Protectiveness of the TCAO/DTR Ecological Approach

Scott Becker, Ph.D.

On behalf of BAE Systems

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Introduction: Scott Becker

- Ph.D. in Fisheries from the University of Washington
- Professional Certifications:
  - Fisheries Scientist – American Fisheries Society
  - Senior Ecologist – Ecological Society of America
- Over 30 years of experience in sediment quality assessment in 14 states, including CA
- Co-author of the 2003 Shipyard Sediment Report

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Key Questions Related to the TCAO/DTR Ecological Approach

1. Is the DTR approach appropriate for the protection of benthic macroinvertebrate communities?

2. What are the relative merits of the Triad indicators?

3. What is an appropriate biological weighting scheme?

4. What were the problems with the mussel toxicity test?

5. What are the merits of the site-specific sediment quality values (i.e., 60% LAETs and SS-MEQ)?

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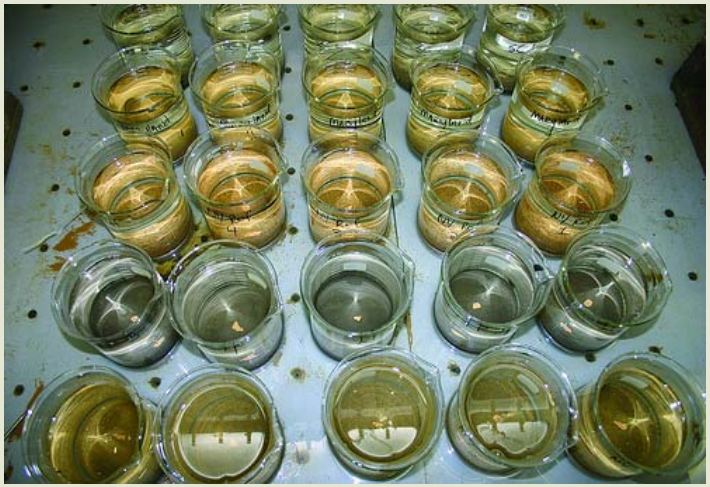
The MLOE Approach is State of the Art

1. Benthic Macroinvertebrate Communities:
   - *Are the native Shipyard Site communities impaired?*

2. Sediment Toxicity Tests:
   - *Is any observed benthic impairment likely due to chemical toxicity?*

3. Sediment Chemistry:
   - *Are chemical concentrations high enough to cause toxicity, after accounting for the true bioavailability at the Shipyard Site?*



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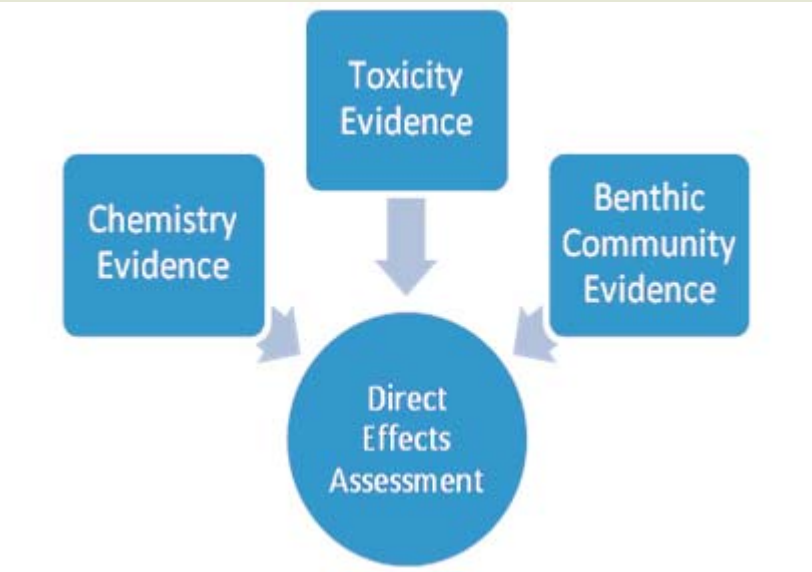
Interpretation of the Triad Results

