Empirical Estimation of Biota Exposure Range for Calculation of Bioaccumulation Parameters

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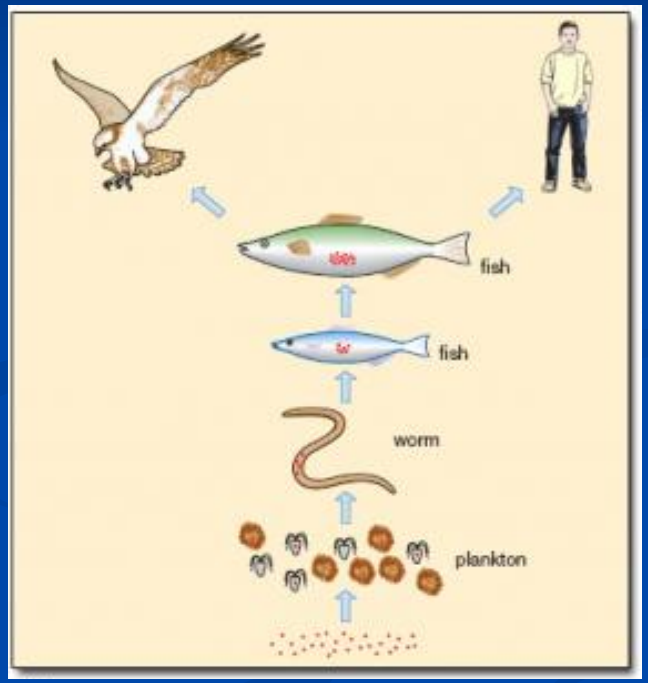
Bioaccumulation Factors

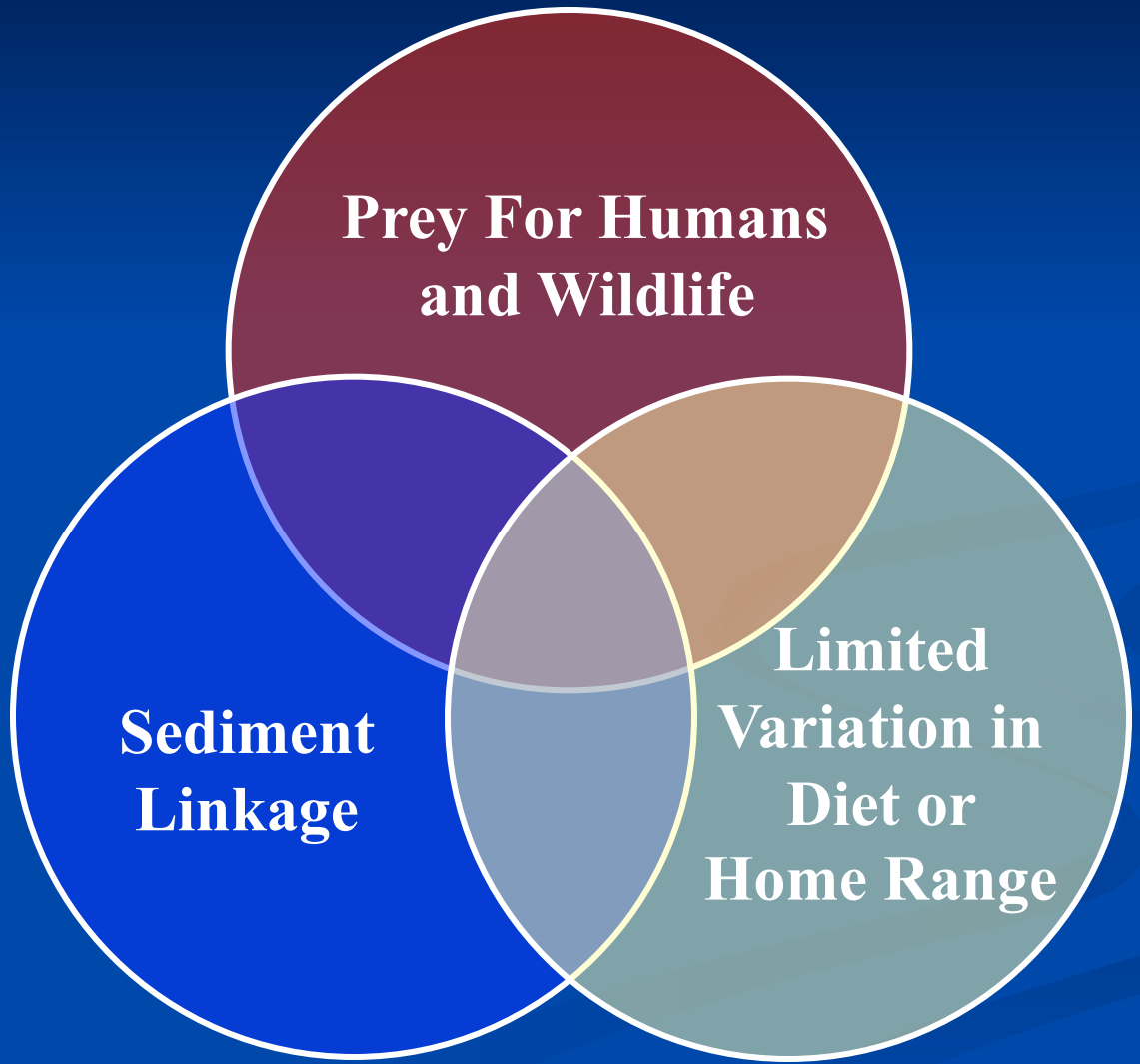
- Bioaccumulation factors
  - Quantify net increase of a chemical by an organism
  - Sediments are primary source of contamination
  - Magnitude of bioaccumulation

- Why are they important?



