National Mussel Watch Monitoring of the California Coast
A collaborative effort between NOAA and California

California Water Quality Monitoring Council Meeting
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NOAA National Mussel Watch Program

- Historic data, years 1986-2009
- California collaboration initiated in 2007
- Total of 71 sites along CA coastline
- Resident mussels
- Historically, 150 contaminants monitored

To support ecosystem-based management and describe the status and trends of contaminants
Why Mussel Watch?

• Mussels are filter feeding bivalves

• Mussels are excellent concentrators of bioaccumulative pollutants

• Mussels are dominant organisms in rocky intertidal environments and are important members of the marine food chain
Historical Data
1986 - 2009
DDT Status (2007-2009 samples, in or adjacent to ASBS)

Highest concentration statewide

Concentration (ppb/dryweight)

Point La Jolla
Scripps Reef
San Nicolas Island
South Catalina Island
Crystal Cove State Beach
Newport Beach
Point Dume
Anacapa Island
San Miguel Island
Santa Cruz Island
Old Stairs
Mugu Lagoon
Julia P. Burns
Point Lobos
Carmel Bay
Pacific Grove Lovers Point
Ano Nuevo Island
Farallon Islands
Duxbury Reef
Point Reyes
Bodega Bay Head
Gerslie Cove
Sea Ranch
Pt. Delgada Shelter Cove
Klamath R.

South

North
DDT Status (2007-2009 samples, coast and enclosed bays)
DDT trends

Significant decrease at Royal Palms (White Point)

Increasing trend, but not significant
DDT Status and Trends (1986-2009)

• Highest DDT concentration in the state was at San Francisco Bay Emeryville site.

• DDT declined at 26 sites, significantly declined at 13 sites.

• Biggest downward trend at Royal Palms (White Point) on the Palos Verdes Peninsula
Total BT trend in SF Bay

Trend of Total
Butyltins concentration at San Francisco Bay Dumbarton Bridge

\[ y = -11.956x + 23936 \]
\[ R^2 = 0.5034 \]

Trend of Total
Butyltins concentration at San Francisco Bay Emeryville

\[ y = -83.585x + 167146 \]
\[ R^2 = 0.4086 \]

Trend of Total
Butyltins concentration at San Francisco Bay San Mateo Bridge

\[ y = -27.168x + 54367 \]
\[ R^2 = 0.4194 \]

Trend of Total
Butyltins concentration at San Pedro Harbor Fishing Pier

\[ y = -79.107x + 158488 \]
\[ R^2 = 0.5222 \]
Total Butyltin Trend (1986-2005 samples)

- Total BT declined at 33 out of 35 stations,
- 18 out of 35 stations had significant declines.
- This is undoubtedly due to the phase out of TBT based hull coatings.
PCBs Status (2007-2009 samples, coast and enclosed bays)
PCB trends

Significant decrease at Royal Palms (White Point)

Significant decrease at San Francisco Bay (San Mateo Bridge)
PCBs Status and Trends (1986-2009)

- Highest concentrations at two sites in San Diego Bay

- PCBs had either no trend or declined at most stations.
  - 21 showed no significant trend
  - 6 exhibited significant declines.

- Largest statistically significant decline was at Royal Palms
PAH Status (2007-2009 samples, coast and enclosed bays)
Total PAHs Trends (1986-2009)

Trend of Total PAHs concentration at San Simeon Point
San Simeon Point

\[ y = 4.7547x - 9428 \]

\[ R^2 = 0.4251 \]

Year

Concentration (ug/dry g)


Trend of Total PAHs concentration at Eureka Humboldt Bay Jetty

\[ y = 4.9699x - 9853.9 \]

\[ R^2 = 0.6903 \]

Year

Concentration (ng/dry g)


Trend of Total PAHs concentration at Mission Bay Ventura Bridge

\[ y = -26.024x + 52321 \]

\[ R^2 = 0.3341 \]

Year

Concentration (ng/dry g)


Trend of Total PAHs concentration at San Diego Bay Coronado Bridge

\[ y = -108.92x + 220522 \]

\[ R^2 = 0.3859 \]

Year

Concentration (ng/dry g)

Total PAHs Status and Trends (1986-2009)

• The largest PAH concentration was at Yerba Buena Island in San Francisco Bay (2008) following the Cosco Busan oil spill.

