The influence of diet on foraging habitat models

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Generalist predator populations

- assumption that all individuals are generalist foragers
- individual specialisation in foraging behaviour across a broad range of generalist taxa
- individual feeding tactics marine mammals and seabirds are often habitual

Marine prey species

- have different environmental preferences and tolerances

So….

- predators consuming different prey types are likely to forage in different habitat types

Marine foraging habitat models

- often perform poorly
- numerous potential causes have been identified in the past
- this study considers the influence of diet

Aim

- to investigate the influence of diet on foraging habitat models

Hypothesis

- core foraging areas are better predicted in predators consuming a single prey type with relatively specific habitat preferences than in predators consuming single or multiple prey types associated with more varied habitats

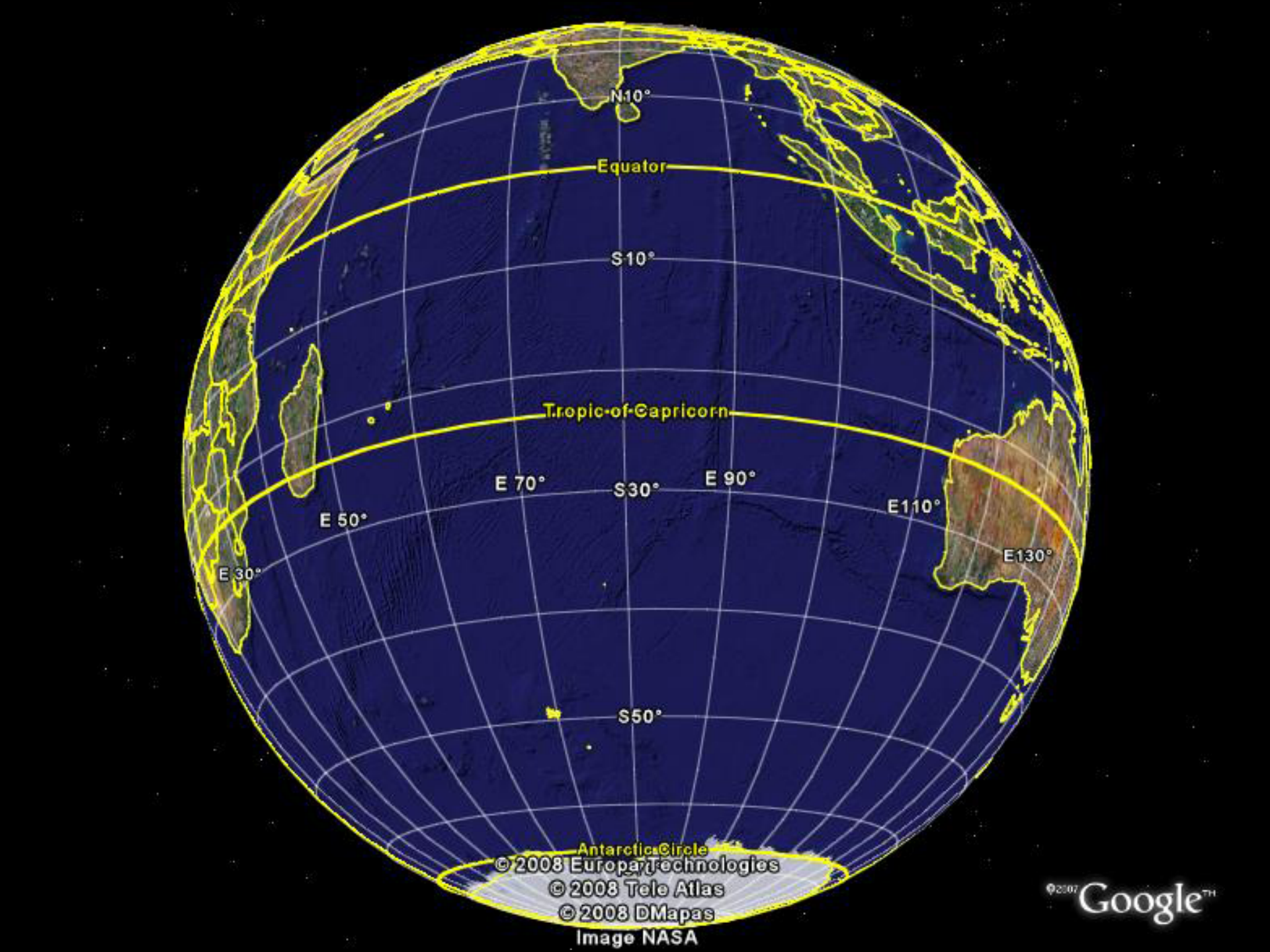
Foraging habitat models

1. Diet
   - What predators eat

2. Foraging habitat
   - Where predators eat

Study animal: nursing Antarctic fur seal (*Arctocephalus gazella*)

Study site: Heard Island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Equator
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Methods
1. Diet: what did they eat?

- faecal samples were collected from female fur seals on return from a foraging trip (n=40)

- prey were identified from faecal samples using both hard part analysis and DNA analysis

Hard part analysis of scats

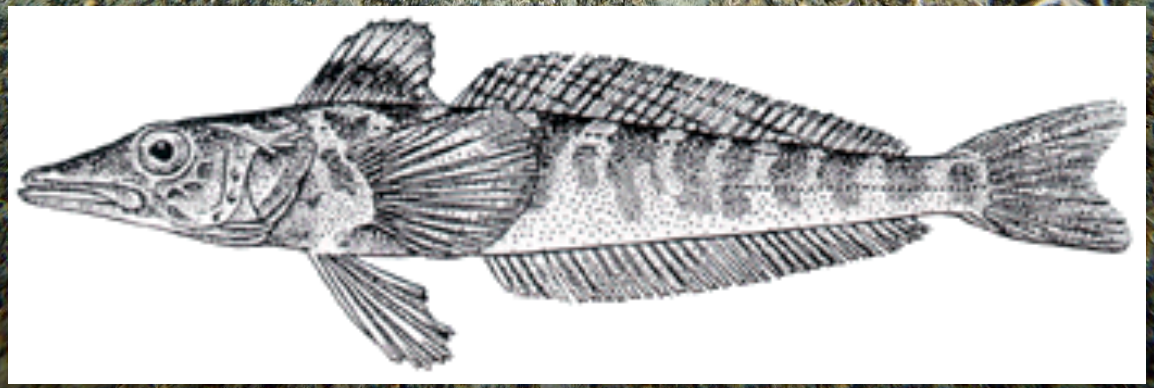
- Typically
  - fish otoliths (ear bones)
  - squid beaks
  - crustacean exoskeletons

