Sediment Quality Objectives

For California Enclosed Bays and Estuaries

Development of Toxicity Indicators

February 28, 2006

Presentation Overview

- **Summary of previous results**
- **SSC recommendations**
- **Results interpretation**
- **Data integration**
- **Recommendations**

Toxicity Indicator Development

- **Select a suite of recommended acute and chronic toxicity test methods**
- **Describe sensitivity, reliability, and ecological relevance for each method**
- **Develop thresholds for use in MLOE framework**
- **Develop data integration strategy and application guidance**

Approach for Test Selection

- **Establish a list of candidate methods**
  - **Potential to meet desired attributes**
- **Compile and synthesize information about tests**
  - **Relate to desired test characteristics**
  - **SQO database, literature, lab studies, other scientists**
- **Select recommended tests**
  - **Match indicator attributes**
  - **Best combination of desired characteristics**

Candidate Tests

- **Amphipod survival (10 day sediment exposure)**
  - ***Ampelisca abdita***
  - ***Eohaustorius estuarius***
  - ***Leptocheirus plumulosus***
  - ***Rhepoxynius abronius***
- **Growth/Reproduction (28 day sediment exposure)**
  - ***L. plumulosus***
  - ***Neanthes arenaceodentata* (polychaete)**
- **Embryo development (2-3 day sediment-water interface exposure)**
  - ***Strongylocentrotus purpuratus* (purple sea urchin)**
  - ***Mytilus galloprovincialis (*mussel)**

Candidate Tests Continued

- **Copepod life cycle (14 day sediment exposure)**
  - ***Amphiascus tenuiremus***
- **Clam growth (7 day sediment exposure)**
  - ***Mercenaria mercenaria***
- **Oyster lysosomal stability (4 day sediment exposure)**
  - ***Crassostrea virginica***

Evaluation Process

- **Separate evaluation for short-term survival and sublethal test methods**
- **Short-term survival**
  - **10-day amphipod tests are accepted**
    - **Species selection is primary issue**
- **Sublethal tests (many issues)**
  - **Feasibility**
  - **Consistency**
  - **Confounding factors**
  - **Sensitivity**
  - **Relevance**
  - **Cost**

Amphipod Species Recommendations

- **Recommended**
  - ***Eohaustorius estuarius***
  - ***Leptocheirus plumulosus***
- **Not recommended**
  - ***Rhepoxynius abronius***
    - **Limited availability**
    - **Grain size sensitivity**
  - ***Ampelisca abdita***
    - **Low sensitivity**
    - **Low test success rate**

Sublethal Test Recommendations

- **28-day Polychaete growth test (*N. arenaceodentata*)**
  - **Familiar and readily available test species**
  - **Method and interlaboratory performance documented**
  - **Highly relevant exposure and endpoint**
  - **Greater sensitivity than acute test documented**

- **Sediment-water interface test using mussel embryos (*M. galloprovincialis*)**
  - **Familiar and readily available test species**
  - **Well documented methods**
  - **Different exposure characteristics**
  - **Highly sensitive life stage**

SSC Recommendations

- **Conduct both acute survival and sublethal tests to evaluate sediment toxicity**
- **Develop thresholds for classifying the results of each test that are test-specific and incorporate the minimum significant difference (msd) value.**
- **Develop a data integration strategy that:**
  - **Gives equal weight to the survival and sublethal tests**
  - **Does not penalize for the use of additional test types**

Results Interpretation

- **Multiple categories of effect for each test result**
  - **Describe variations in magnitude of response**
  - **Reflect uncertainty**
- **Provide two types of information needed for MLOE assessment**
  - **Unaffected (nontoxic) or affected**
  - **Severity of effect**
- **Four categories of response**
  - **Compromise between utility and precision**

Toxicity Categories

- **Nontoxic:** Response not substantially different from that expected in sediments that are uncontaminated and have optimum characteristics for the test species (e.g., control sediments)
- **Low effect:** A response that is of relatively low magnitude; the response may not be greater than test variability
- **Moderate effect:** High confidence that a statistically significant toxic effect is present
- **High effect:** High confidence that a toxic effect is present and the magnitude of response includes the strongest effects observed for the test

Threshold Development

Three thresholds are needed to classify the test results into one of four categories specified by the MLOE assessment approach

Nontoxic

Low Threshold

Low Effect

Moderate Threshold

Moderate Effect

High Threshold

High Effect

Low Threshold

- **Lowest acceptable response for controls and statistically significant difference from controls**
  - **Value specified in test method description**

