Marine ecosystem mapping at the Prince Edward Islands

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SANBI
Biodiversity for Life
South African National Biodiversity Institute
The Prince Edward Islands

- Biomass-rich, enhanced primary productivity through influence and interactions of the islands with surrounding environment

- Ecologically important ecosystem sustaining large populations of seabirds and marine mammals
Relevance of Ecosystem mapping at PEI

- Islands and ocean recognised as sentinels to climate change
- Support top predators including Threatened & Endangered seabirds (threats)
- Support a long-line industry → Patagonian Toothfish (pressures)
Rationale for inclusion

• Prior assessments 2004, 2011 recommended future inclusion

• Internationally recognised unique features, restricted ecosystem types, processes and species not found within mainland marine habitats
  – e.g. South West Indian Ridge; shallow Southern Ocean seamounts, sub-Antarctic front and eddies
Building on previous classification schemes

• PEI conservation planning:
  Lombard et al. 2007, Nel & Omardien 2008

• Existing southern ocean ecoregions
  Benthic - Douglass et al. 2014
  Pelagic - Raymond 2011

• Current mainland marine NBA
  Lombard et al 2007

Douglass et al. 2014
## Integrating patterns and processes (Lombard et al. 2007)

<table>
<thead>
<tr>
<th>Levels (Lombard et al 2007)</th>
<th>Details (examples)</th>
<th>New/Update/Replace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity patterns: (habitats)</td>
<td>Bathymetry, Sediment thickness, Benthic habitats (bathy+sed), Seamounts</td>
<td>N – Pelagic ecoregion classif., N – Benthic ecoregion classif., N – Geomorph features, R – Substratum type (geomorph proxy)</td>
</tr>
<tr>
<td>Biodiversity patterns: (species)</td>
<td>Invertebrates, Fish, Cetaceans</td>
<td>N - Shelf benthic biodiversity, N - VME habitat footprint</td>
</tr>
<tr>
<td>Fixed processes: (fine scale)</td>
<td>Coastal buffer, Island shelf processes (bathy derived), Productive island area (bathy derived), Inshore foraging areas (40km buffer)</td>
<td>N - Kelp map, N - Shelf biodiversity, U - inshore forage</td>
</tr>
<tr>
<td>Flexible processes: (broad scale)</td>
<td>Sea bird foraging areas, Elephant sea foraging, Ave. position of fronts</td>
<td>U - Top predator habitat importance, U - Elephant S. forage, U - Frontal dynamics</td>
</tr>
<tr>
<td>Fishing activities</td>
<td>Fishing effort, Bird bycatch</td>
<td>U - Fishing effort, U - Bird bycatch</td>
</tr>
<tr>
<td>Management boundaries</td>
<td>Island outlines, EEZ</td>
<td>N - MPA zones</td>
</tr>
</tbody>
</table>
Hierarchical classification

- Based on regional benthic bioregionalisation
  → aligned with hierarchical 2011 NBA
## Synopsis of data types used

<table>
<thead>
<tr>
<th>Type</th>
<th>Rationale</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography &amp; Depth</td>
<td>Bathymetric gradients considered the primary driver of benthic biological patterns</td>
<td>Gebco, SA Navy, Antarctic geomorphology, regional and PEI benthic faunal breaks</td>
</tr>
<tr>
<td>Substrate type</td>
<td>Substratum type (hard, mixed, soft) underpins secondary patterns</td>
<td>Antarctic geomorphological proxies</td>
</tr>
<tr>
<td>Geomorphic features</td>
<td>Major features capture bathymetry &amp; substratum</td>
<td>Antarctic geomorphology</td>
</tr>
<tr>
<td>Shore type</td>
<td>Shore form and wave exposure define ecology</td>
<td>High resolution satellite imagery, literature descriptions</td>
</tr>
<tr>
<td>Biogeography</td>
<td>Bioregional patterns of bio-physical characteristics provide broad scale ecosystem types</td>
<td>Merge of existing benthic and pelagic bioregionalisations, refined using major oceanographic front boundaries</td>
</tr>
</tbody>
</table>
Depth and Topography

