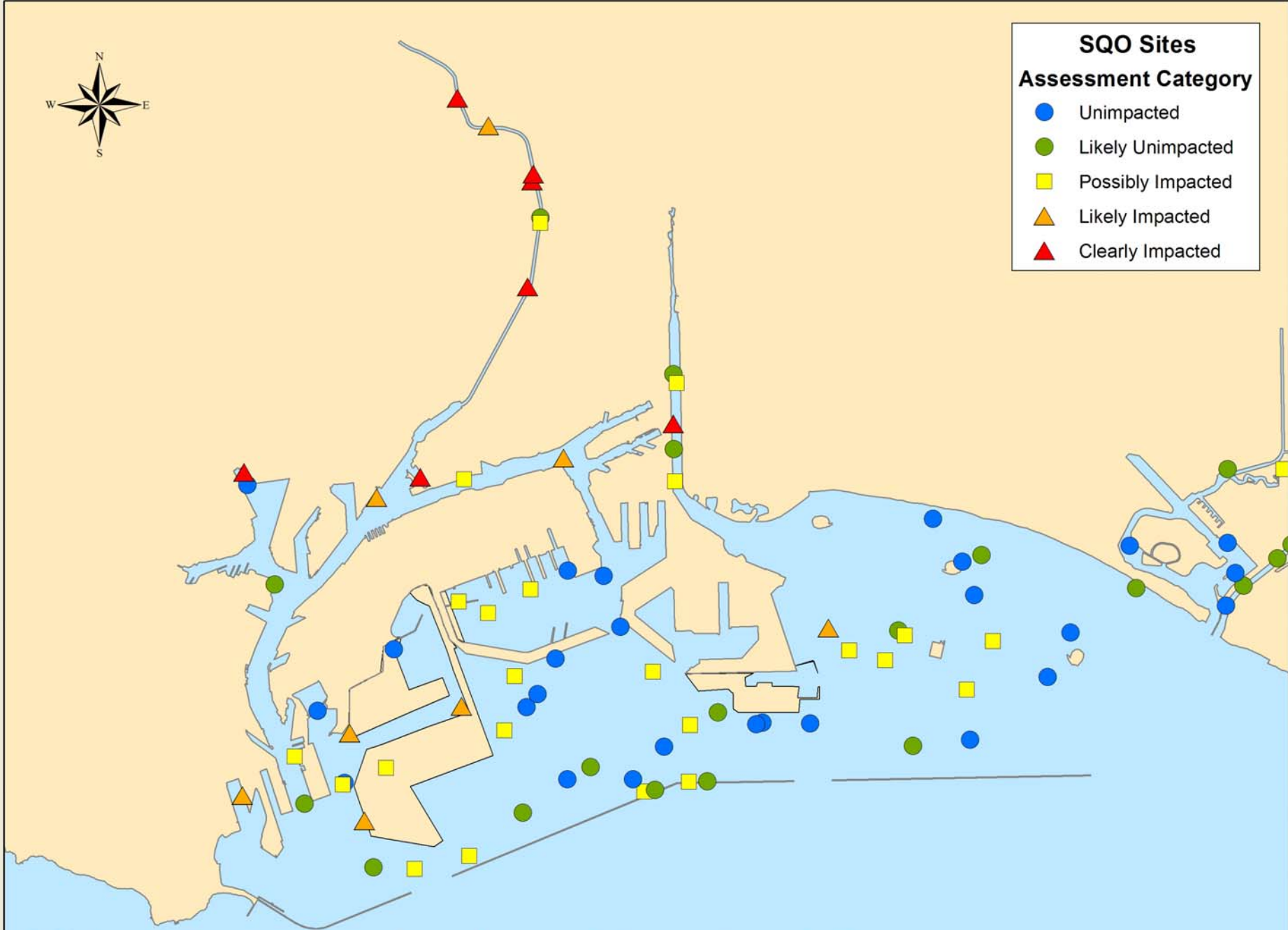
0 0.5 1   2 Km
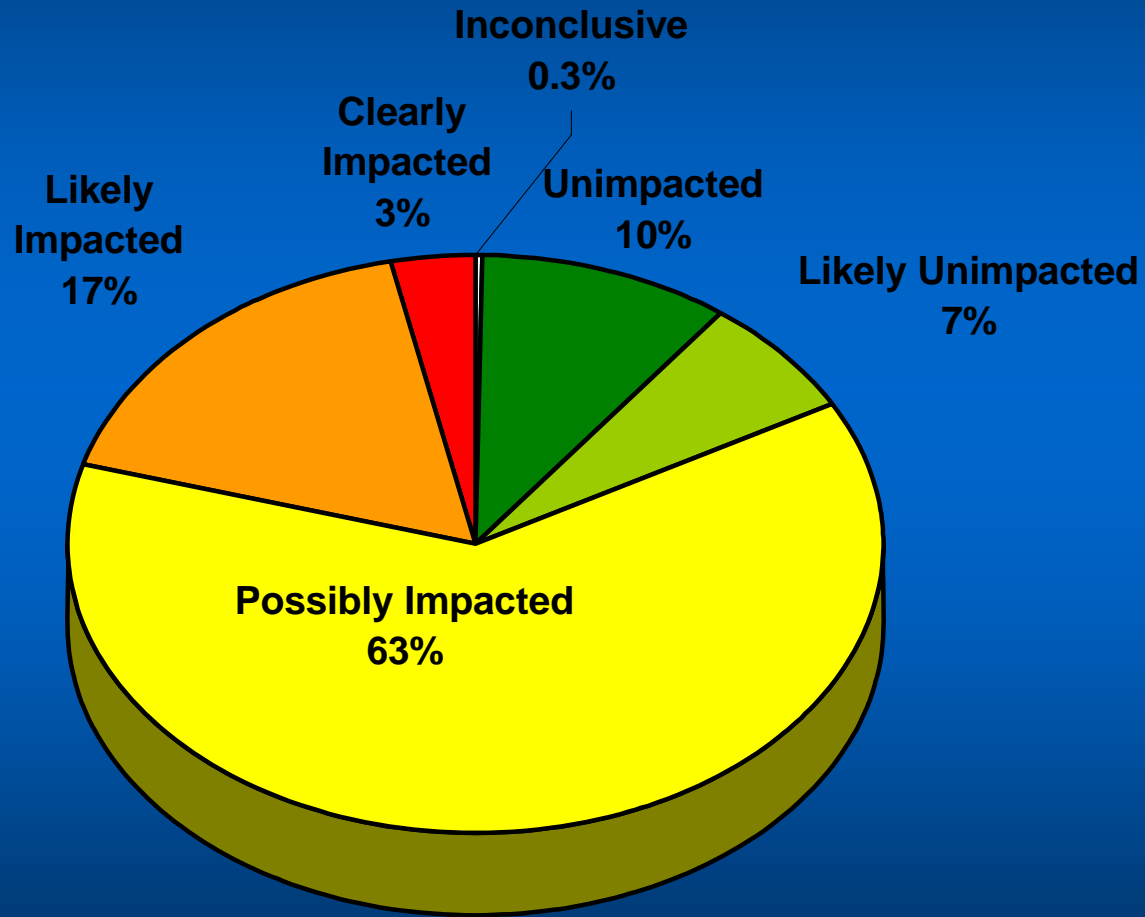
