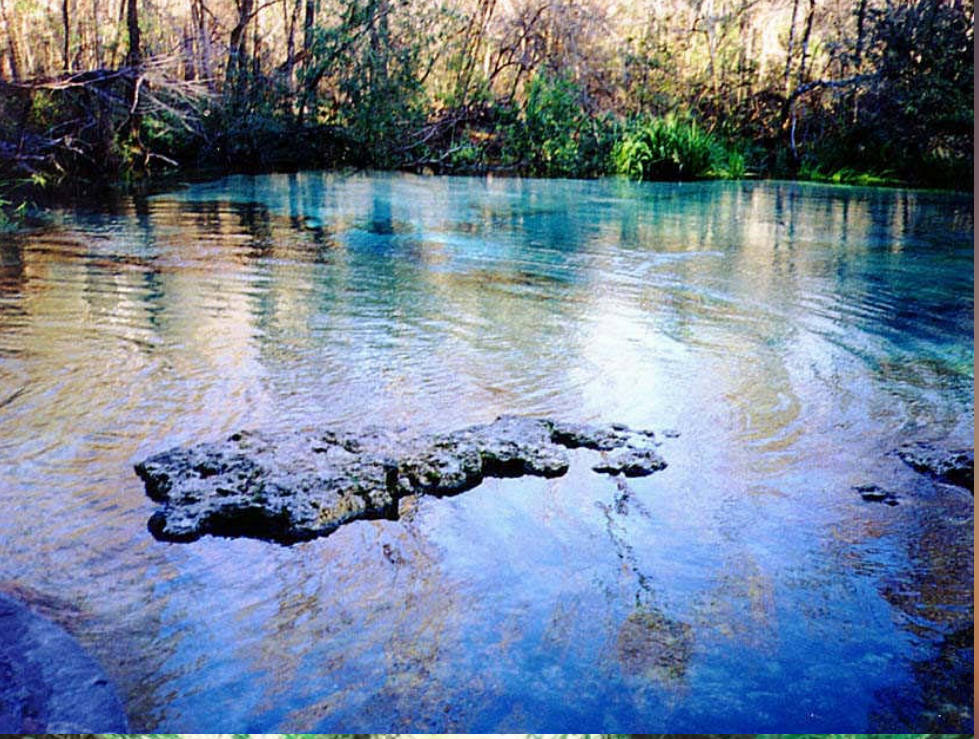

Development of Interpretive Tools for Assessment of contaminants in Coastal & Freshwater Sediments

Gail Sloane
Thomas Seal, Tom Biernacki
Florida Department of Environmental Protection

Alexandra Carvalho, Ph.D.
Steven J. Schropp, Ph.D.
Taylor Engineering, Inc.

Donald MacDonald, *MESL*
Chris Ingersoll, Ph.D, *USGS*

Sediment Quality Assessment Tools

- Metals Geochemical Normalization Tool
- Florida Marine and Freshwater SQAGs
  - Consensus Guidelines and discussion of other metrics to evaluate ecosystem health, including ecological and human health endpoints.
- Guidance Manual (Framework)
  - 3 volume document, Collaboration

    Great Lakes, British Columbia and Florida

The Weight of Evidence Approach

Multiple Lines of Evidence to Support Decision Making

No Single Line of Evidence Should Drive Decision Making

- Some lines of evidence weighted more heavily than others
- Increasingly complex evaluations only when needed
- Weight of Evidence Collected should be proportional to the weight of the decision being made.
- Multiple lines or evidence are necessary since there is no clear consensus on how incorporate uncertainties or relate measurement endpoints

Sediment Metals Interpretive Tool Development

- Reference Element Approach
  - Normalize metal to reference element
- Requirements
  - Reference element(s) unaffected by human activities
  - “Clean” Sediment Database
  - Data from range of sediment grain size (fine to coarse grain sizes) and sediment types.

Sediment Metals

- Ubiquitous natural sediment constituent
  - Variable concentrations
- Common sediment contaminants
  - As, Cd, Cr, Cu, Pb, Ni, Zn, Hg, Ag
  - Difficult to distinguish anthropogenic variability from natural variability

Contaminated Sediment?