From Freedman et al. (1989)

Target Species



Target Species

- Invertebrates (worms, bivalves, amphipods)
  - Widely used in sediment risk assessments
  - Sediment connectivity
  - BAFs typically around 1
- Fish (croaker, flatfishes)
  - Highly relevant indicator for wildlife and human health
  - BSAFs typically around 4
  - Substantial variation in BSAFs

Spatial Scale of Exposure

- Spatial scale of transfer between sediment and biota increase with trophic level, longevity, and mobility
- Sessile invertebrates reflect local conditions
- Higher trophic levels (fish and wildlife) integrate exposure broader spatial scales

Problem Statement

- Identify appropriate spatial scales for species lacking home range information
- Establish relationships between biota and sediment for BAF/BSAF calculation
- Identify potential applications for future sediment quality assessments

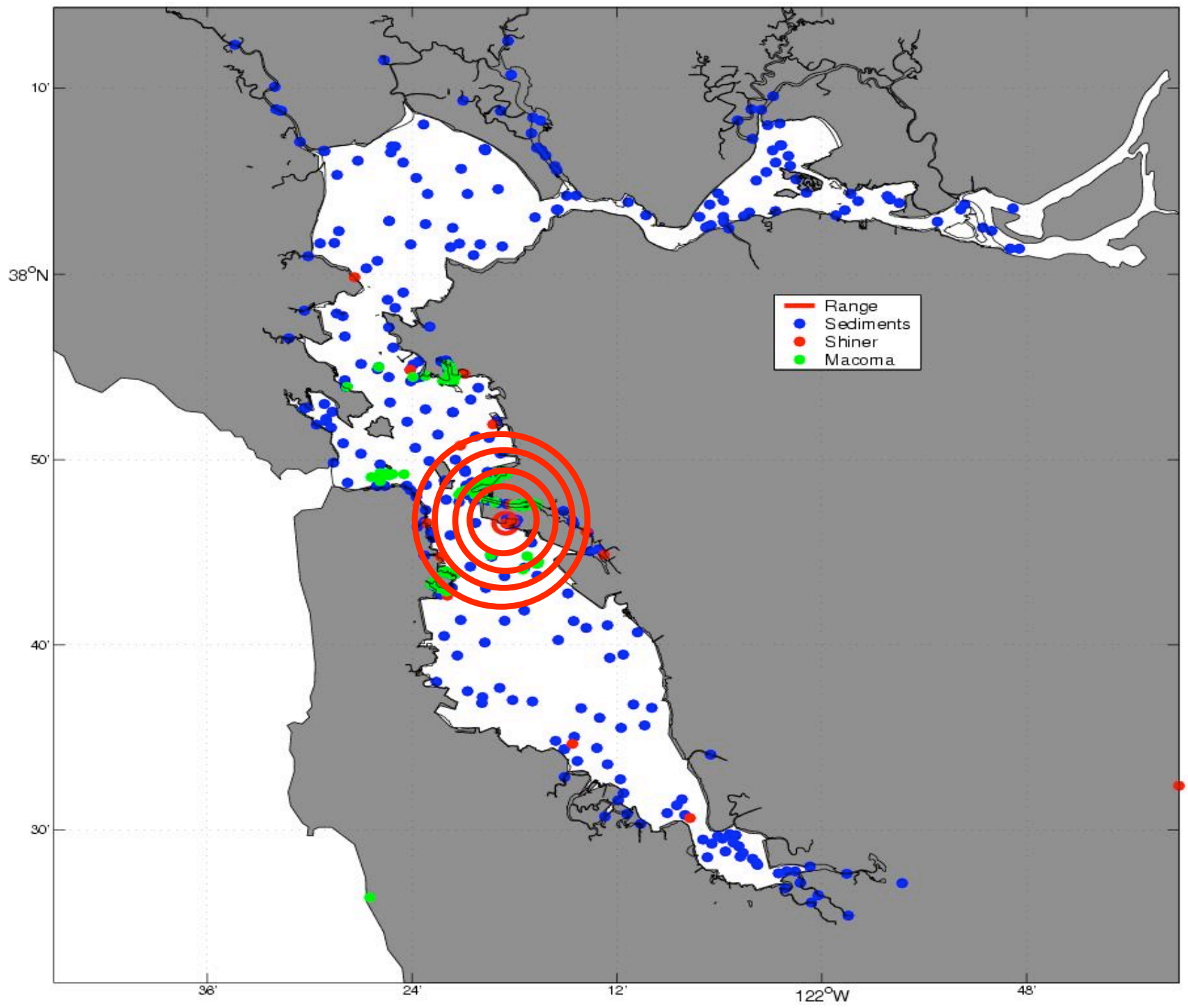
Methods

- Standardized database of California sediment quality assessments (1980 – 2003)
- Bays and estuaries
- Focus on organic pollutants (PCBs, OC Pesticides, HPAHs)

- Surface sediments
- Laboratory bioaccumulation (invertebrates)
- Field collected sediment and fish-tissue data

Bioaccumulation Data

- *Macoma* laboratory testing
  - San Francisco Bay
  - San Diego Bay
- Finfish - Embayments
  - San Francisco Bay
  - San Diego Bay
- Finfish - Offshore Coast
  - Southern California Bight