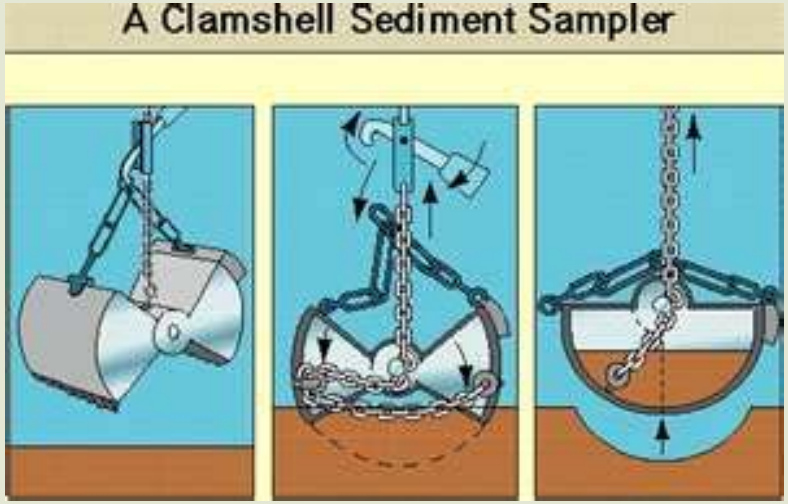
Framework for Interpreting Sediment Quality Triad Data

Bay, S.M., and S.B. Weisberg. 2010.
Integrated Environmental Assessment and Management 7:1-8.



Framework for Integrating MLOEs
(Bay and Weisberg 2010)

"Benthos is given greater weight in this assessment because it is the ultimate endpoint of interest."



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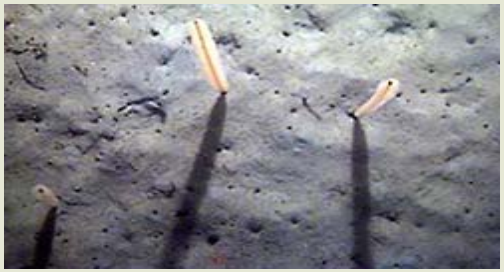
Steve Bay Toxicity Testing Testimony
(9/27/2010 Deposition)

Question 1: "*Relevancy of exposure conditions for predicting effects on benthic macroinvertebrates*."

Mr. Bay: "*Based on that definition, I would say the amphipod test with Eohaustorius is considered to be most reliable.*"

Question 2: "*What would be the second most reliable?*"

Mr. Bay: "I really can't determine whether they would be similar or different. I would say that they're just less reliable in general."



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Steve Bay Toxicity Testing Testimony
(9/27/2010 Deposition)

Question 3: *"This next question is the relevancy of the test endpoint for predicting effects on benthic macroinvertebrates."*

Mr. Bay: *"In general, I would consider the test endpoint for the amphipod test, which is survival to have greater relevance than I would the endpoints for the other tests."*

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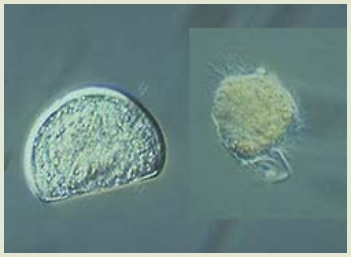
Appropriate MLOE Weighting Scheme

- **Primary LOE:** Benthic macroinvertebrate communities that occur at the Shipyard Site (i.e., nearly 400 species or taxa were identified)

- **Secondary LOE:** Amphipod toxicity test

- **Tertiary LOE:** Sea urchin and Mussel larvae toxicity tests[1]



[1]Quality control issues were found for the mussel test

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The DTR Weighting Scheme was Conservative

- It assumed that all biological measurements were equally meaningful with respect to protecting the native benthic communities.
- It disregarded quality control concerns with the mussel toxicity test.
- It considered any kind of "effect" as indicative of chemical toxicity, regardless of whether the effect may have been due to non-chemical factors.
- The DTR weighting scheme therefore erred on the side of being overly conservative.

Mussel Test Quality Control Issues

- The quality control evaluation found that some results were questionable:
  1. Unusually high variability for 10 stations
  2. Unusually high sensitivity to fine-grained sediment for 17 stations in Batch No. 2

- Exponent (2003) concluded that the mussel results should be used with caution.

- Despite these concerns, the mussel data were used without qualification in the DTR.

