Coastal pollution priorities in British Columbia: from sediments to killer whales

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Where do we start?

- 100 million chemicals registered (EAI, 2015);
- Over 250,000 chemicals on the global marketplace, with 1,000 new chemicals every year;
- Wide variation of properties (water soluble vs. fat-soluble);
- Different receptors or species at risk;
- Range of emission histories;
- Local vs. global pollutants; complex mixtures of contaminant in the ocean.

Our Ocean Pollution Research Priorities

- Marine mammals as sentinels of ocean pollution (PBT chemicals)
- Safe traditional foods for aboriginal populations
- Oil spill science
- PollutionTracker (sediment and mussel monitoring)
- Microplastics in the ocean

The most PCB-contaminated marine mammals in the world: are they harmful and where do they come from?

PCBs are declining very slowly in the environment, with a half-life of approximately 30 years.

Projected times for 95% of population members to fall below the health effects threshold of 17 mg/kg:
- Southern resident killer whales ~2089 A.D. (Hickie, Macdonald & Ross, 2007)

The ocean is a sink for pollutants, where the food web is vulnerable to contamination

Properties of the chemical in question explain its fate in the environment;
- Fat-soluble chemicals attach to particles (sediments) or get into the food web (biomagnification);
- Fish-eating birds and marine mammals prone to high levels of persistent, bioaccumulative and toxic contaminants.

Our backyard: Harbour seals provide evidence of 'local' PCB and PBDE sources in British Columbia and Washington

Sediments reveal PCB and PBDE release and history in the BC coastal environment: sink and a source

Global sources: Salmon import POPs from the Pacific Ocean, while air delivers Asian POPs to BC within 5-10 days

17-06-20
Regulations have helped: PCBs have declined by 4-10 fold since the 1970s.

- PCBs are persistent, bioaccumulative and toxic;
- Were widely used as heat resistant oils in electric transformers and heavy industry 1929 to 1977;
- Have contaminated every single marine mammal on the planet;
- Associated with reproductive impairment, increased vulnerability to disease and endocrine disruption.

Flame retardants in harbor seals from the Salish Sea (BC & Washington) doubled every 3 years before their 2004 elimination.

- PBDEs are persistent, bioaccumulative and toxic;
- Very similar to PCBs;
- Were widely used in furniture, textiles & electronics;
- California children are the most PBDE-contaminated in the world because of strict State fire protection laws (TB 117).

An emerging threat to ocean life

- 25,000 polymers;
- Used in a wide variety of consumer and industrial products;
- Sometimes possesses endocrine-disrupting properties;
- Can cause acute or chronic toxicity;
- Documented in hundreds of species of fish, seabirds and marine mammals around the world;
- Is a pollutant class like no other...

Plastic is everywhere

- Charismatic species have been visible victims of nets and other debris for decades;
- Packing bands and fishing gear entangle turtles, seabirds and marine mammals everywhere;
- A slow, painful death often results.

Smaller yet: microplastics emerge as a new conservation concern

- Microplastic particles < 5 mm (variable minimum sizes, depending on the reporting lab);
- Two basic categories:
  - Primary microplastics are deliberately manufactured (microbeads and pellets);
  - Secondary microplastics are break-down products of larger items.

- Most microplastics likely originate from land-based sources:
  - Household and industrial waste + wastewater;
  - Fishing, aquaculture, shipping;
  - Decomposition of larger items

Seawater: up to 9,200 particles (fibers and fragments) per cubic meter in coastal BC.

Zooplankton are ingesting microplastic particles.

- Highest levels near the coast
- Neocalanus cristata
- Euphausia pacifica

Plastic represents a visible threat to sea life

- Charismatic species have been visible victims of nets and other debris for decades;
- Packing bands and fishing gear entangle turtles, seabirds and marine mammals everywhere;
- A slow, painful death often results.
Baseline contaminant data in coastal British Columbia: The PollutionTracker Project

**The ocean's contaminant sink. Sediments.**

**Integrative water quality: Mussels.**

**PollutionTracker: Provincial Project.**

**PollutionTracker: Preliminary results.**

Aboriginal peoples are more reliant on seafoods than the average consumer.

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### Microplastics found in zooplankton of both species, but differed in terms of frequency, size and type

<table>
<thead>
<tr>
<th>Species</th>
<th>Frequency</th>
<th>Size (µm)</th>
<th>Polydispersity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neocalanus</td>
<td>1 in 38 +/−556 ± 149</td>
<td>816 ± 106</td>
<td>0.019 *</td>
</tr>
<tr>
<td>Euphausia</td>
<td>1 in 17 +/−816 ± 108</td>
<td>800 ± 100</td>
<td>0.014 *</td>
</tr>
</tbody>
</table>

*PollutionTracker: Preliminary results."

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### Troubling conservation questions for sea creatures of all shapes and sizes

- **Where are the straps and nets coming from that are entangling marine mammals?**
- **Where are the microplastics coming from that we found in coastal seawater?**
- Do microplastics represent a similar threat to small creatures (zooplankton or baby fish) that larger plastics present to marine mammals?

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### How can we better understand pollution priorities in coastal environments?

The canary in the coal mine warned the miners of dangerous gases;
monitoring the receiving environment typically reveals our failure to prevent release of pollutants;
The use of ocean ‘canaries’ can be informative, and informs us about mistakes … but their message comes late;
A balance of environmental sciences (field) and risk-based assessment/regulations (model) is needed.

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### Integrated data on coastal British Columbia:"

**PollutionTracker®**

- **PollutionTracker®**
- 50 PollutionTracker sites in coastal BC.

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### Phase 1: 50 PollutionTracker sites in coastal BC.

- **PollutionTracker®**
- 50 PollutionTracker sites in coastal BC.

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### Project priorities in coastal environments?

- Sediment PCB-153 concentrations vary along the BC coast, but highest in Victoria;
- Sediment penta-BDE concentrations vary along the BC coast, but highest in Victoria;
- Sediment PAH concentrations vary along the BC coast, but highest in Victoria;
- Sediment BaP concentrations reveal more complex story of emissions;
- Baseline data reveals more complex story of emissions;
- PollutionTracker profiles will shed light on nature of anthropogenic sources.