

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 agreed-upon by the SFEP (Thompson and Gunther, 2004; TBI, 2003).

- Are Estuary waters and sediments becoming more contaminated?
- 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.

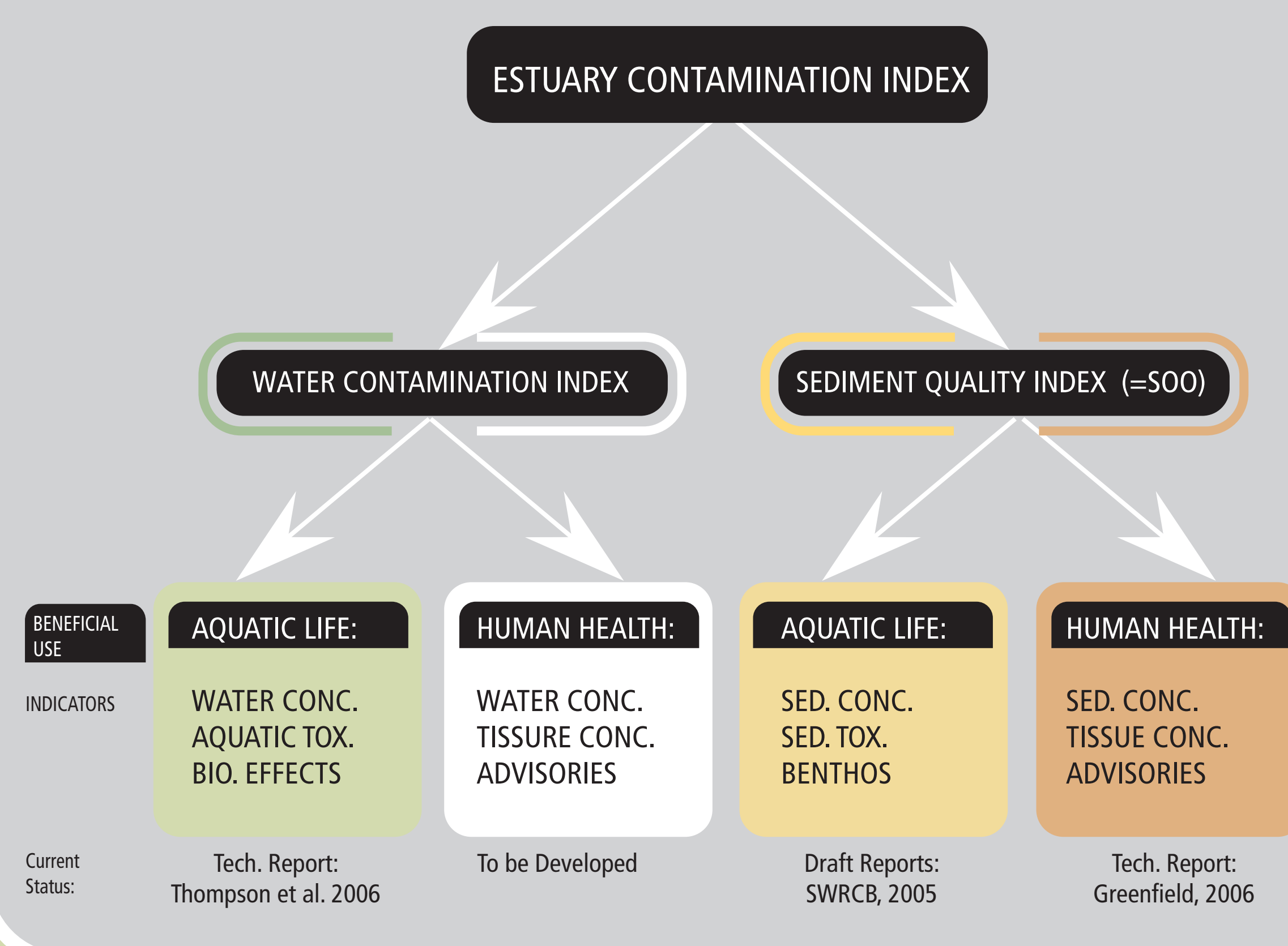
Since anthropogenic contamination is under federal and state regulation, the ECI will be consistent with those regulations by using a framework that parallels regulatory structure and focus.

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.

Figure 1

Framework for the Estuary Contamination Index



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)

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

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

- Unimpacted
- Likely Unimpacted
- Possibly Impacted
- Likely 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.

Wildlife and Human Health Assessment

This indicator evaluates the potential for contaminant effects to wildlife and humans from indirect exposure to sediment contamination via the estuary food web.