10'
38°N
50'
40'
30'
36'
24'
12'
122°W
48'
Range
Sediments
Shiner
Macoma

BAFs and BSAFs

$$BAF = \frac{C_t}{C_s}$$

$$BSAF = \frac{Ct/f_L}{Cs/f_{OC}}$$

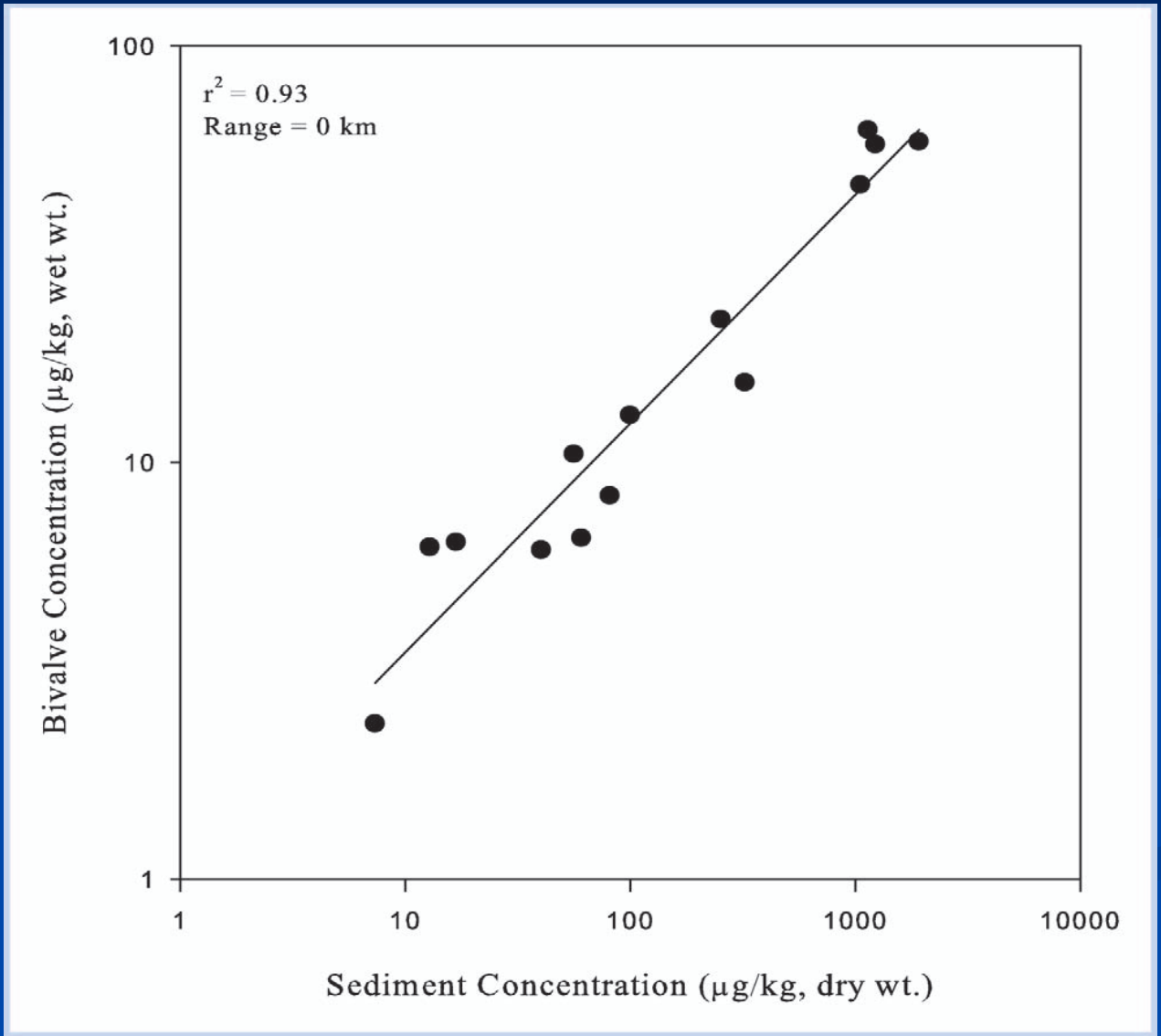
C_t = chemical conc. in tissue

C_s = chemical conc. in sediment

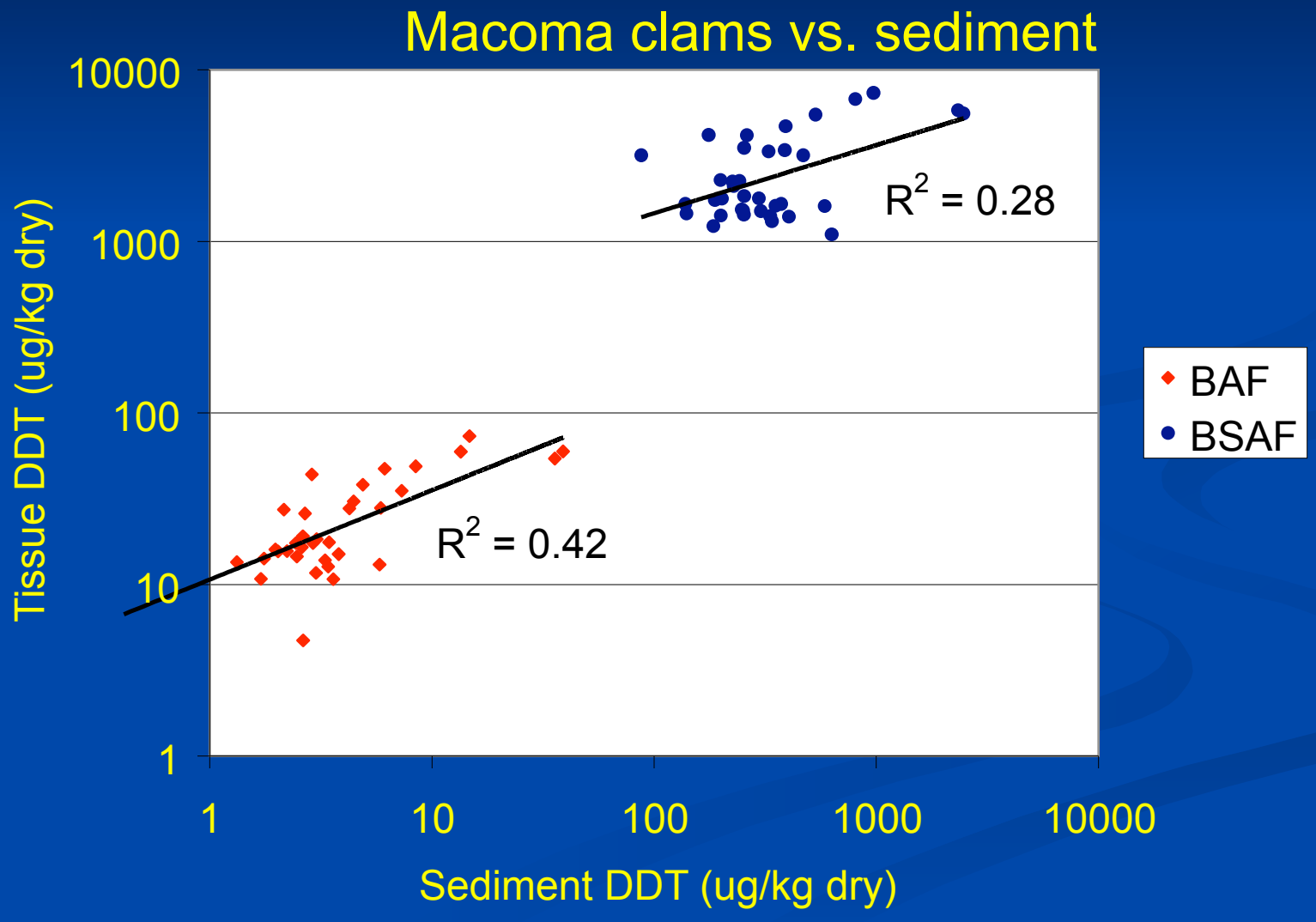
