

Sediment Quality Objectives: Indirect Effects Assessment

Steven Bay

Southern California Coastal Water Research Project

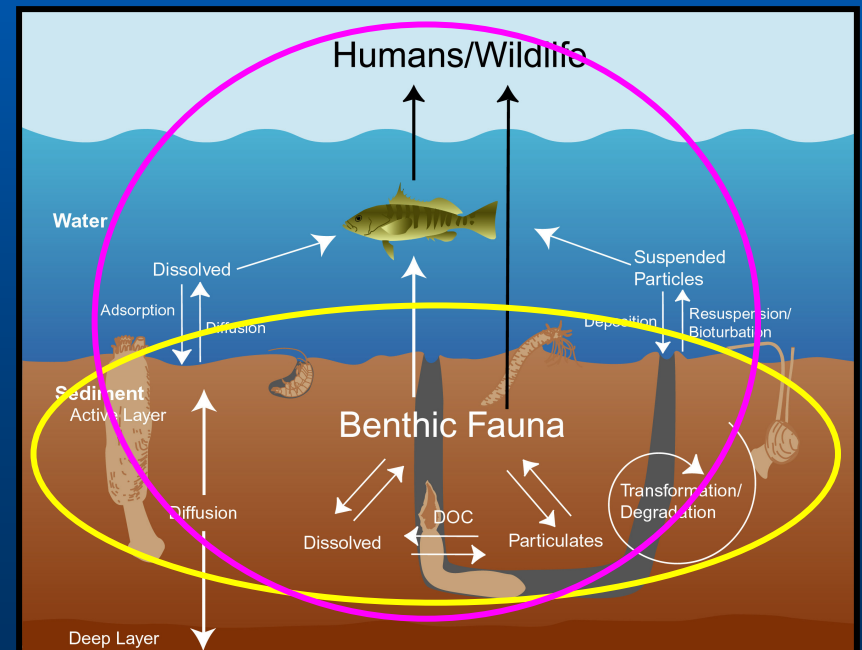
Costa Mesa, CA

www.sccwrp.org

steveb@sccwrp.org

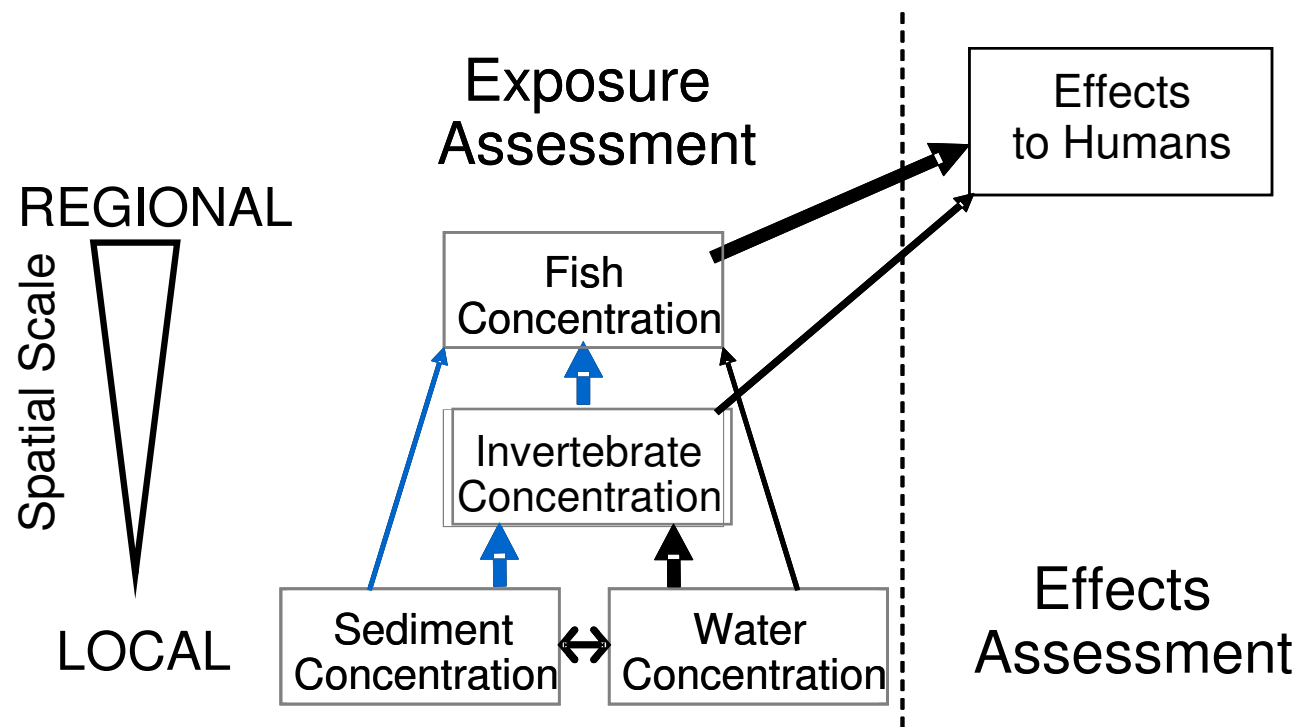
Narrative SQOs

- Two SQOs adopted by State Water Board:
 - **Direct Effects:** Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California
 - **Indirect Effects:** Pollutants shall not be present in sediments at levels that will bioaccumulate in aquatic life to levels that are harmful to human health



The Biggest Challenge: Establishing Linkage Between Sediments and Exposure

Conceptual Model