An assessment framework was developed, and a case study was conducted as part of the California Sediment Quality Objectives Program (Greenfield et al. 2007).

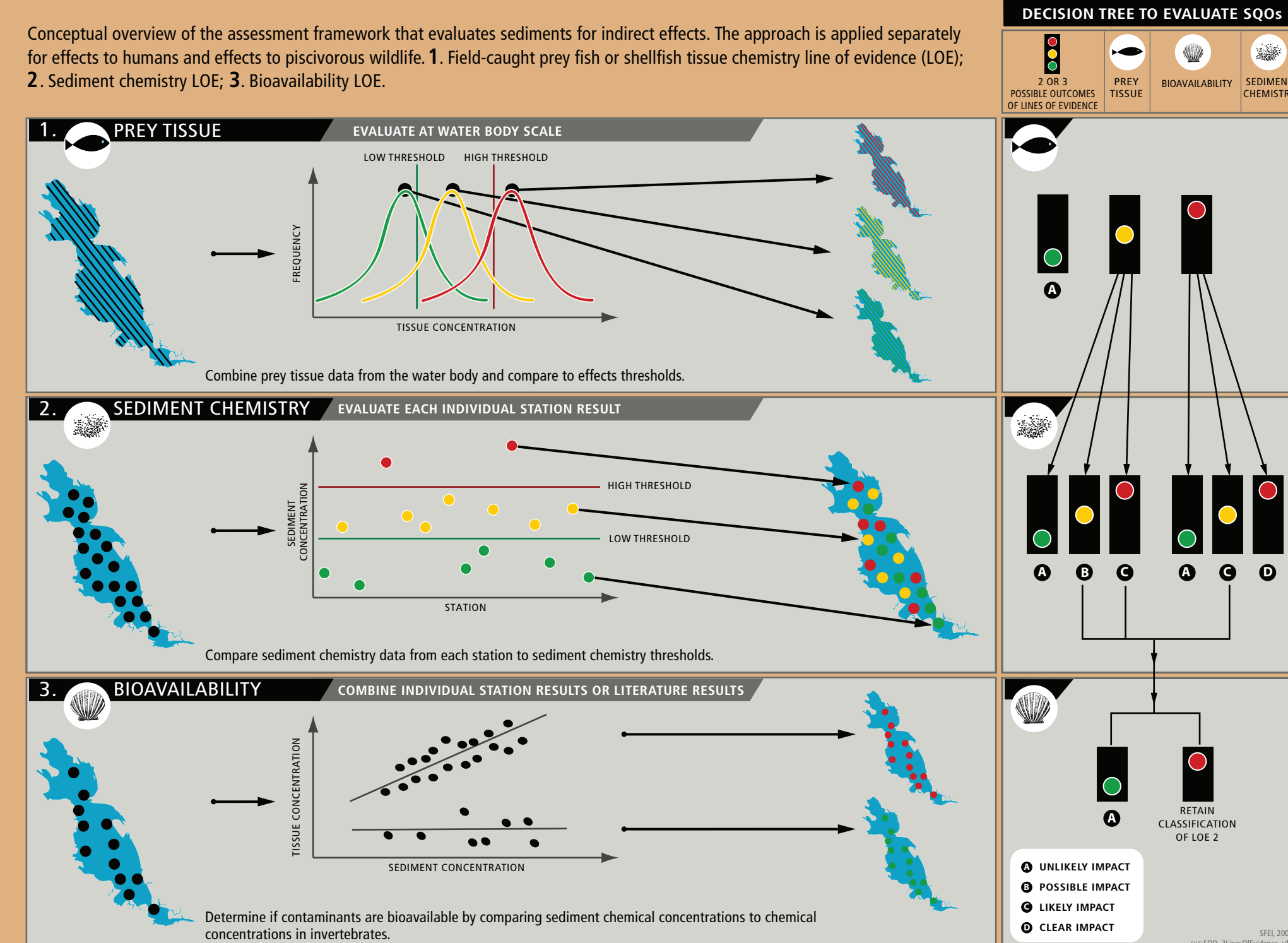
The case study demonstrated application of the framework to legacy pesticides (DDTs, chlordanes, and dieldrin) in San Francisco Bay. These pollutants were chosen because their fate and bioavailability are relatively well characterized in the Bay using literature and local data.