Los Angeles and Long Beach Harbors
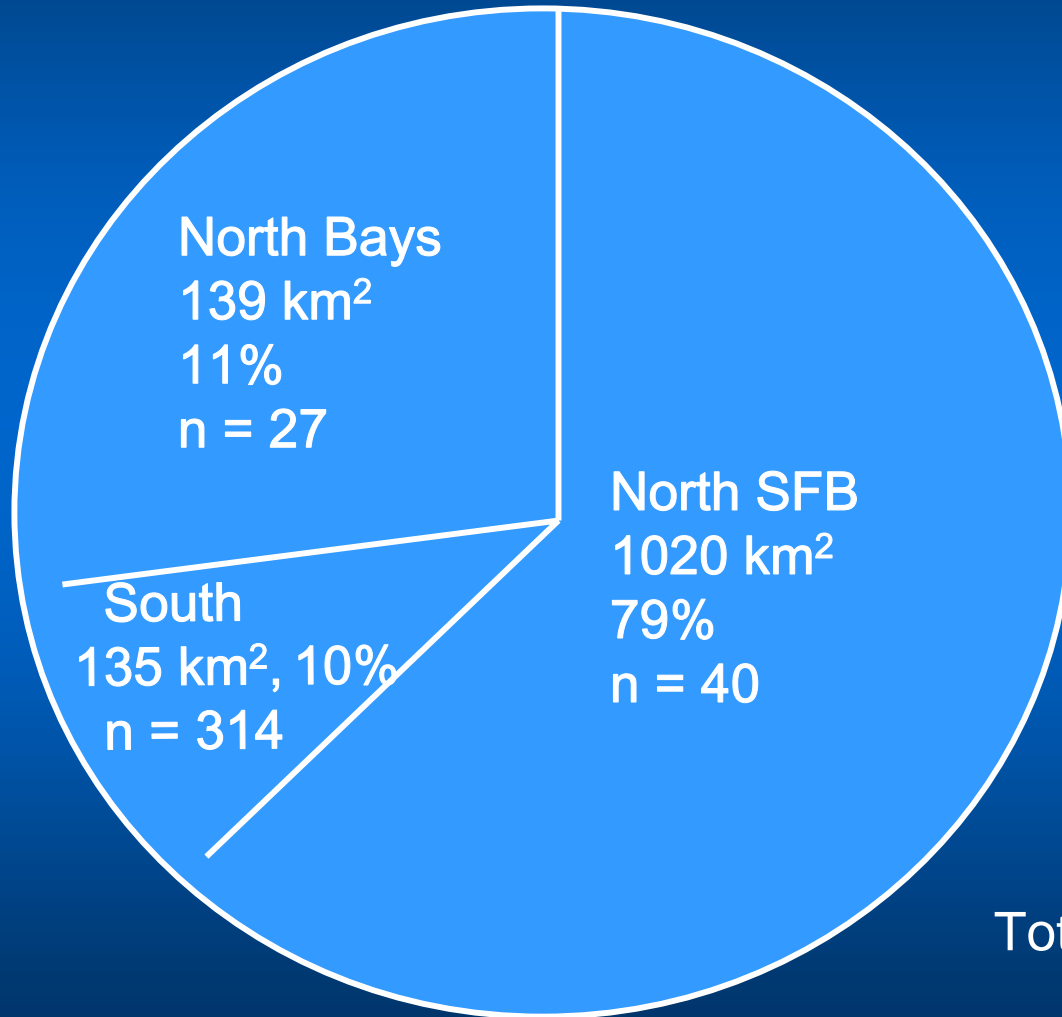
SQO Sites