• No clear trend for PAHs
  • Twenty one out of 35 sites show upward trends, but only 5 of these were statistically significant increases
  • 4 sites had significant declines
Summary

• DDT, PCB, and Butyltins have generally decreasing at many stations
  • Consistent with the implementation of pollution controls

• No clear trend for Total PAHs
  • Highest recent concentrations in SF Bay after oil spill

• Mussel tissue pollutant concentrations vary depending on site conditions:
  • Enclosed bays generally have higher concentrations
  • Most ASBS have low concentrations of contaminants, except those near large watershed sources
Mussel Watch Pilot Study: Contaminants of Emerging Concern (CECs) - 2010
Mussel Watch CEC Pilot Study

- Pioneering study to inform future monitoring efforts on what CECs should be targeted

- To expand the relevance and utility of the National Status and Trends Mussel Watch program to regional, state and local stakeholders

- NOAA applied all its analytical resources toward CA mussel watch, with a focus on CECs

- Collaborators: NOAA, SCCWRP, SWRCB, SFEI, USGS
Mussel Watch Pilot Study Design

- Many new analytes selected (CECs)
  - Traditional pollutants were also analyzed at certain sites to maintain time series
- Contaminant concentrations were assessed according to different land uses and proximity to sources
- Resident mussels were sampled Dec. 2009 - May 2010
# Candidate Contaminants/Classes

<table>
<thead>
<tr>
<th>Analyte Class</th>
<th>Examples</th>
<th>No. analytes</th>
<th>No. Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharmaceuticals &amp; Personal Care Products (PPCPs)</td>
<td>DEET, fluoxetine, ibuprofen, triclosan</td>
<td>86</td>
<td>All</td>
</tr>
<tr>
<td>Industrial and Commercial CECs*</td>
<td>4-nonylphenol, bisphenol A, BDE47, HBCD</td>
<td>54</td>
<td>Partial</td>
</tr>
<tr>
<td>Current Use Pesticides</td>
<td>chlorpyrifos, dachthal, permethrin,</td>
<td>27</td>
<td>All</td>
</tr>
<tr>
<td>Legacy Organohalogens &amp; Butyltins</td>
<td>chlordanes, DDTs, endosulfan, PCBs, TBT</td>
<td>74</td>
<td>Partial</td>
</tr>
<tr>
<td>Polycyclic Aromatic Hydrocarbons (PAH)</td>
<td>Phenanthrene, benzo[a]pyrene, C1-fluorenes</td>
<td>66</td>
<td>Partial</td>
</tr>
</tbody>
</table>
Different land uses/sources

- Land uses:
  - Agriculture
  - Low development
  - Mixed development
  - Urban

- Sources:
  - Storm water discharges
  - Sewage Treatment (POTWs)
  - No significant sources: ASBS, but note that some ASBS do have SW or POTW sources
Concentration comparison of CEC and legacy pollutants

Tissue Measurements, All Sites

sorted by mean concentration, n = number of sites
Tissue CEC concentrations by land use category
Example plot - APs
Tissue CEC concentrations by land use category

**Polyfluorinated Compounds**

- **Total concentration (ng/g d.w.)**
- Ag (n = 8)
- Low Dev (n = 29)
- Mixed Dev (n = 16)
- Urban (n = 14)

**Pharmaceuticals/Personal Care Products**

- **Total concentration (ng/g d.w.)**
- Ag (n = 8)
- Low Dev (n = 30)
- Mixed Dev (n = 16)
- Urban (n = 14)

**Polybrominated Diphenyl Ethers**

- **Total concentration (ng/g d.w.)**
- Ag (n = 8)
- Low Dev (n = 30)
- Mixed Dev (n = 16)
- Urban (n = 12)

**Current Use Pesticides**

- **Total concentration (ng/g d.w.)**
- Ag (n = 8)
- Low Dev (n = 17)
- Mixed Dev (n = 9)
- Urban (n = 11)
Tissue CEC concentrations by discharge category

**Alkylphenols**

- None: (n = 26)
- POTW Only: (n = 4)
- Stormwater and POTW: (n = 7)
- Stormwater Only: (n = 28)

**Pharmaceuticals/Personal Care Products**

- None: (n = 29)
- POTW Only: (n = 4)
- Stormwater and POTW: (n = 7)
- Stormwater Only: (n = 28)

**Polybrominated Diphenyl Ethers**

- None: (n = 29)
- POTW Only: (n = 4)
- Stormwater and POTW: (n = 6)
- Stormwater Only: (n = 27)

**Polyfluorinated Compounds**

- None: (n = 29)
- POTW Only: (n = 4)
- Stormwater and POTW: (n = 7)
- Stormwater Only: (n = 27)
**Conclusions**

- PBDEs, Alkylphenols (APs) and pharmaceuticals/personal care products (PPCPs) were the most frequently detected CECs.
- Urban land use stations generally had higher concentrations for many CECs (PFCs, APs and PBDEs).
- PPCPs were present in all land uses, including agriculture.
- Current use pesticides were highest at agricultural areas, followed by urban land use.
- CECs had the highest concentrations at stations influenced by storm water discharges.
- Reinforces the need to monitor selected CECs (PBDEs, PFCs and APs) in coastal ecosystems, particularly in heavily urbanized regions.
Want to learn more?

- Special Issue of Marine Pollution Bulletin is being developed to publish all this data.

- SETAC (November, Long Beach) will have a special session to present on CECs