A Comprehensive Copper Compliance Strategy: Implementing Regulatory Guidance at Pearl Harbor Naval Shipyard & Intermediate Maintenance Facility

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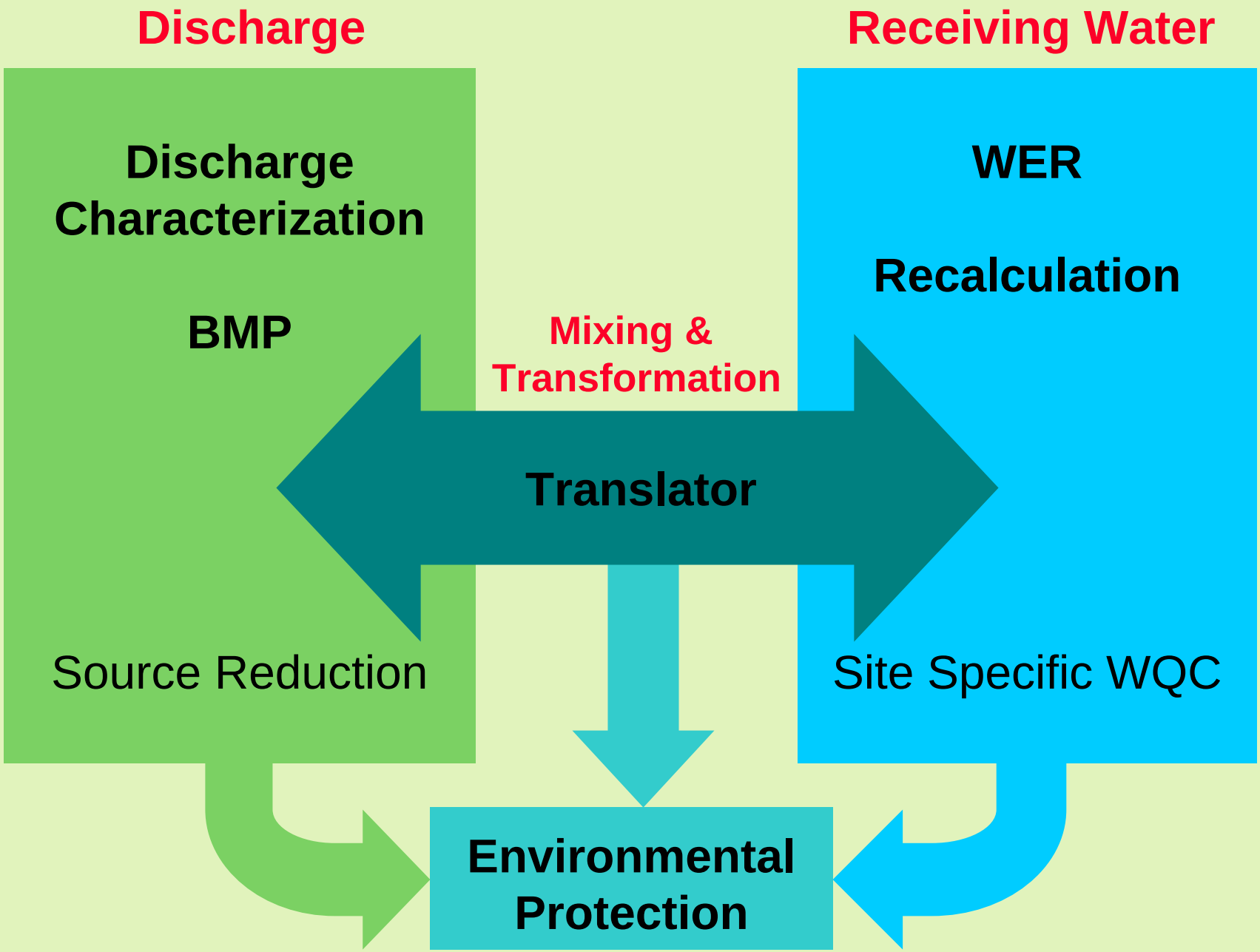
Pat Earley

Space and Naval Warfare Systems Center, San Diego

Environmental Sciences Code 71750


Discharge
Receiving Water
Discharge Characterization
BMP
WER
Recalculation
Mixing & Transformation
Translator
Source Reduction
Site Specific WQC
Environmental Protection

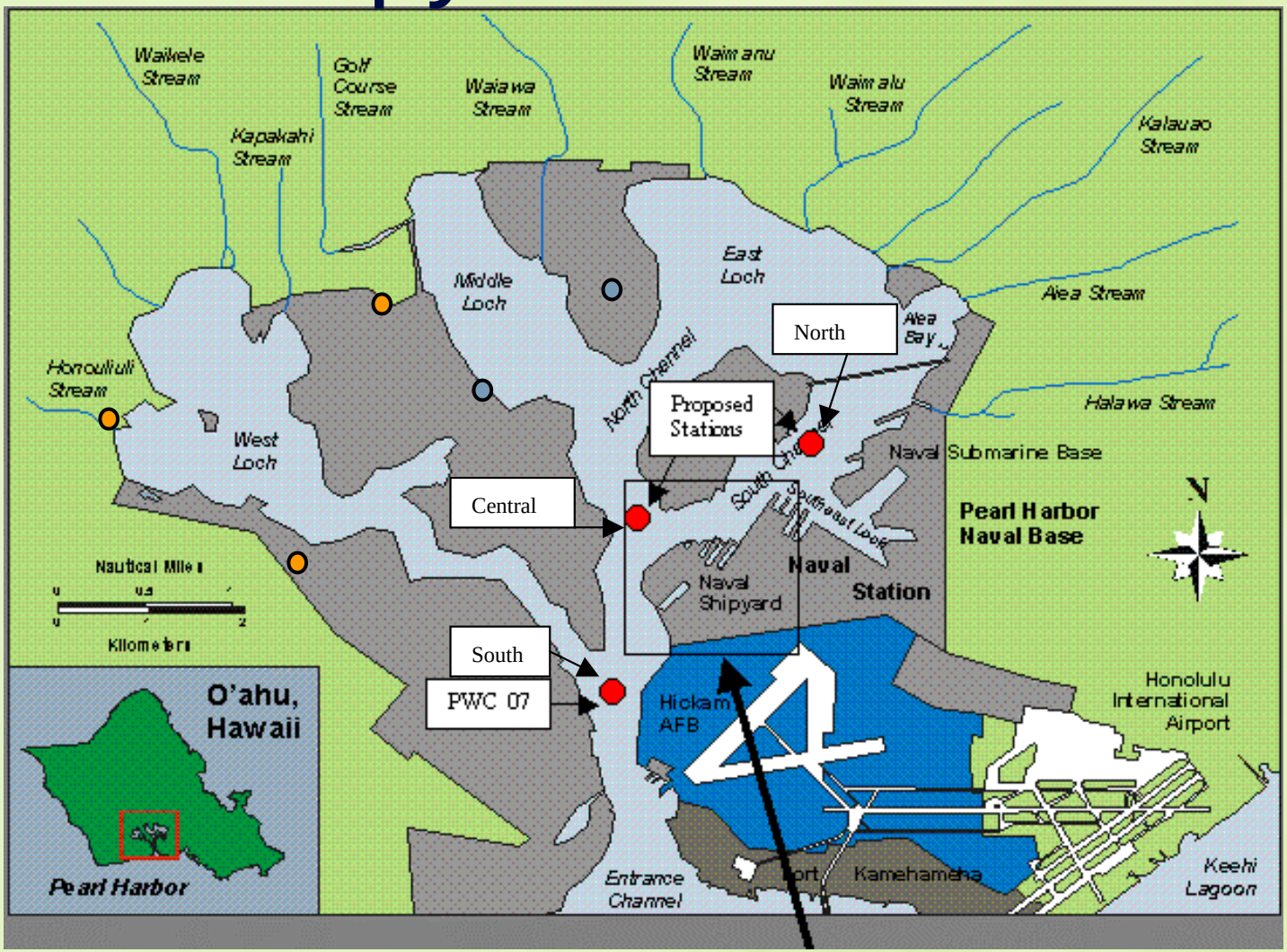
The Copper Problem at Pearl Harbor Naval Shipyard: Origin

- Dec 2001 – Draft final NPDES Permit issued to Shipyard, with a limit of 2.9 ppb Copper by Hawaii Department of Health (DOH)
  - Based on 2000 Hawaii Water Quality Standards
    - Criteria for Total Copper = 2.9 ug/L (Acute and Chronic)
    - (HI Administrative Rules, Title 11, Chapter 54, section 04)
  - 1998 EPA established new dissolved numeric criteria for copper (4.8 ug/L acute and 3.1 ug/L chronic).
    - 63 FR 68357. December 10, 1998
- Dec 2001 – An interim permit limit was negotiated with DOH (23 ppb) allowing SSC to develop a 4-part study in order to address site-specific water quality objectives for copper in Pearl Harbor
- Jan 2002 – Final Permit appealed by PHNSY specifically challenging copper limits

