

Development and Validation of a Framework for Integrating Sediment Quality Data

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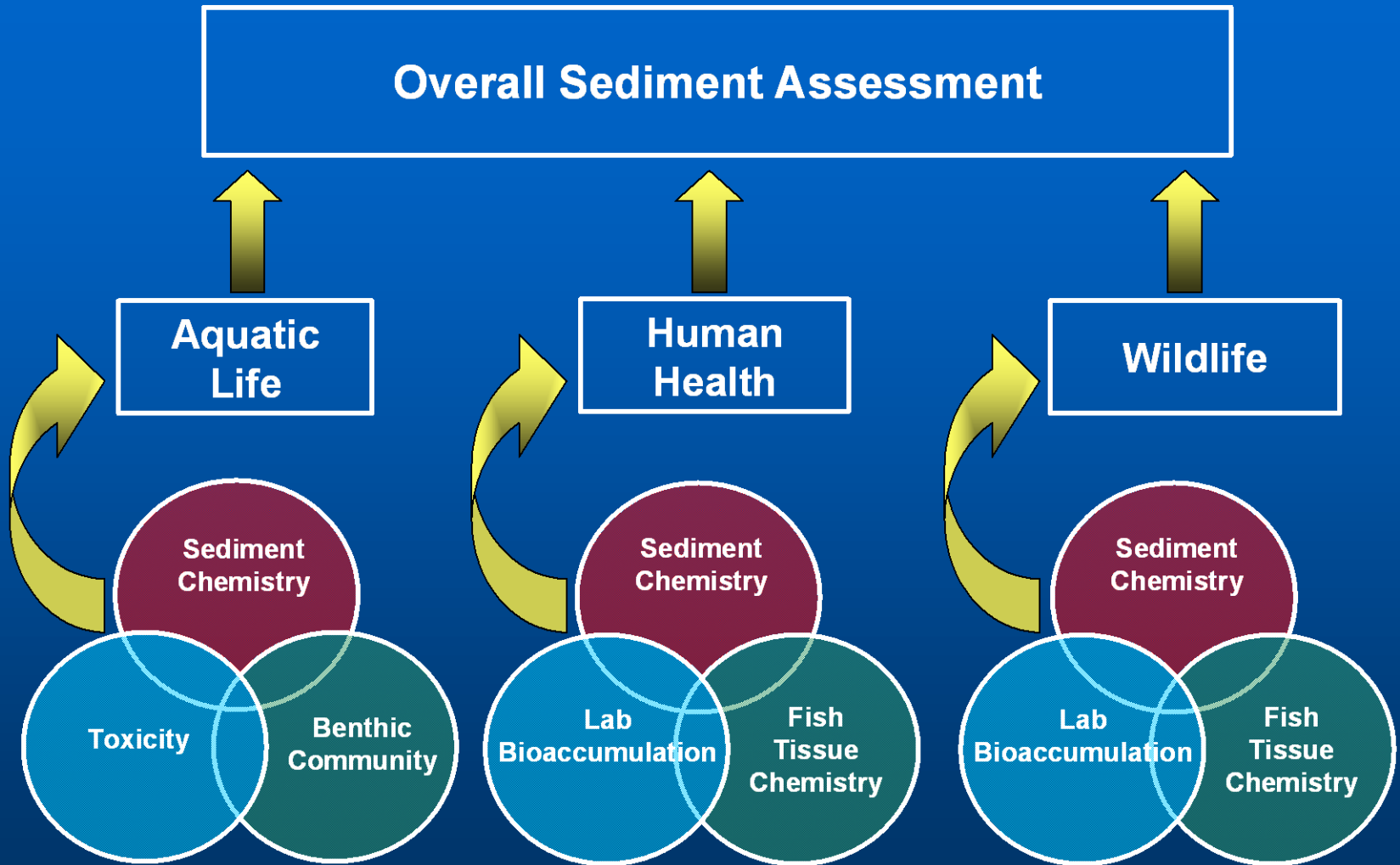
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California Sediment Quality Objectives Program

- **Water quality policy under development for enclosed bays and estuaries**
 - **Phased adoption in 2008-2010**
- **Three beneficial use categories to be protected**
 - **Aquatic life (direct effects on benthos)**
 - **Human health (indirect effects)**
 - **Wildlife (indirect effects)**
- **Within each category, a multiple line of evidence (MLOE) approach will be used**
 - **MLOE involves demonstration of both exposure and effect**
 - **No single line of evidence is sufficient**

