Using Lessons from Chronic Pollution Disturbance to Develop New Marine Ecological Monitoring Tools to Allow Rapid Assessment under Emergency Spill Response

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Sites selected along pollution gradient
Pulp and paper pollution

- Toxicity
- Anoxia
- Physical disturbance
Improvements in Effluent Quality since EEM

Data kindly provided by Environment Canada and Hatfield Consultants, 2004
Economic shutdowns

- Prince Rupert mill closed 2001
- Woodfibre mill closed 2006
- Powell River, closure of 1 of 2 historic mills
Intertidal Quadrat Studies - faunal data

Percent (%) Cover

Under-rock Species Diversity
Questions

1) Were species impacted and how have they recovered?

2) What species traits are selected for in polluted vs. unpolluted sites?

3) Can we assess the condition of a site based on the species present?
Q1: Initial impact - 1990s

![Graph showing the relationship between site condition and standardized distance.](image)

- *P < 0.05
High Exposure: Port Mellon
Reference Site

- Calcareous tubeworms
- Midshipman fish
- Orange sea cucumbers
Q1: Species recovery post regulations

* P < 0.05

[Graph showing species recovery over years from regulations with different sites indicated by different colors and markers.]
Q1: But how are they recovering?

Adapted from Baselga 2009
Q1: Species nestedness

<table>
<thead>
<tr>
<th>Year</th>
<th>Howe Sound</th>
<th>Powell River</th>
<th>Prince Rupert</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>0.6</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>2005</td>
<td>0.4</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>2016</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

* P < 0.05
+ P < 0.1
Q1: Species turnover

* P < 0.05
Q2: Trait assignment

<table>
<thead>
<tr>
<th>Size (cm)</th>
<th>Value</th>
<th>Mobility</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 21</td>
<td>5</td>
<td>Mobile</td>
<td>3</td>
</tr>
<tr>
<td>11 - 20</td>
<td>4</td>
<td>Semi-mobile</td>
<td>2</td>
</tr>
<tr>
<td>3 - 10</td>
<td>3</td>
<td>Fixed</td>
<td>1</td>
</tr>
<tr>
<td>1 - 2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Community average trait value
Q2: Which traits thrive?

\[ P < 0.001 \]
\[ R_{adj}^2 = 0.52 \]
Q2: Which traits thrive?

\[ P = 0.03 \]
\[ R^2_{adj} = 0.05 \]
Q2: Trait implications

Predict & Assess
Q3: Indicator species

Presence-Absence of

Site Condition?
Q3: Determining indicator species

1) Split data into a) training set & b) test set

2) Build training models predicting condition with different combos of the 15 species as predictors

3) Assess predicted values against independent test data ($R^2$)
Q3: How many species?

Most common species coefficients

73 % “accuracy”
Take Aways

1) Mill pollution reduced species richness

2) Recovery *can* occur naturally
   - Beta diversity provides additional insights

3) Pollution selects for smaller, mobile species

4) It is possible to assess the condition of a site based on a subset of species (with good accuracy)
Contaminated Sites Applications

- Use of community traits index more informative than presence/absence surveys - insight into **community health**
- Identify sites which are not recovering naturally, candidates for restoration efforts
- Shoreline Cleanup & Assessment Technique (SCAT)
  - Use indicator species survey technique for **oil spill** response baseline surveys - time restrictive, easily train volunteers
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For more CSI info, go to www.ecotoxicology.ca
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Thank you – Questions?

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