Notes to Scientific Steering Committee Members (before meeting):

1. This talk will discuss the technical approach for a proposed indirect effects framework for the California SQO.
2. During the meeting, just prior to this talk, there will be a talk on the policy objectives of the indirect effects SQO.
3. If your time for reading is limited, the most important section of the indirect effects report ("Indirect Effects Indicators and Framework") is Section 3.

A Framework For Assessing Indirect Effects of Sediment Contaminants

A Presentation to the SQO
Scientific Steering Committee
February 28, 2006

Talk Outline

- Background and Update
  - Feedback –State Board, Committees
  - Objectives of Task
  - Status and Process
- Overview of Framework
  - How Does It Work?
  - Technical Issues
- Case Study Example
  - DDTs in San Francisco Bay

Feedback From Last Meeting

- Generally agreed with Lines of Evidence
- Must Clarify Objectives of Indirect Effects Task
- How implement the approach?
  - Will data be collected at each sampling site or at sub-basin scale?
  - Consider sequential vs. simultaneous approach
  - Role of bioaccumulation test LOE

State Board Objectives

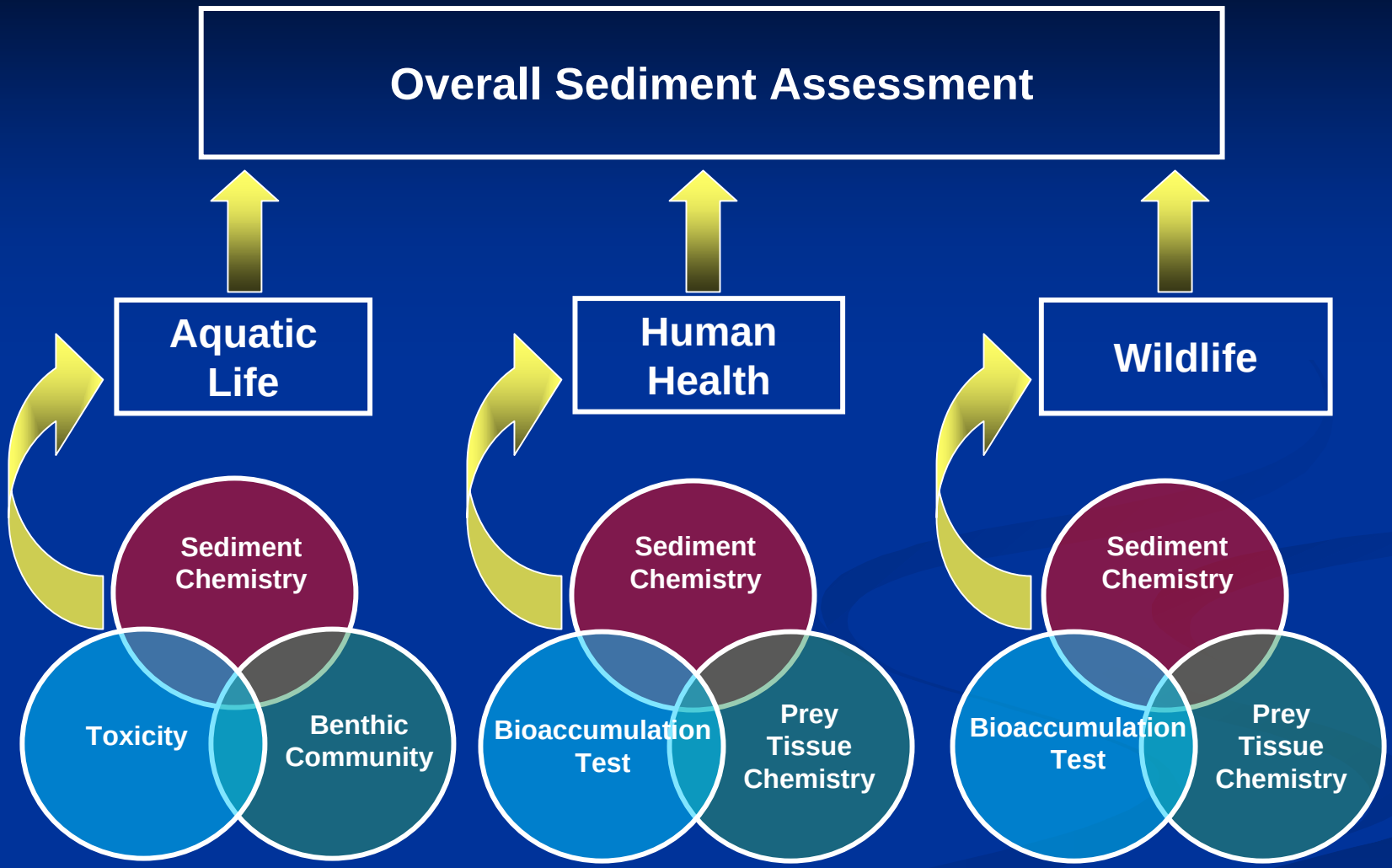
- Draft Narrative Objectives
  - "Pollutants in sediments shall not bioaccumulate in shellfish or fish tissue at a level that poses an unacceptable risk to human or wildlife health. To implement this narrative objective, multiple lines of evidence will be applied."
- Questions to address
  - Are fish/shellfish a risk to consumers?
  - Are sediment pollutants entering the food web?
  - Are pollutants in sediments high enough to account for tissue contamination observed in local fish/shellfish?

Objectives of Indirect Effects Task

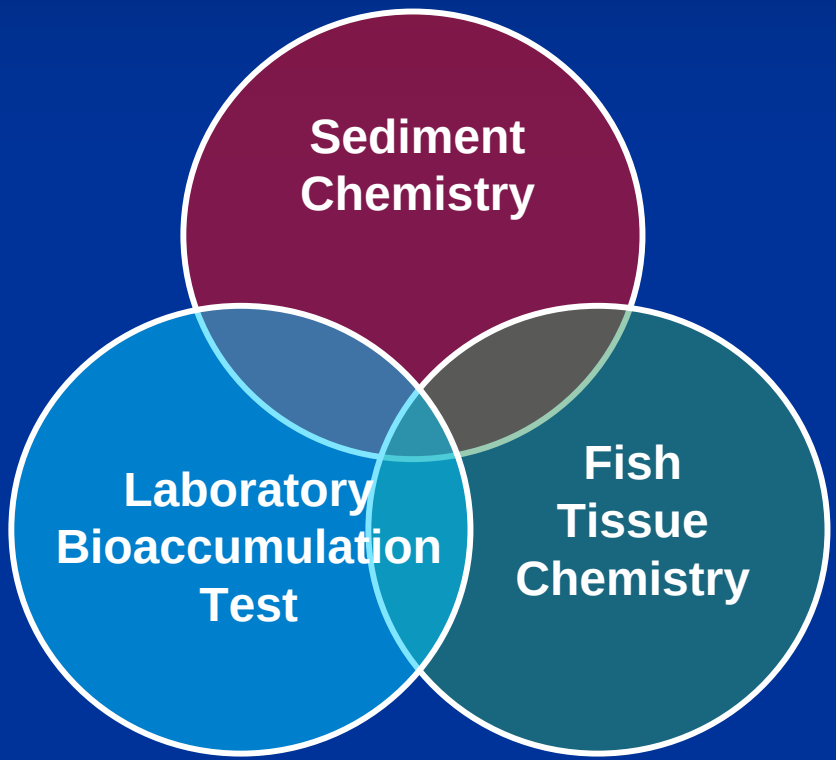
- Develop Assessment Framework
  - Address state narrative objectives and questions
  - Feasible approach for application on a water-body specific basis
- Technical Guidance
  - Address issues in framework application
  - Species, sample sizes, parameters, thresholds, BAFs
- Examples of Application
  - Demonstrate use of framework for chlorinated organic Compounds in two water bodies

Status and Process

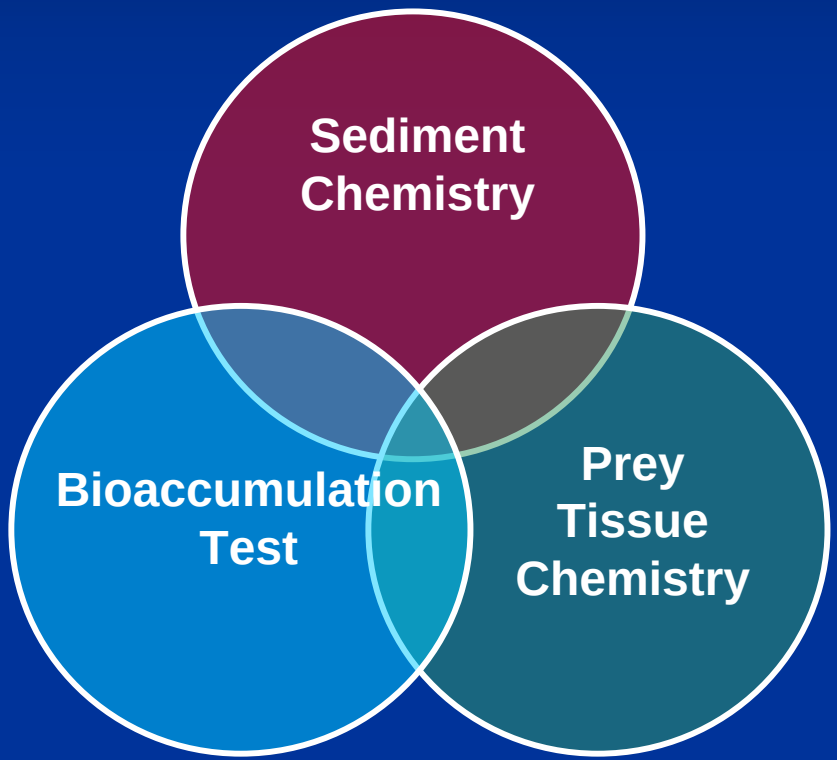
- Draft Technical Report
  - First 5 chapters provided to SSC
  - Remaining 5 chapters completed in March
- Review Process
  - State Board will review findings
  - Assumptions and components of proposed framework will be publicly reviewed as part of the state's Functional Equivalent Document
- Indirect Effects SQO
  - Narrative objectives
  - State will need to decide whether/how much to include the framework we present as technical guidance for implementing the narrative objectives


Overall Sediment Assessment
Aquatic Life
Human Health
Wildlife
Sediment Chemistry
Toxicity
Benthic Community
Sediment Chemistry
Bioaccumulation Test
Prey Tissue Chemistry
Sediment Chemistry
Bioaccumulation Test
Prey Tissue Chemistry

Indirect Effects Multiple Lines of Evidence

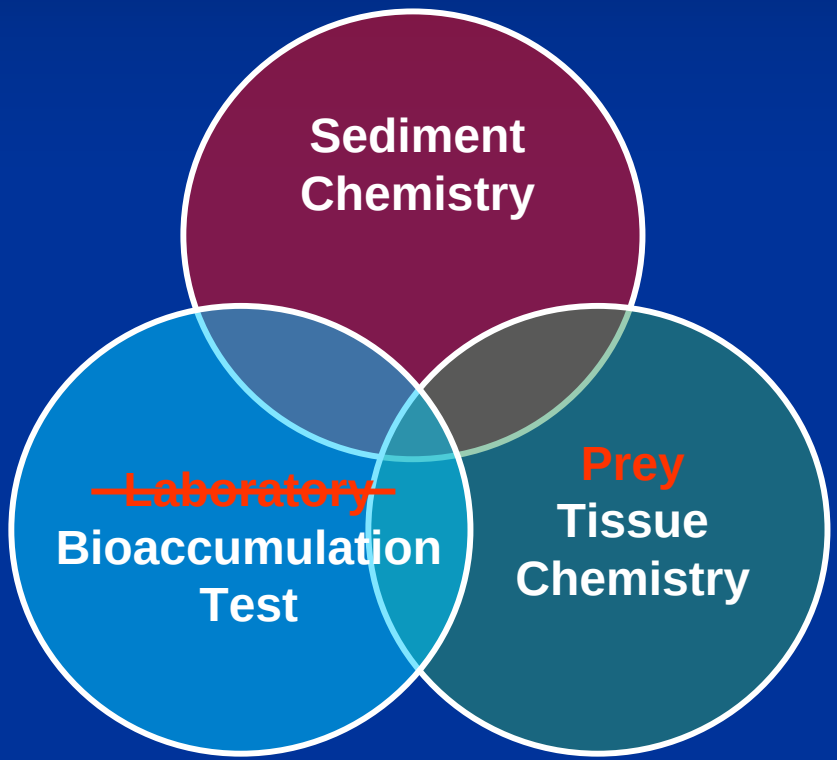


Multiple Lines of Evidence
Feedback From Stakeholders/Agencies



- Fish may not be the protective indicator for some contaminants (e.g., As, Se, PAH)
- Laboratory bioaccumulation test may not be available
  - Recommend option of field-caught invertebrates
- State of the science and policy status not far enough along to warrant developing an approach for effects to fish