Using DNA to determine diet

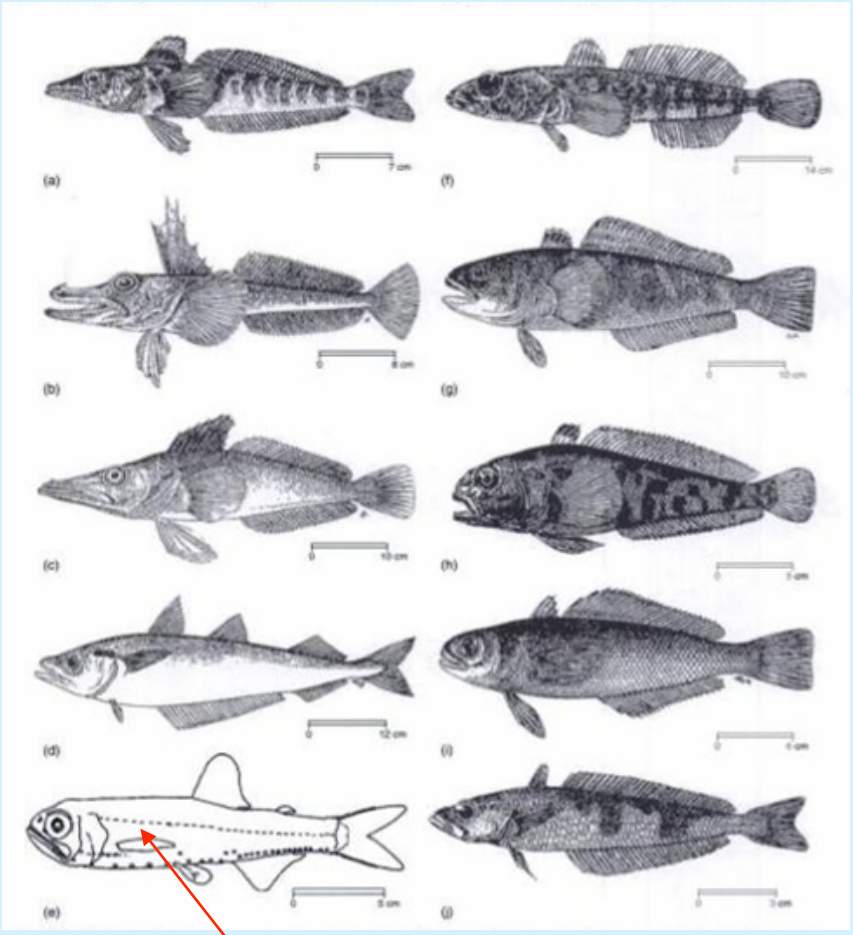
Results: Diet

- 30% seals consumed icefish only
- 20% seals consumed myctophids only
- 50% seals consumed icefish, myctophids and squid

mackerel icefish (*Champsocephalus gunnari*)