Assessment Framework

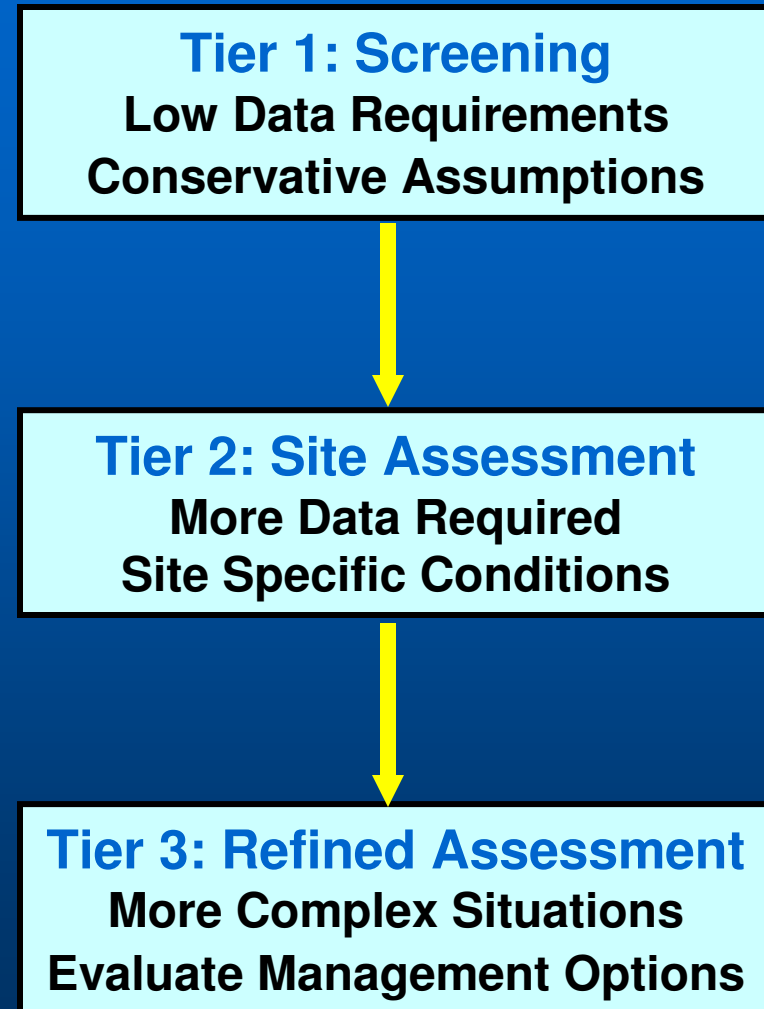
- Conceptual framework based on two key assessment questions:
 - Do pollutant concentrations in seafood (fish and shellfish) pose unacceptable health risks to human consumers? (**seafood consumption risk**)
 - Is sediment contamination from the site substantially contributing to the health risk? (**site sediment risk**)
- Assessment conducted at the site scale
 - An area characterized by multiple sampling locations
 - Boundaries reflect physical, habitat, or programmatic features
- Tools applicable to PCBs and chlorinated pesticides
- Tiered framework used to guide assessment