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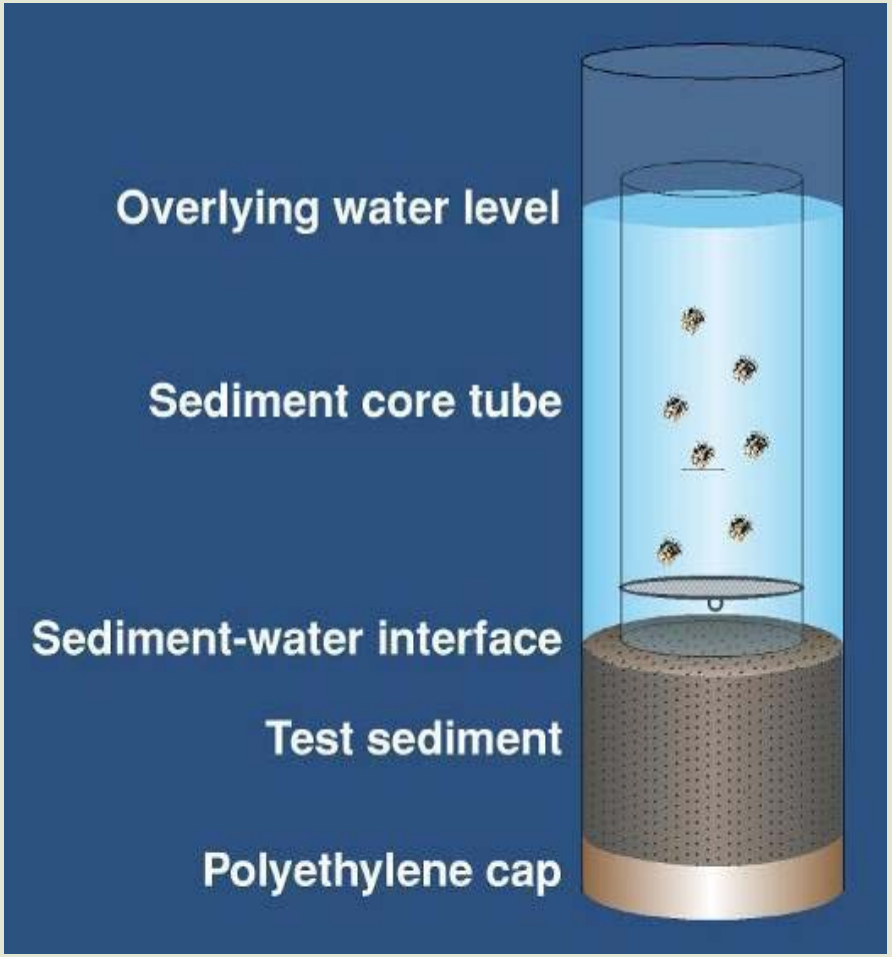
Mussel Test Exposure Chamber



Source: SPAWAR (2009) Technical Report 1986

Mussel Control Tests for Quality Assurance

- **Purpose:** To document that the test organisms are suitably healthy for testing.

- **Reason:** To ensure that any observed effects are likely due to chemical toxicity, and not to unhealthy or unusually sensitive test organisms.

- **Control Types:**
  - Seawater only
  - Seawater and coarse sediment
  - Seawater and fine sediment