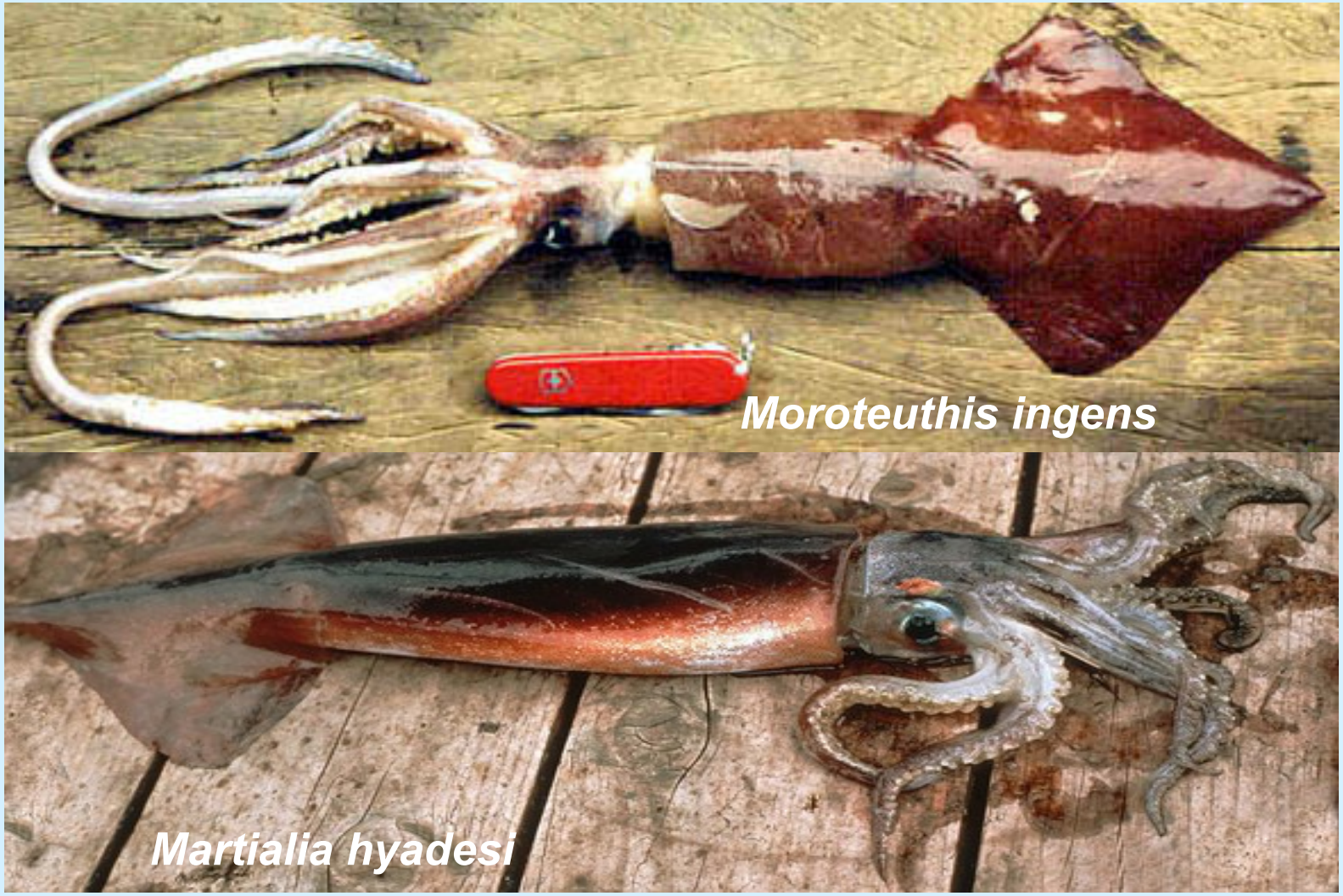


myctophids (mostly *Gymnoscopelus nicholsi*)



Myctophidae: lanternfish

Subantarctic squid



Methods
2. Foraging habitat: where did they eat?

- locations determined from PTT that each seal carried on her foraging trip

- environmental data for these locations from remote sensing

Multiple logistic regression
Classification tree analysis

Potential significant variables included:

- bathymetry
- long term average SST (n=24 years)
- long term SST variability (n=24 years)