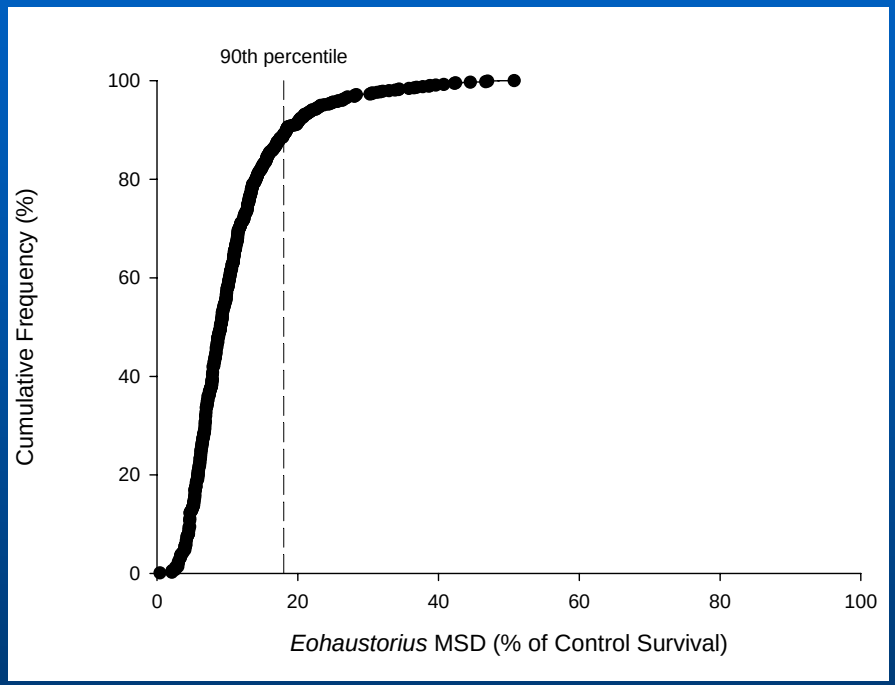
Test	Value
Amphipod Survival	90%
Mussel Development	80% Normal-Alive
Polychaete Survival	80%
Polychaete Growth	90% of controls

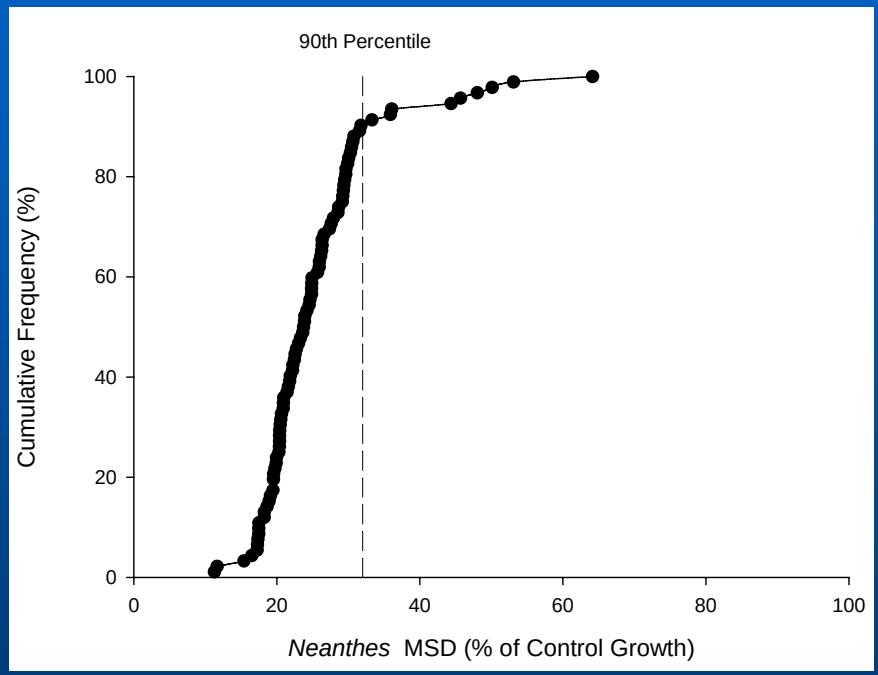
Moderate Threshold

- **90th percentile of the minimum significant difference (MSD) and statistically significant difference from control**
  - **Based on a pair wise comparison (alpha=0.05)**
  - **Value is expressed as a control normalized response**

- **Widely used to differentiate between slight and definite toxicity**
  - **BPTCP, EMAP, Bight surveys, NOAA**
  - **Reflects the within replicate variability characteristic of the test species and method**

Moderate Threshold





Moderate Threshold

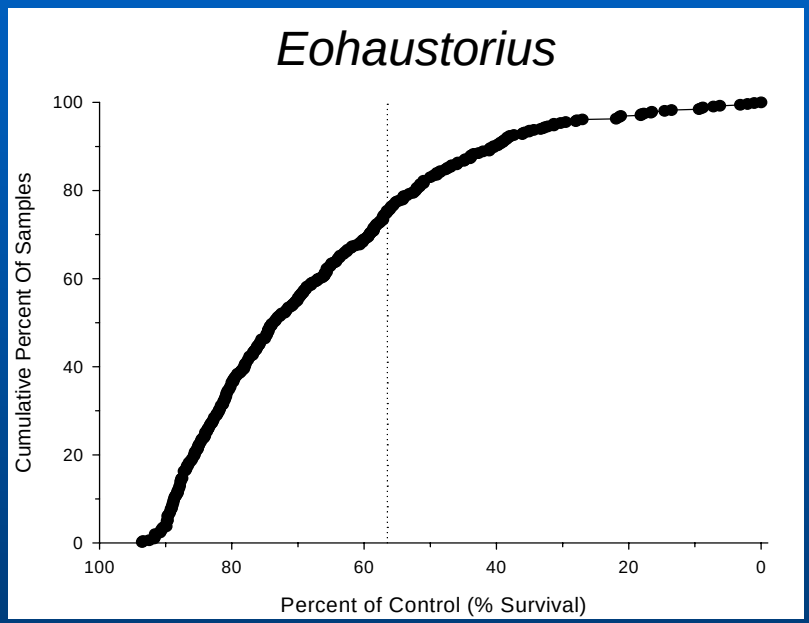
Test	Value
Eohaustorius Survival	82%
Leptocheirus Survival	78%
Mytilus Normal-Alive	77%
Neanthes Survival	NA
Neanthes Growth	68%