Timeline of Technical Efforts

- Oct 2002 - Draft Work Plan presented to DOH & Prelim Sampling #1
- Mar 2003 – Prelim Sampling #2
- April 2004- Prelim Sampling #3, Dispersion study
- March 2005- First Official Sampling
- October 2005- Second Official Sampling
- January 2006- Third Official Sampling (Rain Event)
- May 2006- Fourth Official Sampling Event
- April 2007- Brief to DOH

Study Area: Pearl Harbor and Naval Shipyard



Study Elements

Calculating a new Permit Limit for Pearl Harbor Naval Shipyard and IMF based on USEPA guidance and Procedures

$\text{Permit Limit}_{TRM} = (\text{Recalc } WQC_{DM})*(WER_{DM}) * (DF) /(CT)$

TRM= Total Recoverable Metal

DM= Dissolved Metal

- Recalc WQC_{DM} = Recalculation
- WER_{DM} = Water Effect Ratio
- CT = Metal Chemical Translator
- DF = Mixing Zone Dilution Factor

•Supporting Efforts

- BMP's at PHNSY & IMF
- Ambient Concentrations in Pearl Harbor
- Effluent Characterization
- Final Permit Calculation (numerical values)

Recalculation

Recalculation

Using USEPA Recalculation Method (1994), the 1995 national saltwater toxicity data set for Copper was updated with Pearl Harbor (site-specific) toxicity data.

$$\textbf{Permit Limit}_{TRM} = (\textbf{Recalc WQC}_{DM})*(\textbf{WER}_{DM}) * (\textbf{DF}) /(\textbf{CT})$$

TRM= Total Recoverable Metal

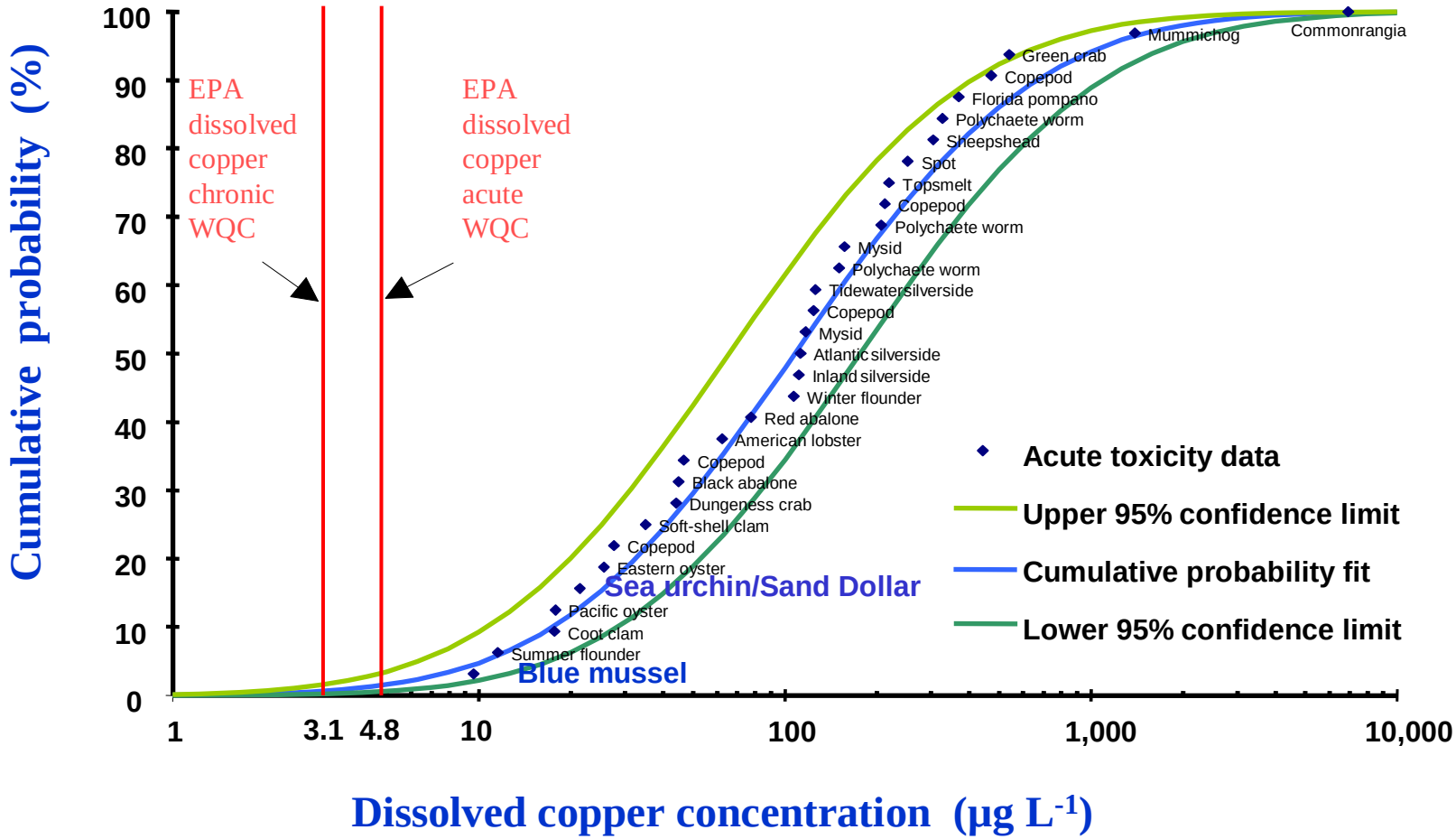
Recalc WQC_{DM} = Recalulated Dissolved Metal Criterion

WER = Water Effect Ratio

CT = Metal Chemical Translator

DF = Mixing Zone Dilution Factor

SALTWATER QUALITY CRITERIA - EPA



Pearl Harbor Recalculation

- **Applied to USEPA 1995 national saltwater toxicity dataset for Cu**
- **Pearl Harbor Legacy Database and other pertinent publications**
- **Resulted in 3 additions, 2 deletions, and 1 correction**
- **NAVFAC (2006) characterization consistent with Recalculation report**

Action	Species	Reason
Addition	Hawaiian collector urchin (*Tripneustes gratilla*)	Present, sensitive
Addition	Lace coral (*Pocillopora* damicornis)	Present, sensitive
Addition	Red tilapia (*Oreochromis mossambicus*)	Present
Deletion	Bay mussel (*Mytilus sp.*)	Not present, but oyster is present
Deletion	Summer flounder (*Paralichthys dentatus*)	Not present, irrelevant life stage
Correction	Eastern oyster (*Crassostrea virginica*)	Newer measured data available

Recalculation Data Sets

Table 1. Four most-sensitive Genera in the USEPA 1995 Addendum dataset.

Sensitivity Rank	Genera	Genus Mean Acute Value (µg/L)
4	Arbacia (Sea Urchin)	21.4
3	Mulinia (Coot Clam)	17.70
2	Paralichthys (Summer Flounder)	11.56
1	Mytilus (Blue Mussel)	9.625

Table 2. Four most sensitive Genera in the Pearl Harbor dataset.

Sensitivity Rank	Genera	Genus Mean Acute Value (µg/L)
4	Crassostrea (Oyster)	22.82
3	Arbacia (Sea Urchin)	21.4
2	Mulinia (Coot Clam)	17.70
1	Tripneustes (Collector Urchin)	14.09

Recalculation Results

- Pearl Harbor Cu criteria (after Recalculation):
  - Acute (CMC): 7.82 µg/L
  - Chronic (CCC): 5.00 µg/L

- National Cu criteria:
  - Acute (CMC): 4.8 µg/L
  - Chronic (CCC): 3.1 µg/L

Expressed as dissolved Cu

Water Effect Ratio

Water Effect Ratio

Applying USEPA guidance (1994) to perform aquatic toxicity tests that account for differences in bioavailability between ambient (site) water and laboratory water

$$\textbf{Permit Limit}_{\textbf{TRM}} = (\textbf{Recalc WQC}_{\textbf{DM}})*(\textbf{WER}_{\textbf{DM}}) * (\textbf{DF}) /(\textbf{CT})$$

TRM= Total Recoverable Metal

Recalc WQC_{DM} = Recalulated Dissolved Metal Criterion

WER = Water Effect Ratio

CT = Metal Chemical Translator

DF = Mixing Zone Dilution Factor

Water Effect Ratio Procedure

Accounts for differences in bioavailability between ambient (site) water and laboratory water