f_L = fraction lipid in tissue

f_{oc} = fraction organic carbon in sediment

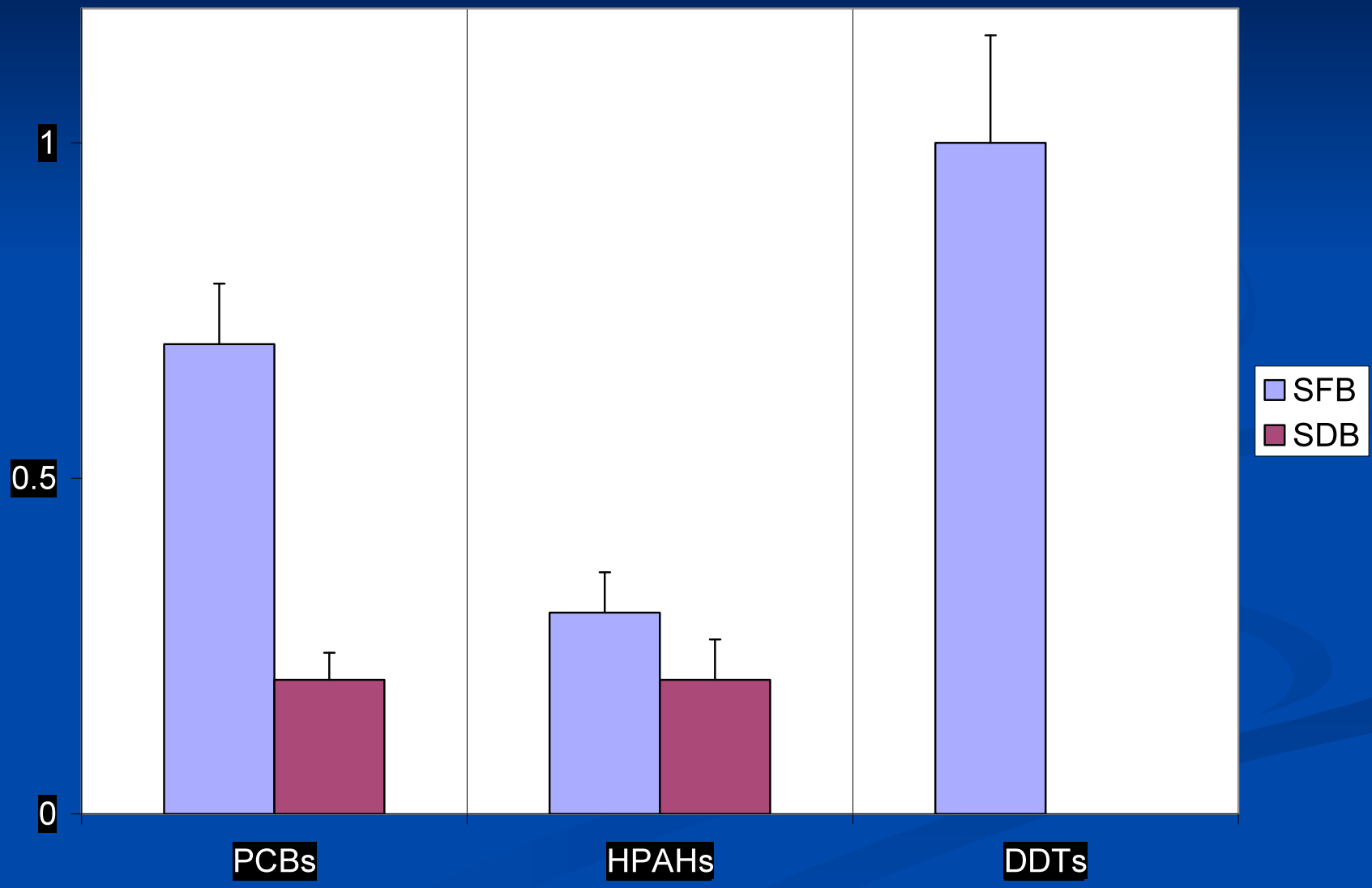