	Metal Concentrations (mg/kg)							
Site	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
A	0.95	1.05	32.4	8.50	11.90	0.015	0.60	18.0
B	4.37	0.33	101	24.40	42.53	0.046	17.85	42.7
C	0.34	0.52	28.0	1.04	2.37	0.115	11.57	14.2
D	0.77	2.00	92.4	7.97	17.31	0.114	23.34	24.2
E	3.65	0.22	10.4	22.60	3.62	0.111	7.14	13.5
F	10.33	1.06	67.0	5.78	12.06	0.081	9.13	25.9
G	4.32	0.03	2.2	0.33	1.19	0.002	0.46	21.0

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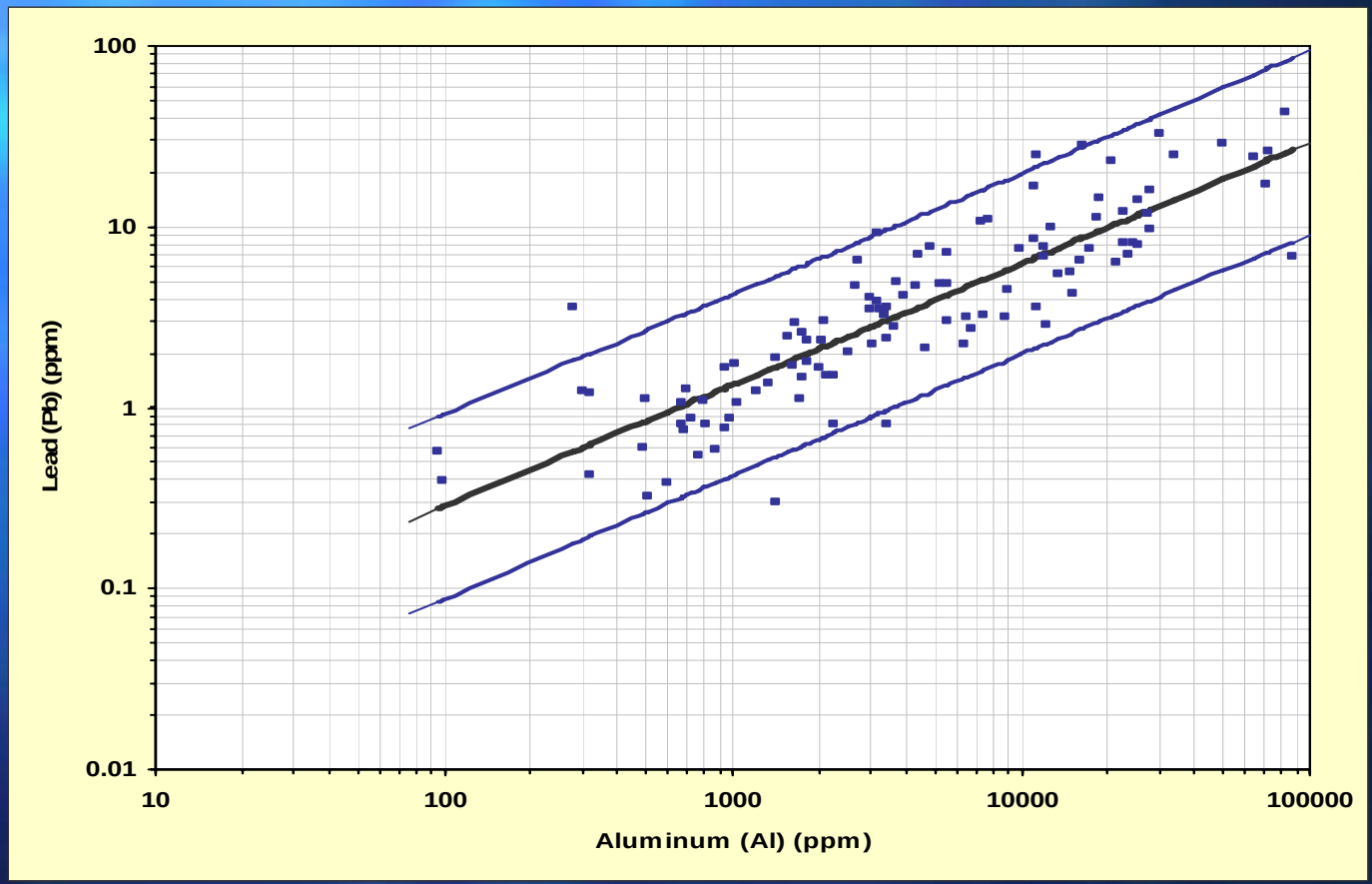
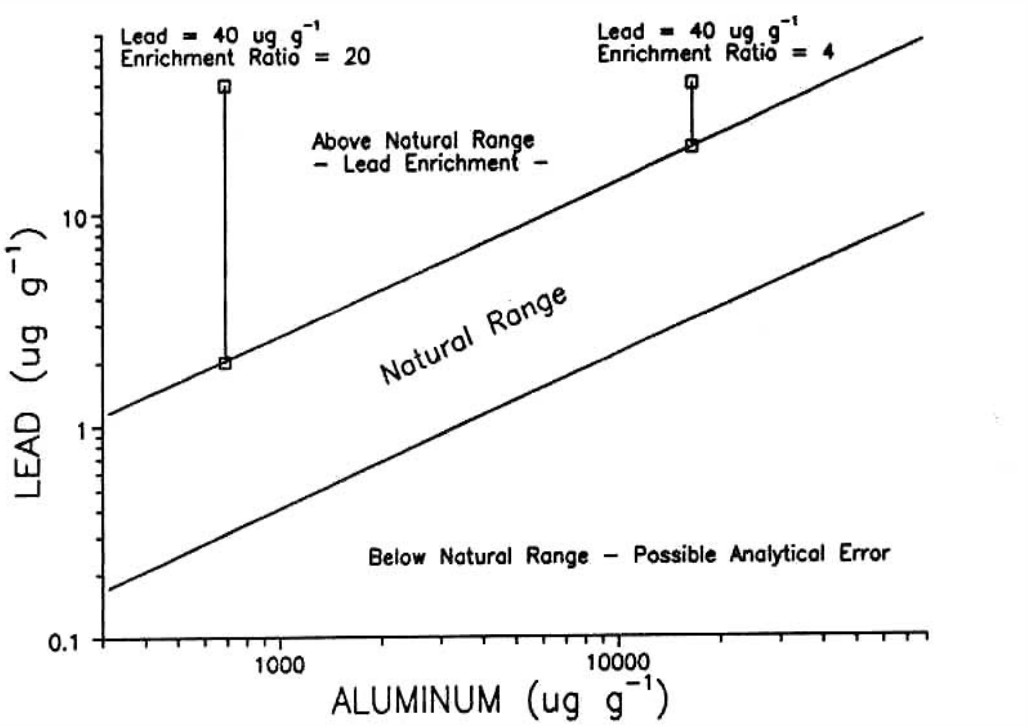
Lead/Aluminum Regression w/ 95% Prediction Limits