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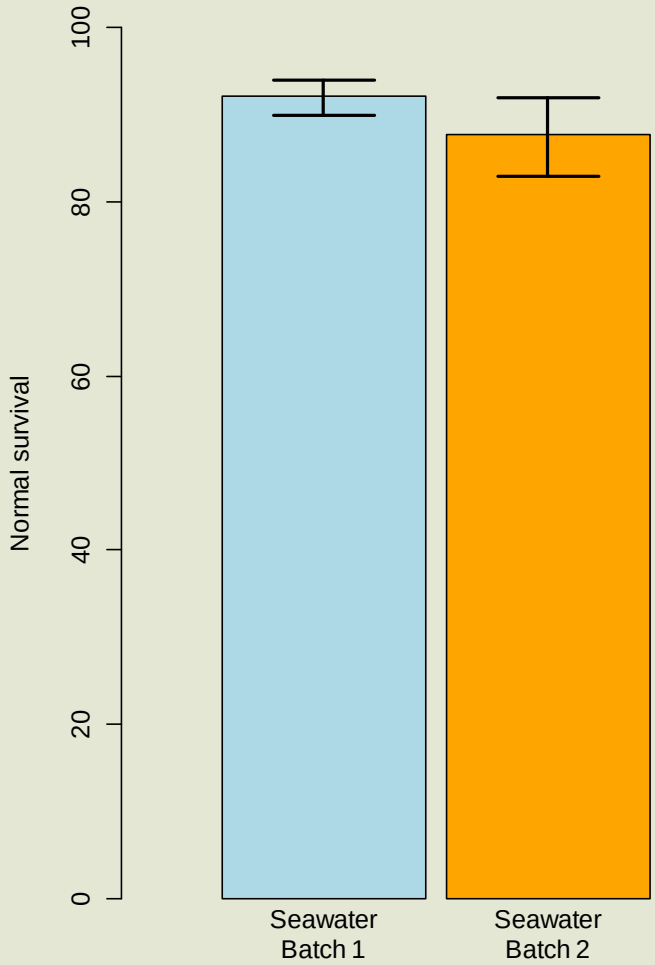