Macoma PCBs in San Diego Bay



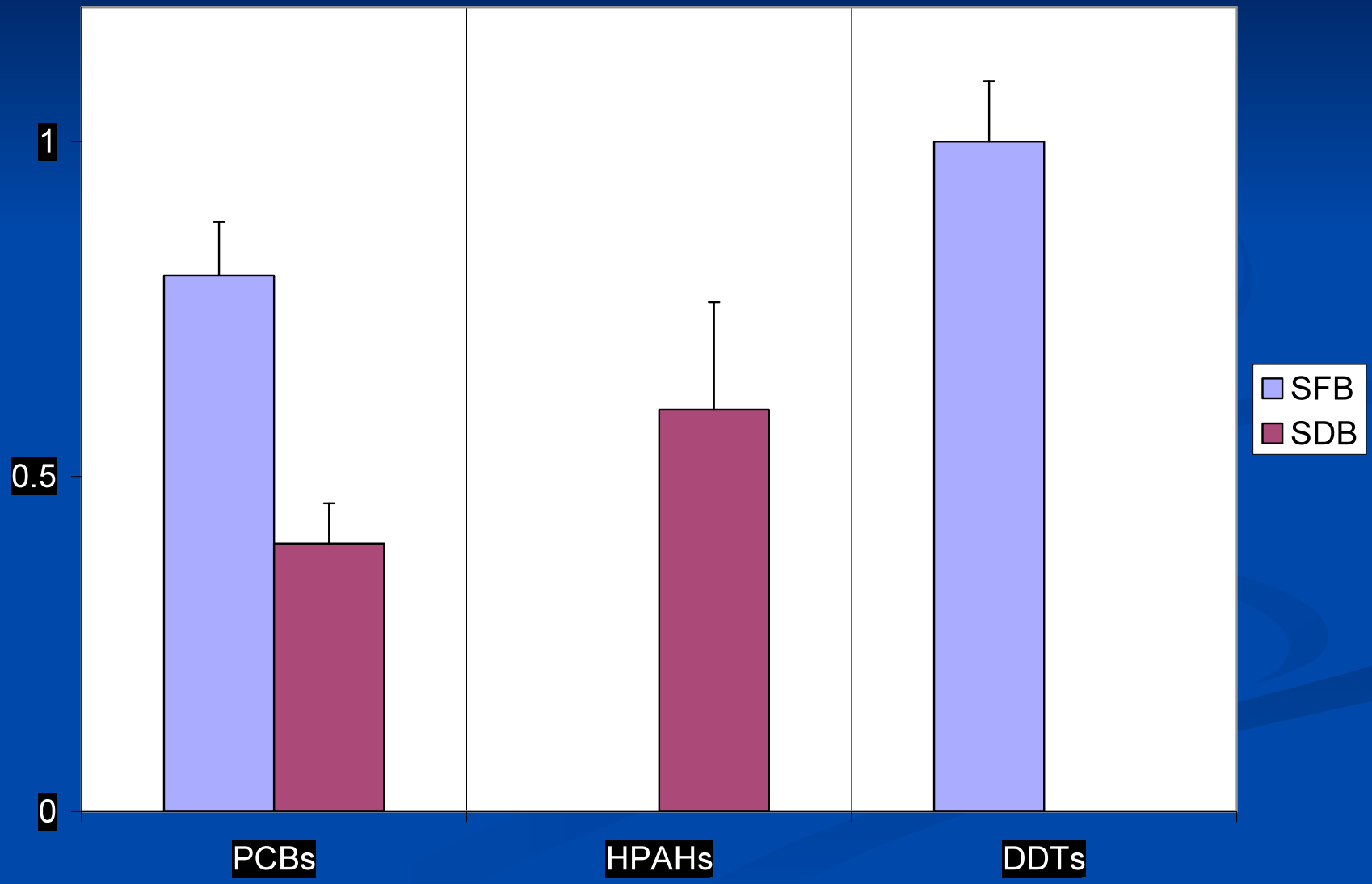
Macoma BAF vs. BSAF



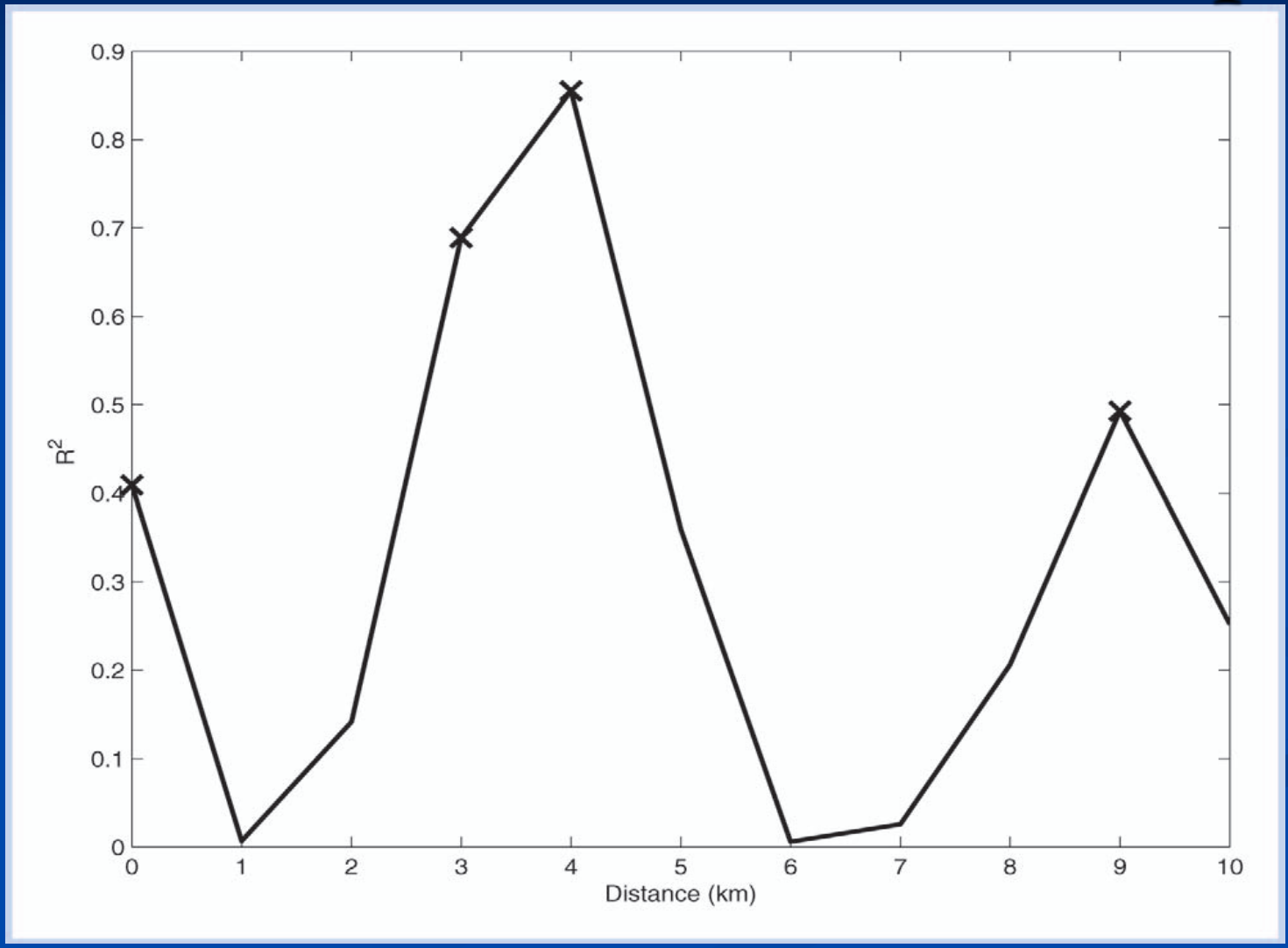
Macoma BAFs