Metal/Reference Element Normalization Approach



Interpretation of Lead data using lead/aluminum relationship.

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Limitations of the Metals/Reference Element Tool

- Use total digestion technique in preparing samples for analysis, total recoverable techniques produce useful information
- Tool is valid for range of Al & Fe concentrations in the freshwater reference data set, and for aluminum in the coastal sediment reference data set
- Some samples from “clean” sites will exceed upper or lower 95% prediction limits
- Freshwater reference data set is from peninsular and north Florida

Sediment Quality Assessment Guidelines

- **Threshold Effects Level (TEL)**

  Marine waters

- **Threshold Effects Concentration (TEC)**

  Freshwater

Concentrations below which effects rarely occur

Concentrations above which effects may begin

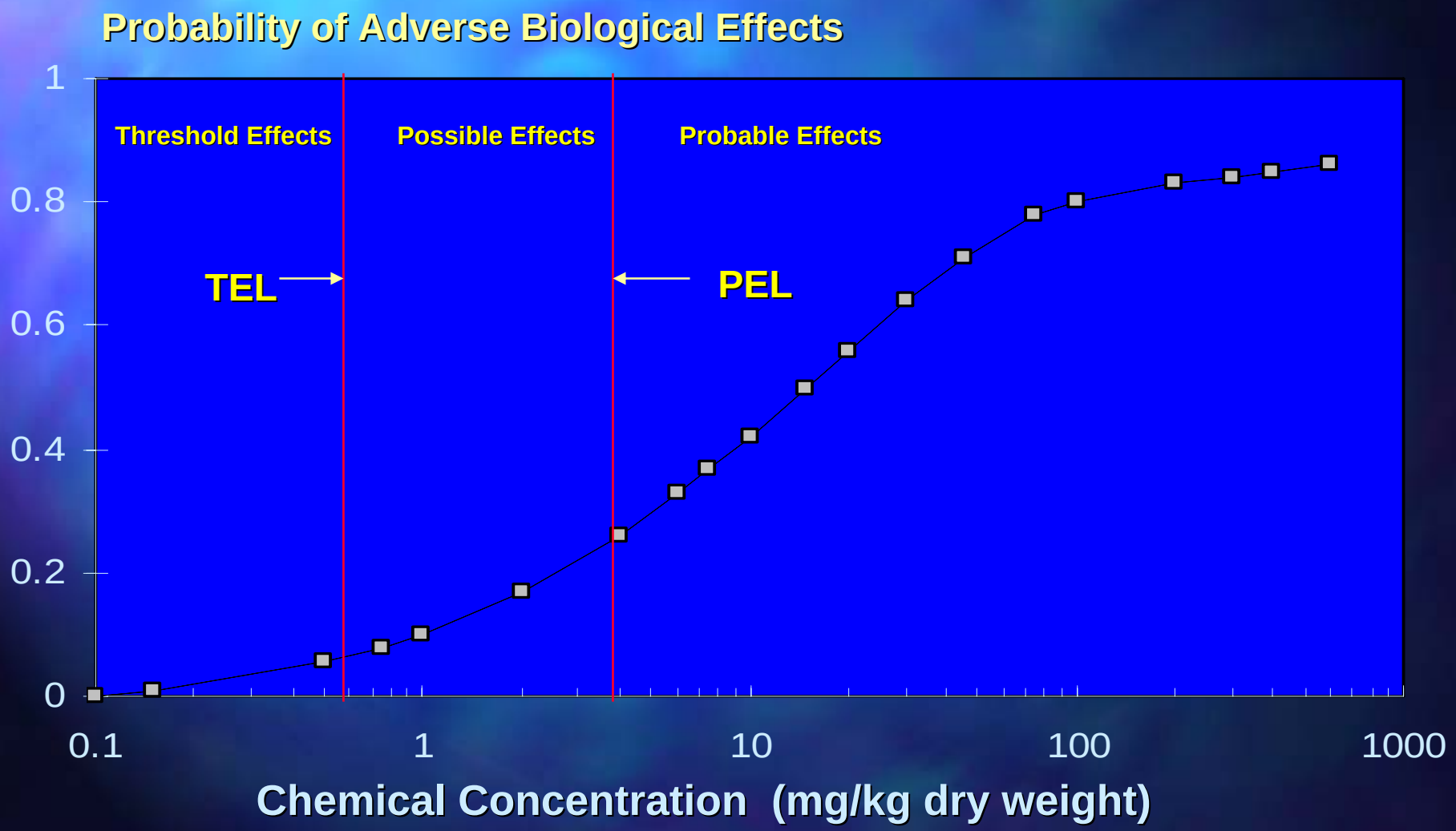
Sediment Quality Assessment Guidelines

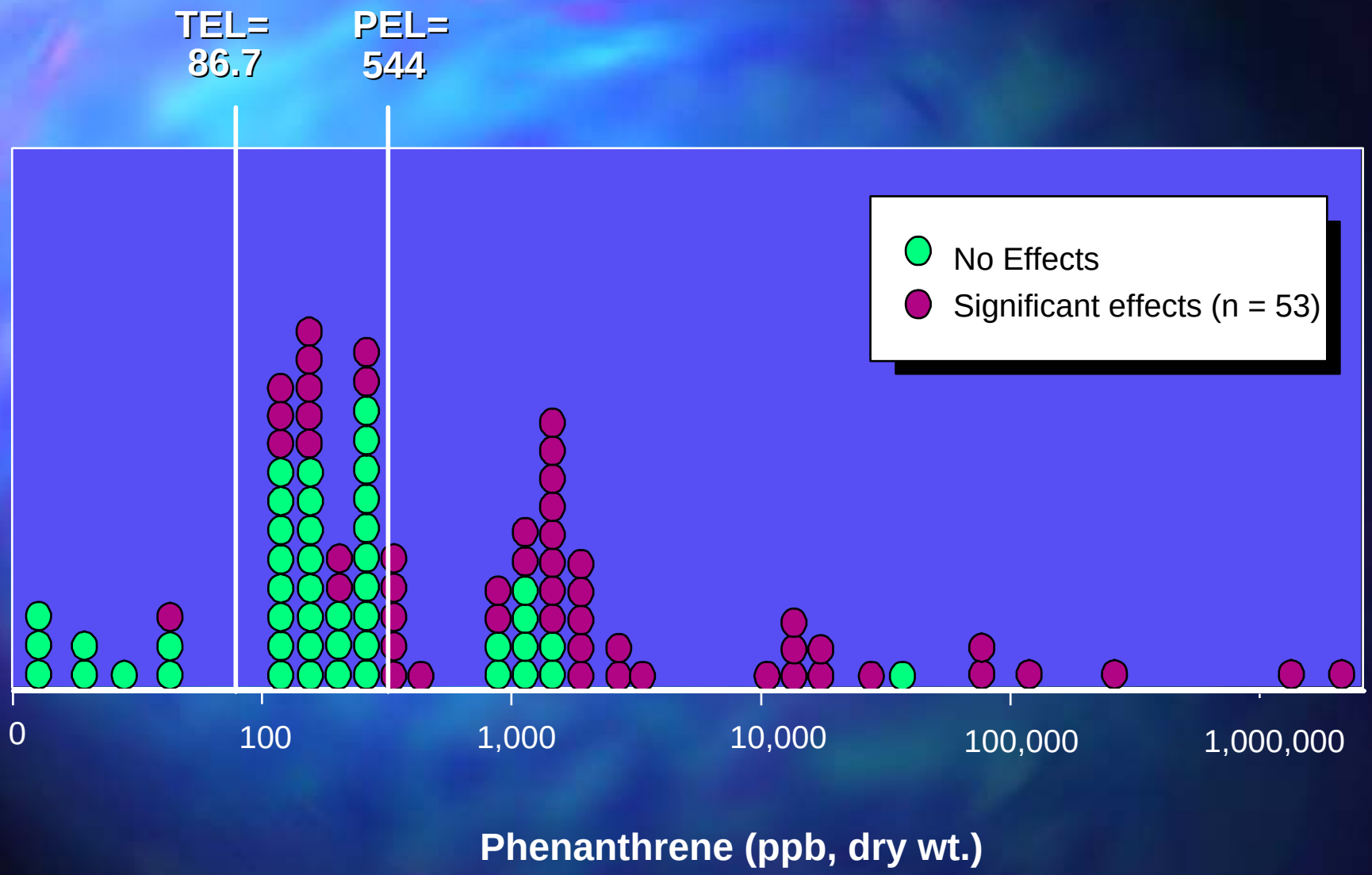
- **Probable Effects Level (PEL)**
  Marine waters

- **Probable Effect Concentration (PEC)**
  Freshwater

concentrations above which effects occur frequently

Conceptual Coastal Sediment Quality Guideline for Cadmium




TEL=
86.7
PEL=
544
No Effects
Significant effects (n = 53)
0
100
1,000
10,000
100,000
1,000,000
Phenanthrene (ppb, dry wt.)

Sediment Quality Guidelines Were Determined for 34 Priority Substances in Florida Coastal Waters, Including:

- 9 trace metals
- 13 individual PAHs
- 3 groups of PAHs