Site Water

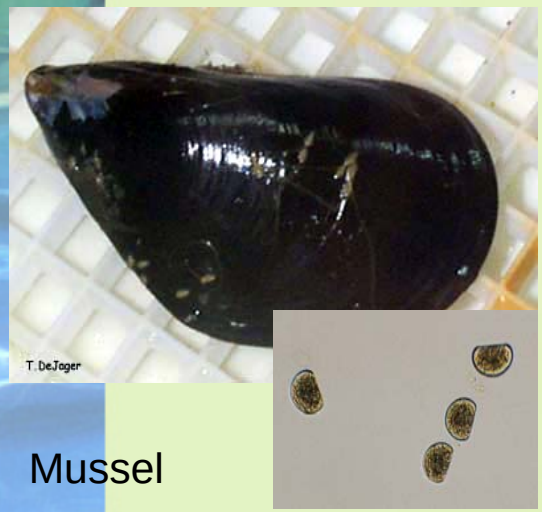
Lab Water

$$WER = \frac{\text{EC50 in Site Water}}{\text{EC50 in Lab Water}}$$

Site-Specific WQC = National WQC X WER

WER Test Species

- Primary Species: Bay Mussel
- Secondary Species: Purple Sea urchin, Pacific Oyster
- Test Endpoint: Embryo-larval development
- Relevance: Endpoint is near criterion to be adjusted



Mussel

(Mytilus galloprovincialis)

Purple sea urchin

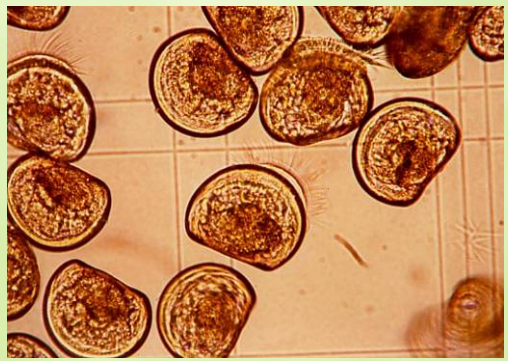
(Strongylocentrotus purpuratus)

Pacific oyster

(Crassostrea gigas)

Why Mussels?

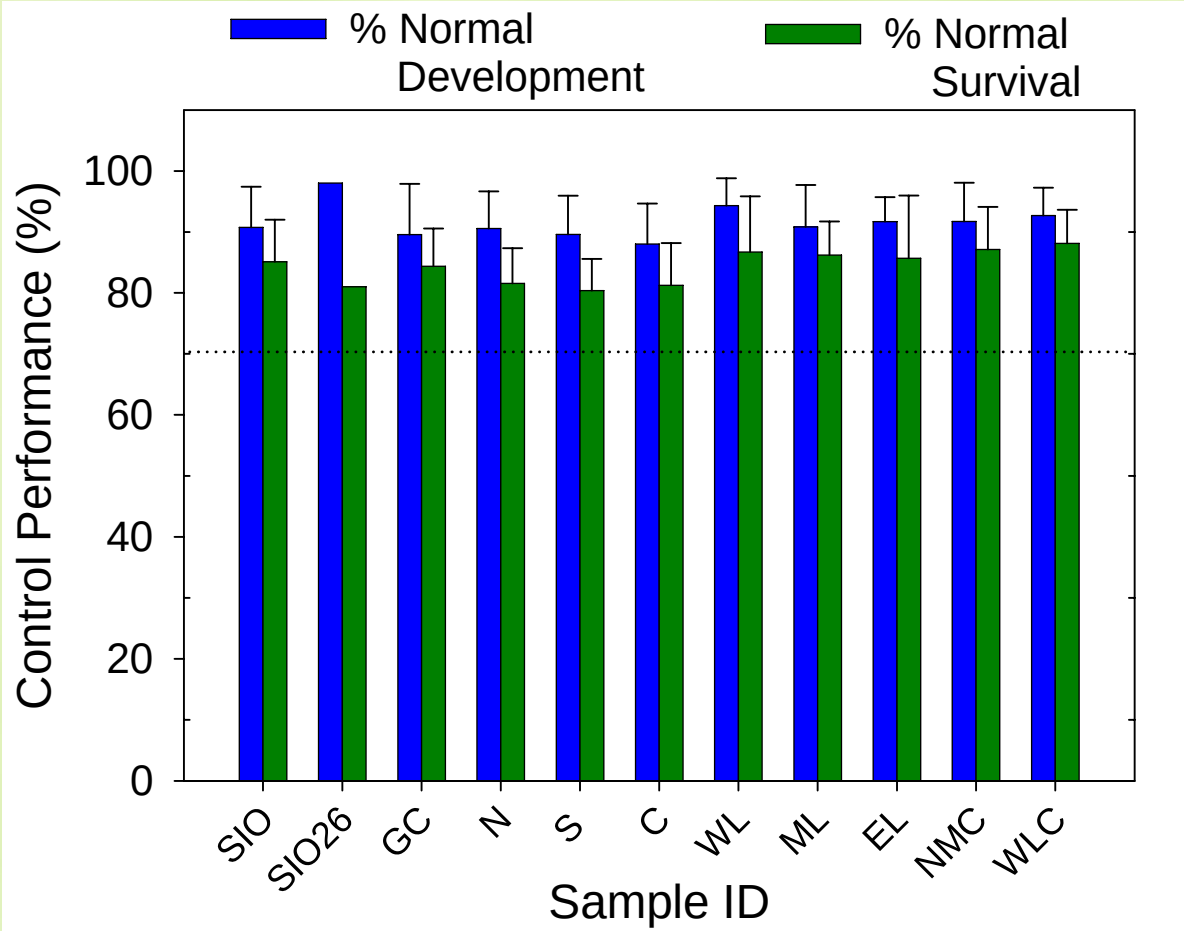
- Bay mussel (*Mytilus sp.*) larvae are highly sensitive to copper (48 h EC50 ~7 µg/L)
- Larval development endpoint for *Mytilus sp.* is driver of USEPA's current chronic water quality criterion (3.1 µg/L) in saltwater



Larvae at 48 h (120 µm)

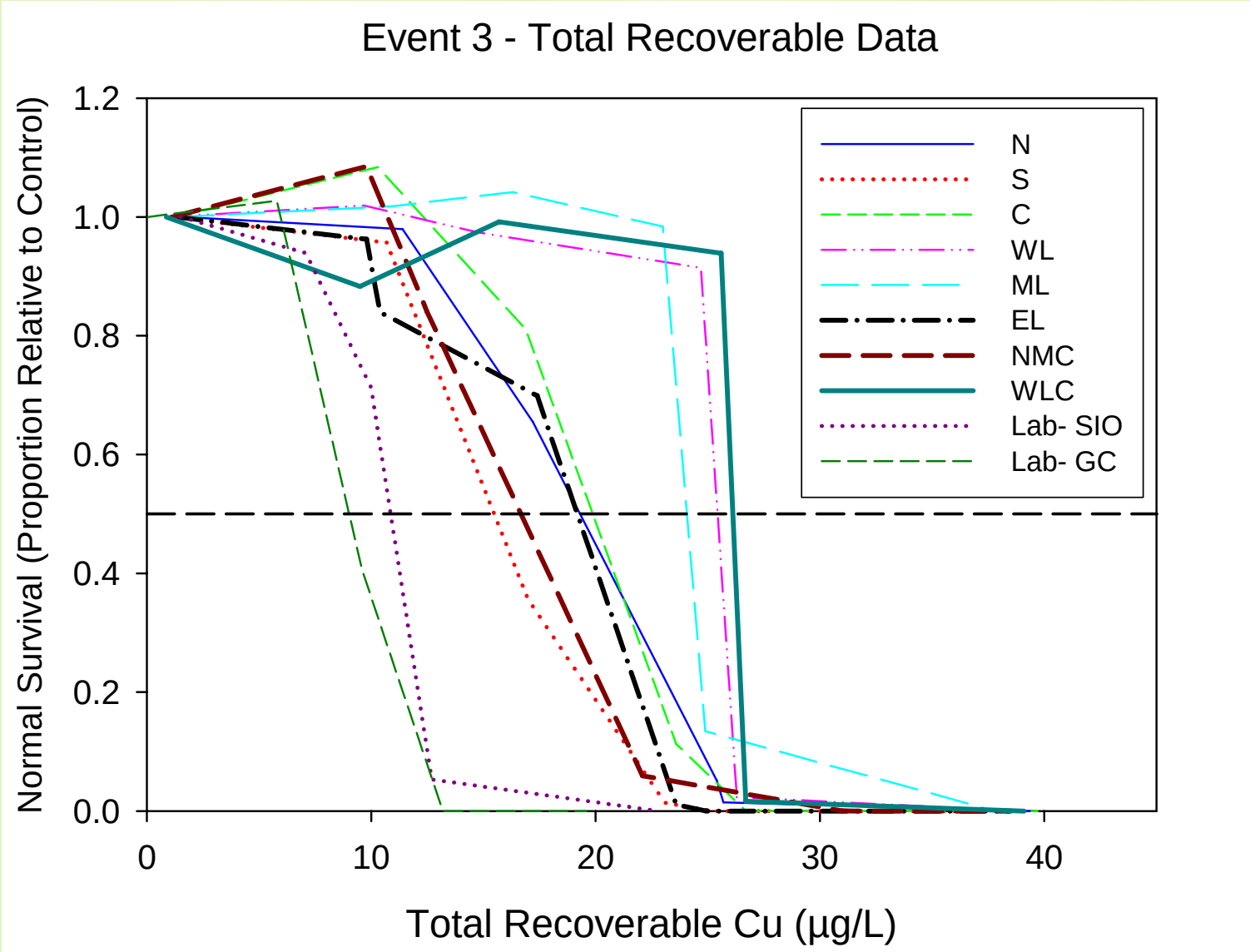
No Ambient Toxicity

- Unspiked site water always exceeded minimum control test acceptability
- Site water controls never statistically lower than Lab water controls for all species