Multiple Lines of Evidence
Feedback From Stakeholders/Agencies



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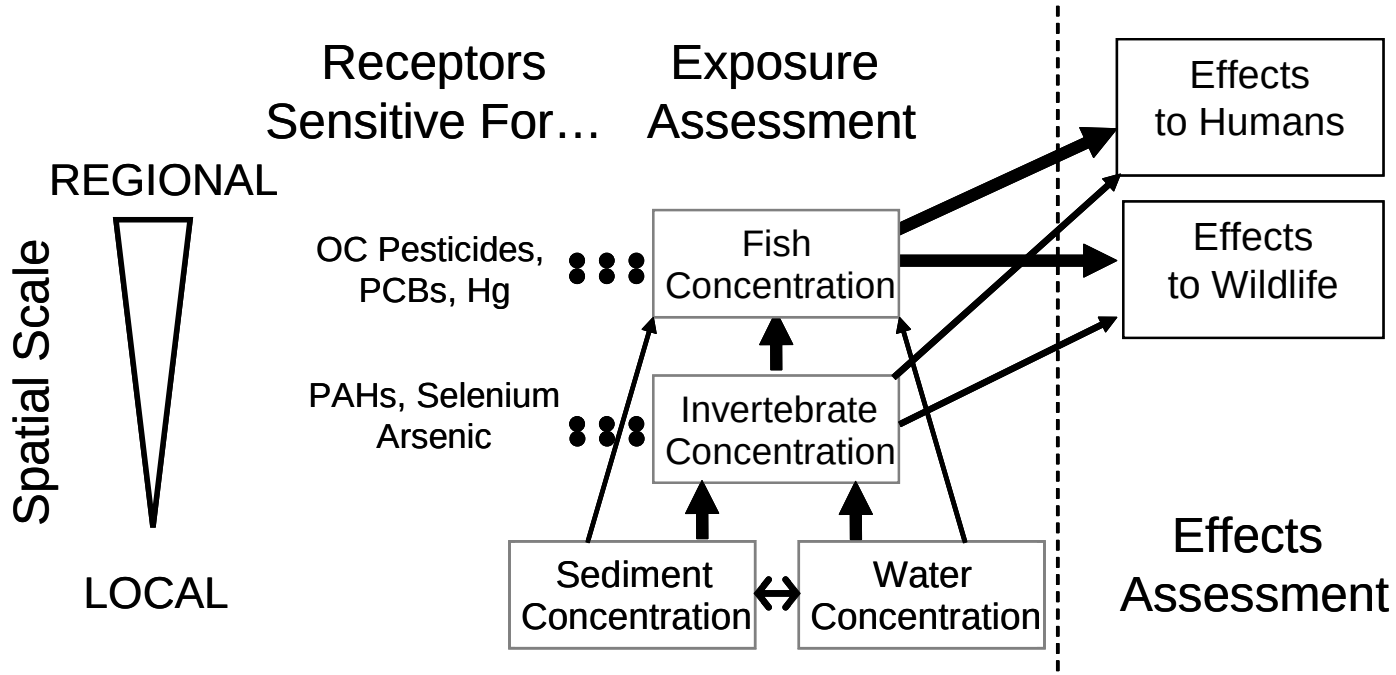
Conceptual Model



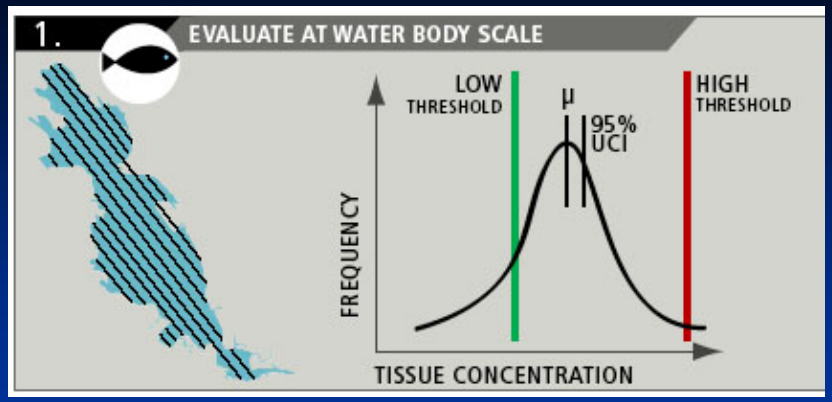
Key Drivers:

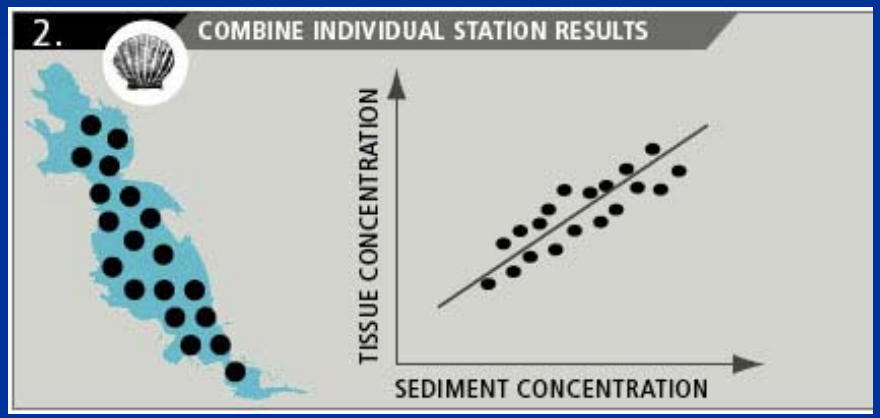
- Diet
- Lipids & Weight
- Spatial scale
- Chemical Partitioning

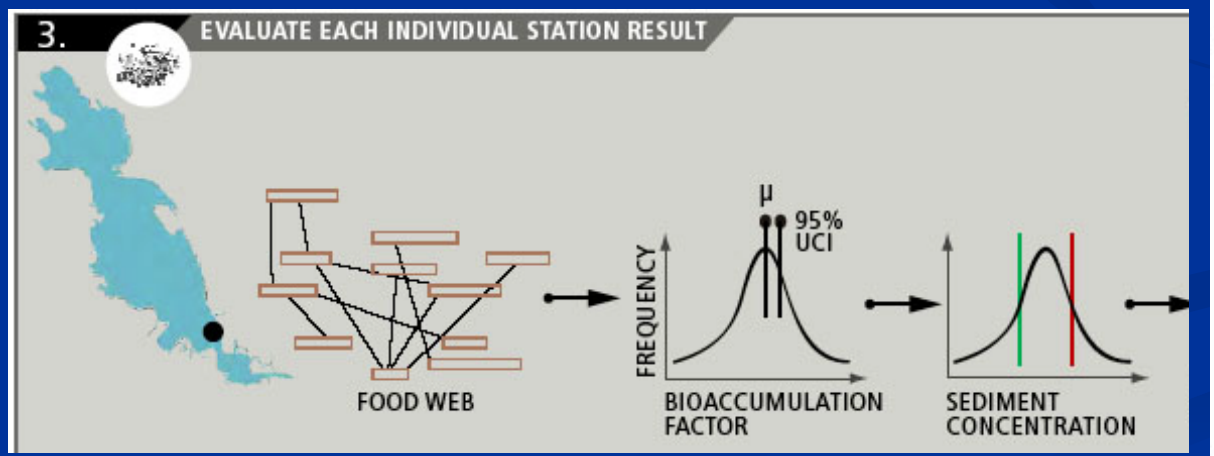
Key Drivers:

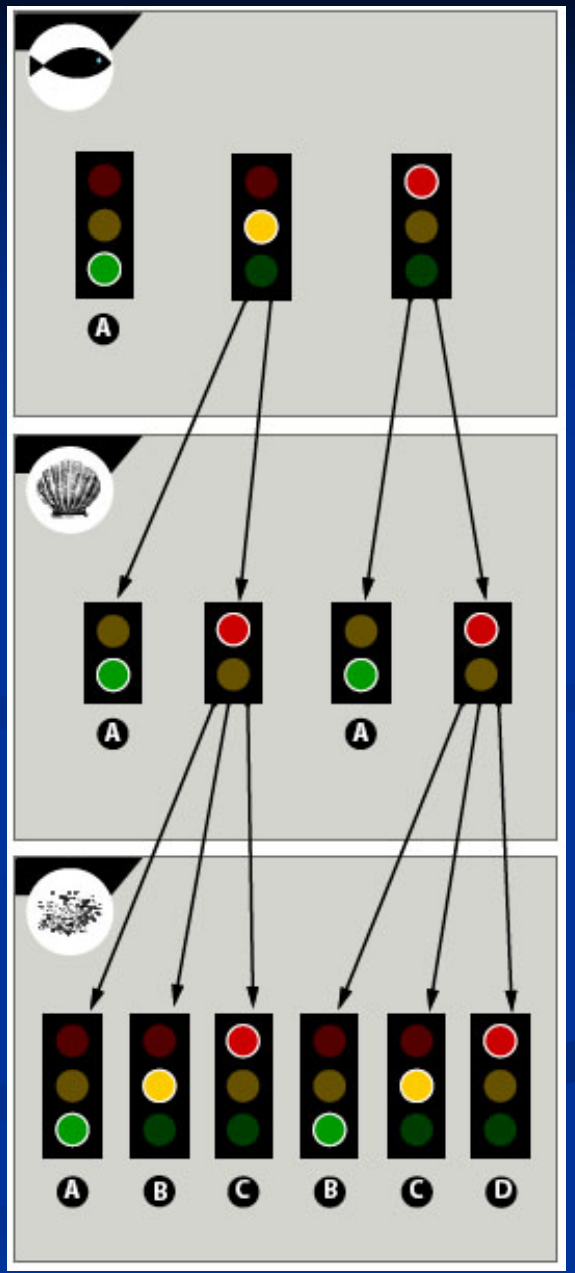
- Consumption Rate
- Size
- Allowable Risk

Report Describes an Implementation Approach. Will discuss Application Now.



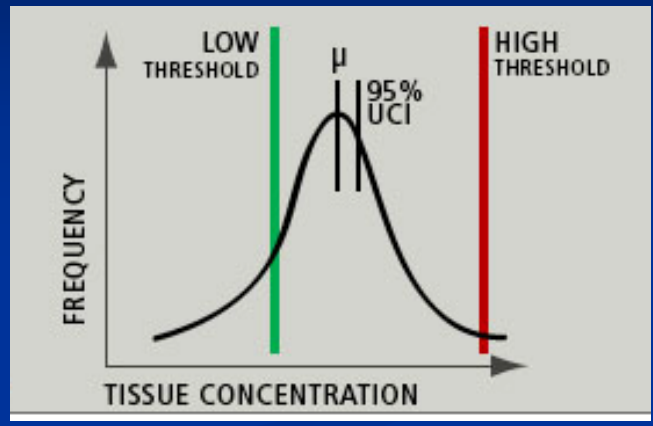


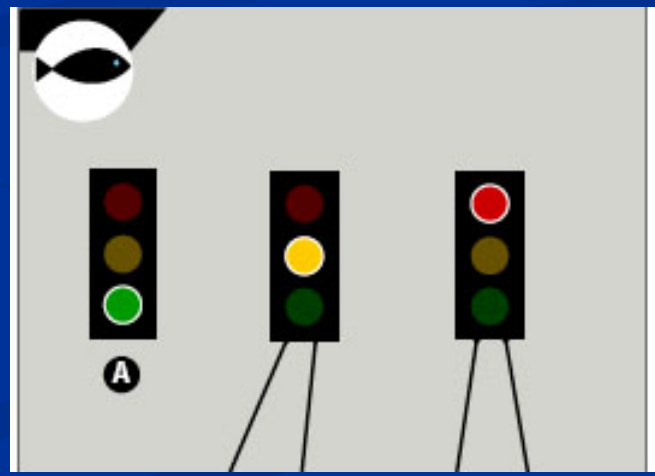




Application
1. Prey Tissue

- Are fish/shellfish a risk to consumers?
  - First, are there CA EPA consumption advisories in place?
  - Combine data at water body scale
  - Compare concentrations to two exposure thresholds
    - Low - Below which adverse effects are unlikely
    - High – Above which adverse effects are likely
  - Finfish or shellfish
  - Below low threshold – objective would be met – no need to proceed to other LOE