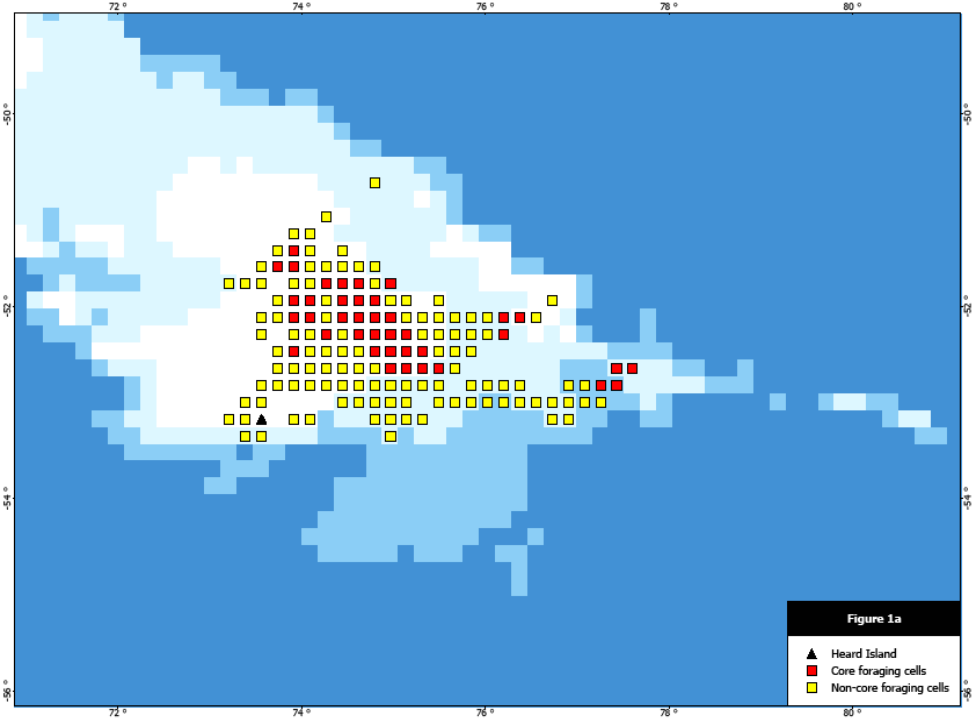


Figure 1a
Heard Island
Core foraging cells
Non-core foraging cells

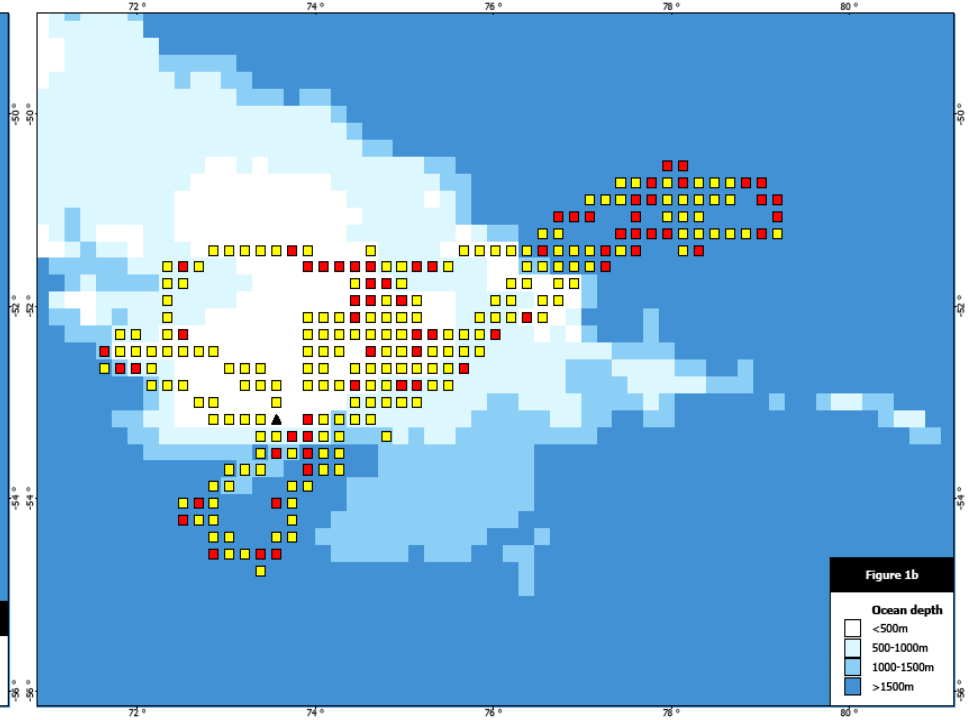


Figure 1b
Ocean depth
<500m
500-1000m
1000-1500m
>1500m

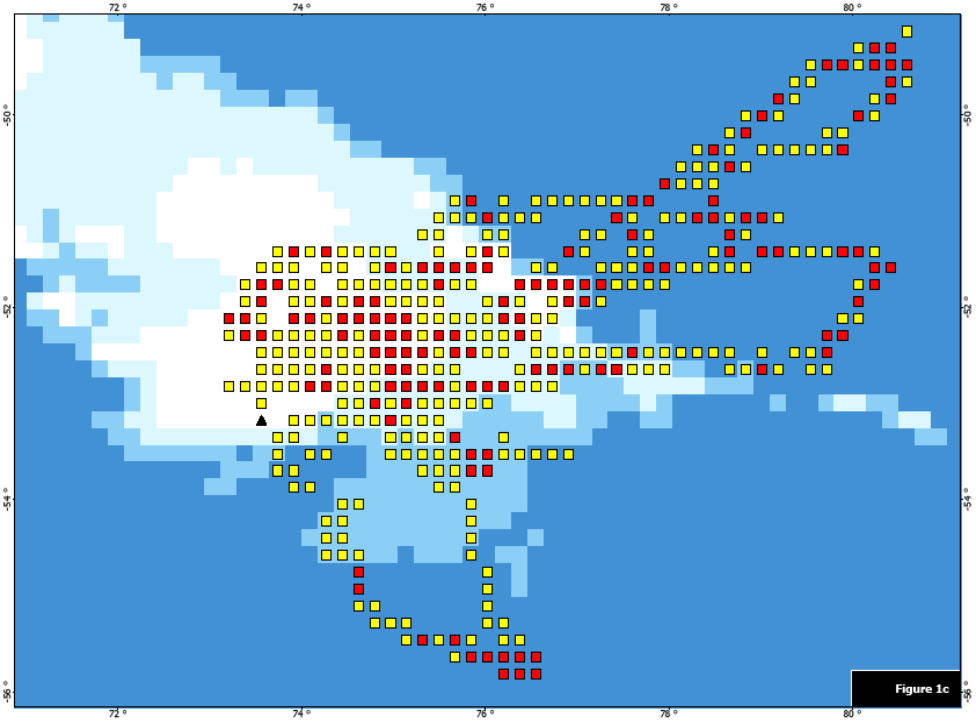


Figure 1c

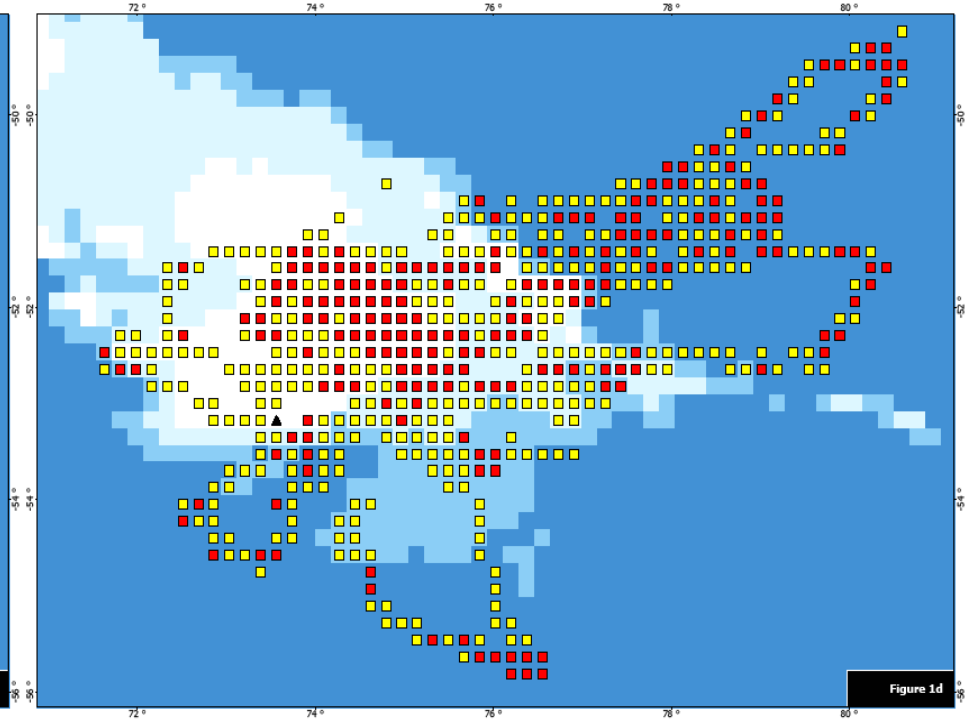


Figure 1d

Can we predict core foraging areas from environmental features?

Modeled core foraging areas of:

- icefish only consumers (n=12)
- myctophid only consumers (n=8)
- multiple prey type consumers (n=20)
- all seals (n=40)

Results: Foraging habitat

Classification Tree (core vs. non-core foraging cells)

SEAL GROUP BY DIET Predictor	Core cell value	Correct core cell classification (%)	Correct non-core cell classification (%)	**Misclassification rate (%)**