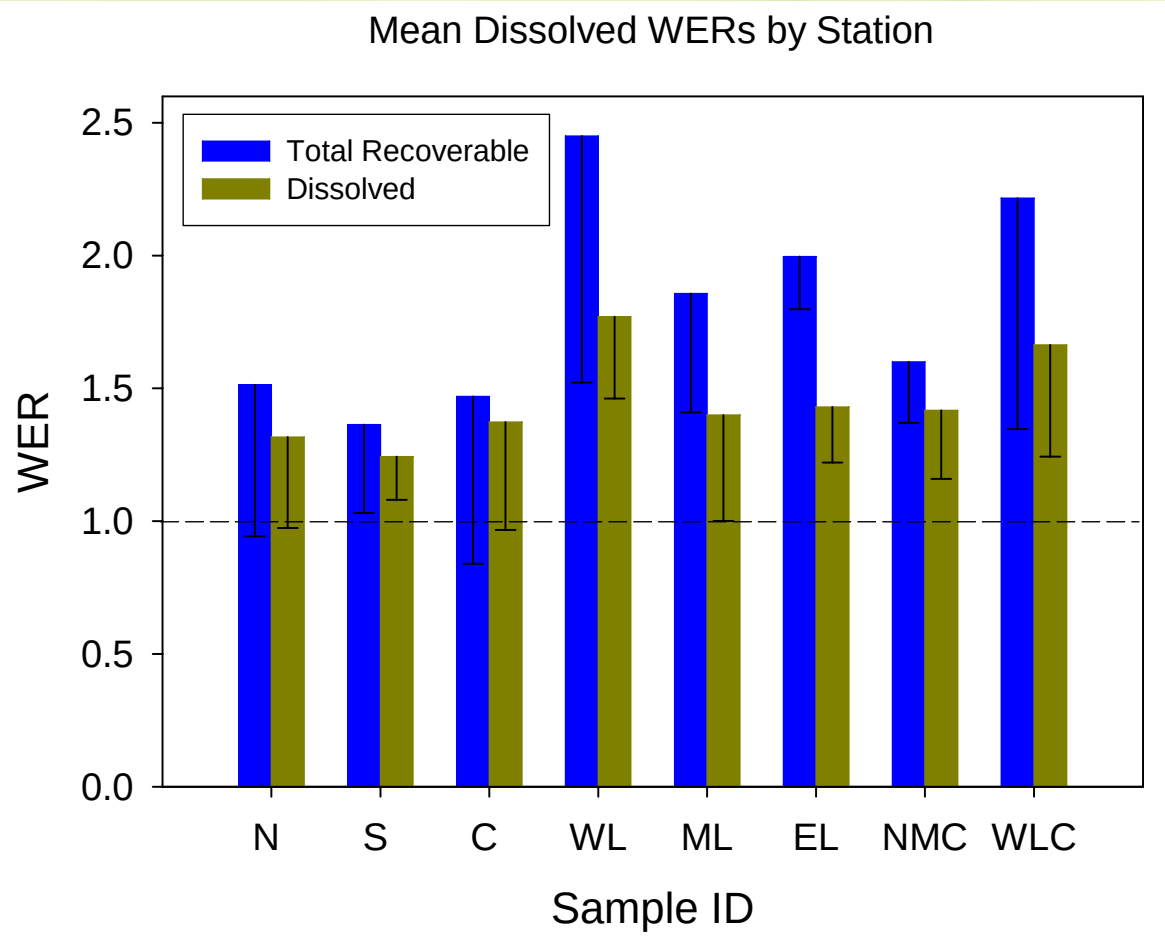
Mussel data shown

Copper Additions (Example)



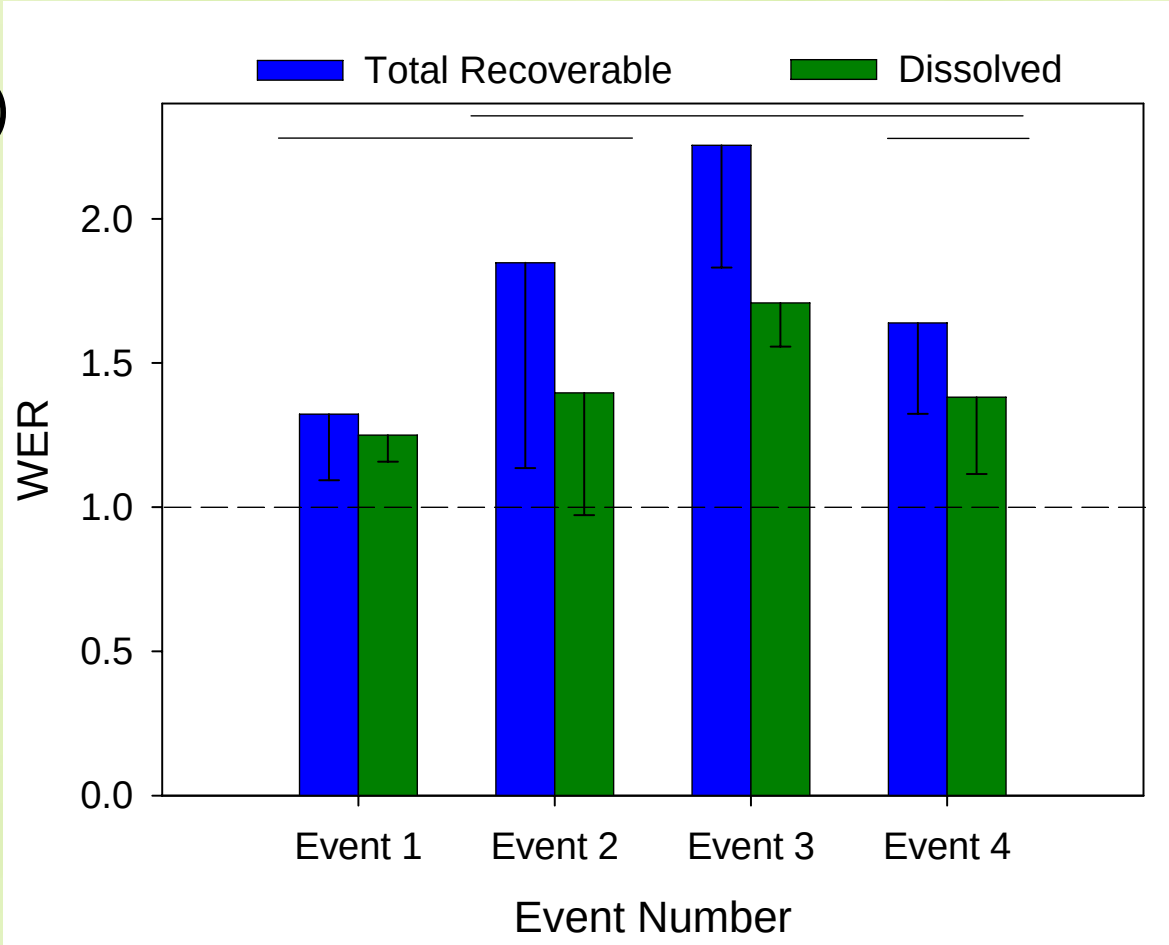
WER Spatial Variability

- WL and WLC were higher, on average, than other stations
- No statistical differences among locations
- All samples resulted in individual WERs within factor of 3 (USEPA 1994)