- Total PCBs
- 7 pesticides
- 1 phthalate ester

- **Metals**
  Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Silver, and Zinc

- **Polycyclic Aromatic Hydrocarbons (PAHs)**
  13 individual PAHs
  Sum LMW-PAHs, Sum HMW-PAHs, Total PAHs

- **Polychlorinated Biphenyls (PCBs)**
  Total PCBs

- **Pesticides**
  Chlordane, Dieldrin, Lindane, p,p'-DDD p,p'-DDE, p,p'-DDT, Total DDT

- **Phthalates**
  Bis(2-ethylhexyl) pthalate

Freshwater Sediment Guidelines

- **Adopt the consensus-based sediment effect concentrations (i.e., threshold effect concentrations and probable effect concentrations) as SQAGs for 28 COPCs.**

Freshwater Sediment Guidelines

Adopt effects-based sediment quality guidelines from other jurisdictions (i.e., the ones that are most consistent with the narrative intent of the SQAGs) as interim SQAGs for other COPCs.

Freshwater Sediment Guidelines

The following strategy for establishing bioaccumulation-based SQAGs was recommended:

- **Adopt the NYSDEC (1999) sediment quality guidelines as interim SQAGs for the protection of aquatic-dependent wildlife;**
- **Adopt the lower of the NYSDEC (1999) or WDOH (1995; 1996) sediment quality guidelines as interim SQAGs for the protection of human health; and,**

Freshwater Sediment Guidelines

- Use tissue residue guidelines for the protection of aquatic-dependent wildlife (Newell *et al.* 1987) and human health (i.e., FDA Action Levels; USEPA 1989) to confirm that contaminated sediments pose a hazard to mammals, birds, and/or human health.