Indirect Effects Program Status

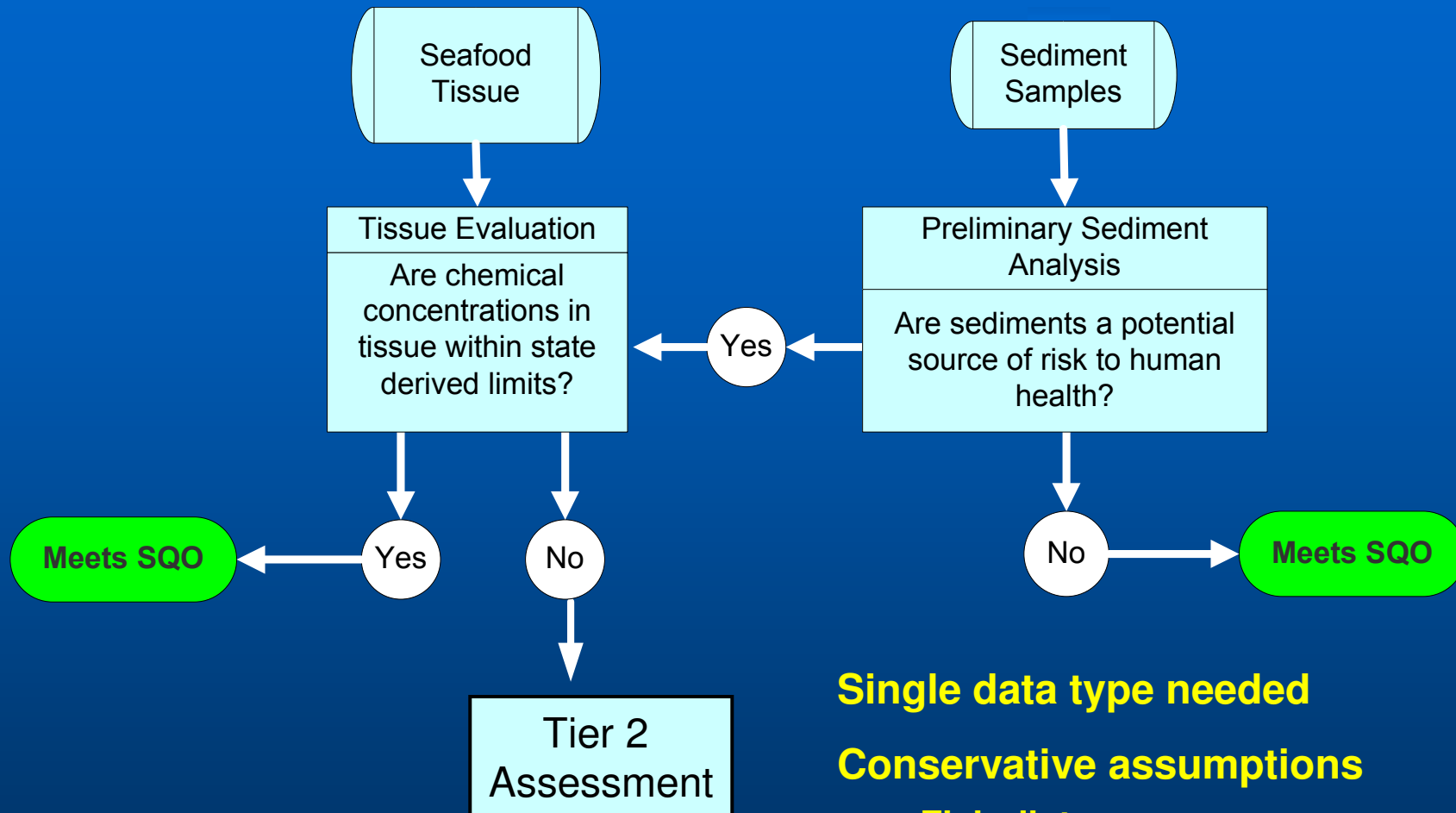
- Data integration framework approved in concept by Scientific Steering Committee in July 2009
 - Two year process
 - Less precedent than direct effects
- Now focusing on developing data analysis tools and assessment methodology
 - Sampling and analysis guidance
 - Health risk calculations
 - Bioaccumulation models
 - Data integration and interpretation methods
- Policy development and consideration for adoption by Water Board
 - By Water Board staff
 - End of 2010