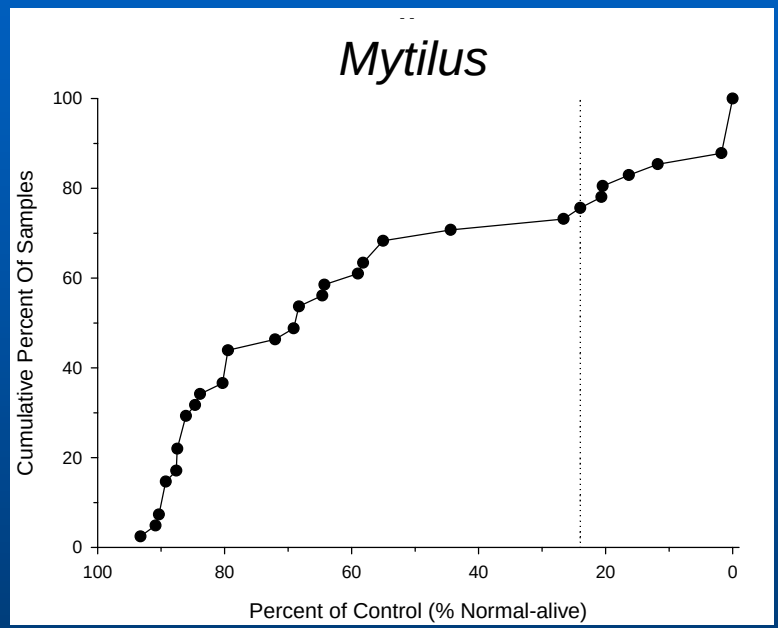
High Threshold

- **Represents a strong and highly significant effect**
  - **Little precedent for this value in other studies**

- **Calculated three estimates based on relevant test characteristics**
  - **Highly significant response**
    - **99th percentile of MSD**
  - **Response characteristic of the most toxic samples**
    - **25th percentile of toxic samples from California**
  - **High contaminant dose present**
    - **Response from a doubling of contaminant dose**

Toxic Sample Distribution





Insufficient data available for *Leptocheirus* and *Neanthes*

Dose Response

- **Median change in test response associated with a doubling of the exposure concentration**
  - **Reference toxicant tests**
    - **Spiked sediment or water**
  - **Test sample dilutions**
    - **Sediment or elutriate**
- **Amphipods**
  - **Combined *Eohaustorius* and *Leptocheirus* data**
    - **Field sediments (21) and PAH (4)**
- **Mytilus**
  - **Elutriates (96) and reference toxicants (11)**
- **Neanthes**
  - **Field sediments (6)**

High Threshold

Test	99th MSD	75th Toxic	Double Dose	Mean
Eohaustorius Survival	61%	57%	70%	63%
Leptocheirus Survival	54%	57%	70%	60%
Mytilus Normal-Alive	60%	24%	30%	38%
Neanthes Survival	NA	NA	NA	NA
Neanthes Growth	46%	NA	72%	59%

Toxicity Thresholds

Test	Low (%)	Moderate (% Control)	High (% Control)
Eohaustorius Survival %	90	82	63
Leptocheirus Survival %	90	78	60
Neanthes Survival %	80	NA	NA
Neanthes Growth %	90*	68	59
Mytilus Normal %	80	77	38

* % of control

Data Integration

- **Objectives:**
  - **Combine multiple toxicity test results to produce a toxicity LOE classification**
  - **Each test is weighted equally**
  - **Accommodate various numbers of tests without penalty**

Integration Strategy

- **If all tests agree, then LOE category is the same**
- **If categories differ, then assign category corresponding to the median**
- **When median fall between categories, then assign the higher effect category**

Data Integration

Test 1	Test 2	LOE Category
Nontoxic	Nontoxic	Nontoxic
Nontoxic	Low	Low
Nontoxic	Moderate	Low
Nontoxic	High	Moderate
Low	Low	Low
Low	Moderate	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	High	High
High	High	High

Research Needs

- **Refine thresholds for *Leptocheirus* and *Neanthes* tests using new data**
  - **Dose-response experiments**
  - **California data**
- **Evaluate additional sublethal test methods for inclusion in the suite of recommended test methods**
  - **A larger toolbox will increase confidence in the results and facilitate site-specific study designs**
- **Improve sediment toxicity identification evaluation (TIE) methods**
  - **Identification of the cause is needed to plan management actions**