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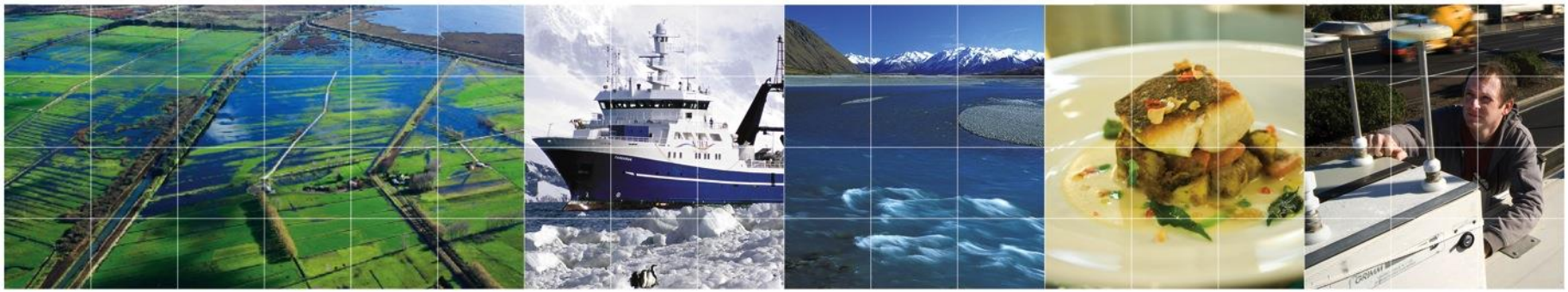
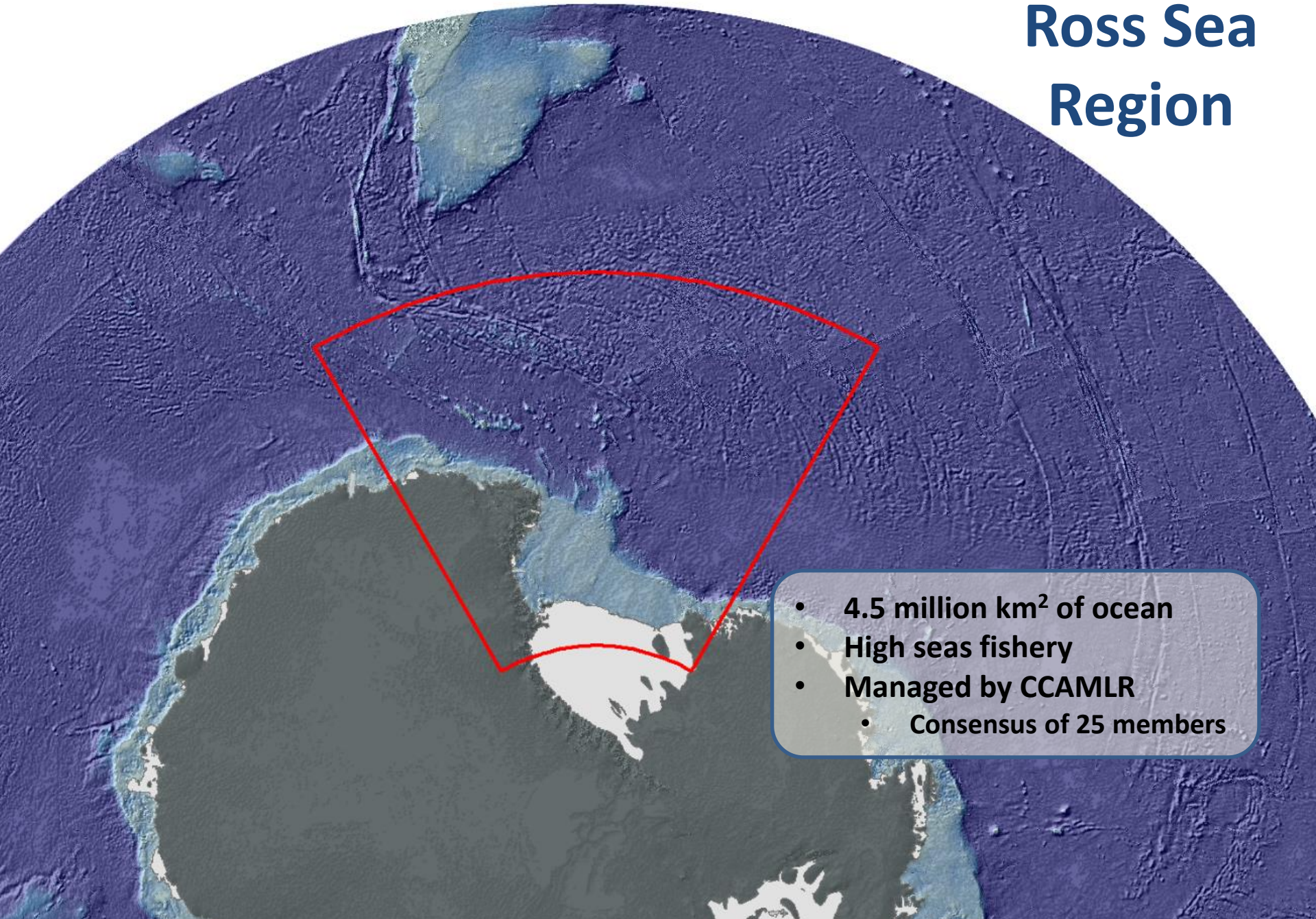
Bycatch accounting and management in the Ross Sea toothfish fishery