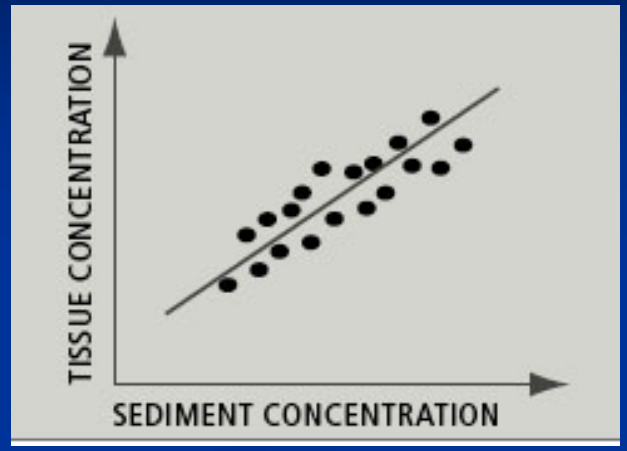
Definition of “Threshold”

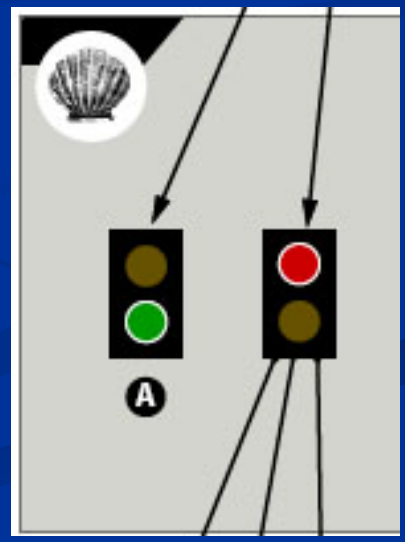
Threshold: a numeric concentration in prey or sediment that indicates a specified level of risk of adversely affecting human or wildlife consumers.

Threshold specification requires policy decisions

Application
2. Bioaccumulation Test

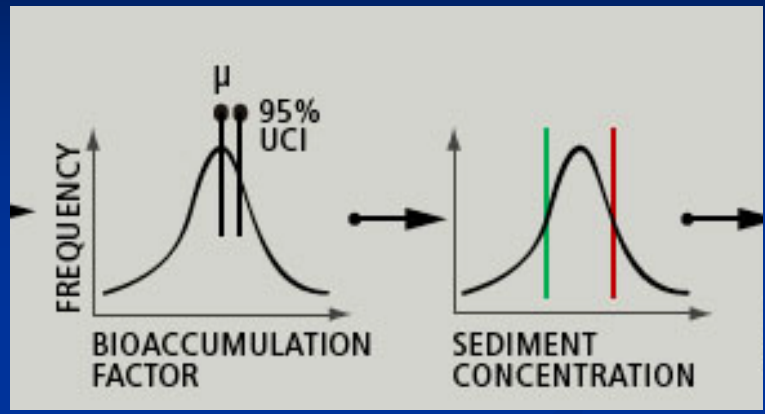
- Are pollutants in sediment entering the food web?
  - Simple hypothesis test
    - Ho: sediment contaminants not biologically available
    - Ha: sediment contaminants are biologically available
  - Evaluate data at water-body scale
  - Clear indication of no bioaccumulation – sediments can not be causing the exposure – no need to proceed to sediment chemistry

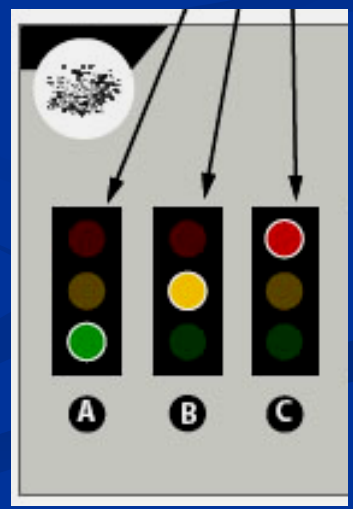




Application
3. Sediment Chemistry

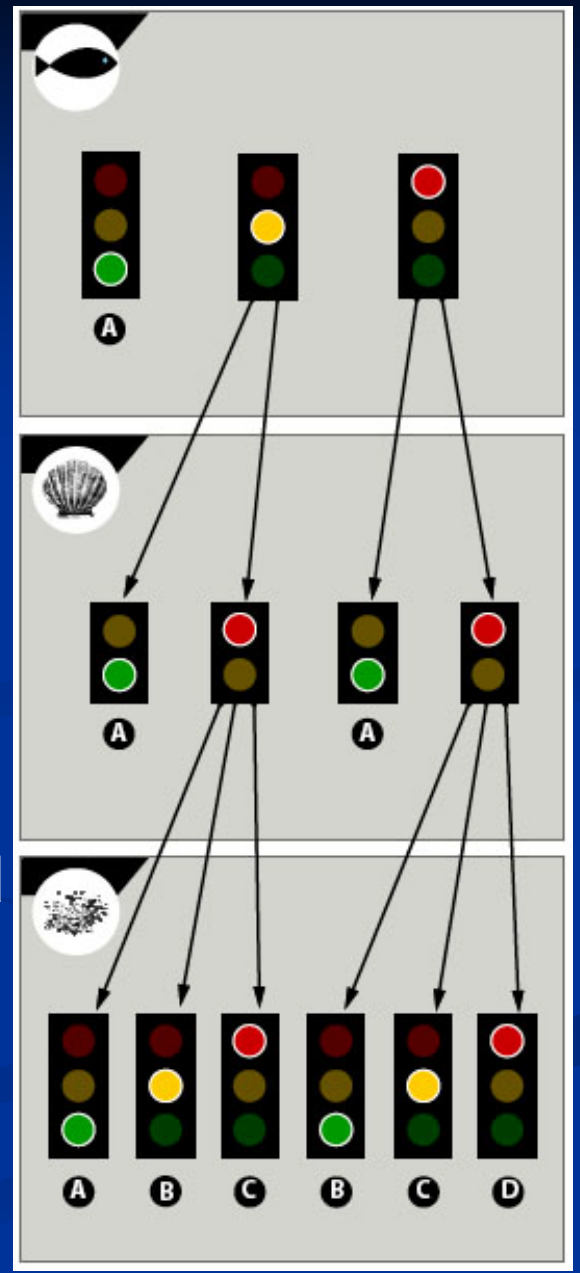
- Are pollutants in sediment high enough to cause risk to consumers of contaminated fish/shellfish?
  - Evaluate individual sediments
  - Compare concentrations to two exposure thresholds
  - Sediment Threshold = Field Tissue Threshold / (BAF or BSAF)





Decision Tree

- Field prey or bioaccumulation test LOE determine whether individual sediment assessment is required
  - Below low threshold - Unlikely impact
  - No bioaccumulation – Unlikely impact
- Field prey LOE between two thresholds and bioaccumulation indicated
  - Individual sediments categorized: Unlikely, Possible, or Likely impact
- Field prey LOE above high threshold and bioaccumulation indicated
  - Individual sediments categorized: Possible, Likely, or Clear impact



Sequential Application

- Driver is beneficial uses – look at tissue first
  - If exposure is low, no need to evaluate further.
- If sediment contaminants are not bioavailable, then the sediments are not the source
- Sediment chemistry evaluation most difficult
  - Focus efforts and resources on contaminants that pose a probable risk

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Technical Issues

- Threshold selection
- Issues raised previously by SSC
  - Bioaccumulation LOE
    - How it fits in framework
    - Target species
    - Field vs. Lab
  - Scale of Application

Use of Bioaccumulation Test

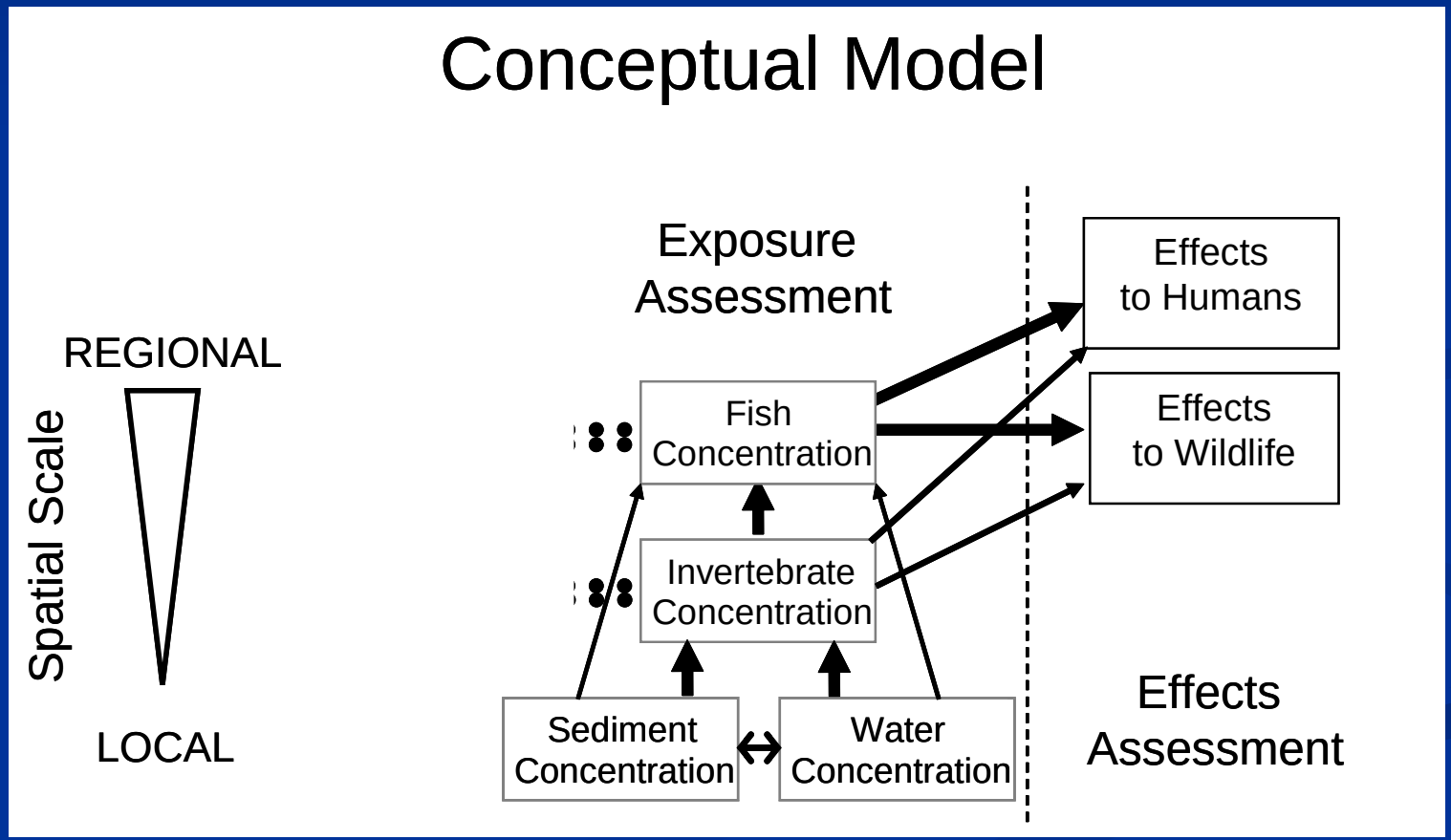
- Recommended lab test organism for trace organics – *Macoma nasuta*

Species	Contaminant	N	Frequency of Detection
Macoma nasuta	4,4'-DDE	178	71%
	alpha-Chlordane	112	50%
	Dieldrin	178	39%
	PCB 118	67	100%
Neanthes virens	4,4'-DDE	53	58%
	alpha-Chlordane	39	0%
	Dieldrin	65	8%
	PCB 118	0	0%
Nephtys caecoides	4,4'-DDE	40	65%
	alpha-Chlordane	9	0%
	Dieldrin	40	22%
	PCB 118	3	33%

Spatial Scale of Application

- Issue consistently raised by committees
- Recommending standardized approach
  - Prey tissue and bioaccumulation test LOE – water body scale
  - Sediment LOE
    - Develop BSAF with explicit consideration of spatial factors when necessary
    - Once BSAF developed, apply LOE at the individual station scale

