Foraging Habitats of Top Predators, and Areas of Ecological Significance on the Kerguelen Plateau

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Avian and mammalian predators play a key role in the ecosystem of the Kerguelen Plateau.

- At-sea distributions of predators are also a powerful way of identifying regions that are particularly important ecologically.
- Concentrations of foraging activity are indicative of enhanced primary and/or secondary productivity.
- These are regions that are of considerable importance in the development of ecological models and climate monitoring systems.
• The aim of this study was to integrate tracking and diving data from a suite of predator species collected as part of both the French and Australian Antarctic programs.
• Data were used from Macaroni and King Penguins, Southern Elephant seals, Antarctic fur seals and Black-browed albatross from Isles Kerguelen and Heard Island.
<table>
<thead>
<tr>
<th>Island</th>
<th>Site</th>
<th>Black-browed Albatross</th>
<th>Antarctic Fur Seal</th>
<th>King Penguin</th>
<th>Macaroni Penguin</th>
<th>Southern Elephant Seal</th>
<th>Grand Total</th>
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</table>

- relatively large multi-species dataset
- ...but lacks spatial and temporal detail
- only two species tracked from more than site
AES defined as:
• Regions used for foraging (as opposed to migration corridors)
• Regions used by many individuals
• Regions used by many species – diverse predator species require diverse prey
Methods: Identification of Areas of Ecological Significance

1. Identify start and end of first foraging trip
2. Run State Space Model with 2h time step
3. Distinguish “search” and “transit” locations
4. Standardise number of locations per species
5. Combine species and produce kernel densities
6. Overlay species richness data
Predator distributions

- a. Southern elephant seal
- b. Black-browed albatross
- c. Antarctic fur seal
- d. King Penguin
- e. Macaroni Penguin
All species combined: Kernel density of “search” locations only

a. Kernel density of “search” locations

b. Species richness

Bathymetry (m)
Areas of ecological significance

...highly influenced by sampling effort, but several areas meet the criteria (kernel density quantile greater than 0.99 and species richness of > 4
## Results: Logistic regression and model selection

<table>
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<tr>
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</table>

- **aes** = Area of Ecological Significance
- **sst** = Sea surface temperature – weekly mean
- **ssha** = Sea surface height anomaly – Aviso – 8 day average
- **dist0m** =
A location is more likely to be an AES in shallow water, within 150 km of shore.
Three dimensional habitat of predators

Relatively poor descriptive power of the models due to:
• limited choice of variables – inclusion of gradients and productivity may help
• environmental data limited to remotely sensed, surface data – inclusion of information on water column will help.
• these data already exist from ship-based work and predators
• need to be related to predator habitat within the water column
Vertical distribution: southern elephant seals
Vertical distribution: southern elephant seals - 95% 3d isosurface

- Diving often on the shelf – regularly to the bottom
- distribution at depth very different to 2d picture from location data alone
Vertical distribution: all diving species combined

- Southern elephant seal (shading corresponds to depth)
- Antarctic Fur seal
- King penguin
- Macaroni penguin
Vertical distribution: all diving species combined - iso-surfaces

- Southern elephant seal (shading corresponds to depth)
- Antarctic Fur seal
- King penguin
- Macaroni penguin
Conclusions:

- A “work in progress”, but demonstrates an approach to community-based habitat analysis
- Predator tracking data can be used to quantify Areas of Ecological Significance
  - AES can be predicted from simple environmental data - the most important of which related to position over the plateau
  - In general AES are all on the plateau and determined by
    - proximity to colonies (breeding constraints)
    - relationship to shelf break and other ocean properties
- But models can be improved by
  - Including more data from more species and more sites
  - Incorporation of the vertical dimension – this will require development of new statistical approaches.
A new synthesis... SAATD

Density of Argos locations (weighted by species)

Areas of Ecological Significance

Species Richness

Re-analysis of all animal tracking data from the Australian Antarctic program
- 18 species
- over 1,000,000 locations

SCAR EB-BAMM undertaking a complete SO Synthesis of Antarctic Animal Tracking Data (SAATD)
- at the data collation stage... anyone willing to provide data see Mark Hindell or Yan Ropert-Coudert
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