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Indicators of Anthropogenic Contamination in the Estuary

Introduction

Anthropogenic contamination exists in the water, sediment, and biota of the Estuary. Various contaminants may exceed various regulatory levels or have the potential for human health or biological effects in the Estuary. This complexity is often difficult to convey to managers and the public in a concise and understandable way.

An Estuary Contamination Index (ECI) is being developed as a major component of the Indicators of Condition of San Francisco Estuary.

The ECI will address two key Assessment Questions related to Estuary contamination in the San Francisco Estuary that have been vetted and agreedupon by the SFEP (Thompson and Gunther, 2004; TBI, 2003).

• Are Estuary waters and sediments becoming more contaminated?

Figure

ESTUARY CONTAMINATION INDEX

SEDIMENT QUALITY INDEX (=SOO)

HUMAN HEALTH:

SED. CONC.

TISSUE CONC.

ADVISORIES

Tech. Report:

Greenfield, 2006

AQUATIC LIFE:

SED. CONC.

SED. TOX.

BENTHOS

Draft Reports:

SWRCB, 2005

Framework for the Estuary Contamination Index

• Are Estuary waters and sediments harmful to biota?

The ECI is currently a concept in development; all of its components have not been detailed. It uses a tiered set of indices and indicators to summarize monitoring information.

Since anthropogenic contamination is under federal and state regulation, the ECI will be consistent with those regulations by using a framework that parallels regulatory structure and focus.

The ECI is largely based on the framework proposed for Sediment Quality Objectives (SQO) for California Bays and Estuaries (SWRCB, 2007).

The current concept for the ECI is shown in Figure 1.

Water Contamination Index (WCI)

The WCI provides an assessment of conditions for aquatic life residing in the San Francisco Estuary (Thompson et al. 2006).

The WCI integrates three lines of evidence:

- Water Contamination
 - Four categories of contamination were established by comparing the concentrations of fifteen commonly measured contaminants to regulatory guidelines (EPA, 2000)
 - The final category is determined by the average score of the fifteen contaminants
- Aquatic Toxicity
 - Four categories of aquatic toxicity were established based on results of t-tests comparing control and test samples
- Biological Effects
 - Four categories of biological effects were established using data on biological thresholds for 25 contaminants in 21 common species that inhabit the Estuary water column (e.g., EPA, 2005)

three LOEs.

The Water Contamination Index (WCI) is determined by combining the

Consistent with the SQO framework (see SQI section), each site to be evaluated is characterized as one of the following:

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

A demonstration of the WCI procedure for three RMP sites is shown in Table 1. These results suggest that there is no impact to aquatic life from exposure to water contaminants at these sites

Table 1. Examples of applying the WCI procedure to selected RMP sites.

RMP Estuary Region	Site	Year	Toxicity Category	Bioeffects Category	Contaminant Exposure Category	WCI Result
Southern Sloughs	C-3-0	1996	Not Toxic	Low	Low Potential	Unimpacted Exposure
Central Bay	BB70	1996	Not Toxic	Minimal Potential	Minimal Exposure	Unimpacted
Rivers	BG30	1996	Low Toxicity	Minimal Potential	Minimal Exposure	Unimpacted

Conclusions

The WCI demonstration at three RMP sites suggests that there is little impact on aquatic life from exposure to water contamination. It must be emphasized that the results shown here are for demonstration purposes only, and

may not represent the current conditions at the sites analyzed.

The WCI is currently a concept being vetted through the SFEP and other interested parties.

This indicator evaluates the potential for contaminant effects to wildlife and humans from indirect

An assessment framework was developed, and a case study was conducted as part of the California

The case study demonstrated application of the framework to legacy pesticides (DDTs, chlordanes,

and dieldrin) in San Francisco Bay. These pollutants were chosen because their fate and bioavailabil-

Examples

AQUATIC LIFE:

WATER CONC.

AQUATIC TOX.