Uses of Sediment Assessment Tools

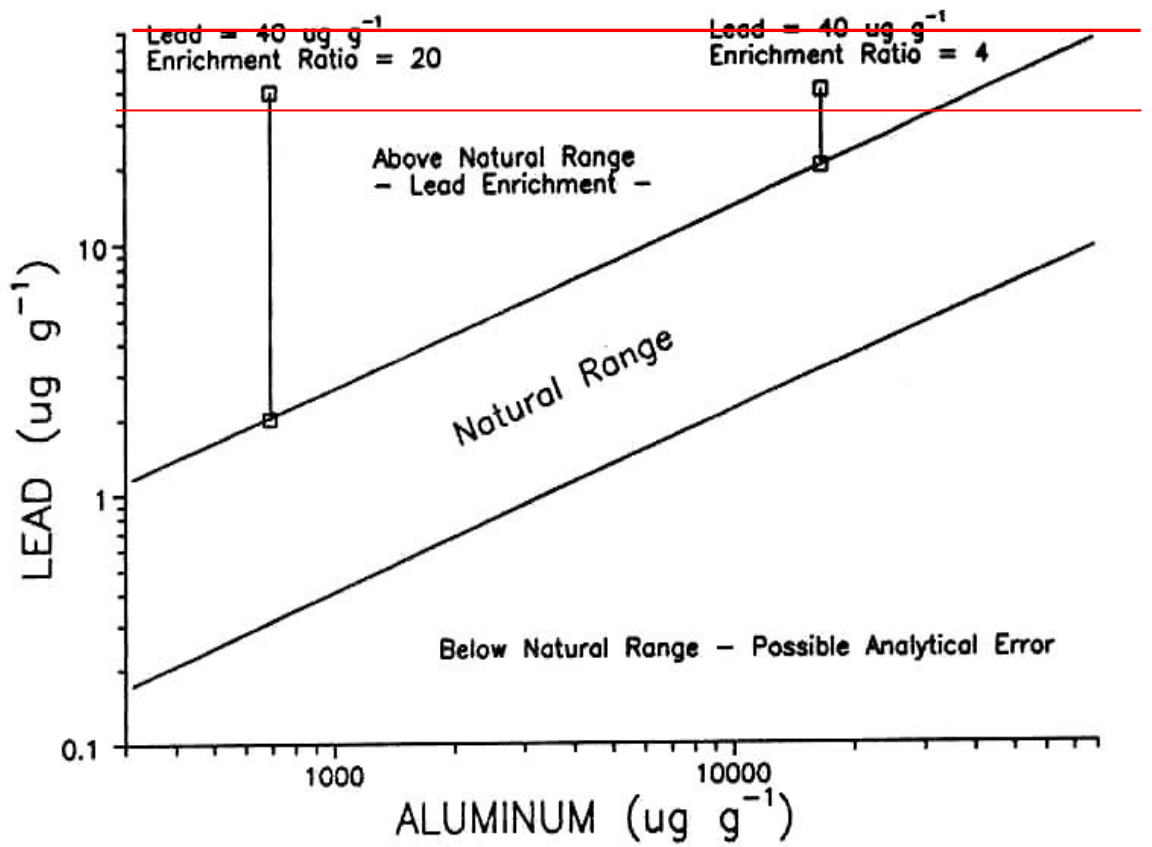
- Help interpret the significance of contaminant concentrations in marine and estuarine sediments
- Determine areas where further, more in depth investigations should be carried out.
- Monitor trends in contaminant concentrations over time.
- Track the influence of point and nonpoint sources.

Uses of Sediment Assessment Tools

- Identify contaminants of concern
- Prioritize areas for restoration
- Identify priority stormwater discharge sites for corrective action.

PEC

TEC



Interpretation of Lead data using lead/aluminum relationship.