Spatial Scale



Spatial Scale: Key Issues

- Issue # 1: what is definition of water body?
- Issue # 2: biota may not remain in water body
- Issue # 3: how consider spatial movement when developing BSAF

Spatial Scale

- Issue # 1: what is definition of water body?
  - Operationally defined, based on the needs of the agencies
  - General case, entire bay or estuary.
  - Smaller scale possible, if needed by agency.
    - Separate hydrological units (reaches or basins) for 303d listing purposes with sufficient data available on each of these units.
    - Superfund Sites handled by CERCLA

Spatial Scale

- Issue # 2: biota may leave water body
  - Must choose appropriate species
    - E.g. of poor choices – white sturgeon, striped bass, salmon
    - E.g. of good choices – spotted sand bass, shiner surfperch, flatfish, gobies
  - Possible to evaluate concern with statistics or site specific knowledge
    - Scale-dependent evaluation to confirm site affinity
    - If concentrations are lower outside the water body, this is less of a concern

Spatial Scale

- Issue # 2: biota may leave water body
  - Must choose appropriate species

Human Prey		Wildlife Prey	
Species	**Movement**	**Species**	**Movement**
B. Smoothhound	Transient	Arrow Goby	Resident
C. Halibut	R/T *	Black Perch	Resident
D. Turbot	Resident	California Halibut	R/T*
O. Corvina	Transient	C. Killifish	Resident
Round Stingray	Transient	Diamond Turbot	Resident
Striped Mullet	Transient	P. S. Sculpin	Resident
S. Sand Bass	Resident	Shiner Surfperch	Resident
Y. Croaker	Transient	Cheekspot Goby	Resident
Barred Sand Bass	Transient		
C. Corbina	Transient		
Fantail Sole	Transient		
Spotfin Croaker	Transient		
S. Turbot	Transient		

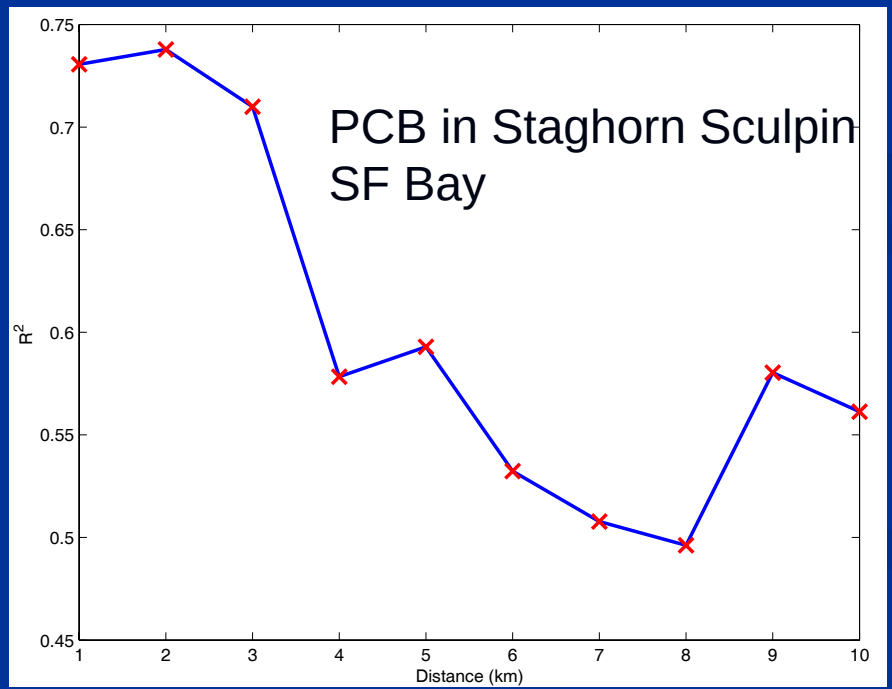
Spatial Scale

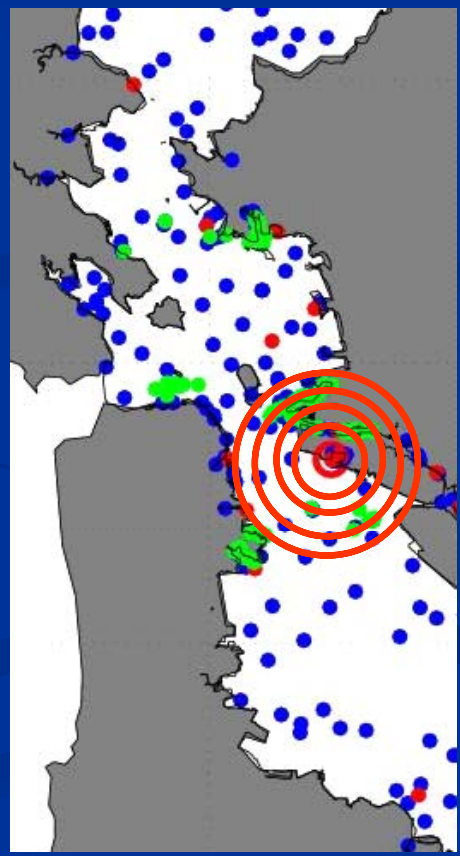
- Issue # 3: how consider spatial movement when developing BSAF?
  - Target species selection
  - Empirical calculations based on home-range estimates
  - Probabilistic approaches (monte carlo simulation)

Spatial Scale

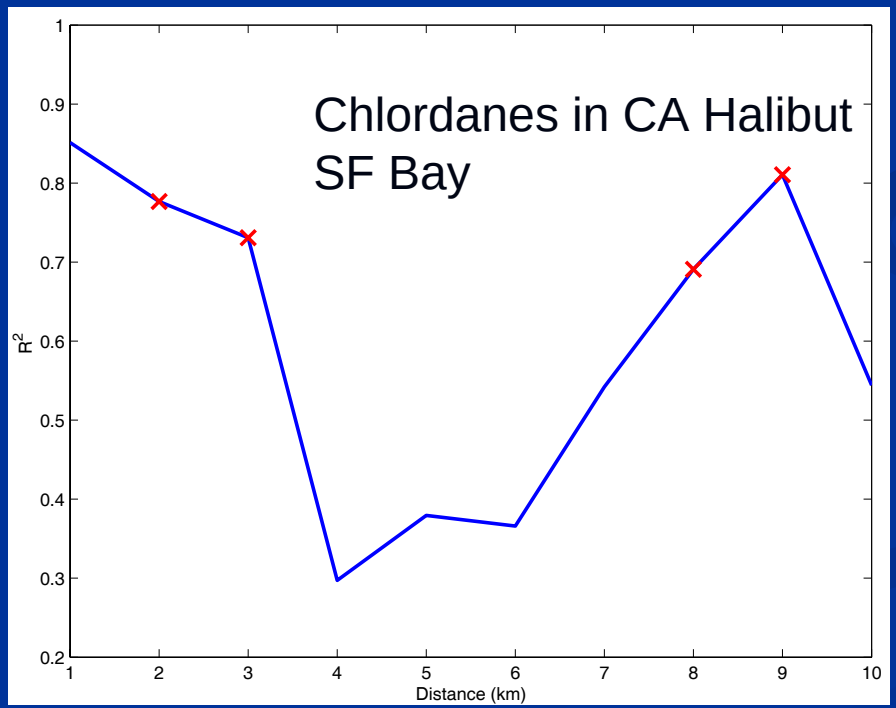
- Issue # 3: how consider spatial movement when developing BSAF?
  - Target species selection
    - Species to develop BSAF for sediment chemistry LOE may be different from species to represent prey tissue LOE

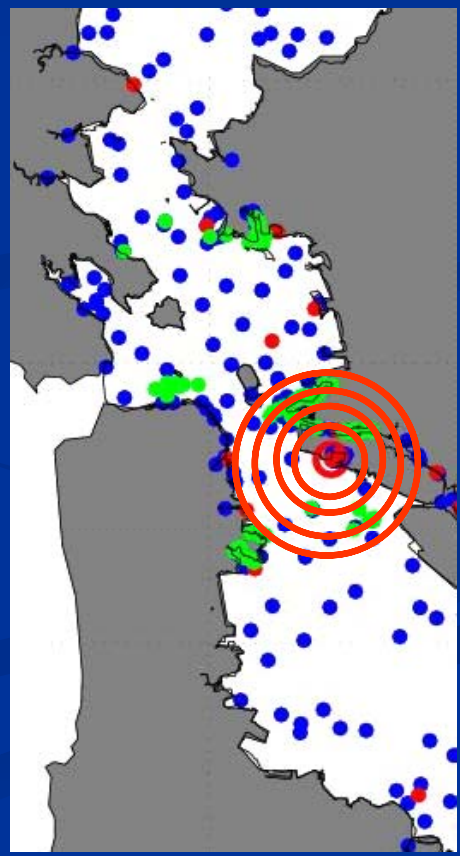
- Empirical calculations based on home-range estimates
  - Fish concentrations compared with sediments in a disk centered at each fish sampling location.
  - Use regression results to estimate best averaging scale





- Empirical calculations based on home-range estimates
  - Fish concentrations compared with sediments in a disk centered at each fish sampling location.
  - Use regression results to estimate best averaging scale
  - Requires large sample sizes and doesn't always work out





Spatial Scale

- Issue # 3: how consider spatial movement when developing BSAF?
  - Probabilistic approaches (monte carlo simulation)

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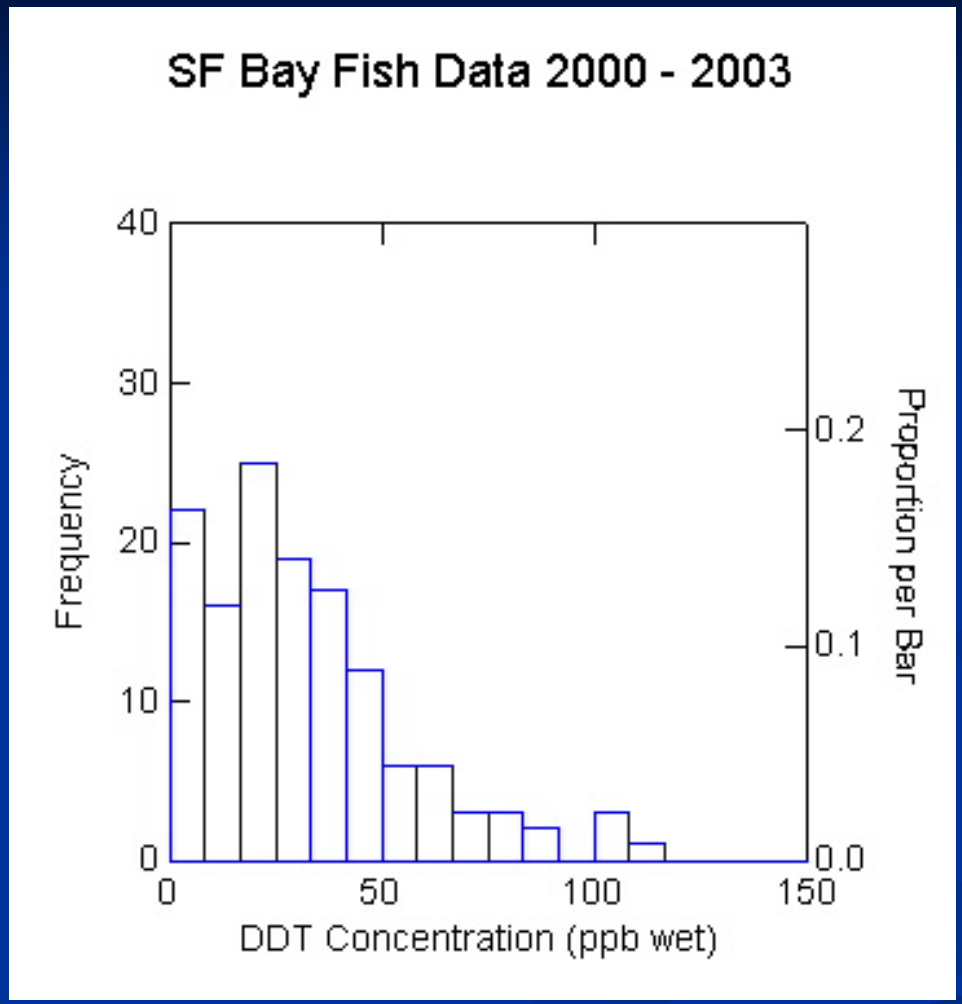
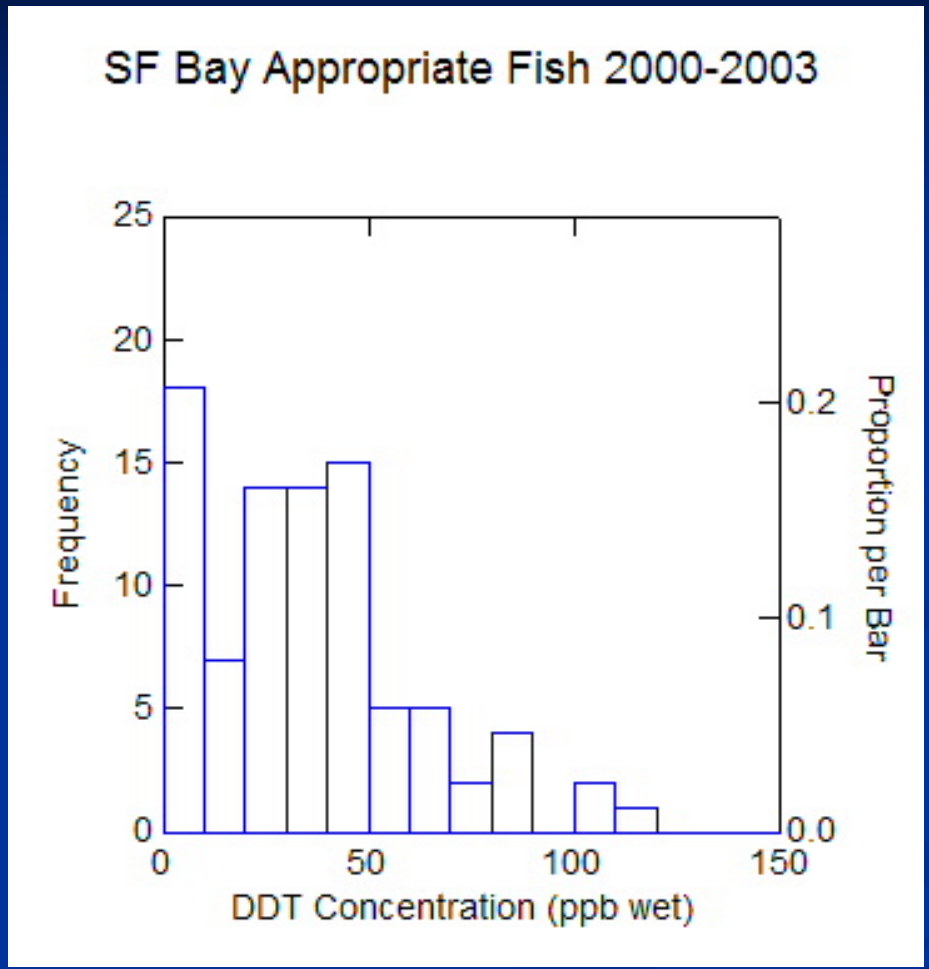
Example: SF Estuary Case Study