Tiered Assessment Framework

- **Multiple tiers**
 - Data requirements and complexity relate to situation
 - Reduced effort/cost for sites of low concern



Tier 1



Single data type needed

Conservative assumptions

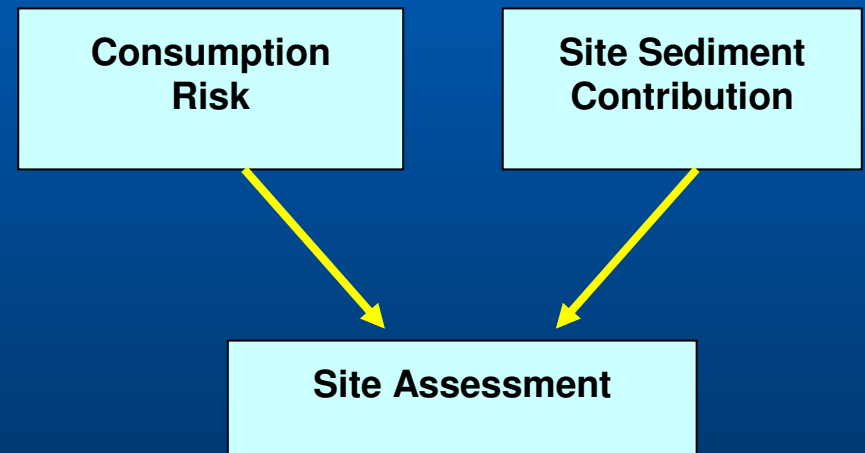
Fish diet

Upper concentration range

Early off ramps for sites of low concern

Tier 2

- Data are used to quantify indicators that address each assessment question
 - Seafood consumption risk: health risk from consuming resident seafood
 - Site sediment contribution: health risk associated with bioaccumulation of contaminants from sediment
- Multiple categories of risk are used to reflect gradations in magnitude and certainty for each indicator
- Site and species-specific characteristics used in assessment
 - Fish diet and forage range
 - Sediment TOC
 - Average concentrations

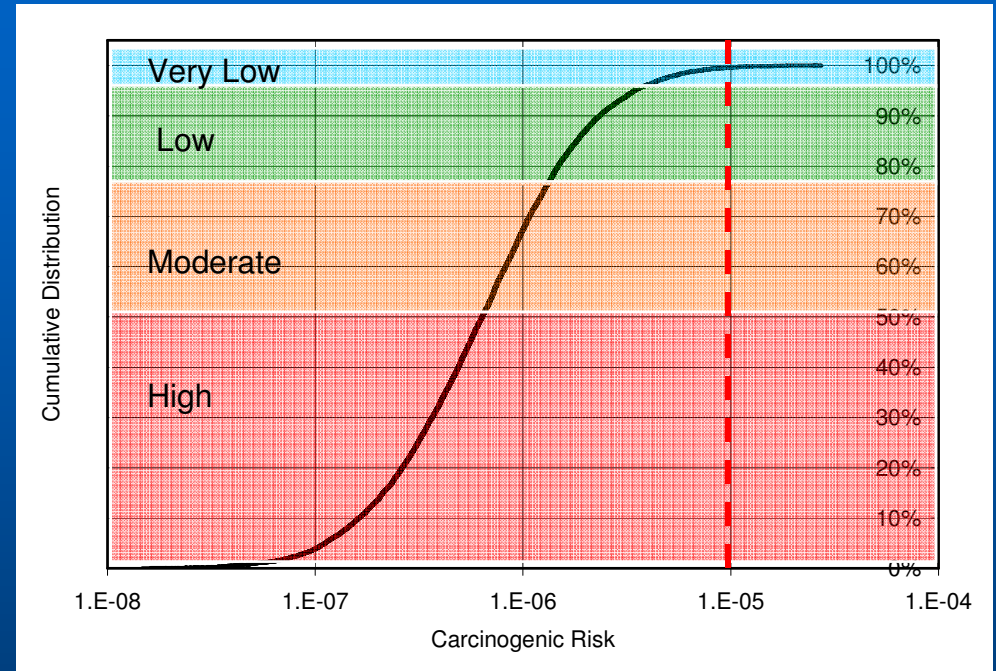


Consumption Risk Indicator

- Seafood contaminant concentration analysis
- Indicates overall hazard to seafood consumers for each contaminant
- Integrates all sources and factors affecting bioaccumulation at the site
- Requires collection and analysis of seafood from site
- Cancer risk and noncancer hazard calculated using standard equations