Guidance Manual (Framework)

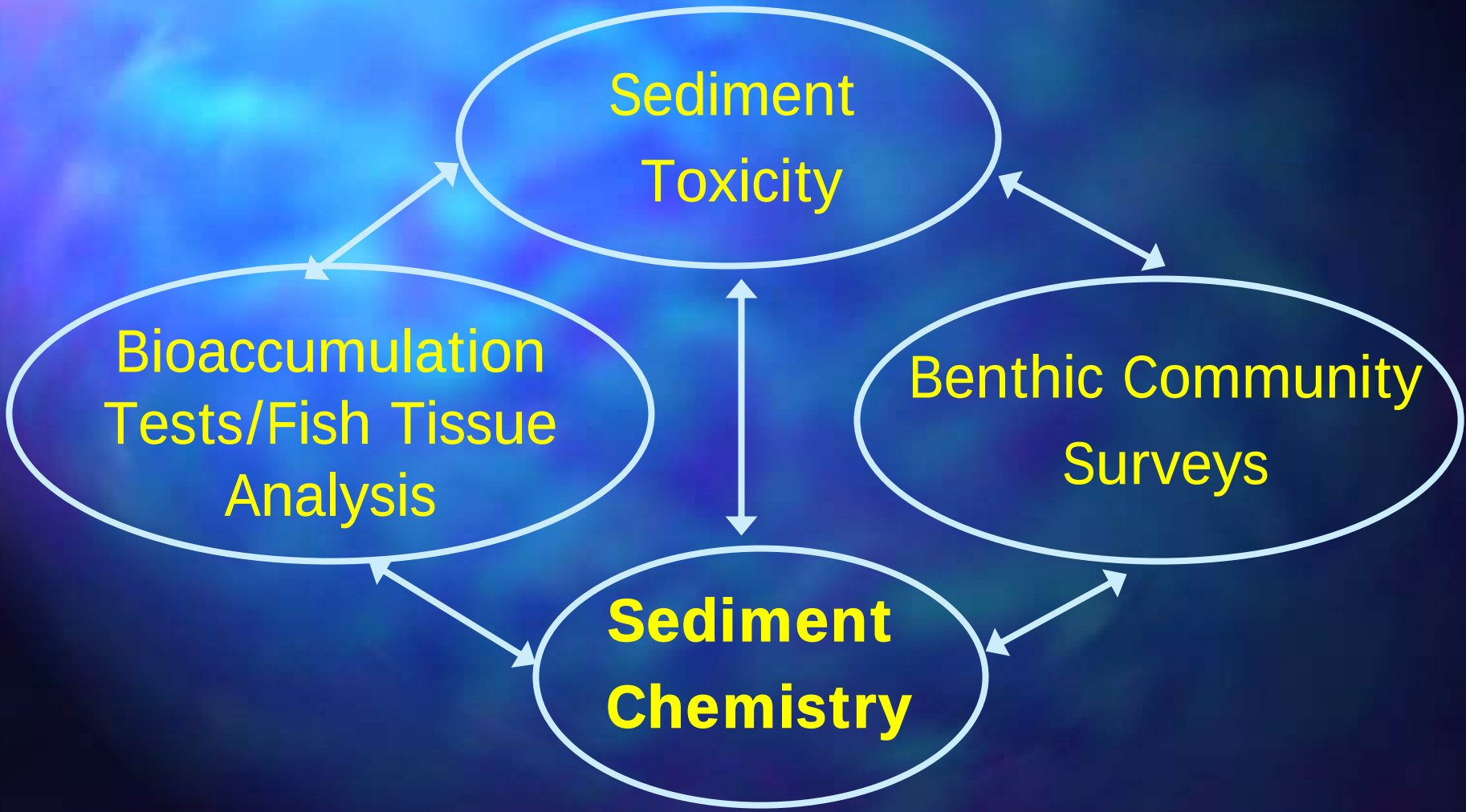
3 volume document, Collaborative Effort

Great Lakes, British Columbia and Florida

Planning a Sediment Assessment Survey

- Identify Sediment Quality Issues and Concerns
- Evaluate Existing Sediment Quality Data
- Develop a QAPP and Implement a Sampling Plan Preliminary Site Investigation (Goals: Identify Priority Sites for Further Investigation) Determine endpoints and normalizers as part of QAPP
- Develop a QAPP and Implement a Sampling Plan for a Detailed Site Investigation (Goals: Determine Magnitude and Extent of Contamination and Delineation)
- Make Decisions Regarding the Need for Remediation

THE SEDIMENT QUALITY "QUADRAD"



Drawing Conclusions

Chem	Tox	Benthic	Bio	Potential Conclusions
+	+	+	+	Sediment contamination present and contributing to toxicity, benthic impairment, and bioaccumulation
-	-	-	+	Bioaccumulation has potential to impact higher trophic levels, but not impacting benthic community. Source of contamination undetermined.
+	-	-	+	Bioaccumulation has potential to impact higher trophic levels, but not impacting benthic community. Sediment likely the source.
-	+	-	+	Bioaccumulation has potential to impact higher trophic levels. Unmeasured factors influencing toxicity. Source of contamination undetermined.