- Goal: illustrate how the framework would be applied
- Fish Tissue Chemistry LOE
  - DDTs in fish - human health target
  - Recent fish tissue data
  - Fish tissue thresholds described in draft report



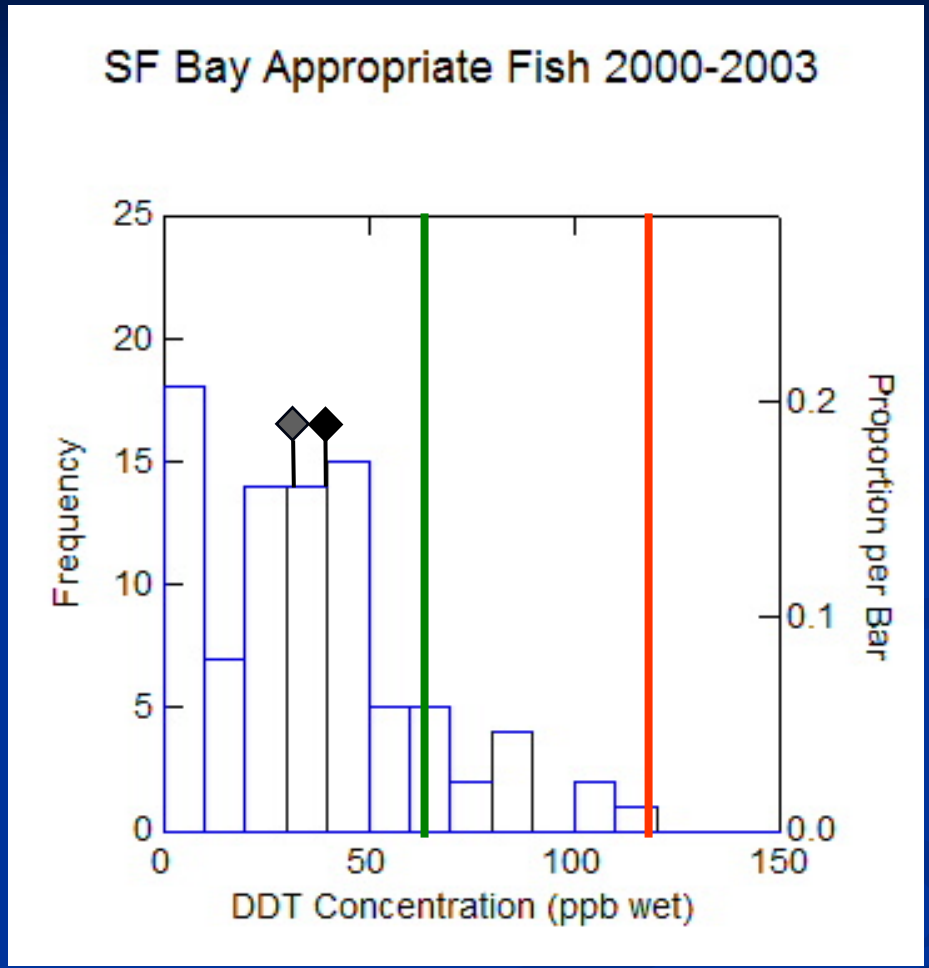
Compile Target Tissue Data – Human Prey Species

	Food Web	Range
Anchovy		
California Halibut	X	X
Herring		
Jacksmelt		
Leopard Shark	X	X
Sardine		
Shiner Surfperch	X	X
Striped Bass		
White Croaker	X	X
White Sturgeon	X	

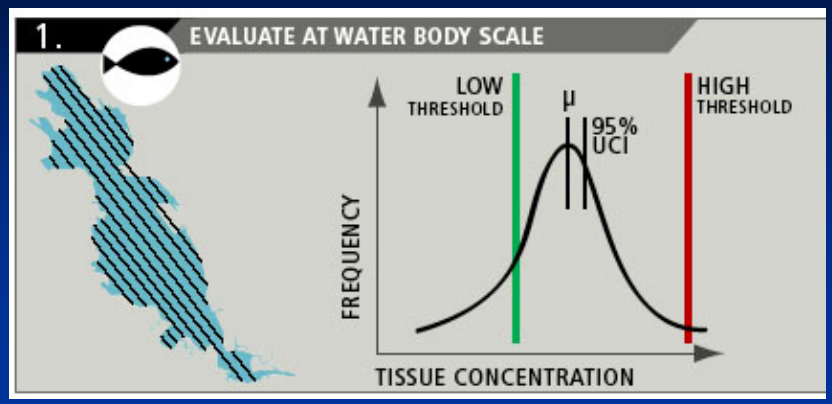


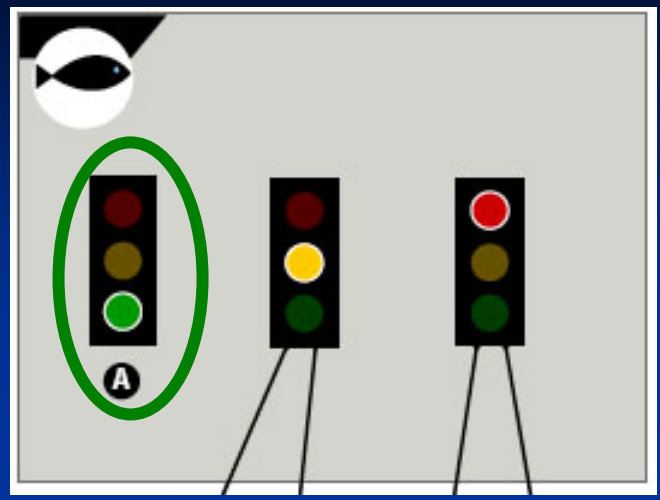
Select Appropriate Subset of Species

Average	34.9
High Threshold	118
SE	2.9
95% UCI of Mean	40.5
Low Threshold	64



Compare Average Estimates to Thresholds



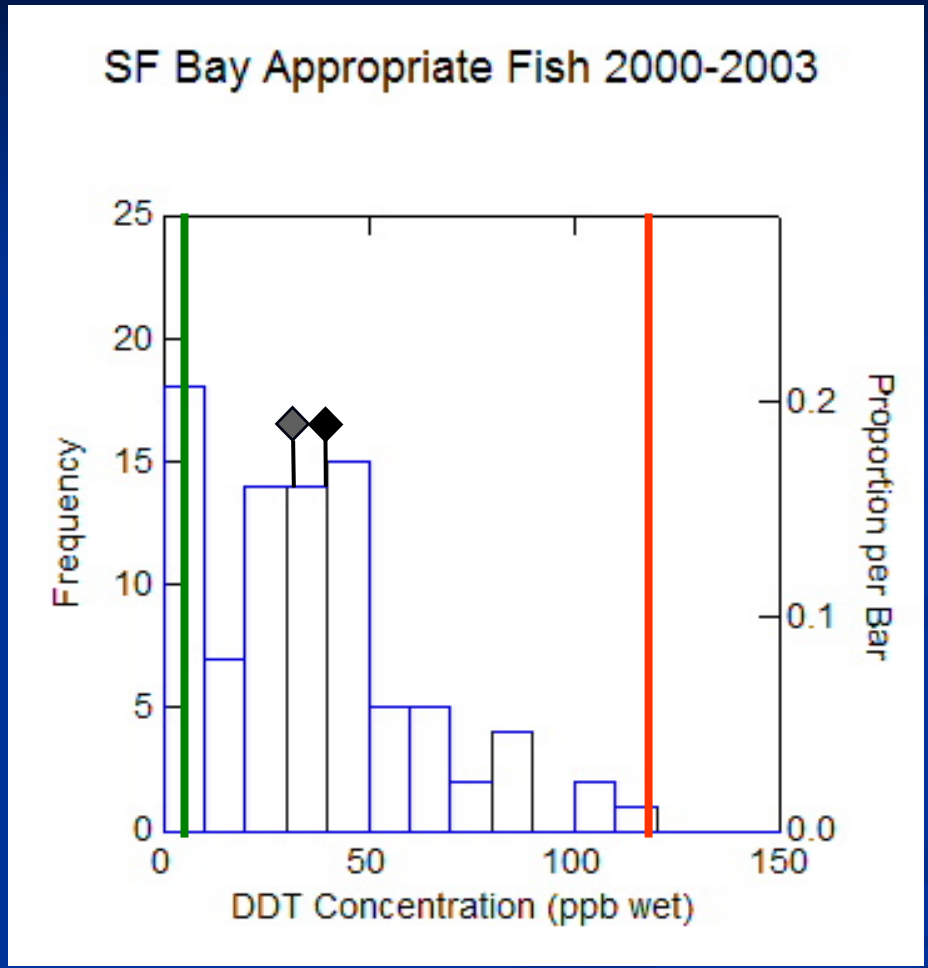


- Result for DDTs – Below low threshold – unlikely impact.
  - Sediments are protective for human health endpoint
- In this case, would not need to evaluate other LOE.