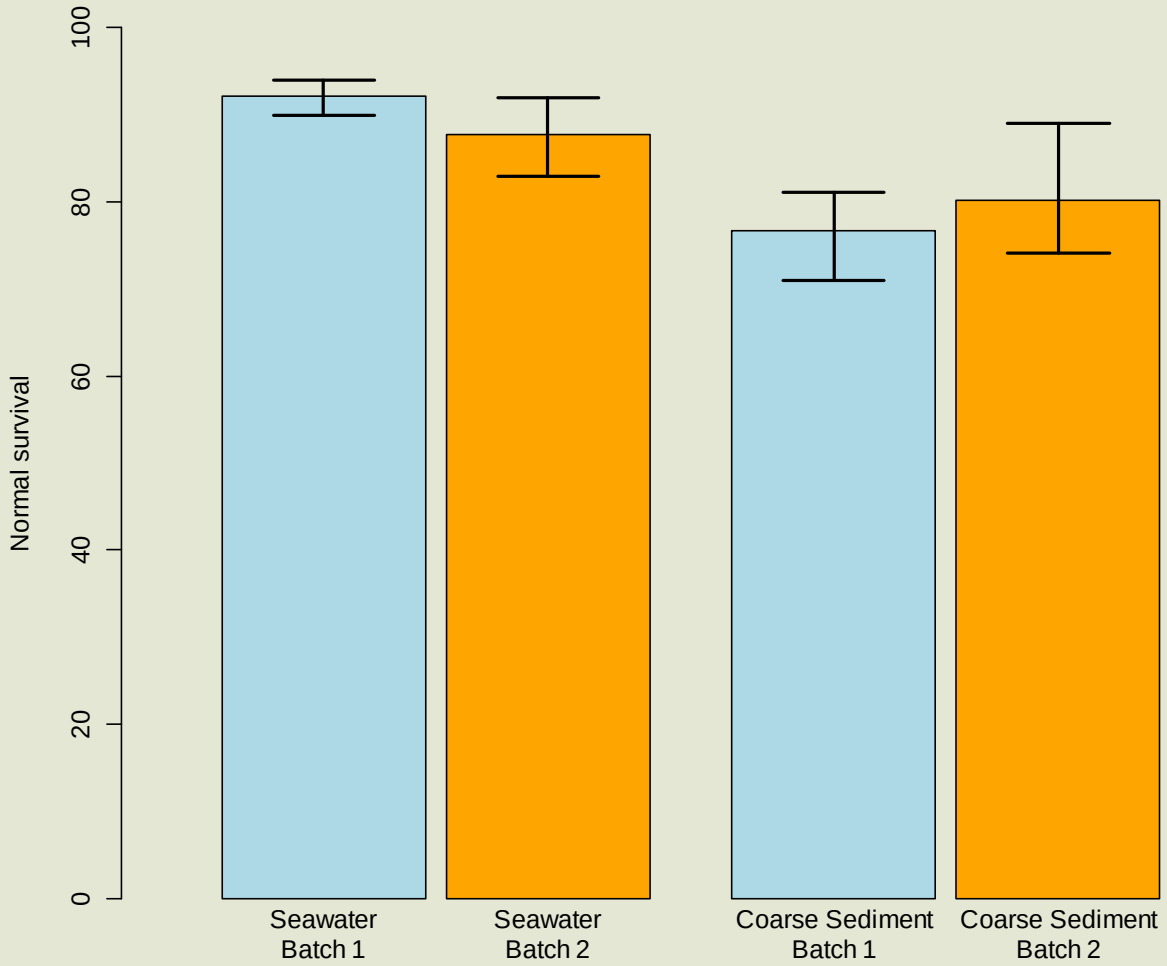
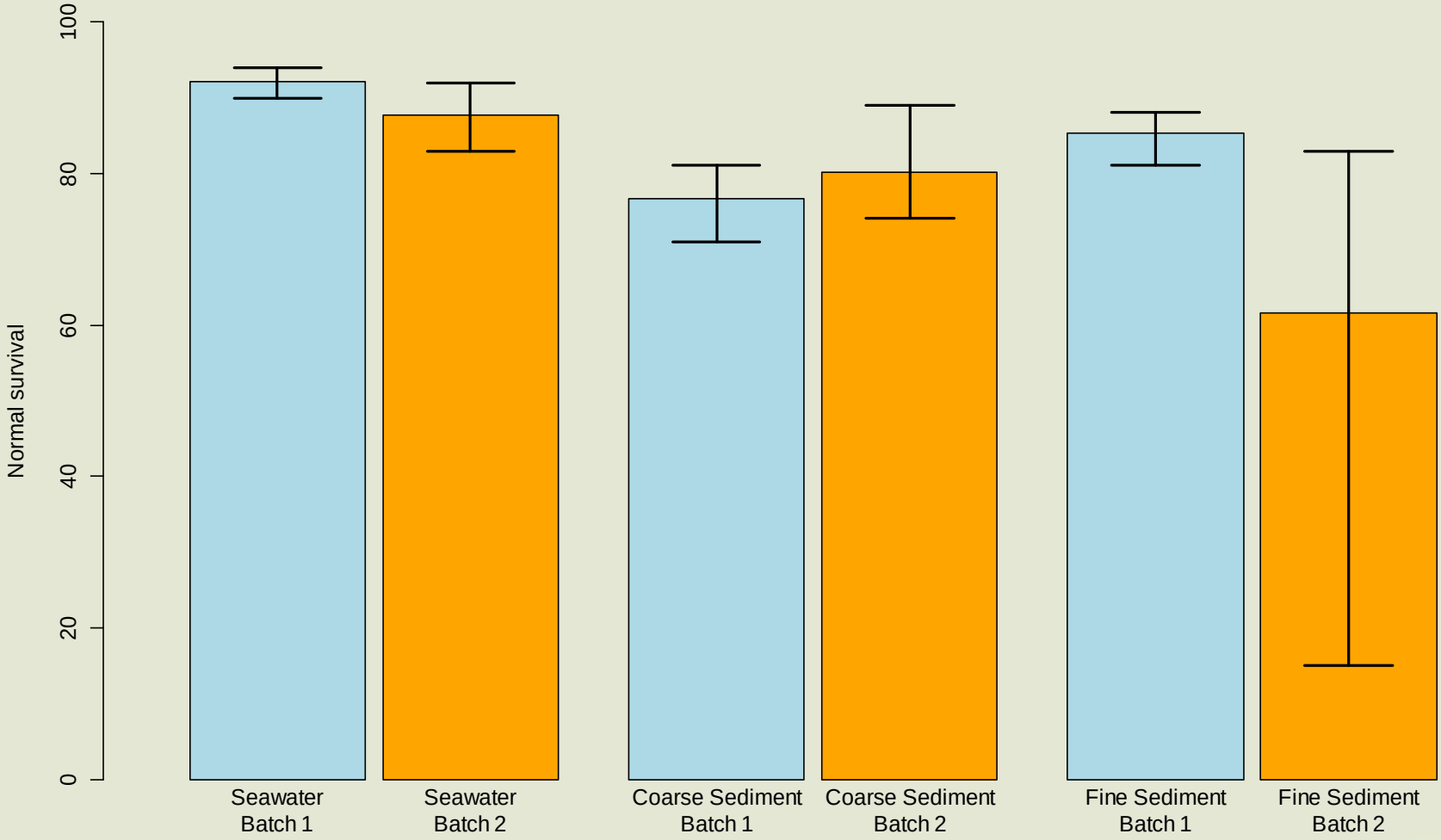
Mussel Test: Survival in Clean Seawater