Summary

- Recommend Use of Multiple Lines of Evidence for Sediment Assessment
- Make Use of Technical Guidance Manuals that are Available
- Decision-Making is a Complex Process, but can be Simplified by Collecting the Right Information. Make sure you have appropriate endpoints and normalizers.

Contact Information

www.dep.state.fl.us/water/monitoring.htm

Gail M. Sloane/Thomas L. Seal
2600 Blair Stone Road MS 3525
Tallahassee Fl, 32399-2400
850-245-8512/850-245-8514
Gail.Sloane@/Thomas.Seal@DEP.STATE.FL.US

Evaluation of Sediment Chemistry Results

- Analysis of Chemical Concentrations in Sediment and Pore Water
- Comparison to Sediment Quality Guidelines (Screening Purposes Only)
- Comparison to Regulatory Guidelines
- Use in Human Health and Ecological Risk Assessments
- Simultaneously Extracted Metals (SEM) minus Acid Volatile Sulfide (AVS) Analysis

Sediment Chemistry - Advantages

- Provides direct information on presence of contaminants of concern
- Standard Methods available for many chemicals
- Useful in tracking down and eliminating source of contamination

Sediment Chemistry - Disadvantages

- Does NOT provide direct information regarding impacts and effects of contaminated sediments.
- Can be fairly expensive
- Matrix interferences may impact detection limits and usability of data
- Lack of Standard Methods for Emerging Chemicals
- Important chemicals may be missed

Whole Sediment Toxicity Tests

- Exposure of benthic organisms to sediment samples in the laboratory and response endpoints are evaluated
- 2 different species (e.g., Hyallea, Chironomus, Daphnia, etc) and two different endpoint (e.g., growth, survival, reproduction, etc.) are recommended
- Comparison of results to reference site or control sediments

Sediment Toxicity - Advantages

- Direct indication of impact and effects on aquatic organisms
- Standard methods and evaluation procedures available
- Sensitivity to impact of mixtures and/or unmeasured chemicals

Sediment Toxicity - Disadvantages

- Field collected sediments are manipulated which may impact their integrity and toxicity
- Results may be less relevant than in situ type tests
- Can’t discriminate impacts of individual chemicals (causality)
- Organism sensitivity varies on organism and contaminant class
- Long-term and inter-generational effect tests can be expensive
- Results influenced by physical properties of sediments in additional to chemical composition

Benthic Community Assessments

- An evaluation of the number and diversity of sediment-dwelling organisms
- Test sites compared to reference sites
- Evaluation of the identity, abundance, and distribution of species present in a sediment sample
- Variety of metrics are available for evaluation data from these assessments

Benthic Community Assessments - Advantages

- Direct evaluation of in situ effects of contaminated sediments
- Benthic Organisms are “continuous monitors” of sediment health
- Assessments focus on indigenous populations with direct impact to overall health of the aquatic ecosystem

Benthic Community Assessments -Disadvantages

- Lack of standardized methods for collecting and processing samples
- Benthic Communities are influenced by chemical, physical, and hydrologic properties of the sediments and sampling site
- High variance in samples requires large number of samples and large volumes to be collected
- Can't discriminate impacts of individual chemicals (causality)
- Numerous metrics available, which makes interpretation of data complex

Bioaccumulation Assessments

- In-situ and/or Ex-situ tests to determine contaminant uptake by organisms (benthic organisms, fish, birds, etc.)
- Used at sites where contamination by bioaccumulative chemicals (PAHs, PCBs, mercury, dioxins/furans, etc.)
- Used in conjunction with sediment chemistry and bioaccumulation models
- Results compared to reference sites and/or regulatory benchmarks

Bioaccumulation Assessments - Advantages

- Availability of standard methods
- Measurement of contaminants uptake by organisms.
- Can include in situ and/or ex-situ tests
- Can target site-specific contaminants
- Useful in tracking down and eliminating source of contamination

Bioaccumulation Assessments Disadvantages

- Very Expensive
- Collection of required mass of tissue from in-situ organisms is cumbersome
- Field collected sediments for laboratory tests are manipulated which may impact their integrity and bioaccumulation potential
- Few benchmarks exist for decision making based on tissue concentrations