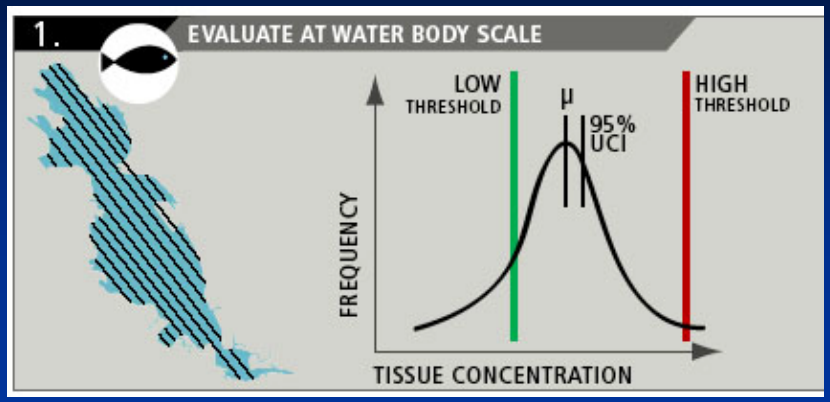
Thresholds – Science/Policy

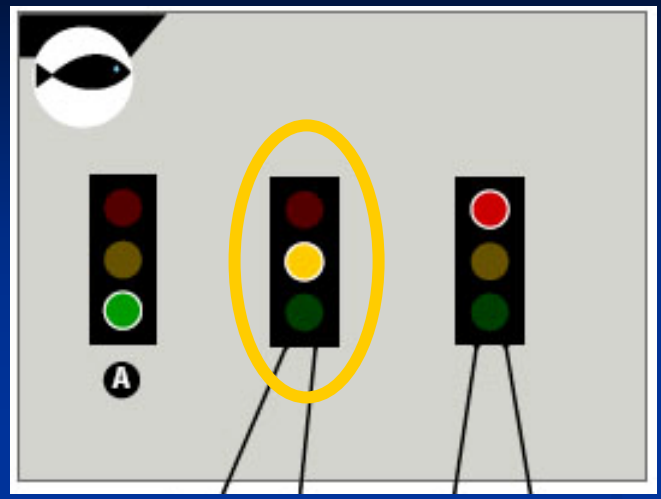
- The thresholds we presented had specific risk assumptions
  - Sport fisher and general public consumption rate
  - 10^-5 allowable increased cancer risk for carcinogens
  - Resulted in DDT thresholds of 64 and 118
- Thresholds chosen based in part on policy decisions
  - E.g., 10^-5 for high threshold and 10^-6 for low threshold. Other assumptions the same
  - Results in DDT thresholds of 6.4 and 118
- Now illustrate how the framework would work with these thresholds

Average	34.9
High Threshold	118
SE	2.9
95% UCI of Mean	40.5
Low Threshold	6.4

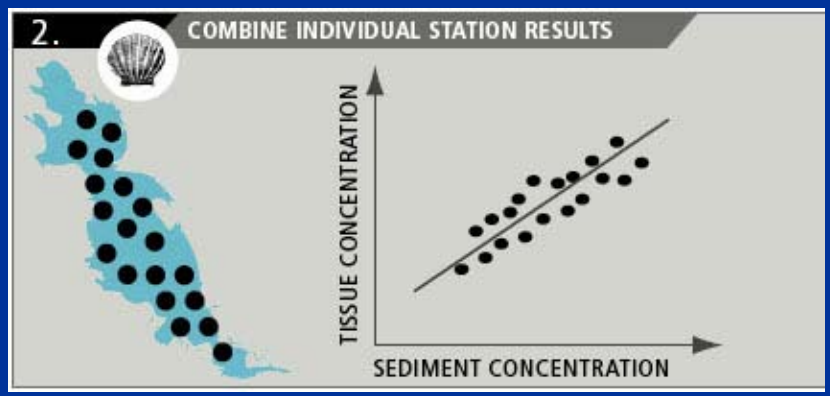


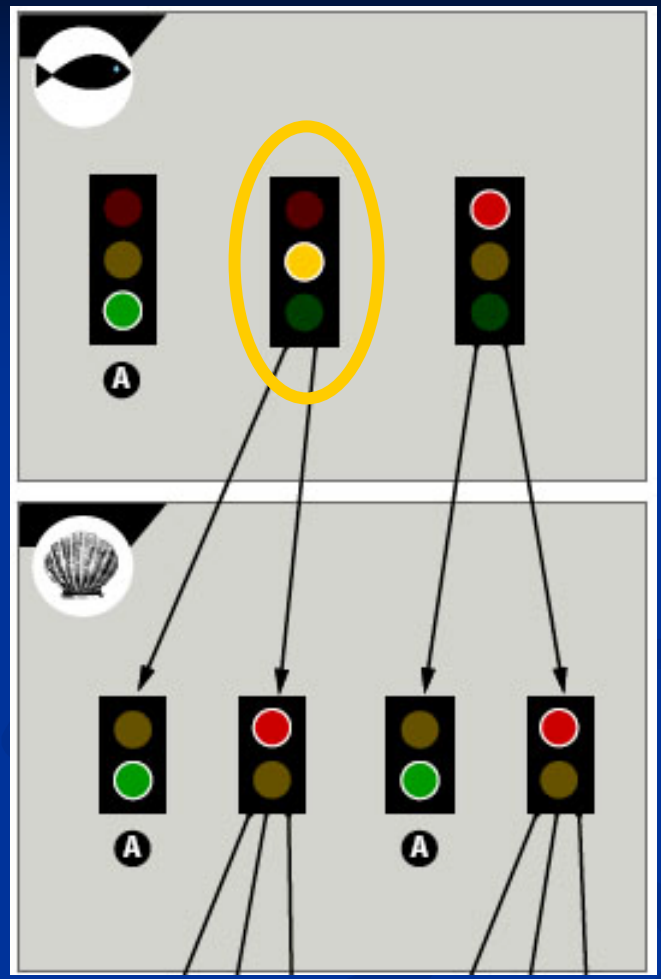
Compare Average Estimates to More Conservative Thresholds



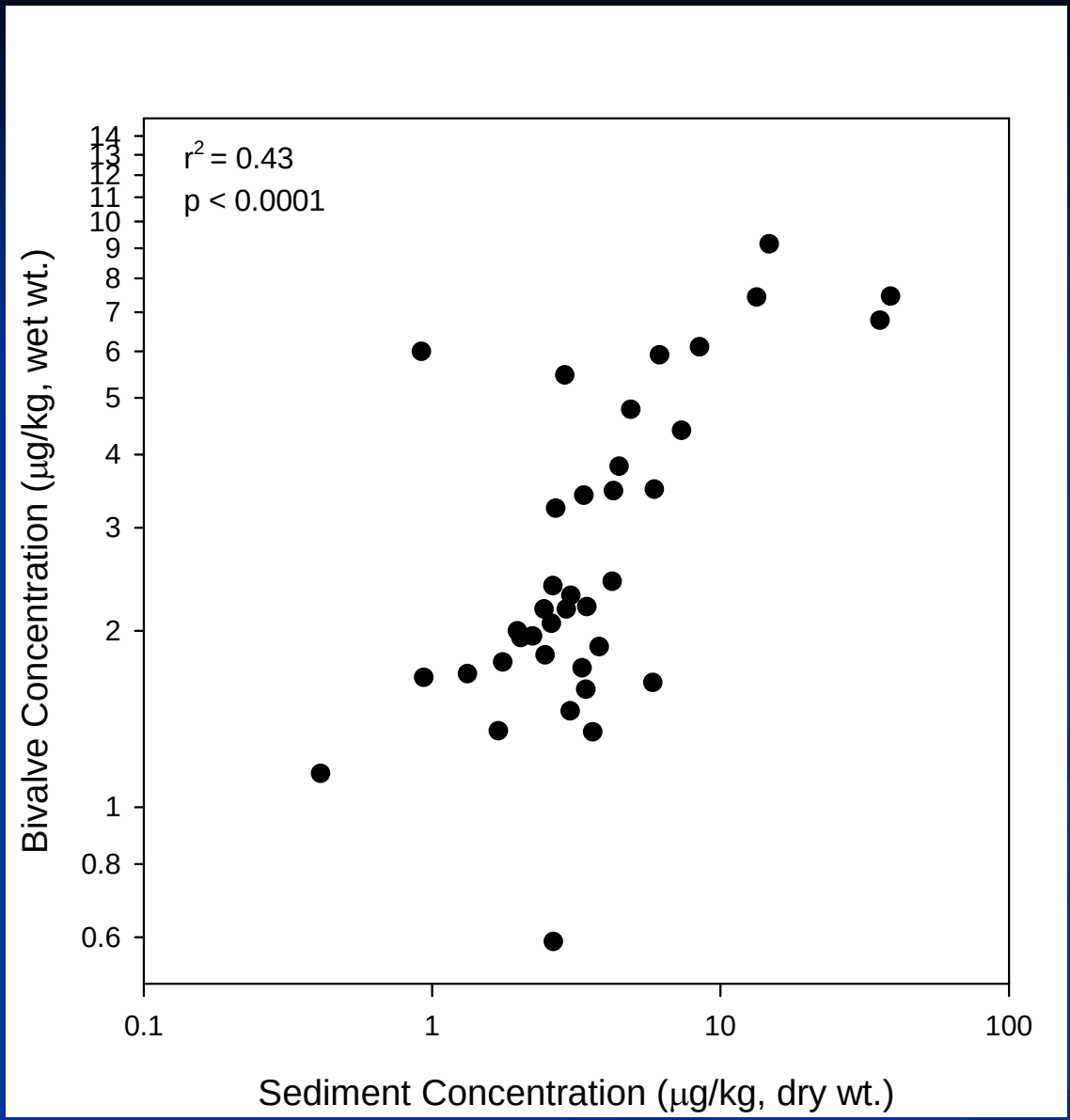


Average Estimates Are Between Thresholds



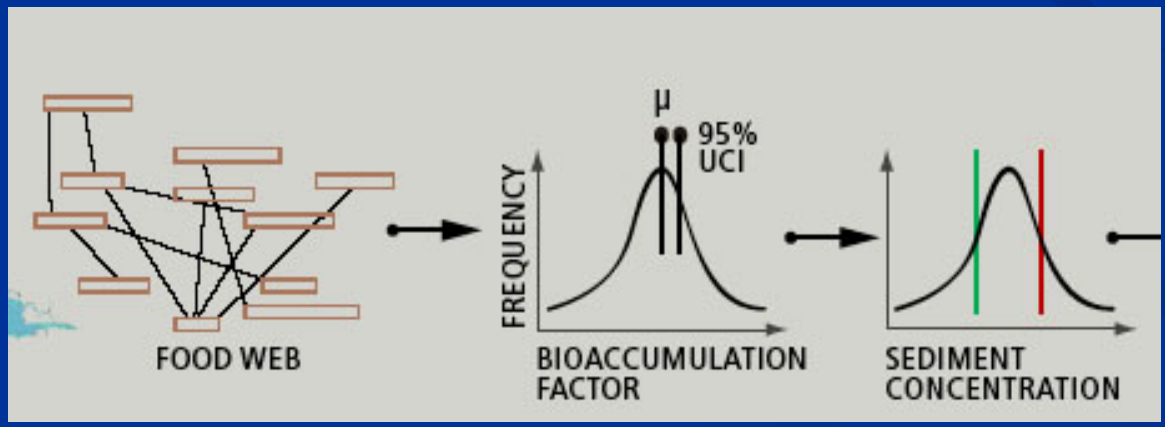


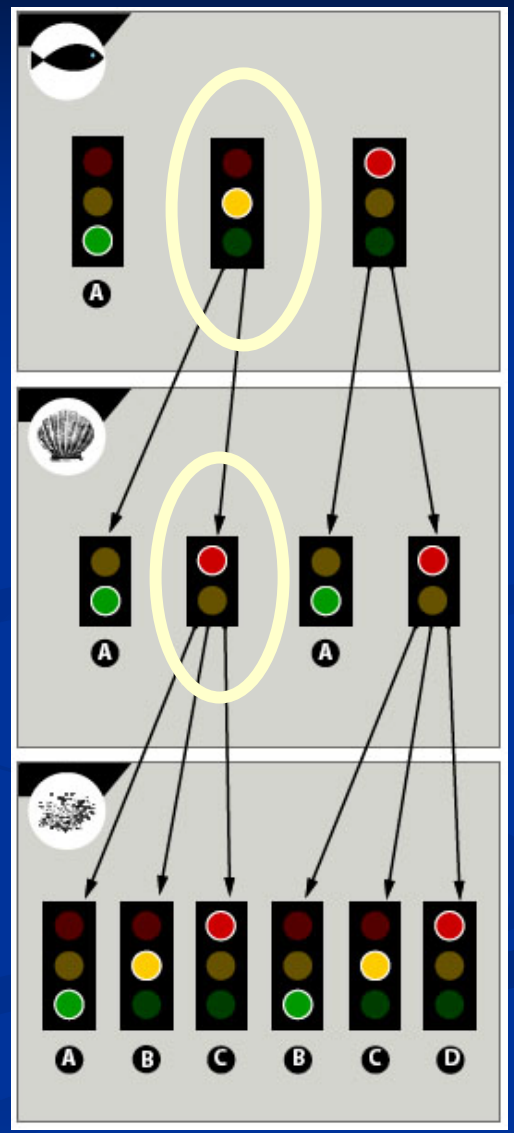
Continue to Bioaccumulation Test LOE
Bioavailable? Yes/No