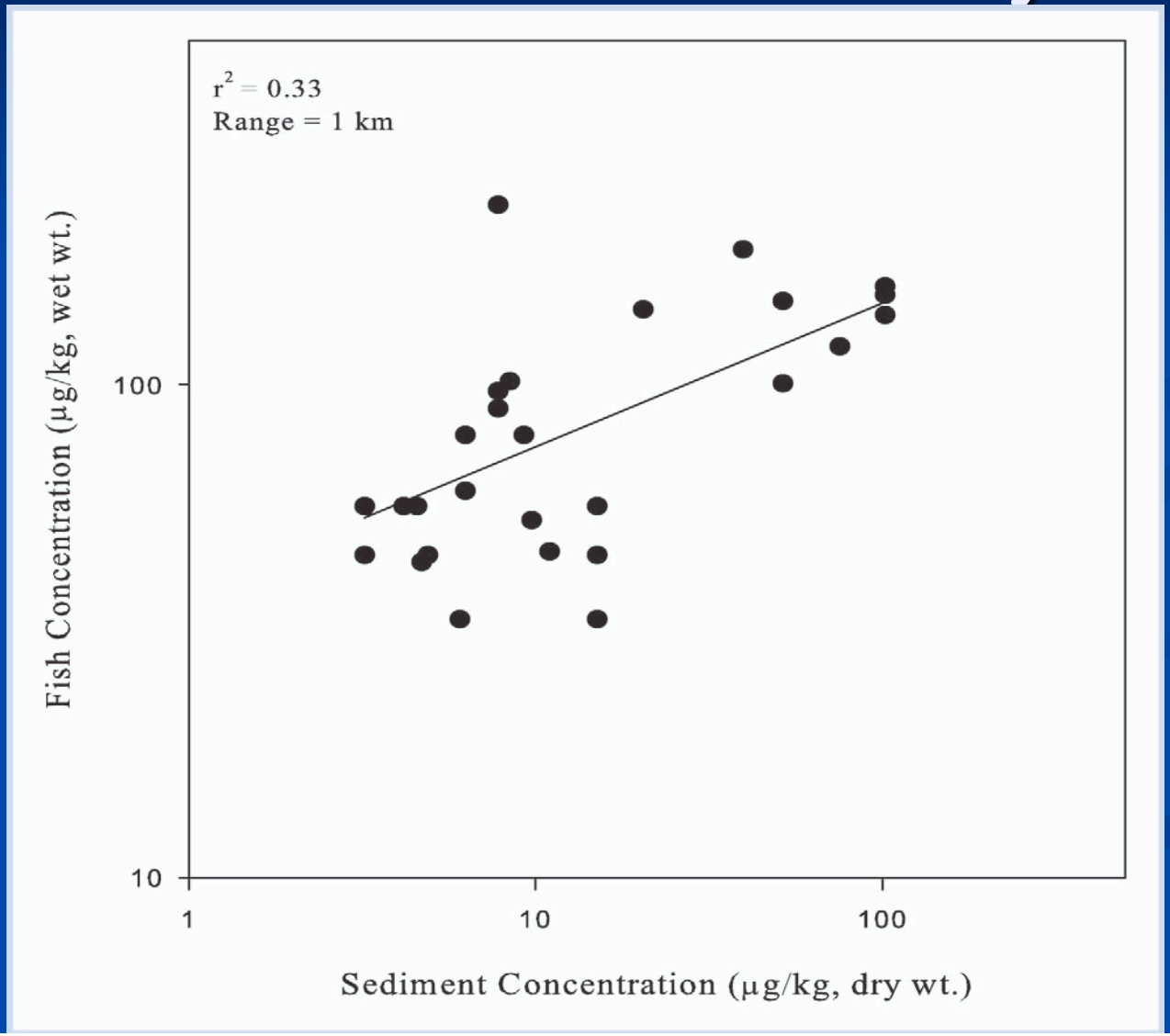
Macoma BSAFs



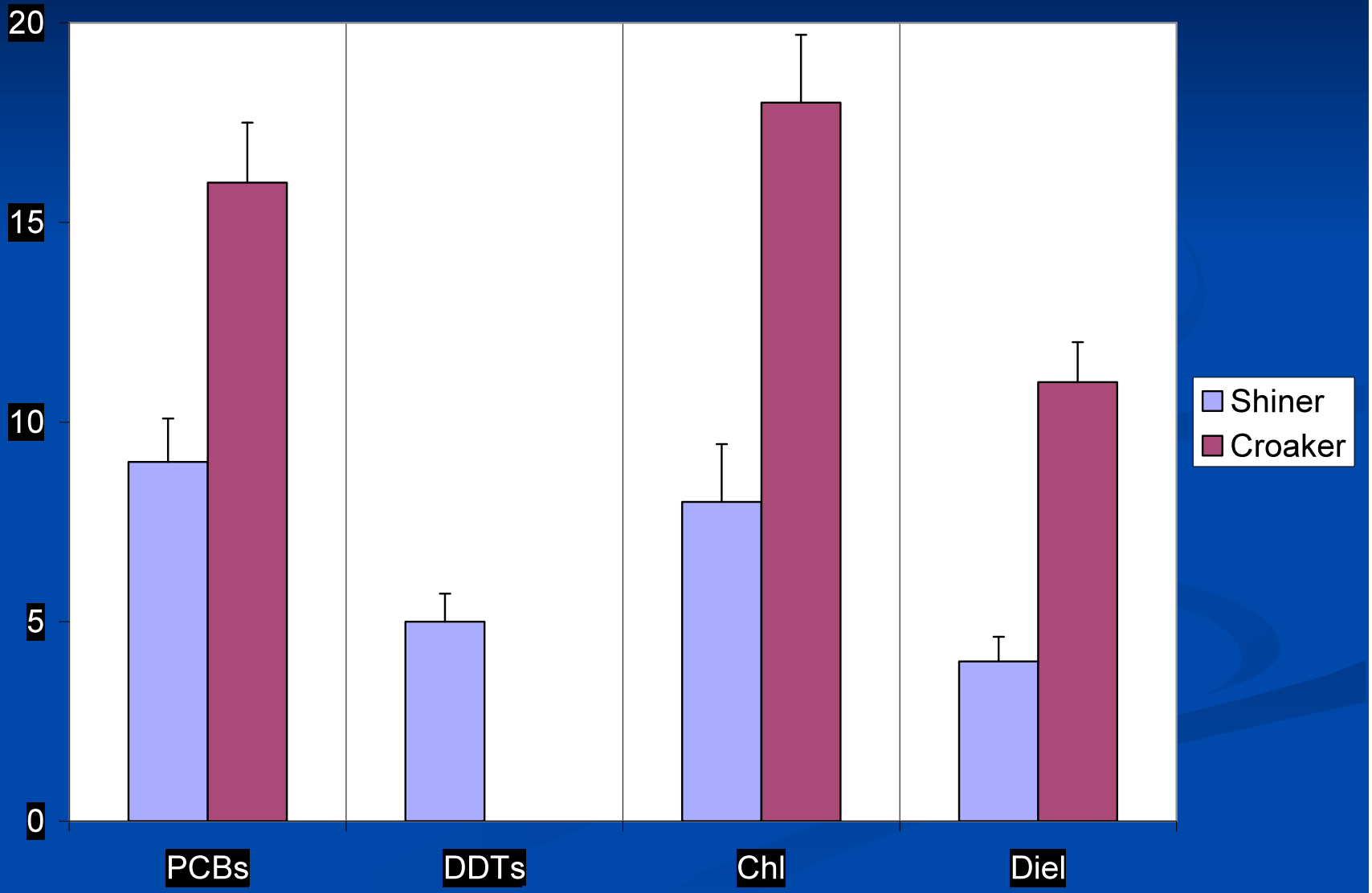
Scale-Dependent Finfish-Sediment Relationships