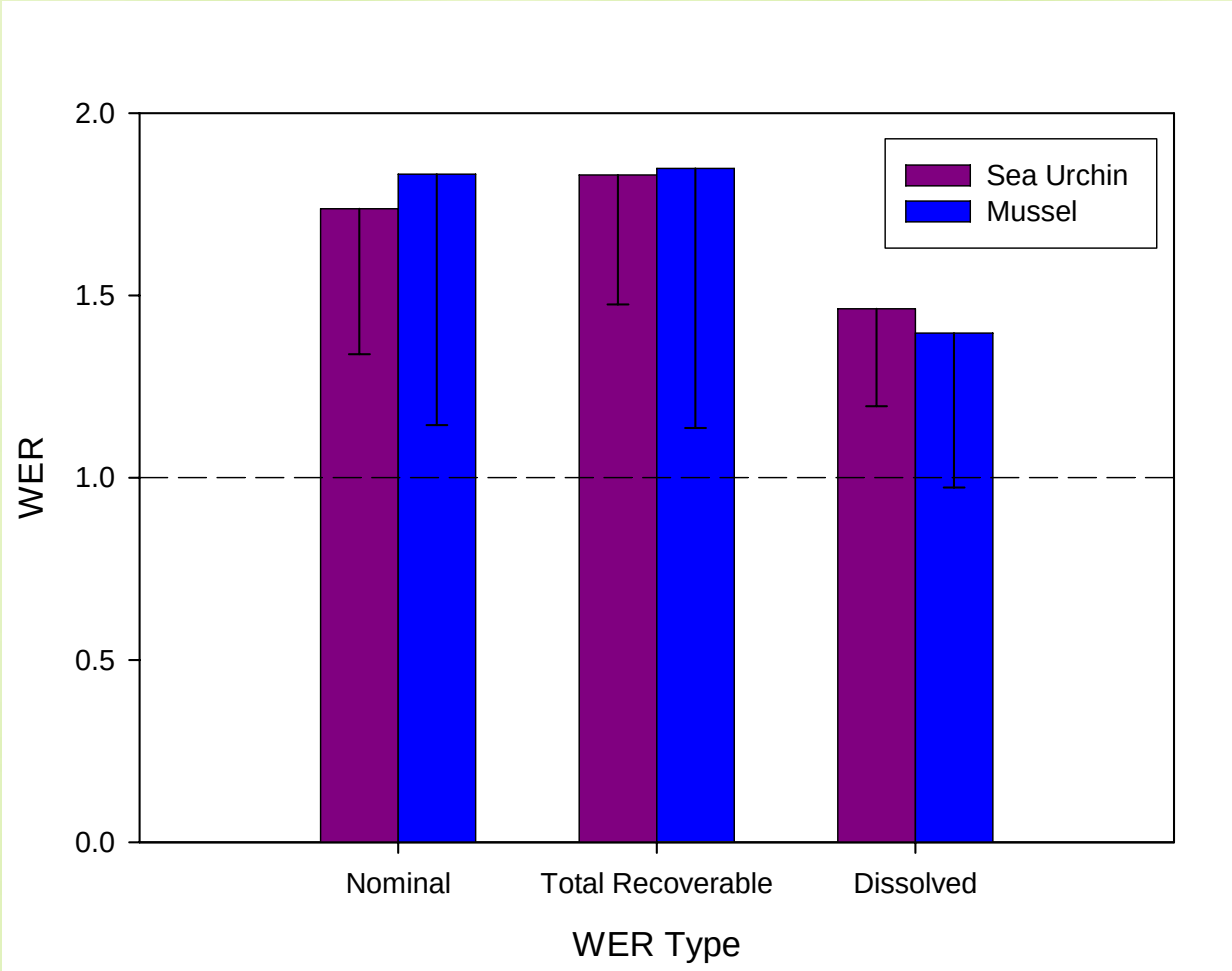
WER Temporal Variability

- Event 3 (Rain event) WERs slightly higher, but only statistically different from Event 1
- All events resulted in individual WERs within factor of 3 (USEPA 1994)



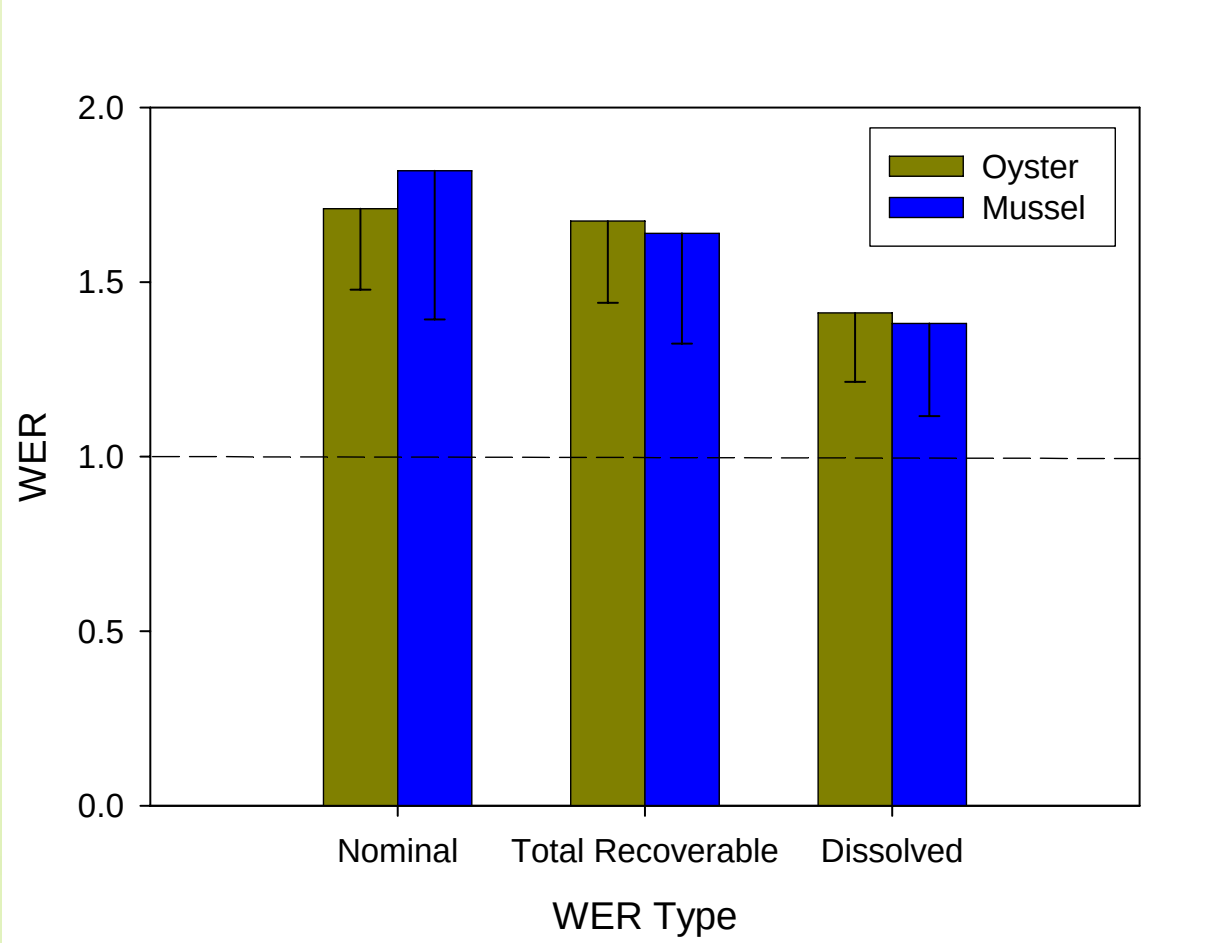
Secondary Species Event #2

- Mussel and Sea Urchin conducted concurrently
- No statistical differences
- Means differed 2-7% depending on WER type



Secondary Species Event #4

- Mussel and Oyster conducted concurrently
- No statistical differences
- Means differed 2-6% depending on WER type