Assessment Category

- 🔵 Unimpacted
- 🟢 Likely Unimpacted
- 🟨 Possibly Impacted
- 🔺 Likely Impacted
- 🔺 Clearly Impacted

0 2.5 5   10 Km

San Francisco Bay

Spatial Assessment

- **Select Regions of Interest**
  - **Statewide**
  - **North, SFB, South**

- **Combined Sample Frames, and Recalculated Area Weights**
  - **We used GIS tools to post-stratify**
  - **Area weights were recalculated separately for North and South**

- **% Area in MLOE Category**
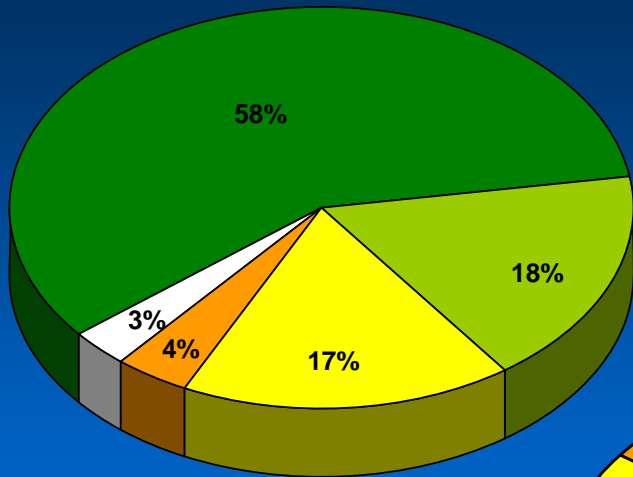 - **= Sum of area weights in category/total area weight**