The Wildlife and Human Health assessment uses three exposure indicators:

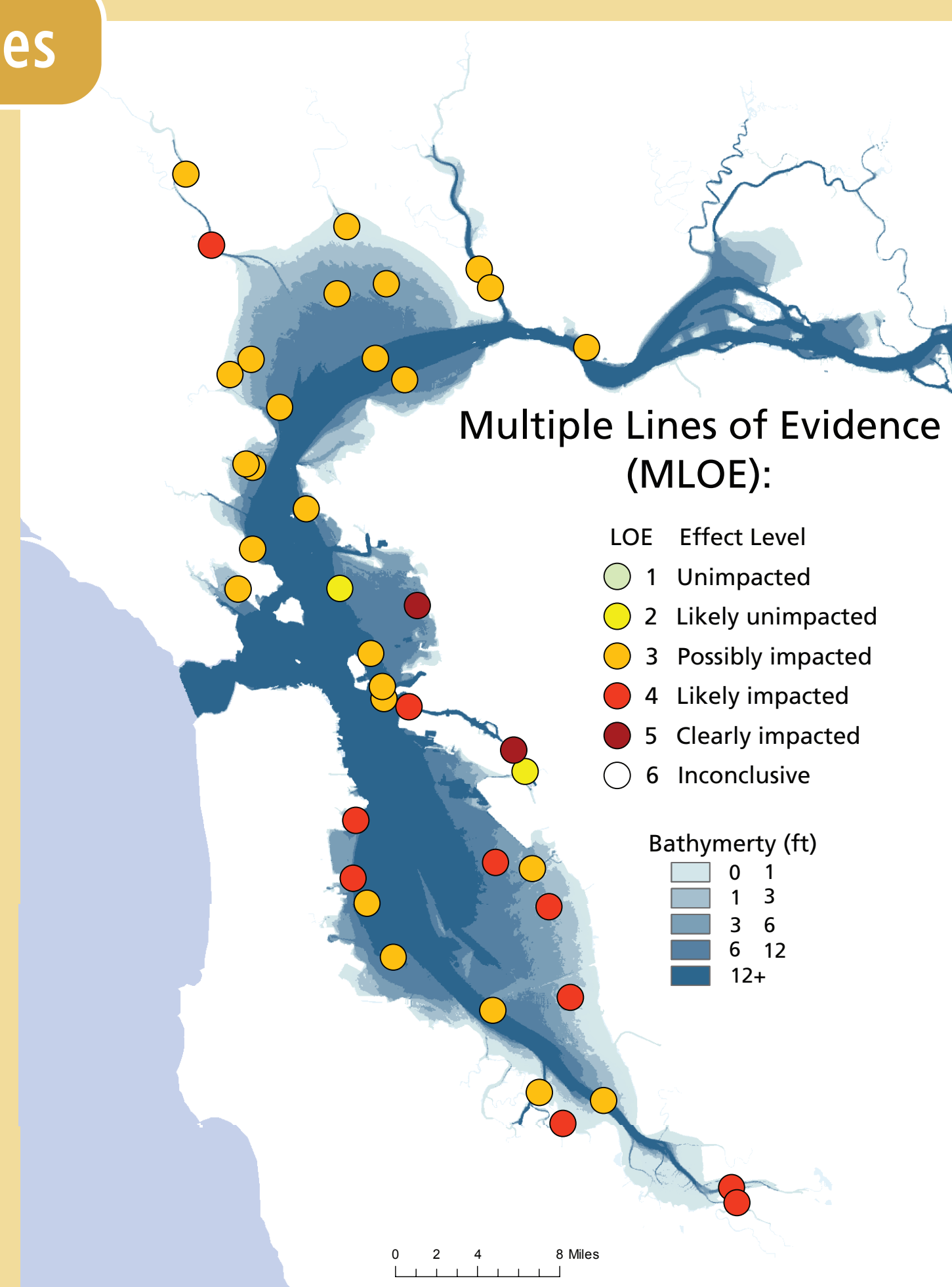
- Chemical concentrations in prey organisms
- Chemical concentrations in sediment
- Bioavailability of contaminant, as demonstrated in field or laboratory test organisms

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



Examples



1

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 |
|------------------------|-----------------------------------|--------------|--------------|
| Sediment Contamination | CA LRM | 0.541 | 3 |
| Sediment Toxicity | Control Adjusted Mortality | 38.4% | 4 |
| | 10 day bulk sediment exposure | | |
| | Eohaustorius estuarius (amphipod) | | |
| Benthic Assemblages | | | |
| | RBI | 0.08 | 4 |
| | IBI | 1 | 3 |
| | BRI | 36.9 | 3 |
| | RIVPACS | 0.39 | 2 |
| SQO Assessment Value= | "Likely Impacted" | | 4 |

2

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.

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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