Mussel Test: Survival in Clean Coarse Sediment



Mussel Test: Survival in Clean Fine Sediment



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Summary of Mussel Results at Polygons Where Mussel Toxicity was Identified in the DTR

Mussel Toxicity Suspected	Test Batch	High Variability
NA09	2	–
NA12	2	Yes
NA16	2	Yes
NA19	2	–
NA22	2	–
SW13	1	Yes
SW15	1	–
SW17	2	Yes
SW22	2	–
SW23	2	Yes
SW25	2	Yes
SW27	2	Yes

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Implications of the Mussel Results for the BAE Site: Sediment Toxicity

Polygon	Amphipod Toxicity
SW02	no
SW03	no
SW04	no
SW08	no
SW09	no
SW11	no
SW13	no
SW15	no
SW17	no
SW18	no
SW21	no
SW22	no
SW23	no
SW25	no
SW27	no

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Implications of the Mussel Results for the BAE Site: Sediment Toxicity

Polygon	Amphipod Toxicity	Sea Urchin Toxicity
SW02	no	no
SW03	no	no
SW04	no	no
SW08	no	no
SW09	no	no
SW11	no	no
SW13	no	no
SW15	no	no
SW17	no	no
SW18	no	no
SW21	no	no
SW22	no	no
SW23	no	no
SW25	no	no
SW27	no	no

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Implications of the Mussel Results for the BAE Site: Sediment Toxicity

Polygon	Amphipod Toxicity	Sea Urchin Toxicity	Mussel Toxicity
SW02	no	no	no
SW03	no	no	no
SW04	no	no	no
SW08	no	no	no
SW09	no	no	no
SW11	no	no	no
SW13	no	no	YES
SW15	no	no	YES
SW17	no	no	YES
SW18	no	no	no
SW21	no	no	no
SW22	no	no	YES
SW23	no	no	YES
SW25	no	no	YES
SW27	no	no	YES

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Implications of the Mussel Results for the BAE Site: Benthic Community Effects

Polygon	BRI
SW02	no
SW03	no
SW04	no
SW08	no
SW09	no
SW11	no
SW13	no
SW15	no
SW17	no
SW18	no
SW21	no
SW22	no
SW23	no
SW25	no
SW27	no

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Implications of the Mussel Results for the BAE Site: Benthic Community Effects

Polygon	BRI	Total Abundance
SW02	no	no
SW03	no	no
SW04	no	no
SW08	no	no
SW09	no	no
SW11	no	no
SW13	no	no
SW15	no	no
SW17	no	no
SW18	no	no
SW21	no	no
SW22	no	no
SW23	no	no
SW25	no	no
SW27	no	no

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Implications of the Mussel Results for the BAE Site: Benthic Community Effects

Polygon	BRI	Total Abundance	Total # Taxa
SW02	no	no	no
SW03	no	no	no
SW04	no	no	no
SW08	no	no	no
SW09	no	no	no
SW11	no	no	no
SW13	no	no	no
SW15	no	no	no
SW17	no	no	no
SW18	no	no	no
SW21	no	no	no
SW22	no	no	no
SW23	no	no	no
SW25	no	no	no
SW27	no	no	no

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Implications of the Mussel Results for the BAE Site: Benthic Community Effects

Polygon	BRI	Total Abundance	Total # Taxa	Diversity
SW02	no	no	no	no
SW03	no	no	no	no
SW04	no	no	no	YES
SW08	no	no	no	no
SW09	no	no	no	no
SW11	no	no	no	no
SW13	no	no	no	no
SW15	no	no	no	no
SW17	no	no	no	no
SW18	no	no	no	no
SW21	no	no	no	no
SW22	no	no	no	no
SW23	no	no	no	no
SW25	no	no	no	no
SW27	no	no	no	no

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Implications of the Mussel Results for the BAE Site: Benthic Community Effects

Polygon	BRI	Total Abundance	Total # Taxa	Diversity	Mussel Toxicity
SW02	no	no	no	no	no
SW03	no	no	no	no	no
SW04	no	no	no	YES	no
SW08	no	no	no	no	no
SW09	no	no	no	no	no
SW11	no	no	no	no	no
SW13	no	no	no	no	YES
SW15	no	no	no	no	YES
SW17	no	no	no	no	YES
SW18	no	no	no	no	no
SW21	no	no	no	no	no
SW22	no	no	no	no	YES
SW23	no	no	no	no	YES
SW25	no	no	no	no	YES
SW27	no	no	no	no	YES

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Summary of the Mussel Test Results

- Mussel toxicity was indentified at 7 of the 15 polygons at the BAE Site in the DTR:
  - No other toxicity effect was found at those 7 polygons
  - No benthic community effects were found at those 7 polygons

- **Conclusion:** The mussel test was the only biological indicator responsible for identifying 7 of the 15 polygons at the BAE Site as having possible or likely effects.