BIO. EFFECTS

Tech. Report:

Thompson et al. 2006

INDICATORS

WATER CONTAMINATION INDEX

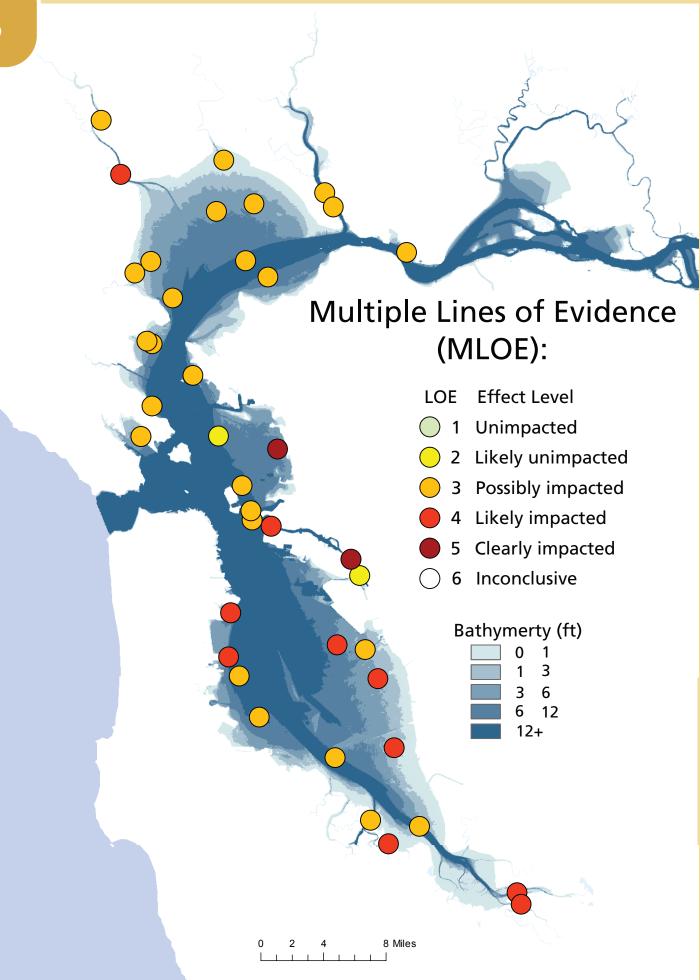
HUMAN HEALTH:

WATER CONC

ADVISORIES

To be Developed

TISSURE CONC.



Sediment Quality Index

The Sediment Quality Index (SQI) is a summary of the condition of Estuary sediments, expressed as a categorical narrative assessment.

The SQI uses the California Sediment Quality Objectives (SQO; SWRCB, 2007) methodology. The SQOs are intended to protect benthic infaunal invertebrates.

The SQI integrates three lines of evidence:

- Sediment Contamination
 - This information is included to assess the exposure of benthic organisms to sediment contamination
 - Concentrations of 12 commonly measured contaminants combined into an index called the CA LRM, which is based on Logistic Regression Models
- Sediment Toxicity
 - Assesses the toxicity of sediments
 - At least two different tests are required, and must include chronic and acute end-

2. Low impact

- Benthic Assemblages
 - Assesses impacts on benthic assemblages
 - Uses 2 4 different benthic indices, depending on assemblage:

The results for each LOE are placed into one of 4 categories of impact.

3. Moderate impact

The Sediment Quality Index is determined by combining the 3 LOEs categories in two a final sediment quality assessment is expressed as one of six categories.

Unimpacted

1. No impact

- 4. Likely impacted
- Likely unimpacted
- 5. Clearly impacted
- 6. Inconclusive Possibly impacted

Application of the SQO Methodology to EMAP Station CA007 (Off San Leandro) in 2000.

Demonstration of SQO Application at EMAP Station CA007 Sediment Indicator Metric Metric Value LOE Category CA LRM **Sediment Contamination Sediment Toxicity Control Adjusted Mortality** 38.4% 10 day bulk sediment exposure **Eohaustorius estuarius (amphipod)** Benthic Assemblages 0.08 36.9 RIVPACS 0.39 "Likely Impacted" SQO Assessment Value=

The SQO methodology was applied to 40 samples from the San Francisco Estuary using data collected by EPA and NOAA in 2000, as part of a statewide assessment of sediment quality (Barnett et al. 2007). The final assessment values are shown on Figure 2.

Conclusions

The Statewide assessment of San Francisco Estuary showed that 95% of the samples and 96.1% of the area of the Estuary assessed had sediment impacts. However, the SQO assessment did not identify the specific cause of the impact.

4. High impact

The Wildlife and Human Health assessment uses three exposure indicators:

Wildlife and Human Health Assessment

exposure to sediment contamination via the estuary food web.