Statewide Condition

Inconclusive
0.3%

Clearly
Impacted
3%

Unimpacted
10%

Likely
Impacted
17%

Likely Unimpacted
7%

Possibly Impacted
63%

California Regions

North Bays
139 km^2
11%
n = 27

North SFB
1020 km^2
79%
n = 40

South
135 km^2, 10%
n = 314

Total = 1295 **km^2**

Regional Condition

North — 58%, 18%, 17%, 4%, 3%

San Francisco Bay — 73%, 19%, 4%, 4%

South — 43%, 24%, 19%, 12%, 2%
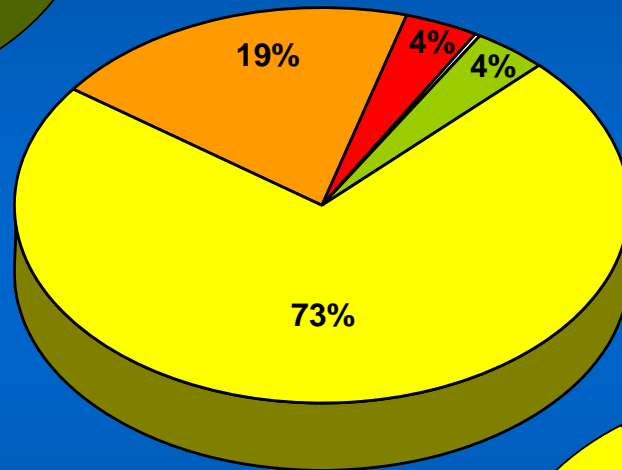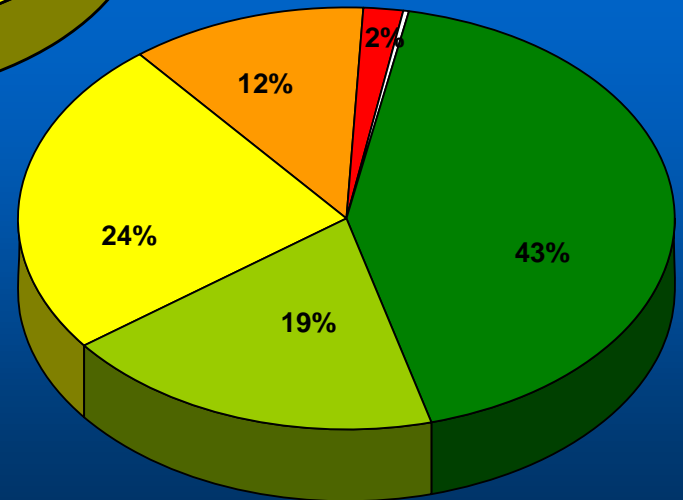
Do We Believe The Results?

Several potential sources of uncertainty:

- **Data Errors**
  - QA review of data and calculations

- **Assessment Framework Application**
  - Individual LOE Responses
  - Concordance/Discordance

- **Data Differences**
  - Variations of tools among regions
    - Actual tools vs "Common" tools

Data QA Review

- **Verified All SF Bay Sediment Toxicity Results**

- **Hand-Checked Calculations for Each LOE**

- **Independent Check of All MLOE Station Classifications**

- **No Errors Found**

LOE Responses (% Area)

Region	Response	Benthos	Toxicity	Chemistry
North	Affected	51	20	7
SFB	Affected	62	86	46
South	Affected	24	29	44