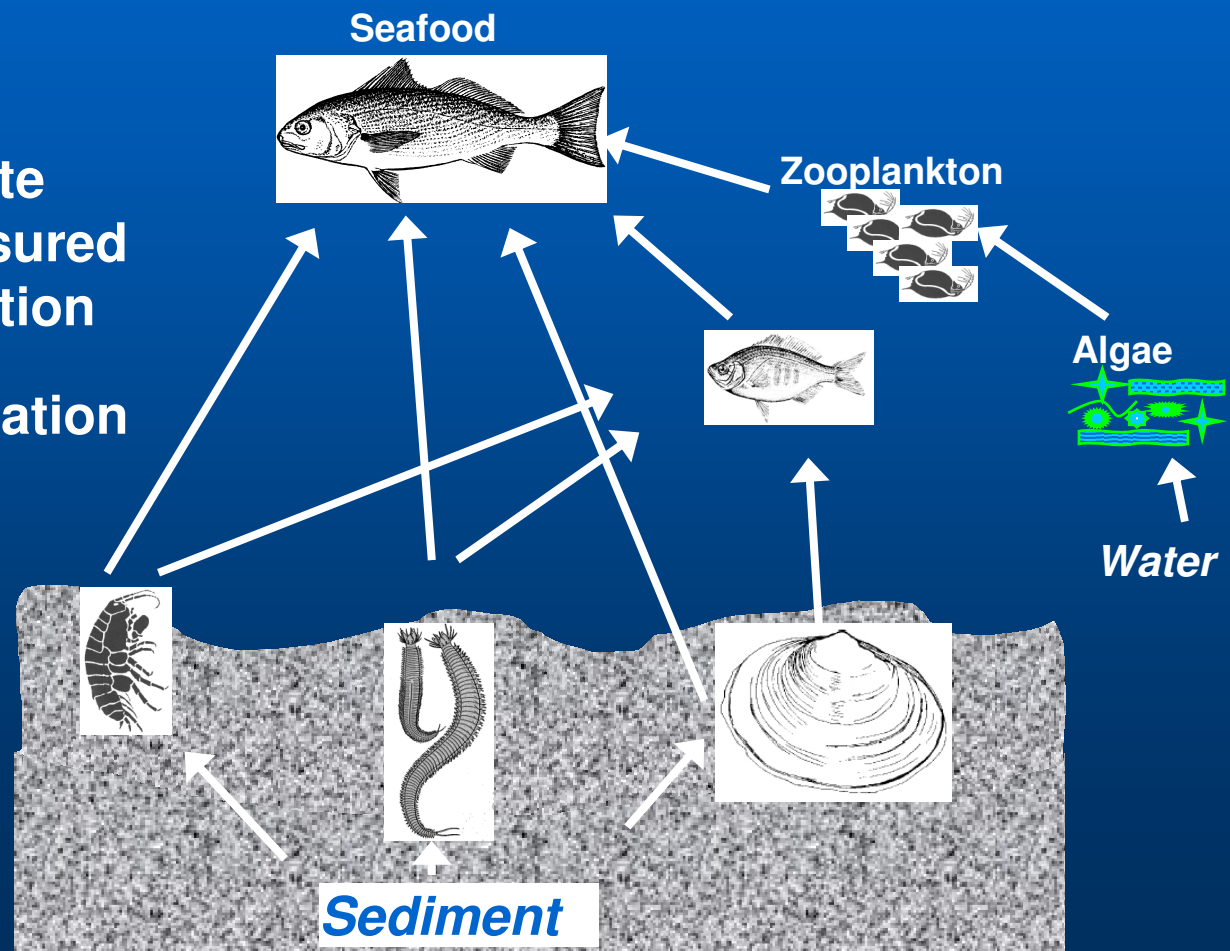
Tissue Data Interpretation

- Consumption risk indicator expressed as degree of risk to human health
 - Cancer risk probability
 - Noncancer hazard quotient
- Multiple categories
 - Categories provide mechanism to communicate results
- Use numeric thresholds to assign categories
 - Cancer and noncancer hazard
 - Proportion of population affected