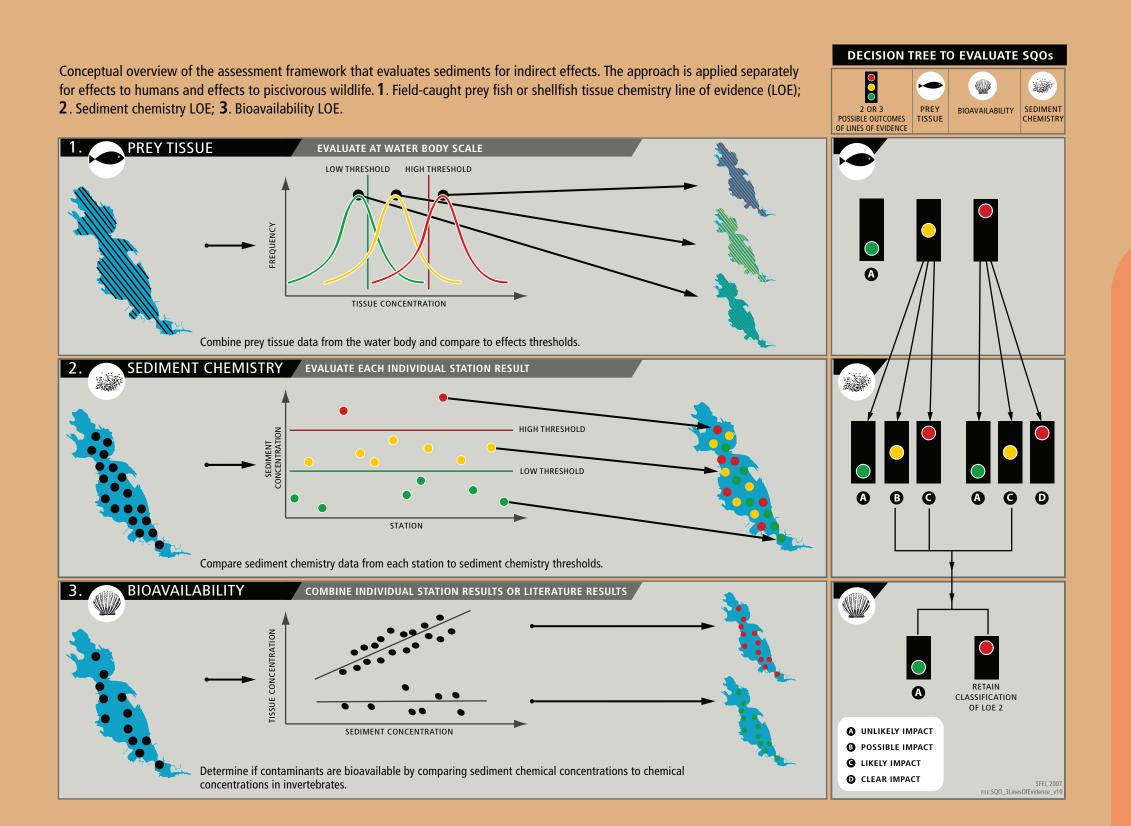
Sediment Quality Objectives Program (Greenfield et al. 2007).

- Chemical concentrations in prey organisms
- Chemical concentrations in sediment
- Bioavailability of contaminant, as demonstrated in field or laboratory test organisms

ity are relatively well characterized in the Bay using literature and local data.

Figure 3 depicts the assessment procedure.

- Key features of the procedure include:
 - Separate assessment for humans vs. wildlife
 - Risk-based approach Multiple categories
- Sequential approach
- Application at multiple scales
- Separate evaluation of specific contaminant classes



Conclusions

Concentrations in prey fish tissue were below relevant human health effects thresholds. Based on this finding, the sequential approach determined that legacy pesticides in Bay sediments are unlikely to impact human health.

Next steps include developing technical guidance on application of the framework for additional contaminant classes (e.g., metals) as well as contaminant mixtures (e.g., dioxin-like compounds and PAHs).

Summary

At this stage of development of the ECI, conclusions about the condition of the Estuary in terms of contamination are generalized based on the three components developed so far, and are considered preliminary:

- The WCI results at three sites suggests that there is little impact on aquatic life from exposure to water contamination
- Most sediments in the Estuary are impacted to some degree, mainly due to widespread sediment toxicity
- Sediment contamination by DDTs and other legacy pesticides are unlikely to impact wildlife or human health

Water contamination impacts on human health and wildlife have not been formally developed for the ECI. However, the potential for impacts of PCBs and mercury in water are well documented, and are the current focus of regulatory TMDLs in the Estuary. Methods for combining the WCI and SQI into an overall ECI expression need to be developed.

Acknowledgments

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