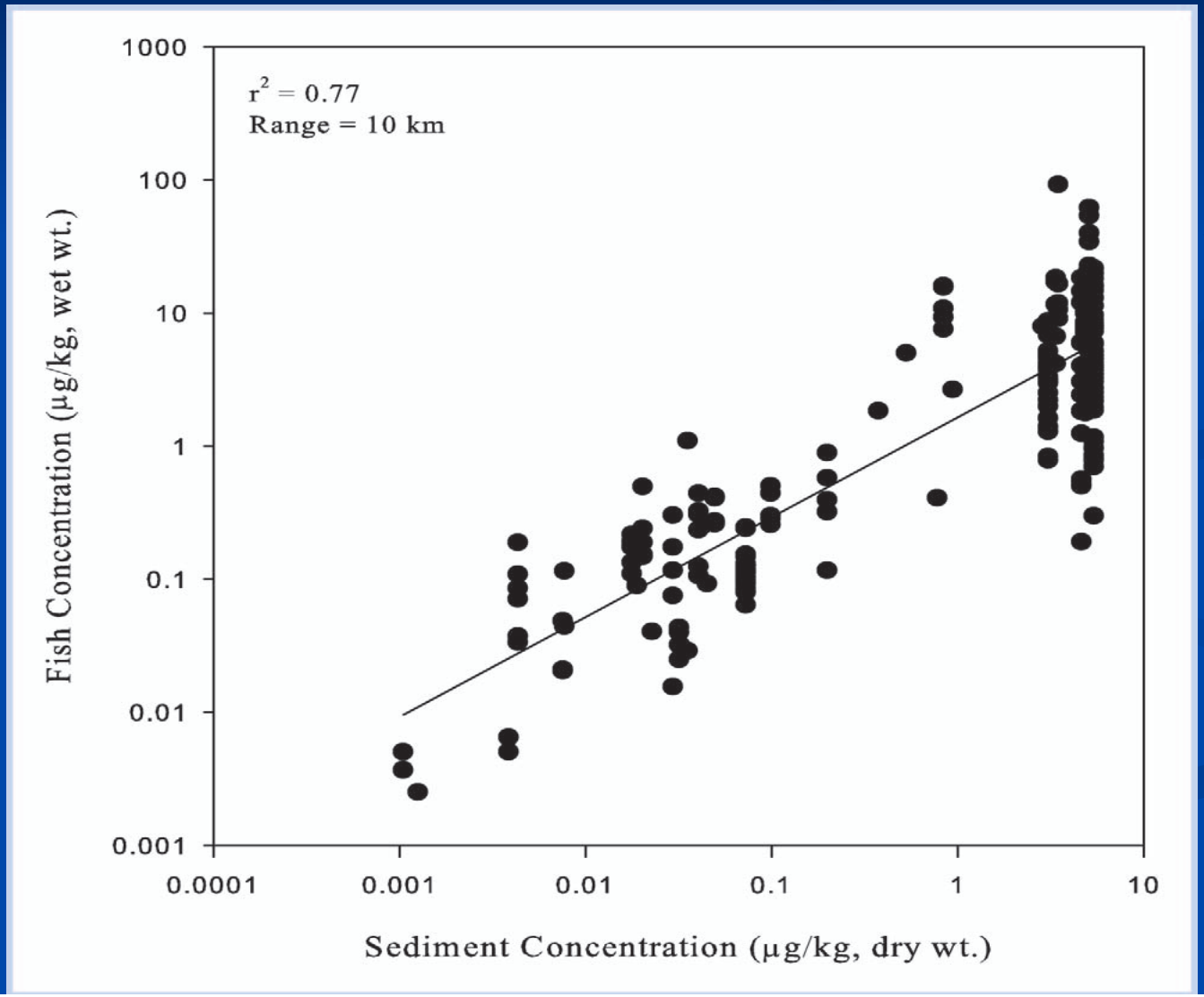
Shiner Perch PCBs in San Francisco Bay



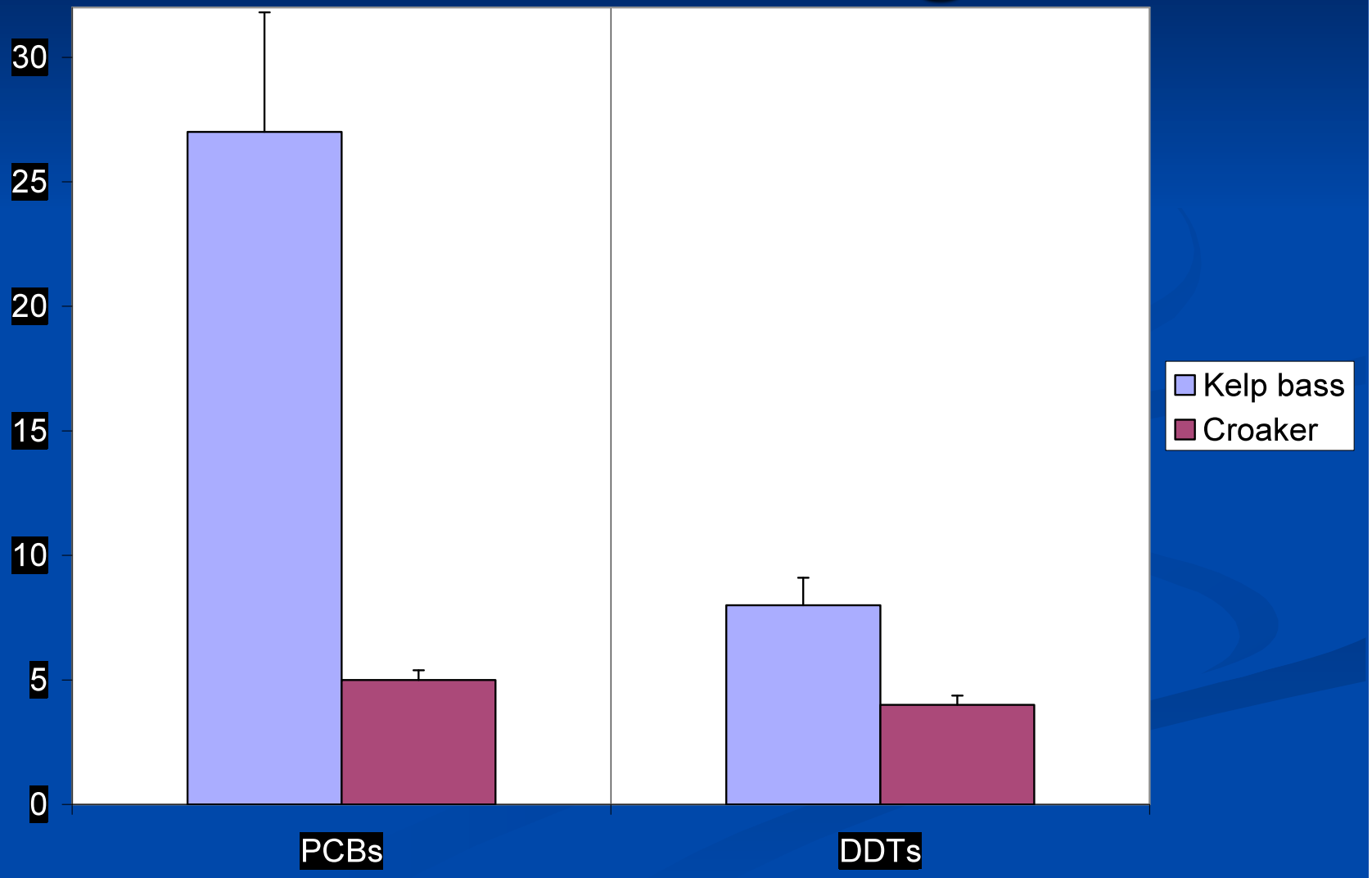
Finfish BAFs in San Francisco Bay



White Croaker DDTs in So. Calif. Bight



Finfish BSAFs in So. California Bight



Exposure Area

Species	Range in r^2	Spatial Scale
Shiner perch	0.25 - 0.44	1 km
White Croaker	0.17 - 0.77	1 - 10 km
California halibut	0.63 - 0.86	4 km
Kelp bass	0.31 - 0.37	2 km

Summary

- Significant biota–sediment relationships may be obtained by optimizing the spatial scale of exposure
- Identified spatial scales that were consistent with known life-histories of the species examined
- Relationships varied among species and waterbodies

Applications

- Identify species with relatively strong spatial association to sediment contamination
- Identify the appropriate spatial scale of biota exposure to sediments
- Development of data sets for determining empirical BAFs or BSAFs when biota and sediment sampling are not colocated
- Compare across waterbodies to develop hypotheses for magnitude of bioaccumulation

Thank you!

Photo by Manfred Delphoa