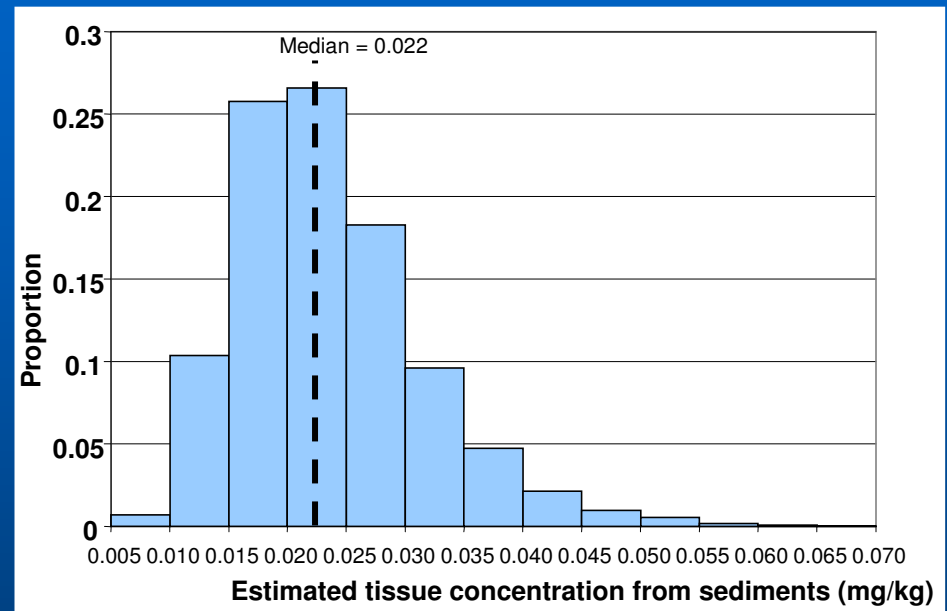
Site Sediment Contribution Indicator

- Sediment contaminant concentration analysis
- Estimate of contribution of site sediment to measured tissue contamination
- Uses bioaccumulation models and assumptions



Sediment Data Interpretation

- Estimate seafood contaminant concentration using site-specific bioaccumulation factor derived from model
- Compare estimate to average concentration in seafood from site
 - = % site sediment contribution
- Classify sediment contribution based on percentage



Data Integration and Site Assessment

- Applies to Tier 2 assessment
 - Use both indicators to determine site condition

Consumption Risk	Sediment Contribution	Narrative description	Final category
1. Very Low	1. Very Low	Virtually all of the seafood consuming population is at an acceptable risk from seafood contamination. Very little of the seafood tissue burden is due to site sediments.	Unimpacted
2. Low	3. Moderate	Most seafood consumers are at an acceptable risk from seafood contamination. A substantial portion of the seafood tissue burden is due to site sediments.	Likely Unimpacted
3. Moderate	3. Moderate	Upper end sport fish consumers are at an unacceptable risk from seafood contamination. A substantial portion of the seafood tissue burden is due to site sediments.	Likely Impacted

- Multiple categories for ranking and prioritization
 - Reflect a gradation of magnitude and certainty of human health risk due to site sediment contamination
 - Unimpacted
 - Likely Unimpacted
 - Possibly Impacted
 - Likely Impacted
 - Clearly Impacted

Setting numeric targets

- SQO program will establish water quality standards for future TMDLs
 - In progress TMDLs are exempted?
- SQO program will not establish TMDL targets
 - Tools and thresholds intended for assessment only
 - Only sediment pathway considered
 - General guidance will be provided for establishing clean up levels
- Tools and information in SQO program may provide useful resources for establishing TMDL targets
 - Tier 1 screening values for tissue and sediment
 - Stochastic model for determining risk/hazard distribution
 - Bioaccumulation model for estimating seafood contamination under different scenarios
 - Final thresholds and parameters not available yet