SQO Assessment Framework



Multiple Lines of Evidence

- For many years, scientists have advocated a multiple line of evidence approach for evaluating sediment quality
 - Sediment quality triad
- The triad has been widely used in site-specific assessments, but has not found its way into most statutory frameworks
 - Most applications are based on best professional judgment
- Use of triad in regulatory programs presents challenges
 - Developing methods/assessment consistency across the state
 - Standardizing data interpretation among individuals with varying expertise

Three Levels of Assessment

- Individual LOE
 - Merging multiple indicators to characterize sediment chemistry, toxicity, and benthic community condition
- Sampling station level
 - Merging MLOE to determine attainment of SQO at a site
- Water body scale
 - Merging multiple sampling stations to identify impairment

MLOE Integration Framework Goals

- **Classify stations with respect to both presence and severity of impacts**
- **Incorporate risk assessment elements of exposure and effect**
- **Establish a consistent and objective process for use by diverse organizations**
- **Provide scientifically credible results**

Sediment Quality Lines of Evidence

RESPONSE	CHEMISTRY (Exposure)	TOXICITY (Toxicity)	BENTHOS (Disturbance)
Equivalent to reference or control condition	Minimal Exposure	Nontoxic	Reference
Slight change of uncertain statistical significance	Low Exposure	Low Toxicity	Low Disturbance
Reliable difference generally regarded as significant	Moderate Exposure	Moderate Toxicity	Moderate Disturbance
Highly reliable response of high magnitude	High Exposure	High Toxicity	High Disturbance

- Tools and classification thresholds developed for each LOE
- 64 possible LOE combinations

Direct Effects Station Assessment

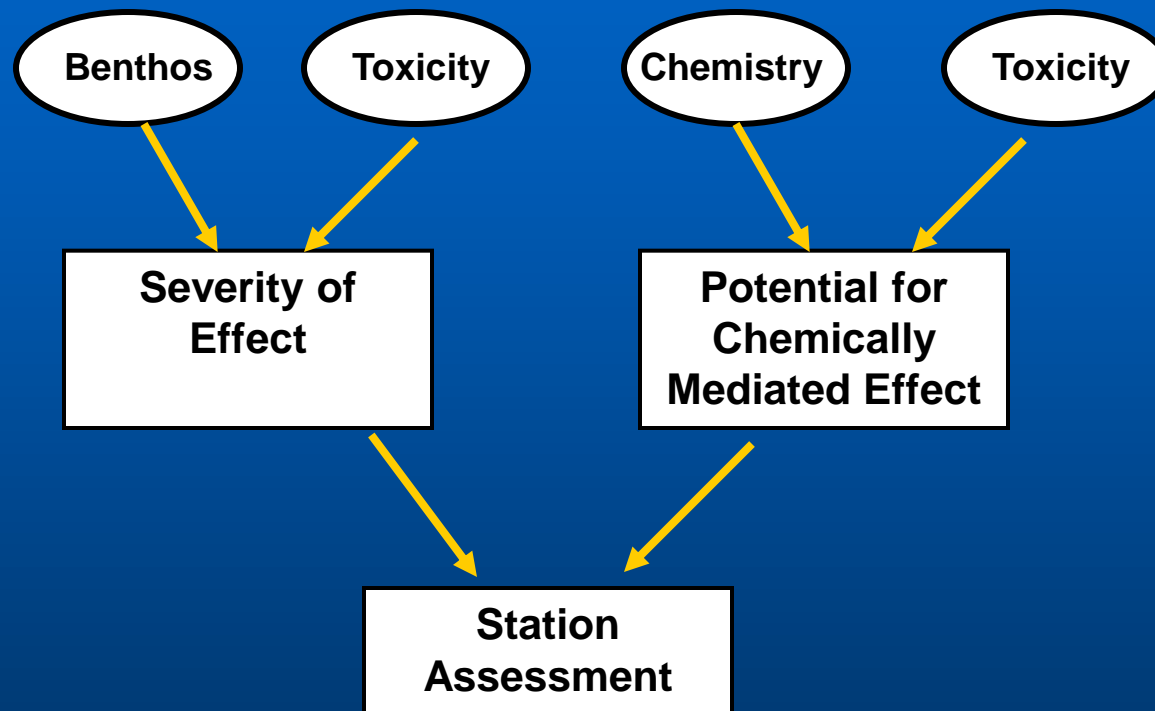
Six assessment categories (narrative definition developed for each category)