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Mussel Test Conclusions

- The mussel test had quality control issues that were disregarded in the DTR.
- Specifically, the test organisms appeared to be overly sensitive to fine-grained sediment.
- Because sediments at many of the Shipyard stations were fine-grained, it is not clear whether any observed mussel effects were due to chemical toxicity or to stress related to fine-grained sediment.

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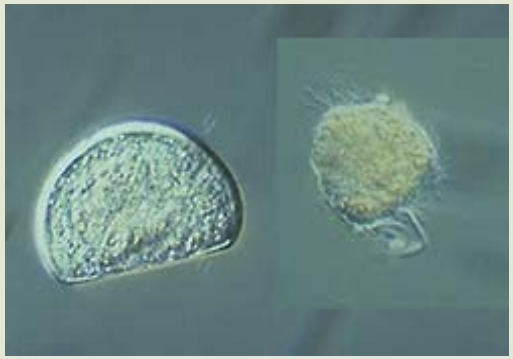
Mussel Test Conclusions (continued)

- The mussel test was inappropriately used as a stand-alone indicator of biological effects for 7 polygons at the BAE Site, despite the quality control issues associated with that test.

- The DTR treatment of the mussel test was not a valid application of the MLOE approach and erred on the side of being overly conservative.



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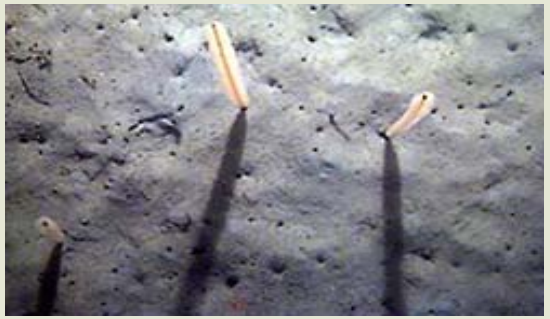
The 60% LAETs are Conservative

- Site-specific
  - True bioavailability of chemicals at the Shipyard Site
  - True sensitivities of native organisms that live at the Site
- Lowest value for four sensitive toxicity indicators:
  - Benthic communities
  - Amphipod survival
  - Mussel larval development
  - Sea urchin reproduction



- A safety factor of 60% was added based on the judgment of the Cleanup Team, which errs on the side of being overly conservative.