Steve Parker
Sophie Mormede
Stuart Hanchet

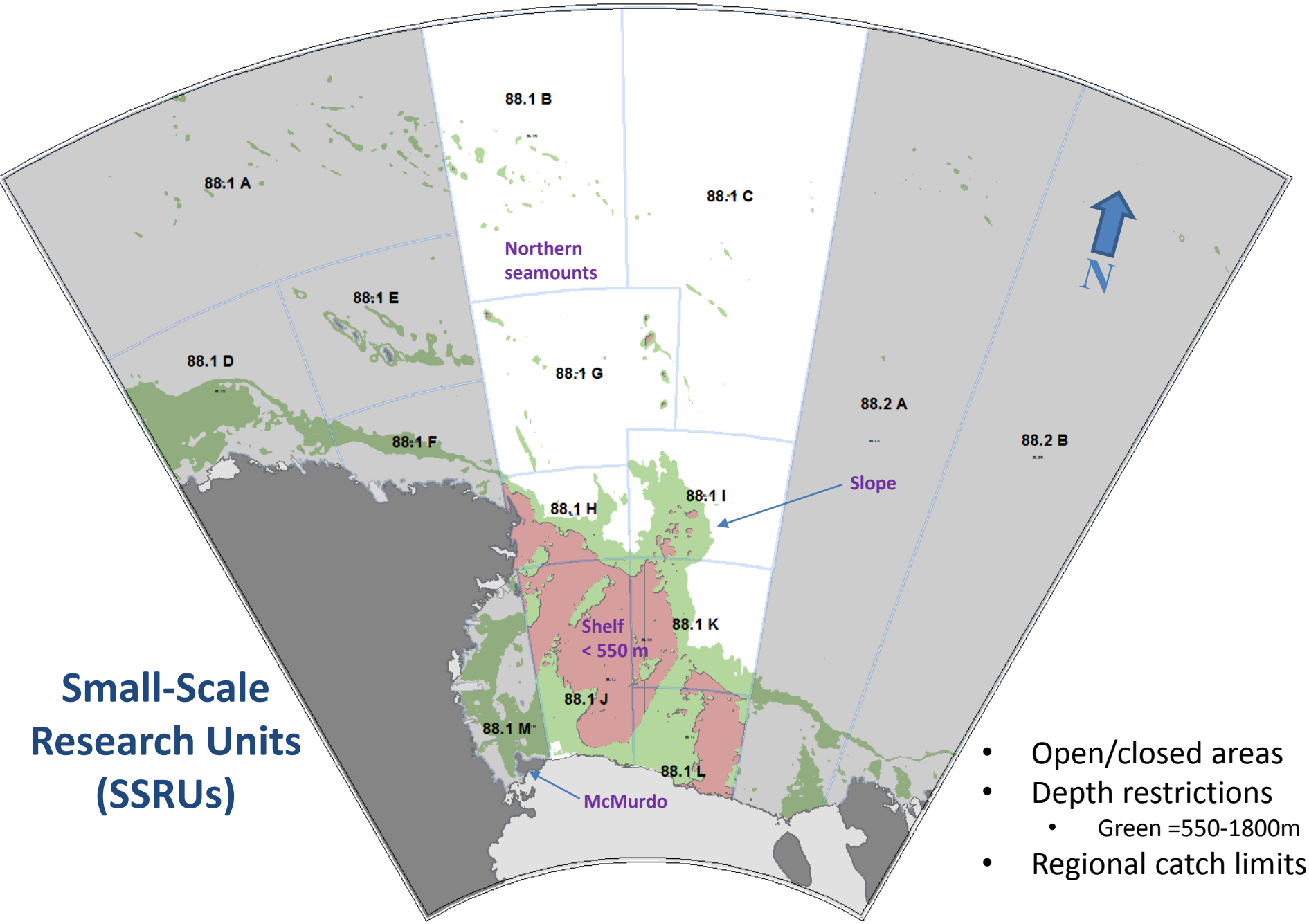
New Zealand



Ross Sea Region



- 4.5 million km^2 of ocean
- High seas fishery
- Managed by CCAMLR
  - Consensus of 25 members