- Unimpacted
- Likely Unimpacted
- Possibly Impacted
- Likely Impacted
- Clearly Impacted
- Inconclusive



MLOE FRAMEWORK

Direct Effects



Framework elements developed with input from stakeholders and scientific review committee

Severity of Effect

Toxicity

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	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 for Chemically Mediated Effects Toxicity

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	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 Assessment

Severity of Effect

	Unaffected	Low Effect	Moderate Effect	High Effect
Minimal Potential	Unimpacted	Likely Unimpacted	Likely Unimpacted	Inconclusive
Low Potential	Unimpacted	Likely Unimpacted	Possibly Impacted	Possibly Impacted
Moderate Potential	Likely Unimpacted	Possibly Impacted	Likely Impacted	Likely Impacted
High Potential	Inconclusive	Likely Impacted	Clearly Impacted	Clearly Impacted

Potential
that
Effects are
Chemically
Mediated

Assessment Framework Validation

- **Is the approach accurate and reliable?**
 - Need a “gold standard” for comparison
- **Comparison to best professional judgment**
 - Can a standardized system replicate results obtained by experts in sediment quality assessment?
 - Is the framework biased?

Expert Opinion Comparison

- Six experts
- Evaluated data from 25 sites (California embayment stations)
 - Chemistry
 - Toxicity
 - Benthic assessment category
- Asked them to define condition
 - Rank from best to worst
 - Five assessment categories plus “inconclusive”
- Use consensus results as “gold standard”

Study Participants

- Walter Berry (USEPA)
- Peter Chapman (consultant)
- Rusty Fairey (Moss Landing Marine Labs)
- Tom Gries (Washington Dept. Ecology)
- Ed Long (NOAA ret.)
- Don MacDonald (consultant)

Expert Results

Station #	Reviewer 1	Reviewer 2	Reviewer 3	Reviewer 4	Reviewer 5	Reviewer 6
1	1	1	2	1	1	1
2	2	3	3	3	2	2
3	2	2	3	3	2	2
4	1	2	2	2	1	1
5	4	3	4	3	2	4
6	1	1	2	1	1	1
7	2	x	3	x	2	x
8	4	x	4	x	3	x
9	3	x	4	3	2	x
10	4	3	4	5	3	4
11	5	3	4	5	4	5
12	3	2	3	3	2	2
13	3	3	3	3	2	3
14	4	3	4	3	4	4
15	5	3	4	3	4	4
16	3	2	3	x	1	3
17	3	2	3	4	1	3
18	1	1	1	1	1	1
19	5	3	5	5	5	5
20	5	4	5	5	5	5
21	5	4	5	5	5	5
22	5	4	5	5	5	5
23	1	1	2	x	1	1
24	1	1	2	x	1	1
25	1	1	2	x	1	1

Unimpacted
Likely unimpacted
Possibly impacted
Likely impacted
Clearly impacted
x Inconclusive

MLOE Framework Results

Station #	Expert Median	MLOE Framework
1	1	1
2	3	3
3	2	3
4	2	1
5	4	4
6	1	1
7	2	2
8	4	4
9	3	3
10	4	4
11	5	5
12	3	2
13	3	3
14	4	5
15	4	4
16	3	1
17	3	3
18	1	1
19	5	5
20	5	5
21	5	5
22	5	5
23	1	1
24	1	1
25	1	1

Unimpacted
Likely unimpacted
Possibly impacted
Likely impacted
Clearly impacted
x Inconclusive

Comparison to Median Expert

	Reviewer 1	Reviewer 2	Reviewer 3	Reviewer 4	Reviewer 5	Reviewer 6	MLOE Framework
Error rate	6/25	16/22	13/25	10/19	14/25	5/22	6/25
Bias	+4	-14	+12	+7	-14	-1	-2

Summary

- Incorporation of MLOE approach represents a milestone for sediment assessment policy development
- A unique approach to MLOE framework validation was developed
 - First comparison among experts
- Accuracy and bias varied among experts
 - Reflects conceptual differences in assessment approach
- A standardized MLOE framework is feasible for implementing a statewide sediment quality assessment program
 - results were equivalent to best professional judgment