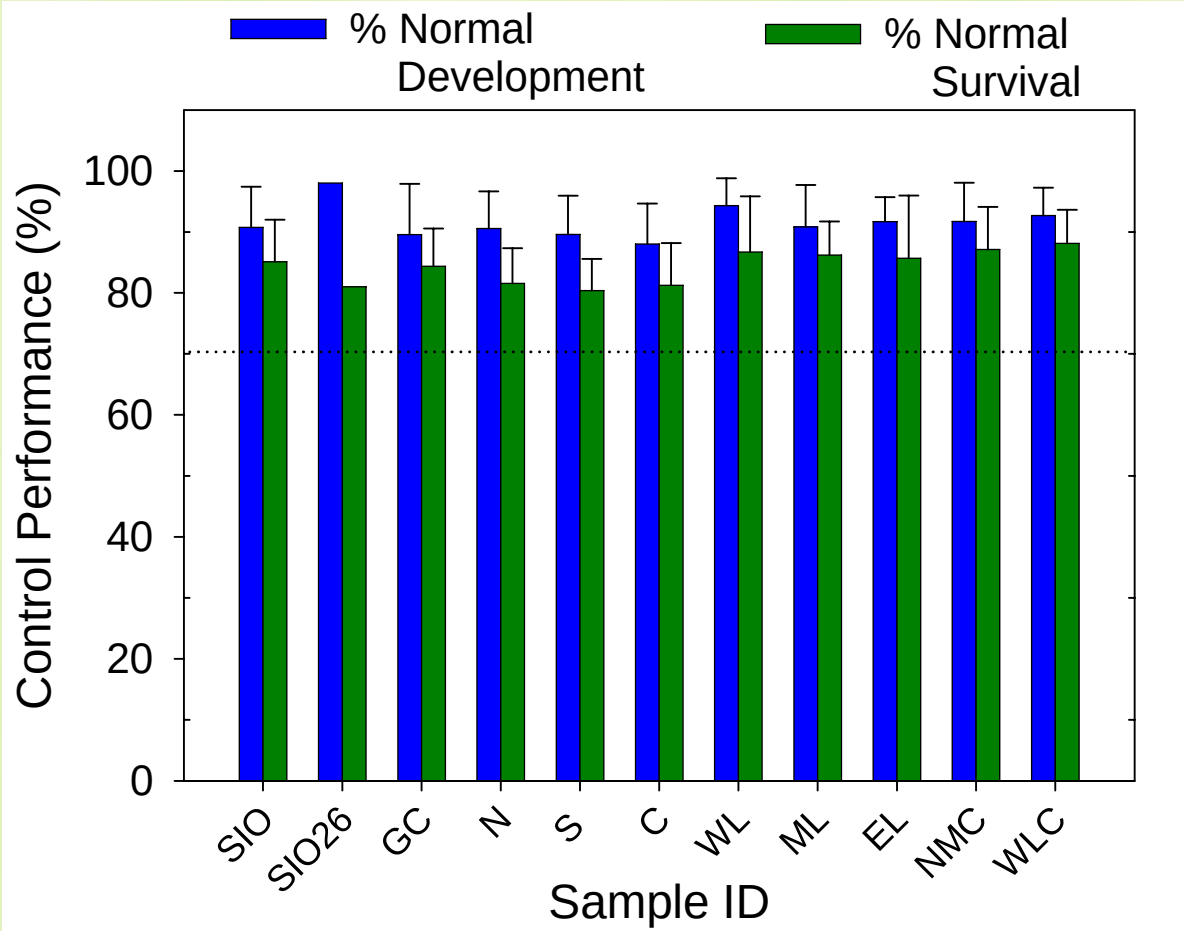


Ambient Concentrations

- Pearl Harbor does not appear to be impaired, based on 7 rounds of sampling from (3 preliminary sampling events)
  - Ambient Copper levels at 1 ppb and below.

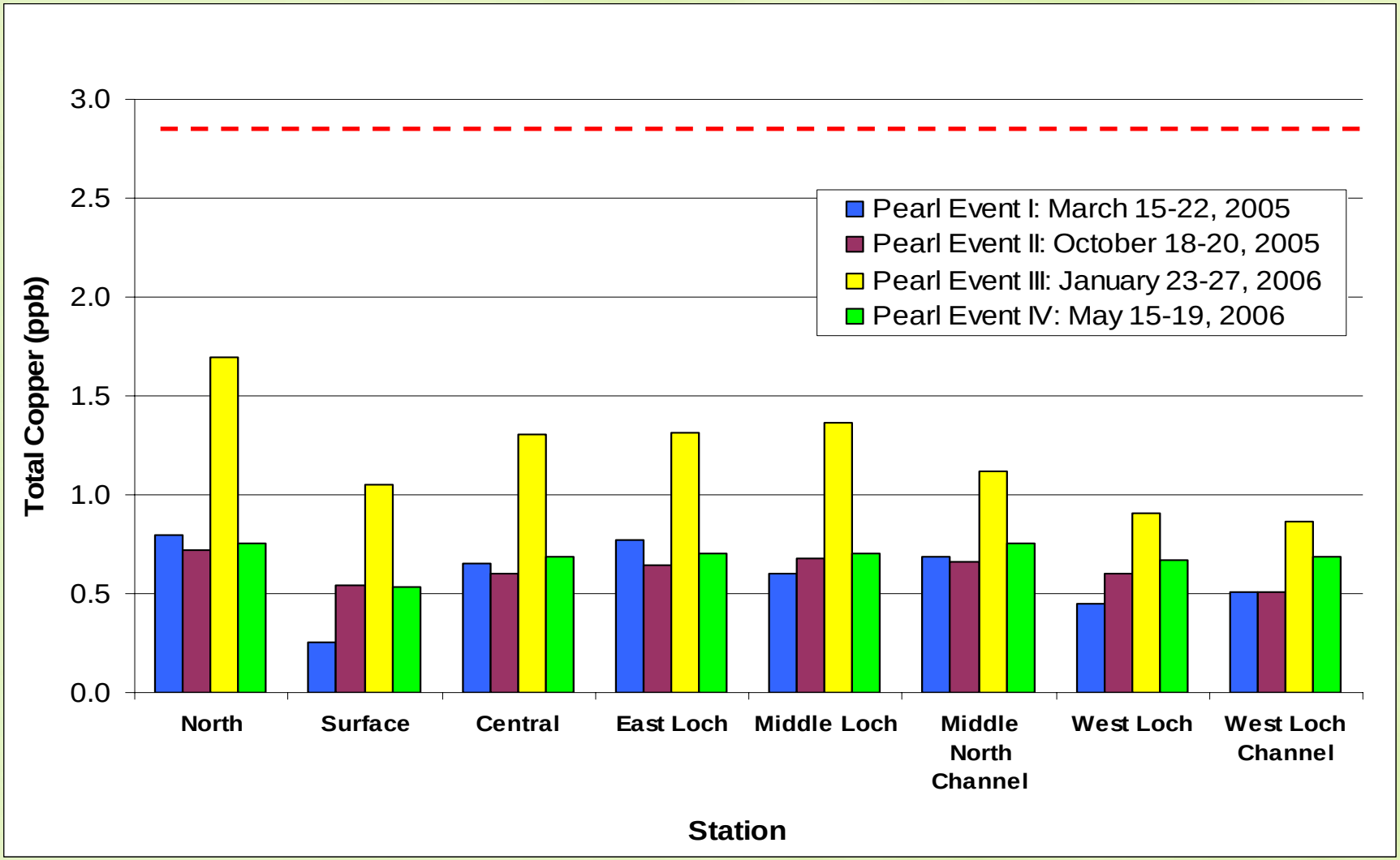
No Ambient Toxicity

- Unspiked site water always exceeded minimum control test acceptability
- Site water controls never statistically lower than Lab water controls for all species

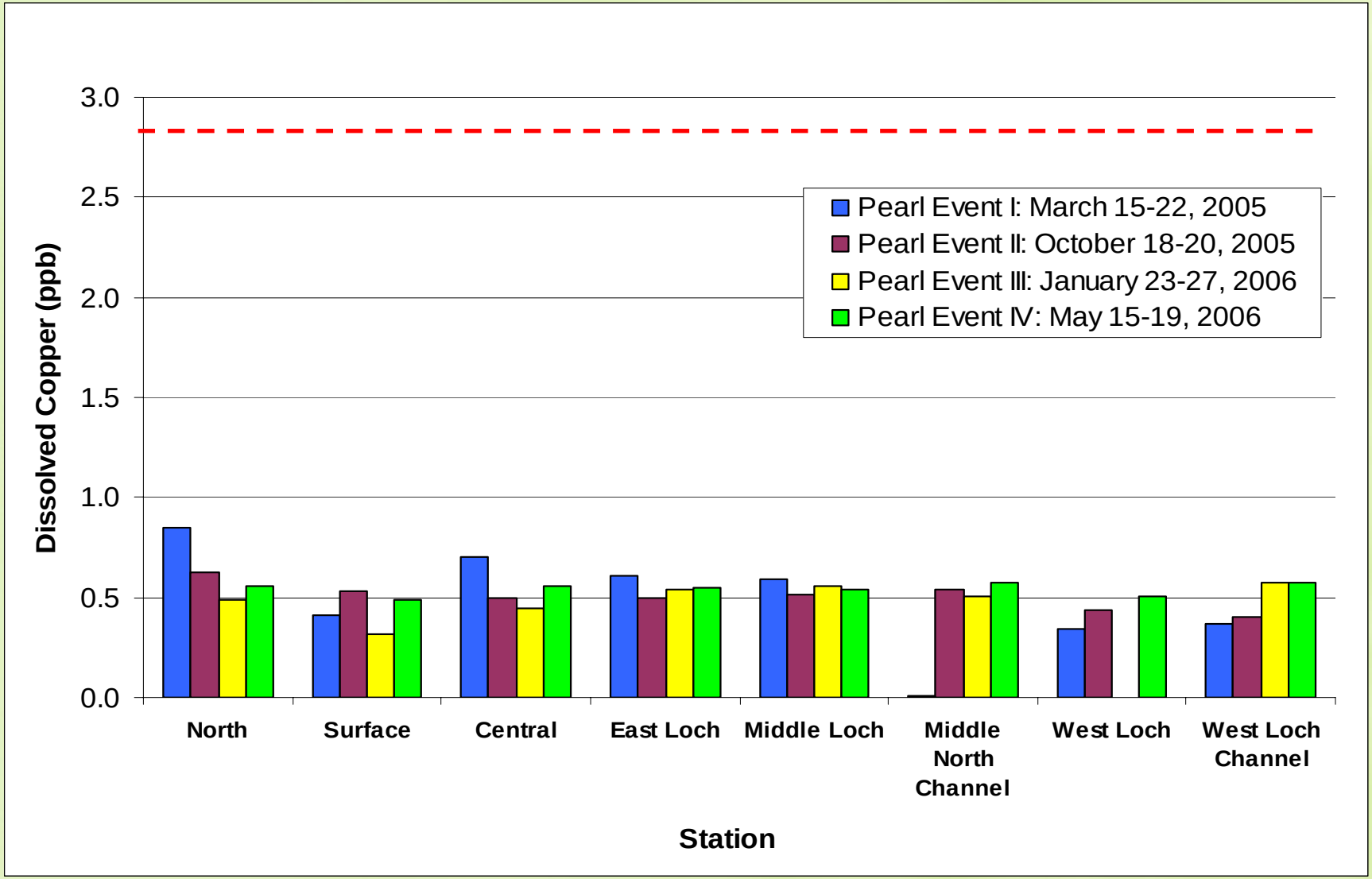


Mussel data shown

Ambient Concentration (Total)