ICEFISH *SSTclimSD* (°C) and Ocean depth (m)	≥0.80 ≤478	74.4	75.7	**24.7**
MYCTOPHID Ocean depth (m)	>382	93.9	26.0	**55.9**
MULTI PREY *SSTclimSD* (°C)	≥0.81	86.6	32.6	**49.6**
ALL SEALS *SSTclimSD* (°C)	≥0.81	81.9	39.5	**44.6**

Results: Foraging habitat

Core foraging areas of Icefish only consumers could be described using environmental variables

- bathymetry
- long term SST variability

But other groups could not…

Why?

Different prey types have different habitat tolerances

- Icefish have relatively specific habitat preferences
  - around islands, shallow banks
- Myctophids are found in more varied habitat
  - open ocean, continental shelves, oceanic banks

Foraging habitat models may be more predictive where:

- predators consume single vs. multiple prey types
- prey have relatively specific habitat requirements, e.g. icefish vs. myctophids

Implications

- predator-prey relationships are commonly inferred by combining
  - foraging trip data from known individuals
  - dietary data from unknown individuals

- habitat modeling may be improved by applying more accurate diet information to spatial data

Implications

- habitual monotypic consumers may be more vulnerable in years of poor prey availability, caused for example by climate change or commercial fishing


Casper RM et al. (2010). Ecography 33:748-759
Casper RM et al. (2007). Marine Biology 152:815-825
Thank you
(can you spot the seals?)