Tissue targets for indirect effects

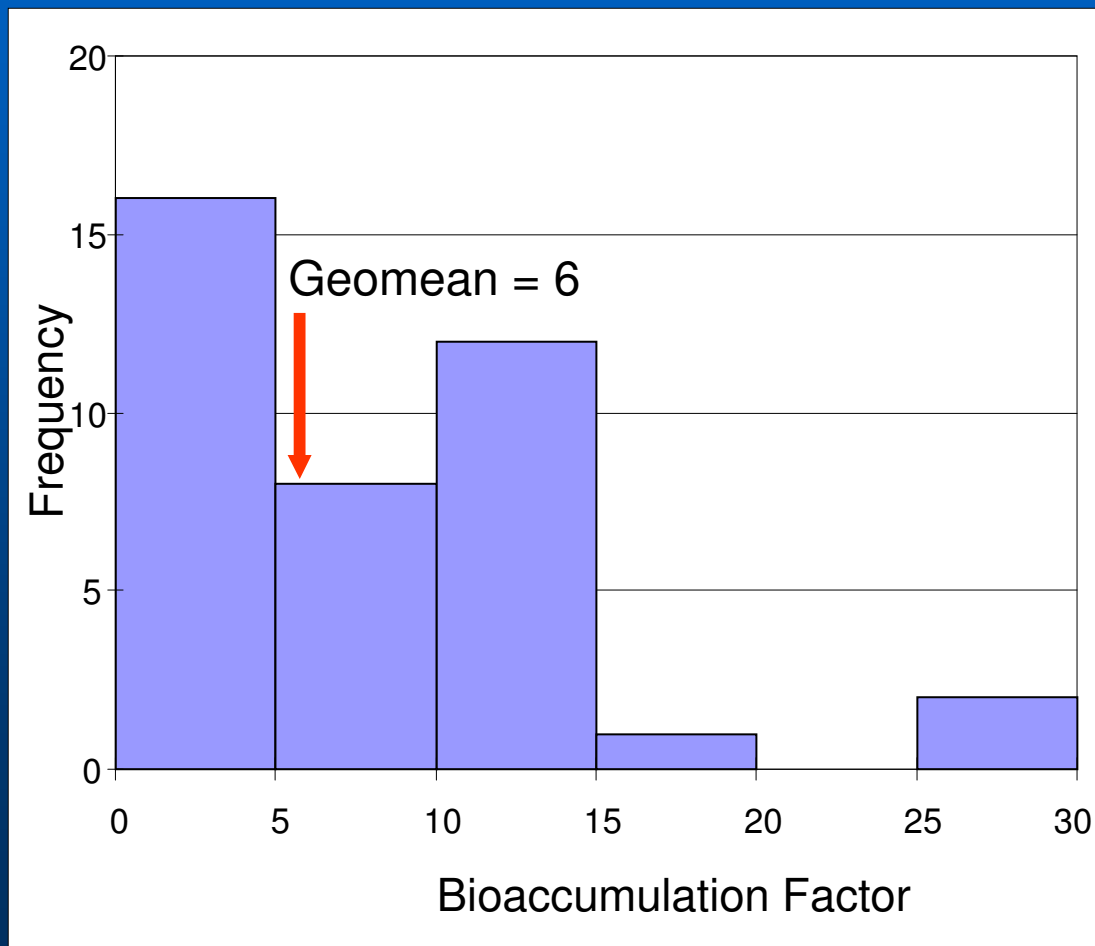
- Focus on resident seafood (fish)
 - Tissue thresholds from OEHHA or EPA
 - Calculated using risk assessment models
- Key parameters
 - Consumption rate
 - SQO program will use a range of values based on California studies
 - Level of acceptable risk
 - Draft SQO framework based on 10^{-5} cancer risk; HQ=1

Sediment targets for indirect effects

- **Don't use toxicity-based SQGs (ERM/ERL, PEL/TEL)**
 - No scientific basis for bioaccumulation application
- **Calculate targets from tissue thresholds using bioaccumulation models**
 - Empirical: Biota-Sediment Accumulation Factor (BSAF)
 - Mechanistic: Food Web Models
- **Site use by seafood must be considered**
 - Site area > forage range: model assumptions apply
 - Site area < forage range: targets won't achieve desired condition unless applied to larger region

Sediment Target Determination using BAF

- Use the distribution of the monitoring data and/or bioaccumulation models to determine a suitable BAF (e.g. Geomean)



BAF = Tissue/Sediment

Rearrange so that

Sediment = Tissue/BAF

**A BAF of 6 and
a tissue target of 21 ng/g
yields a sediment target
of 3.5 ng/g**

Example Sediment Values

Location	DDTs ug/kg	PCBs ug/kg	
Newport Bay	2-27	2-27	SQO draft case study Empirical BAF
San Francisco Bay	10-24		SQO draft case study Empirical BAF
		4-18	Gobas et al. 2010 Mechanistic model

SF Bay PCB TMDL provides a good resource for developing values