Affected: Moderate or High response

Chemistry:Toxicity Relationships
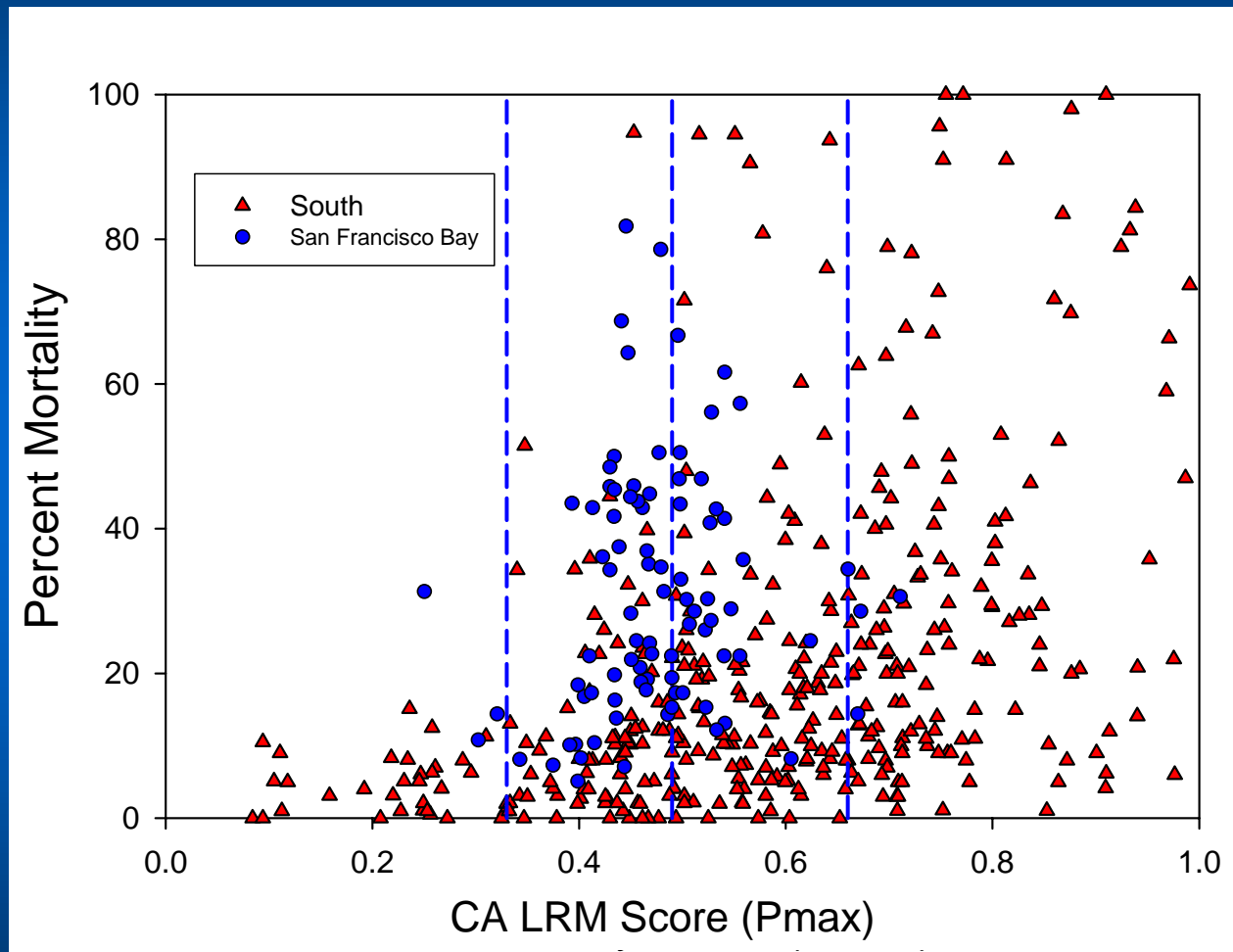
LOE Concordance Analysis

- **Highly Concordant**
  - 2-3 LOEs agree, no more than one category difference
  - E.g., Low/Low/Low; Low/Low/Moderate

- **Somewhat Concordant**
  - All LOEs differ by no more than two categories
  - E.g., Low/Moderate/High

- **Somewhat Discordant**
  - All LOEs differ by three categories
  - E.g., Minimal/Low/High

- **Moderate Outlier**
  - 2 LOEs agree, other LOE differs by two categories
  - E.g., Low/Low/High

- **High Outlier**
  - 2 LOEs agree, other LOE differs by three categories
  - E.g., Minimal/High/High

Concordance Summary

Category	North %	SFB %	South %
Highly Concordant	36	69	62
Somewhat Concordant	8	19	17
Somewhat Discordant	32	8	7
Moderate Outlier	12	4	13
High Outlier	12	0	1

Tool Differences Among Regions

Region	Toxicity	Benthos	Chemistry
North	*Eohaustorius*	RBI	CA LRM
SFB	*Eohaustorius*	RBI, IBI, RIVPACS, BRI	CA LRM
South	*Eohaustorius*	RBI, IBI, RIVPACS, BRI	CA LRM CSI

Common Tools: *Eohaustorius, RBI, CA LRM*

Effect of Tool Differences on % Area Estimates

Region	Response	Tools	Benthos	Toxicity	Chemistry
North	Affected	All	51	20	7
North	Affected	Common	51	20	7
SFB	Affected	All	62	86	46
SFB	Affected	Common	90	86	46
South	Affected	All	24	29	44
South	Affected	Common	37	29	50

Summary

- **SQO Assessment Framework Successfully Applied Throughout State**
    - **Integrated data from 381 stations**
    - **Few inconclusive station classifications**

- **Variation in Tools Had Little Impact on Outcome**
    - **Similar results with "common" tools**

- **MLOE Results Generally Concordant**
    - **Relative agreement among LOEs**
    - **SFB and South show similar degree of concordance**

- **Results Provide a Focus for Research and Management Actions**
    - **Stressor identification studies in SF Bay and other areas**
    - **Develop benthic indices for other habitats**