Ambient Concentration (Dissolved)

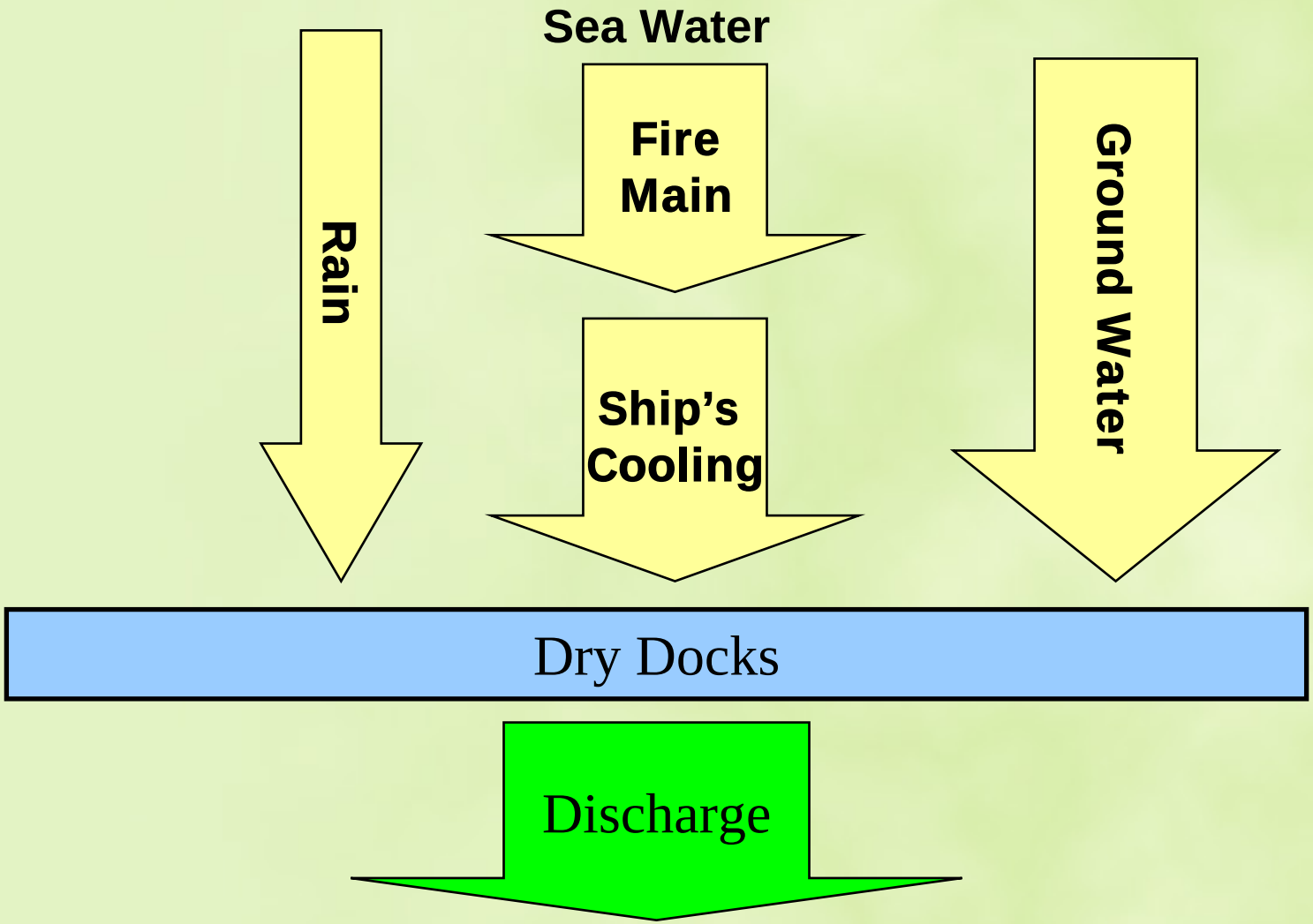


Effluent Characterization

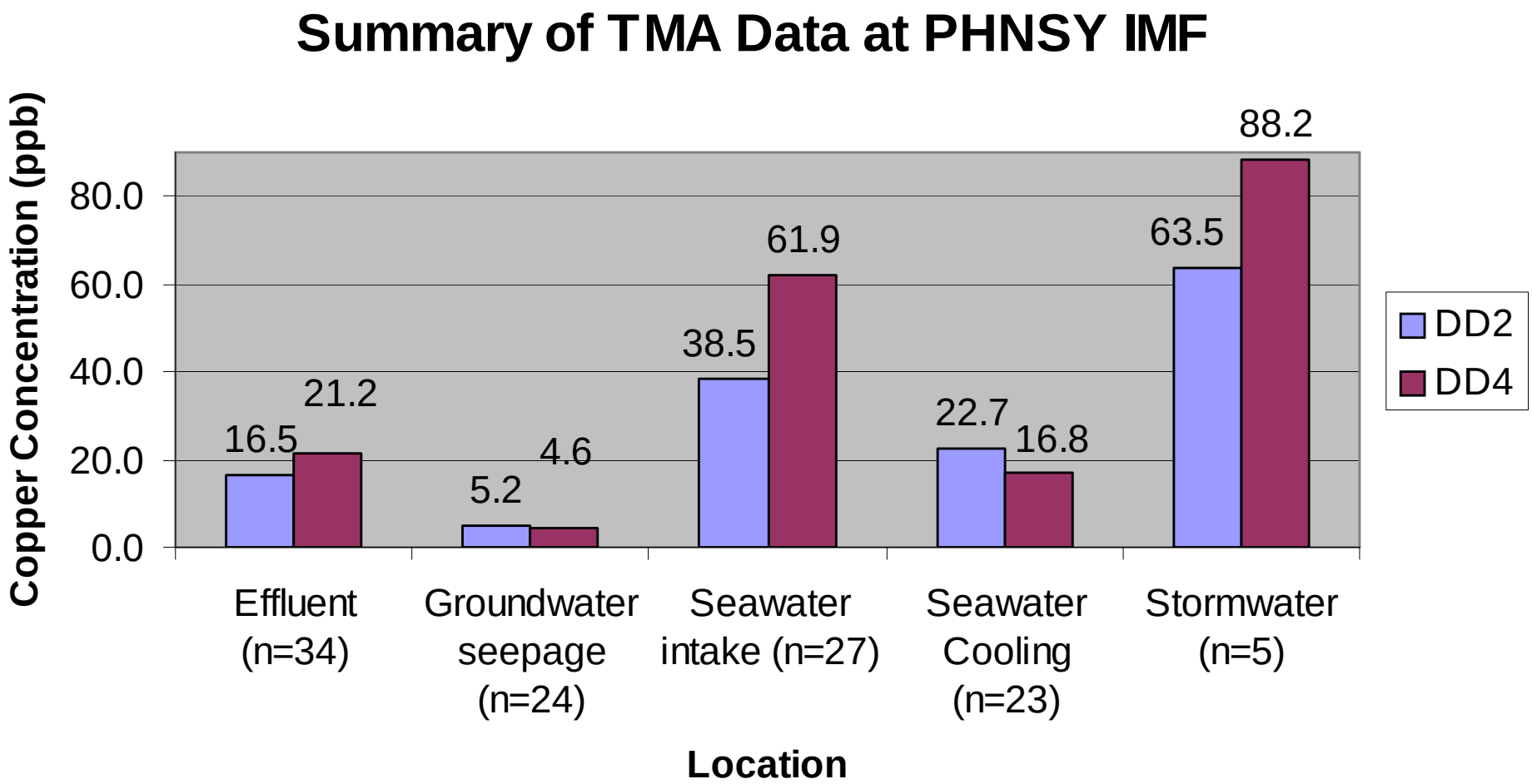
Historical Challenges for Controlling Copper Discharges

- Experiences from other Naval and Civilian Shipyards throughout the United States:
  - Most of the water leaving the dock is clean.
  - Intermittent flows/ varying concentrations.
  - Exceedances of Cu often associated with rainfall.
  - Copper released as mostly very small particles.
  - Relatively low concentrations of copper in high volume rain events.
  - Limited options for treatment due to variability of flows and concentrations