• Broad Patterns
  Literature review of benthic species patterns:
  ✓ Regionally
  ✓ Antarctic peninsula
  ✓ Oceanic islands

• PEI Specific Patterns
  • Local species data: 0 - 1000m
  • Regionally established, Southern Ocean data: 1000 – 3500+ m
Substratum type – Geomorphic features

- Relied on geomorphic features as proxies for substrate
  - These are also habitat features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
<th>Feature classification</th>
<th>PEI classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamount</td>
<td>Roughly circular areas which rise above the surrounding sea floor by at least 1000 m. ([IHO differentiates seamounts (&gt;1000m), knolls (500-1000m), hills (100-500m)]</td>
<td>Hard</td>
<td>Hard</td>
</tr>
<tr>
<td>Seamount ridges</td>
<td>Elongate ridges that protrude hundreds to thousands of meters above the surrounding sea floor. Their shape has the potential to influence deep current activity.</td>
<td>Hard</td>
<td>Hard</td>
</tr>
<tr>
<td>Plateau</td>
<td>Relatively flat regions elevated above the surrounding sea floor by more than a few hundred meters (implied possibility of hard and soft substratum)</td>
<td>Not explicitly defined</td>
<td>Mixed</td>
</tr>
<tr>
<td>Plateau slope</td>
<td>Broad regions sloping from the margins of large plateaus to the surrounding deep ocean floor. (implied possibility of canyons and sediment gravity flows)</td>
<td>Not explicitly defined</td>
<td>Mixed</td>
</tr>
<tr>
<td>Abyssal plain</td>
<td>Extensive, flat, gently sloping or nearly level region of sediment covered seafloor at abyssal depths</td>
<td>Soft</td>
<td>Soft</td>
</tr>
<tr>
<td>Trough</td>
<td>Closed elongate depressions (in the ocean floor) more than 4500 m deep and hundreds of kilometres long, generally associated with fracture zones.</td>
<td>Soft</td>
<td>Soft</td>
</tr>
</tbody>
</table>

Table 4.1 Substrate types of offshore geomorphic features found within PEI EEZ. Descriptions of features are from Douglass et al. (2014); substrate type classifications for these features are based on O’Brien et al. (2009).
Refining the mapping rules: Geomorphic features

To avoid splitting geomorphic features unnecessarily into many depth zones ➔ All seamounts were classified by shallowest point into:

- Shallow seamounts (those rising to within 90-250m depth)
- Seamounts (all deeper seamounts)

- Other emergent features (namely plateaus) were similarly simplified into a ‘slope’ or ‘rise’ component and an upper component of ‘plateau’ defined by the depth zone in which each arise
3 Shore types: Wave exposure X substratum

Based on descriptions (De Villiers et al. 1976, Blankley & Grindley 1985)

- Highly Exposed Cliff & Broken shores
- Exposed Cliff & Broken shores
- Least Exposed Boulder & Mixed shores
Four integrated bioregions

- Indian Temperate
- Del Cano sub-Antarctic
- Atlantic Basin Polar Front
- Ob & Lena Polar front

Refined using boundaries of major ocean fronts ➔ merged to create 4 benthic-pelagic bioregions
Biogeography

3 existing pelagic bioregions:
1. Temperate
2. sub-Antarctic
3. Antarctic Polar front

3 existing benthic bioregions:
1. Del Cano
2. Atlantic Basin
3. Ob & Lena
Summary of new classification

• So far how many habitat types?
Vulnerable Marine Ecosystem (VME) taxa

- Fine scale layers forming habitat descriptions
- Align with geomorphic features
Kelp habitat

- **Kelp**
- **Outer shelf**
- **Inner shelf**
Top predator foraging habitats

• New modelled habitat importance scores based on multi-spp data (Reisinger et al. 2017)
  – NB for pressures and threats
What’s next?

• Map still in progress → How to overlay VME, Kelp, and top predator data

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Thank you