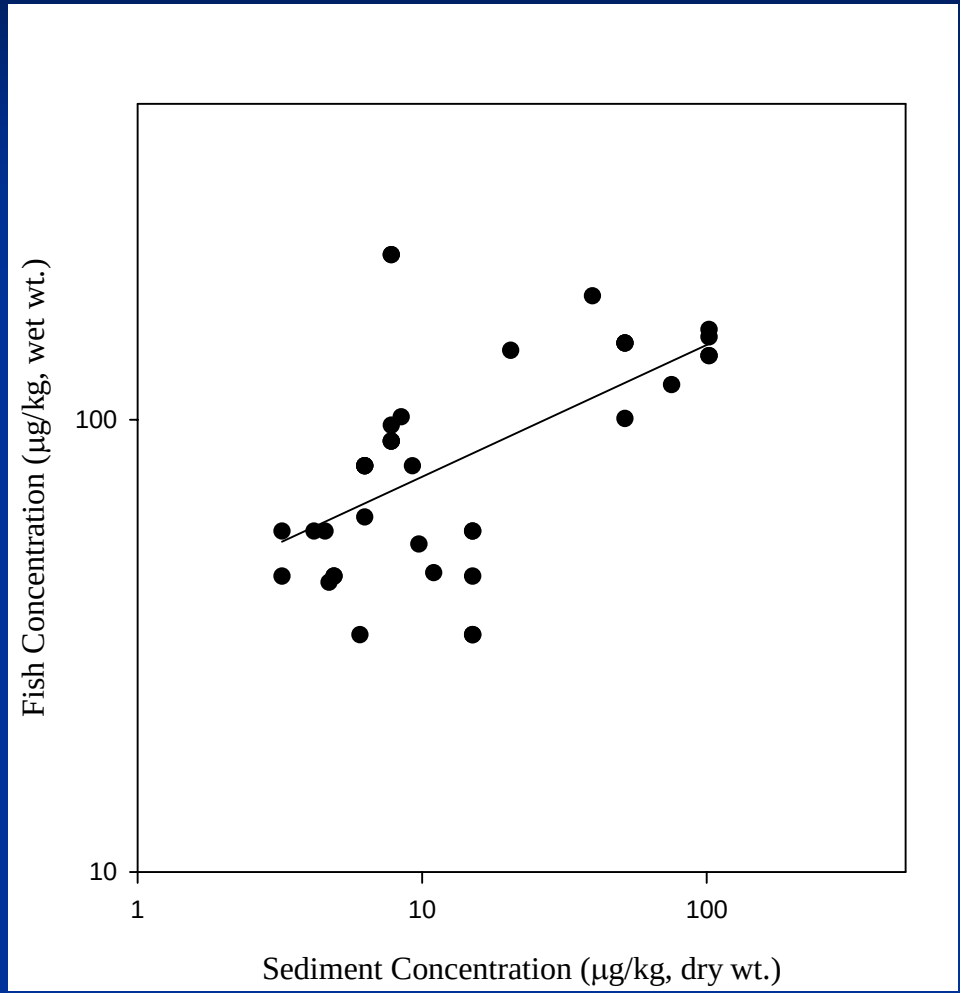
Significant relationship: Yes. Bioavailable? Yes

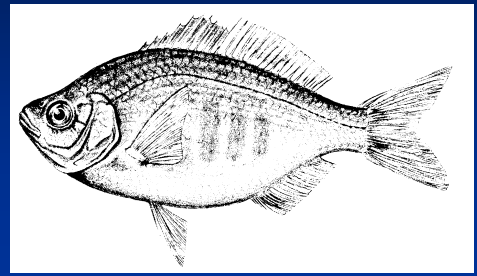
Continue to Sediment Chemistry LOE

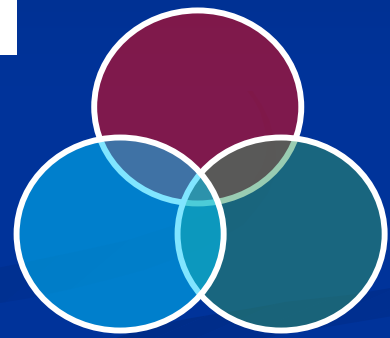




Select Appropriate Species to Develop Bioaccumulation Factor: Shiner Surfperch

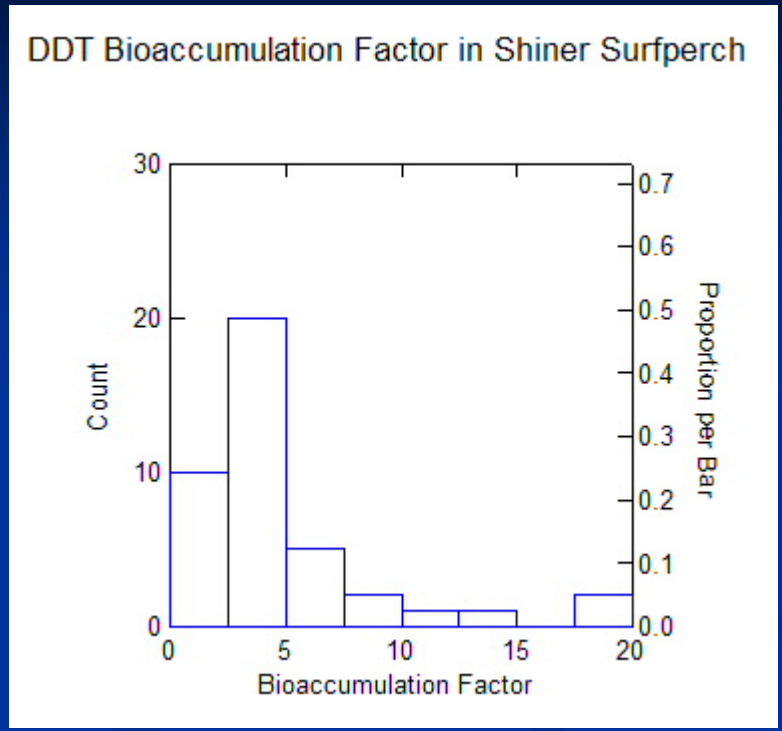


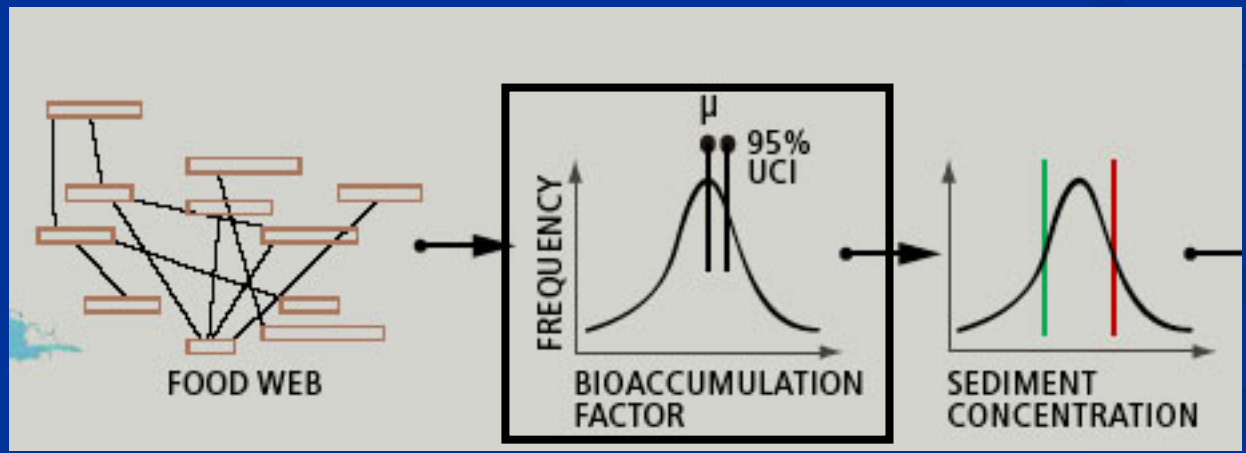




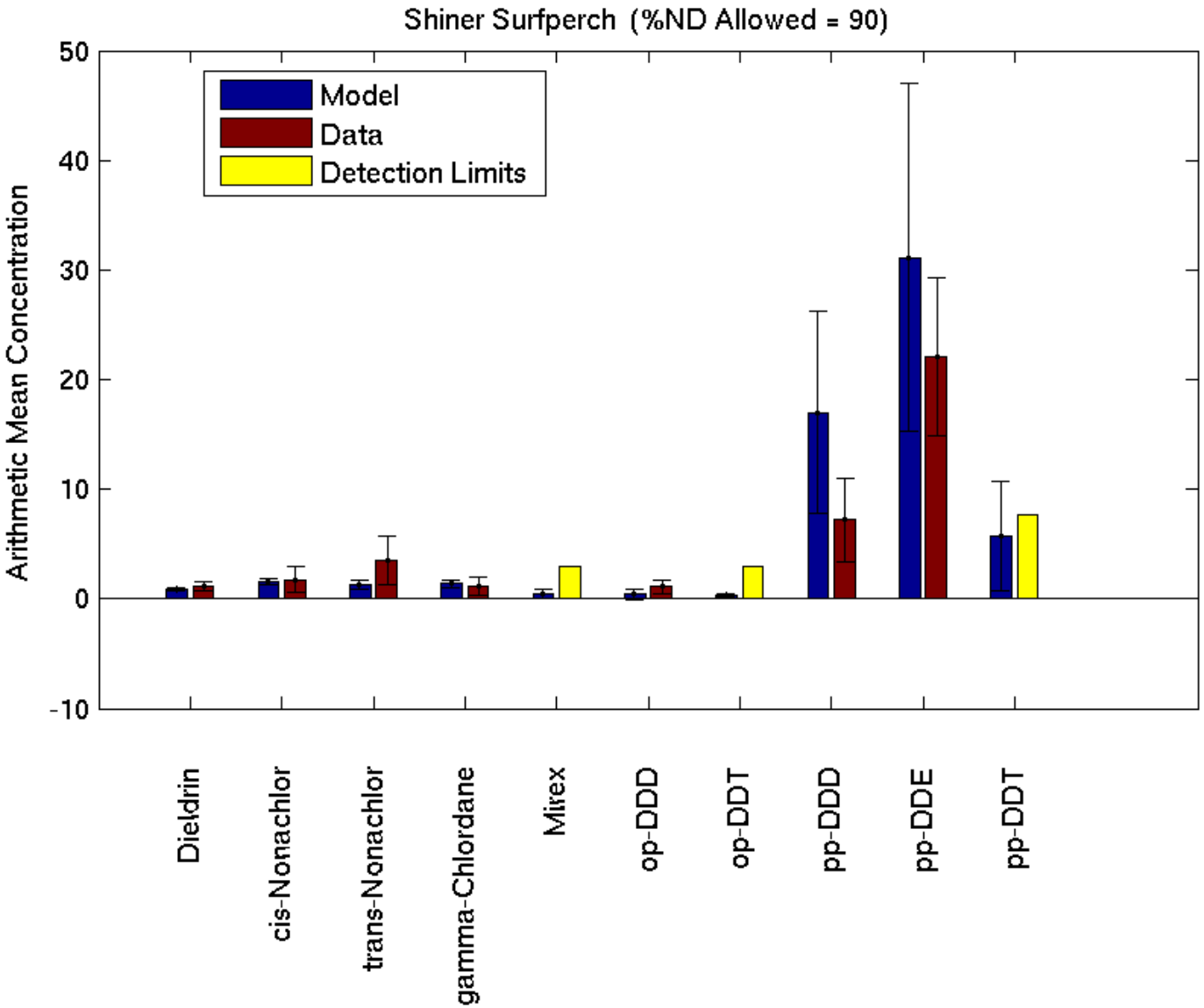
Contaminant	N	R^2	p - value
Chlordanes	36	0.25	0.002
Dieldrin	41	0.33	0.0001
Total DDTs	41	0.44	< 0.0001
Total PCBs	39	0.33	0.0001