Summary of Effluent Characterization

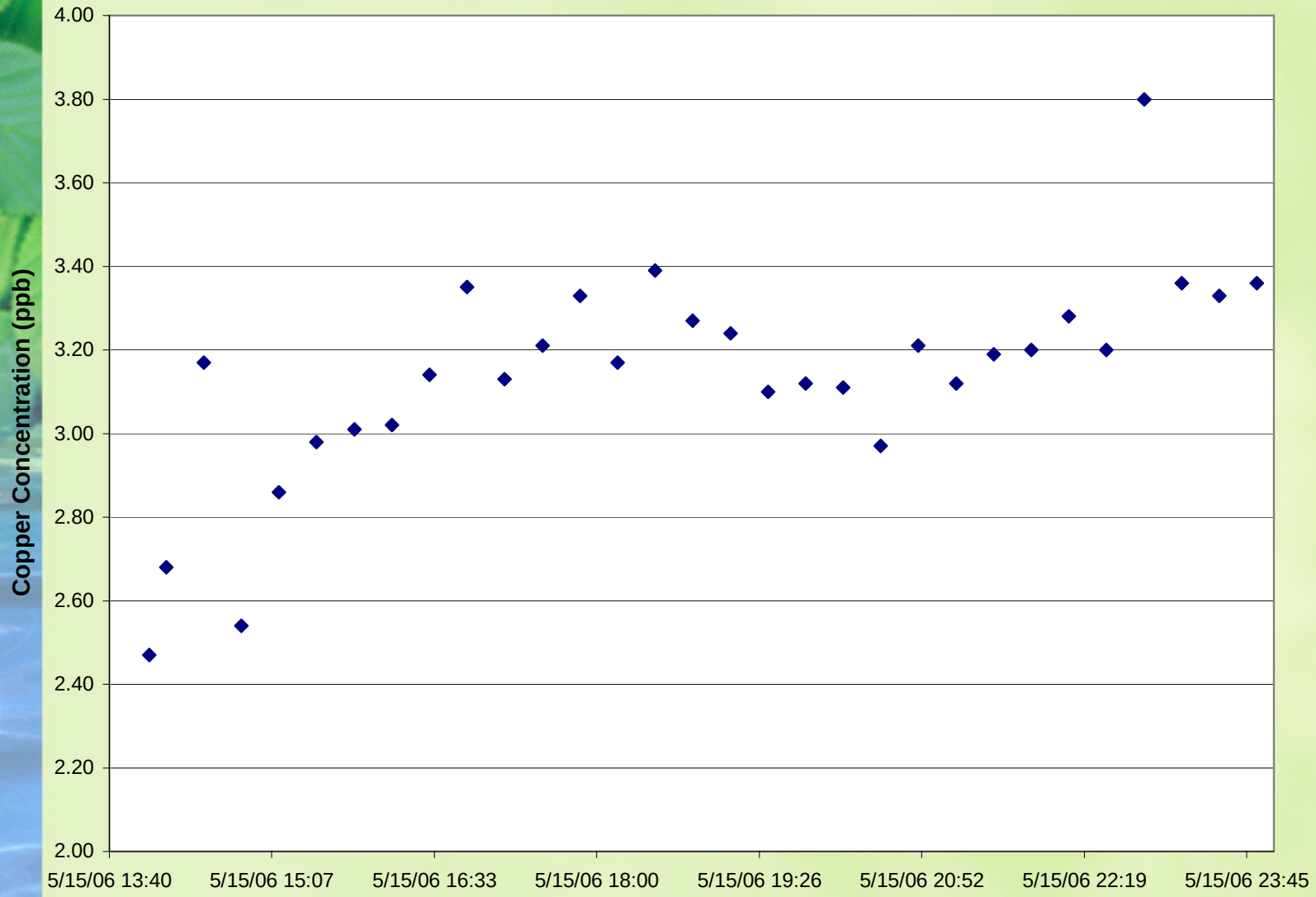


Discharge Component Copper Concentrations



PWC Seawater Intake Channel

Samples taken from 14:00-2400 on 5/15/2006



Final Permit Limit for copper

Permit Limit$_{TRM}$ = (Recalc WQC$_{DM}$)*(WER$_{DM}$) * (DF) /(CT)

50.02 µg/L = 7.82 µg/L * 1.42 * 2.8 / 0.62

Where: Recalc WQC$_{DM}$ = Recalculated Dissolved Metal Criterion, WER = Water Effect Ratio, CT = Metal Chemical Translator, DF = Mixing Zone Dilution Factor

Full Report:

http://www.spawar.navy.mil/sti/publications/pubs/tr/1952/tr1952cond.pdf

SPAWAR Environmental Sciences Website:

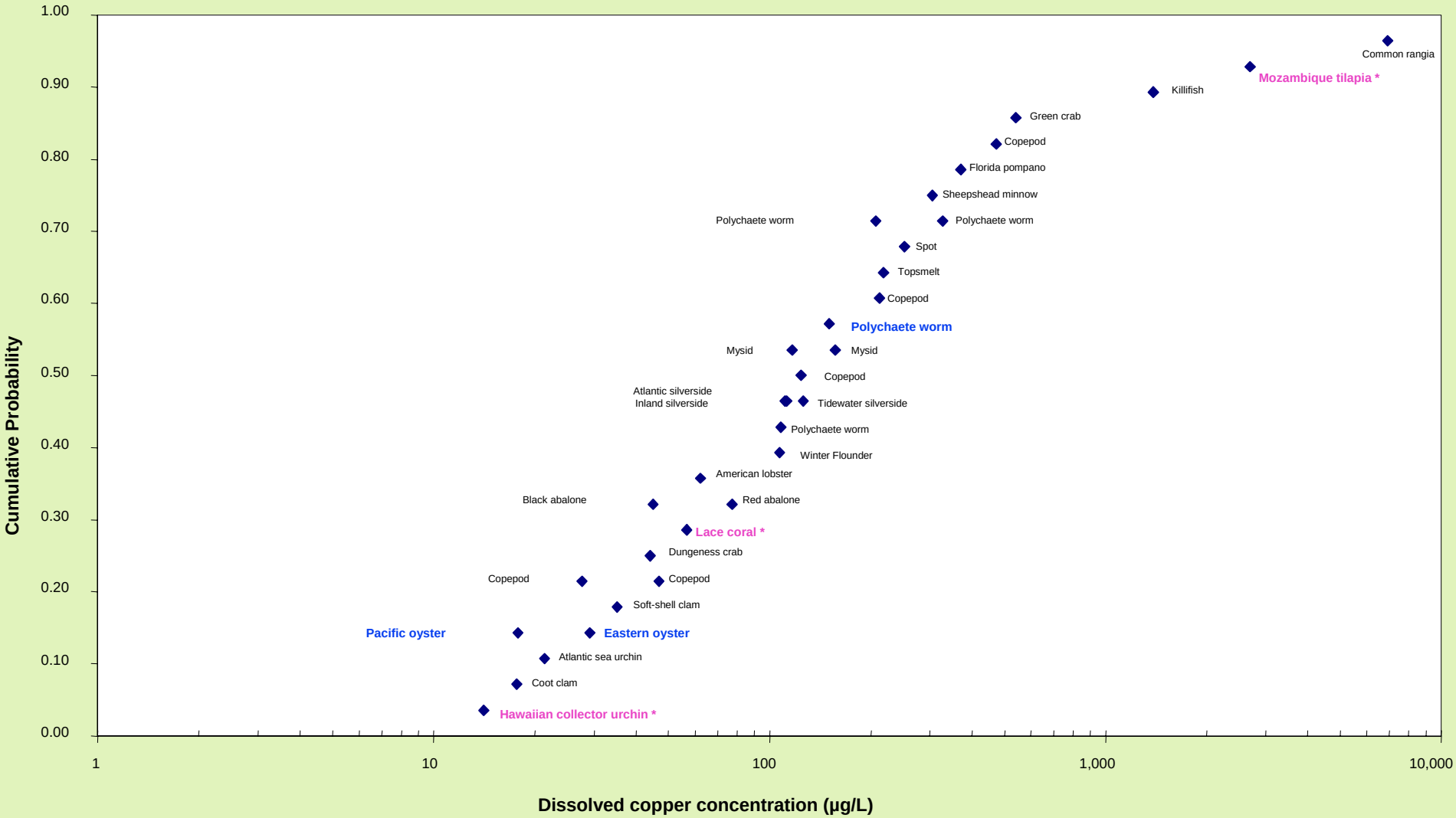
http://environ.spawar.navy.mil/

Backup Slides

Options for Compliance

- Adoption of Site Specific Criteria and associated permit limits presented in the Study
  - Requires possible DOH rulemaking efforts
  - Shipyard to conduct mixing zone/ dye study
- Submersion of Shipyard outfalls
  - Multiple year MILCON project
  - Requires interim limits until project is complete
- BMP Based Permit
  - Requires more efforts at the Shipyard to comply with requirements and constant vigilance to evaluate and update BMP's
  - Shipyard will still report analytical results to help establish record of success.

Site-Specific Dataset



Lead and Zinc Recalculations

- Lead (Pb)
  - Current Permit Limit: 140 µg total Pb/L
  - Site-specific Permit Limit: 288 µg total Pb/L
  - Increase largely attributed to:
    - Error in 1984 data set
      - Mummichog GMAV is 315 mg/L, not 315 µg/L
    - Accessibility to more current, updated draft dataset (1998)
    - Several site-specific additions and deletions
- Zinc (Zn)
  - Major update to 1987 document required, outside scope of this study