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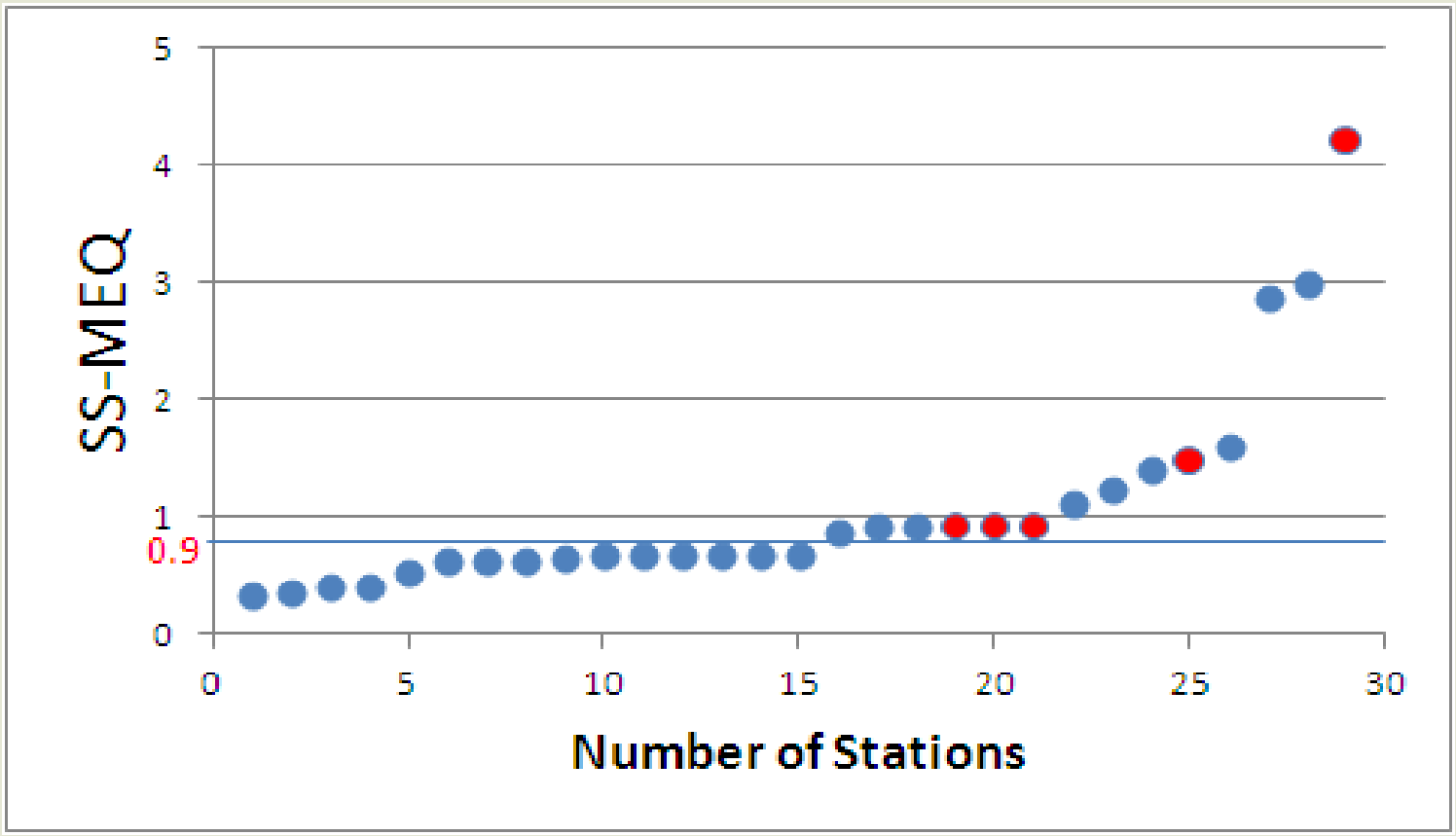
The SS-MEQ is Conservative

- SS-MEQ: Site-Specific Mean Effects Quotient
  - Single Index Value of the combined toxicity of multiple chemicals : (A/SQG + B/SQG + C/SQG)/3

- Identification of presence/absence of "Likely Effects":
  - Likely effects absent = 100% accurate
  - Likely effects present = 38% accurate

- **Conclusion:** Nearly two-thirds of the polygons identified as toxic did not have "Likely Effects", which errs on the side of being overly conservative.

The SS-MEQ Predictive Reliability



Two Monitoring Plans must be Approved by the Water Board

- Remediation Monitoring Plan:
  1. Water quality
  2. Sediment quality
- Post-Remediation Monitoring Plan:
  1. Sediment chemistry
  2. Sediment toxicity
  3. Benthic community assessment
  4. Bioaccumulation in clams
- Board Review in Years 2, 5, and 10

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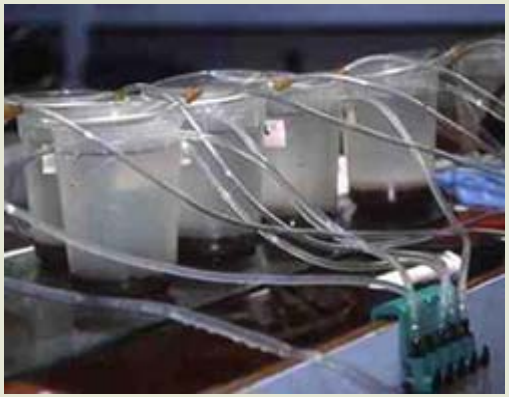
Conclusions on the TCAO/DTR Approach

The TCAO/DTR approach is:

- State of the art in general
- Based on multiple sensitive toxicity indicators
- Comprehensive and quantitative
- Errs on the side of predicting effects where they do not occur, and therefore is often overly conservative



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