Determine Bioaccumulation Factor At Appropriate Scale



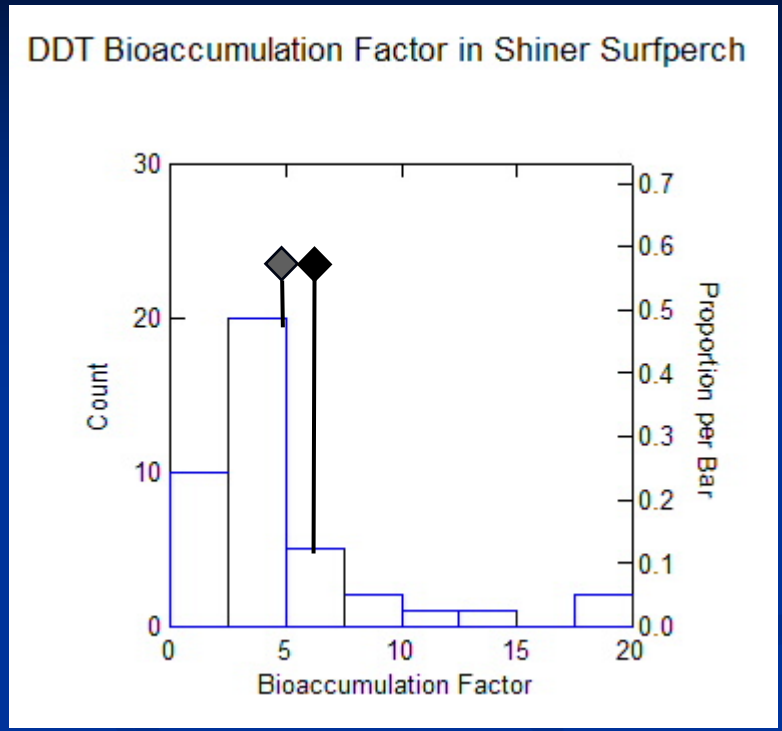


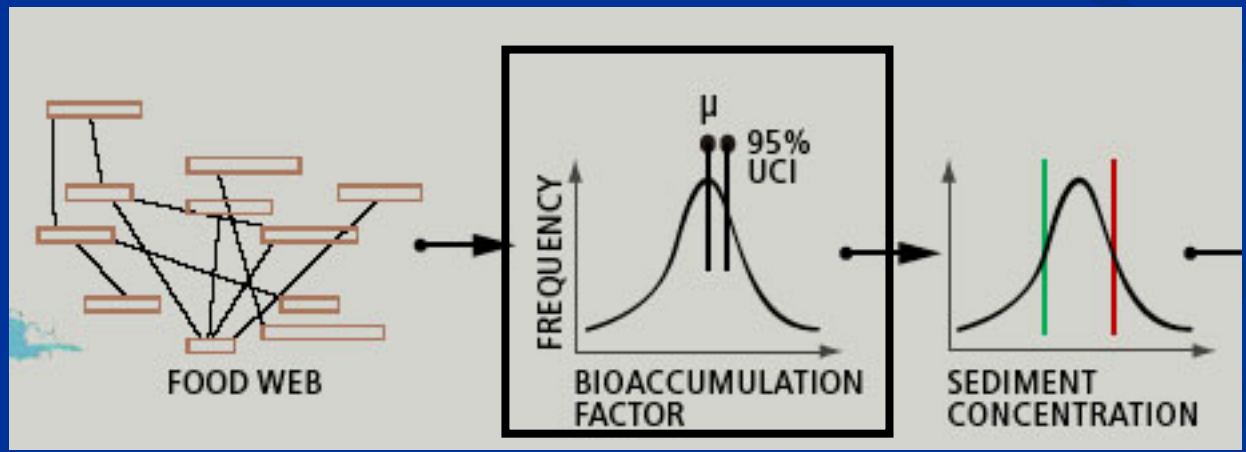
Corroborate With Mechanistic Model Results



Summarize Bioaccumulation Factor

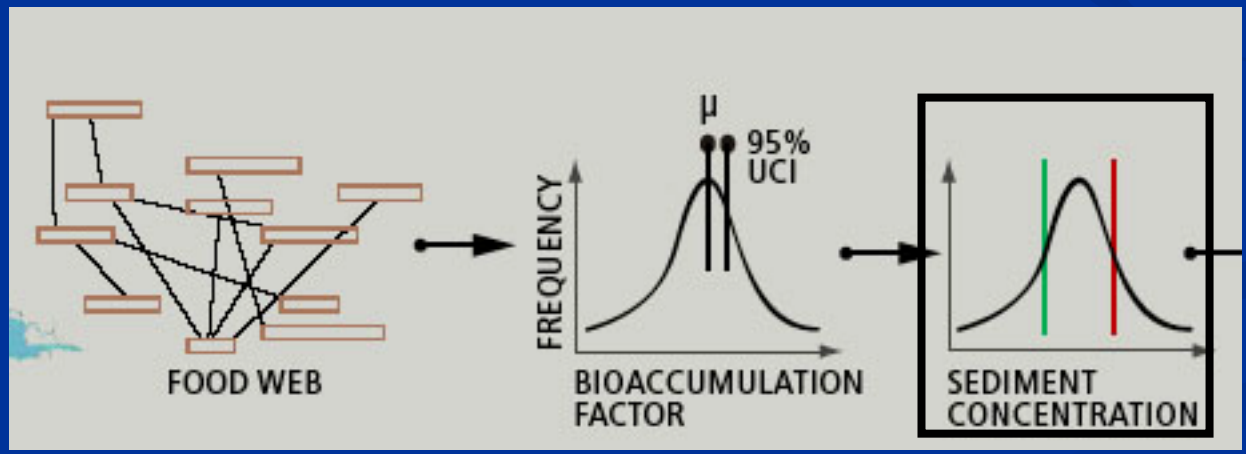
Average BAF ◆	5.0
SE	0.7
95% UCI of Mean ◆	6.4





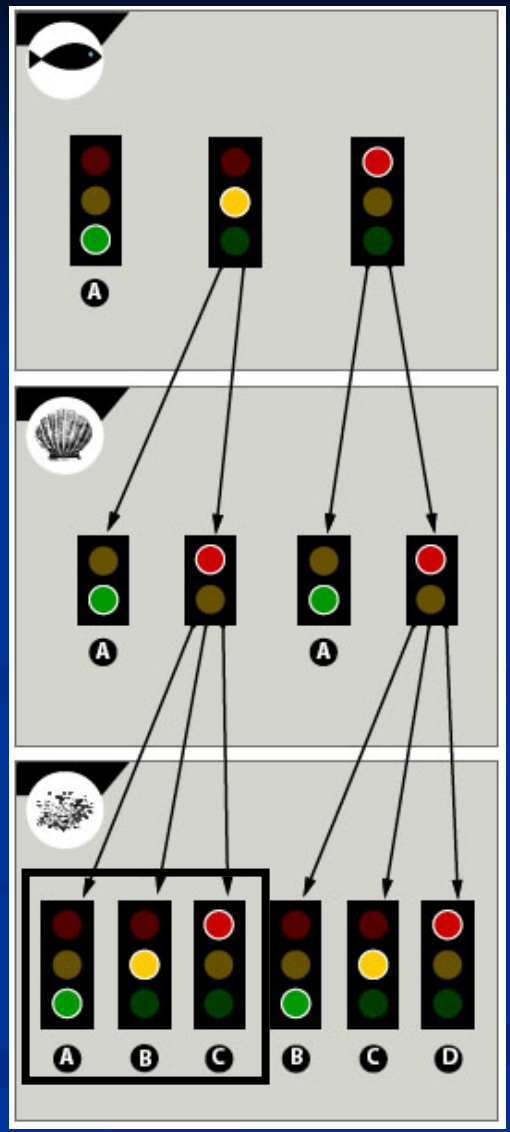
Combine Bioaccumulation Factor With Tissue Threshold To Calculate Sediment Threshold

Threshold Type	Risk	Tissue Threshold	BAF	Sediment Threshold
High	Higher	118	5.0	118/5 = 23.6
Low	Lower	6.4	6.4	6.4/6.4 = 1.0

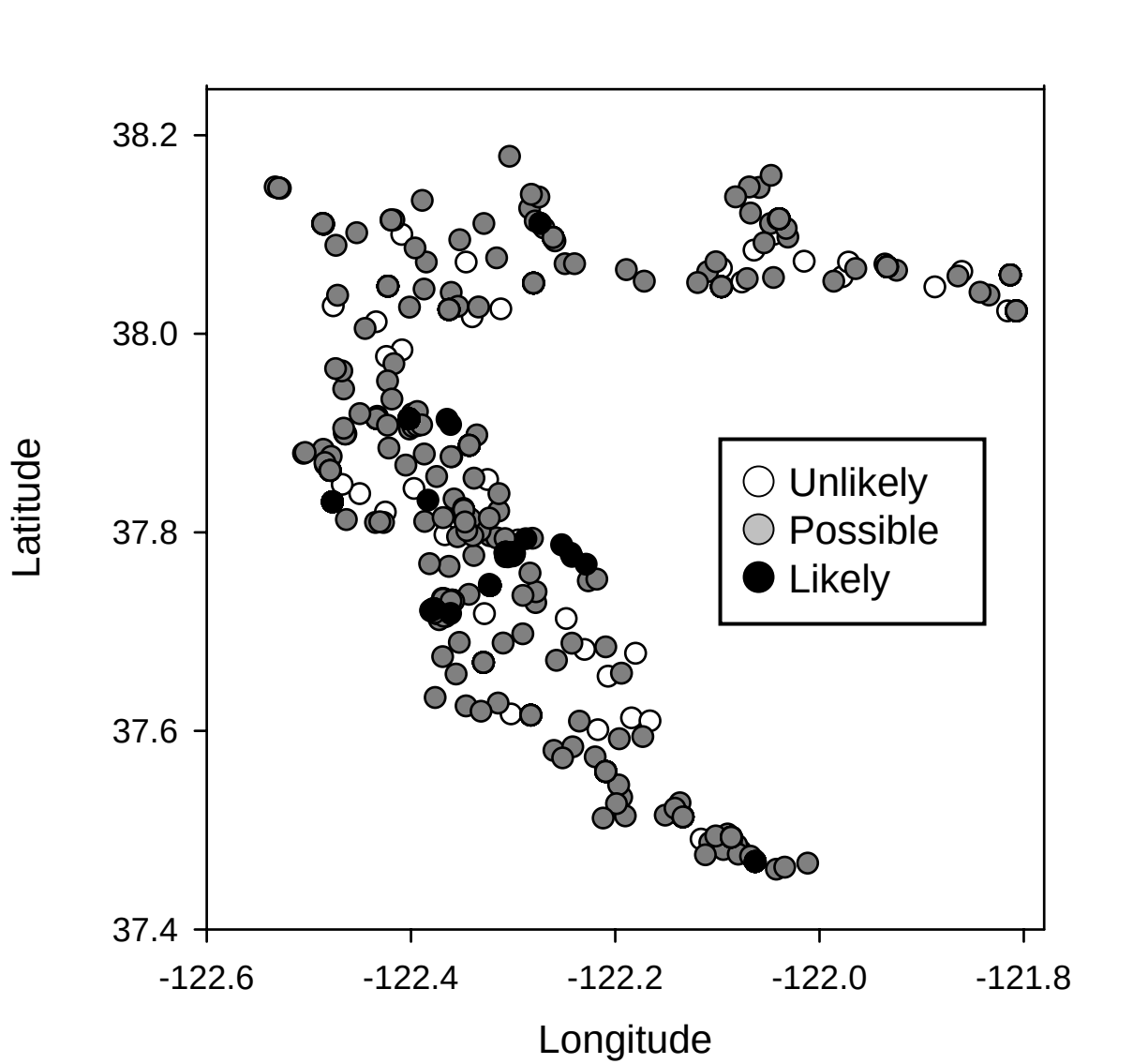


Evaluate Individual Sediment Stations

Sediment Category	Concentration	Number Samples	Percent
Unlikely Impact	**< 1.0**	**85**	**12%**
Possible Impact	**1.0 - 23.6**	**550**	**78%**
Likely Impact	**>23.6**	**72**	**10%**



Spatial Map of Results



Summary

- Sequential MLOE framework for evaluating indirect effects
- Streamlined approach specifies LOE and testing strategy in advance, rather than full-blown ecological risk assessment
- Process explicitly incorporates risk and uncertainty
  - Probabilistic evaluation of exposure
  - Effects thresholds risk-based
- Spatial considerations important – must be considered at site specific basis
  - Careful species selection
  - Study Area Selection

Items For Discussion

- Is the framework appropriate for the management objectives
  - "Pollutants in sediments shall not bioaccumulate in shellfish or fish tissue at a level that poses an unacceptable risk to human or wildlife health."
- Technical Input
  - Spatial scale
  - Use of bioaccumulation LOE