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?
Target Species

- Prey For Humans and Wildlife
- Sediment Linkage
- Limited Variation in Diet or Home Range
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

- 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
BAFs and BSAFs

\[
\text{BAF} = \frac{C_t}{C_s}
\]

\[
\text{BSAF} = \frac{C_t/f_L}{C_s/f_{OC}}
\]

\(C_t\) = 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

![Graph showing the relationship between bivalve concentration (μg/kg, wet wt.) and sediment concentration (μg/kg, dry wt.). The graph has a linear trend with an r² value of 0.93 and a range of 0 km.](image)
Macoma BAF vs. BSAF

**Macoma clams vs. sediment**

- **Sediment DDT (ug/kg dry)**
- **Tissue DDT (ug/kg dry)**

- **BAF**
- **BSAF**

**R² = 0.28**

- **R² = 0.42**
Scale-Dependent Finfish-Sediment Relationships

![Graph showing scale-dependent relationships between Finfish and Sediment]

- The graph plots $R^2$ against distance in km.
- The data shows two significant peaks at certain distances, indicating strong relationships.
- The peak at 4 km is notably higher, suggesting a stronger dependency at that scale.
Shiner Perch PCBs in San Francisco Bay

$r^2 = 0.33$
Range = 1 km
Finfish BAFs in San Francisco Bay
White Croaker DDTs in So. Calif. Bight

\[ r^2 = 0.77 \]

Range = 10 km

Fish Concentration (μg/kg, wet wt.)

Sediment Concentration (μg/kg, dry wt.)
Finfish BSAFs in So. California Bight

![Graph showing PCBs and DDTs levels for Kelp bass and Croaker]
# Exposure Area

<table>
<thead>
<tr>
<th>Species</th>
<th>Range in $r^2$</th>
<th>Spatial Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shiner perch</td>
<td>0.25 - 0.44</td>
<td>1 km</td>
</tr>
<tr>
<td>White Croaker</td>
<td>0.17 - 0.77</td>
<td>1 - 10 km</td>
</tr>
<tr>
<td>California halibut</td>
<td>0.63 - 0.86</td>
<td>4 km</td>
</tr>
<tr>
<td>Kelp bass</td>
<td>0.31 - 0.37</td>
<td>2 km</td>
</tr>
</tbody>
</table>
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 BSAsFs when biota and sediment sampling are not colocated
- Compare across waterbodies to develop hypotheses for magnitude of bioaccumulation
Thank you!

Photo by Manfred Delphoa