Small-Scale Research Units (SSRUs)

- Open/closed areas
- Depth restrictions
  - Green =550-1800m
- Regional catch limits

- Bottom longline only
- Started in 1998
- ~3200 t annually
- Summer only (Dec-Feb)
- Deepwater (800-2000 m)
- ~20 vessels from 10 nations
- Two scientific observers each
- Assessed via mark-recapture and integrated stock assessment

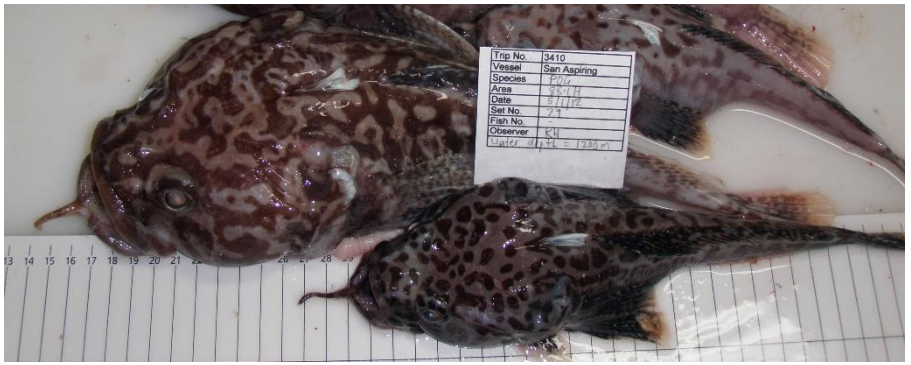
Bycatch species

3 grenadiers (*Macrourus whitsoni*, *caml, holotrachys*)
2 skates, (*Amblyraja Georgiana*, *Bathyraja* cf. *eatoni*)
1 eelcod (*Muraenolepis evseenkoi* +?)
1 icefish (*Chionobathyscus dewitti)*
1 deep sea cod *(Antimora rostrata)*
Several rock cods *(Trematomus sp.)*
Other minor species *(e.g., plunderfish)*

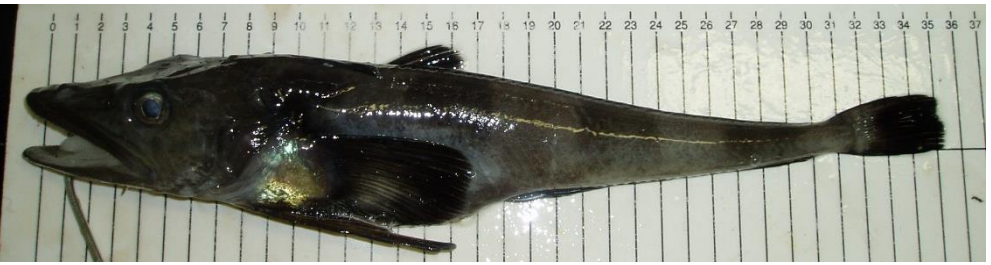
Habitat forming invertebrates (23 taxa)
Seabirds (1 in 2004, 1 in 2013)
No penguins
No marine mammals

Minor bycatch species

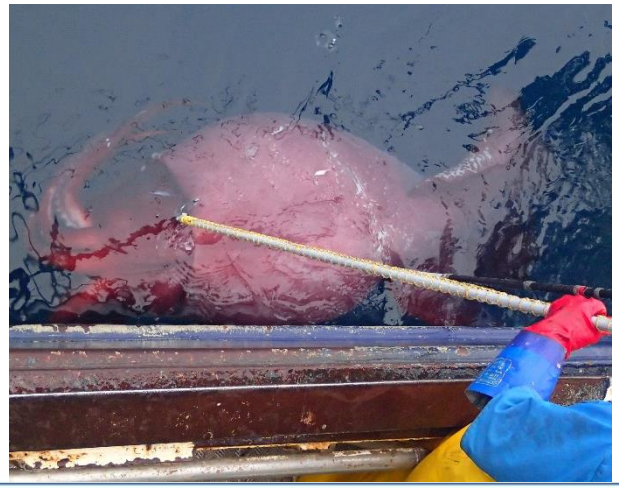
Eelcod



Plunderfish



Icefish



Bycatch management

- Article II of the CCAMLR Convention
  - Target fished population is above a level which ensures stable recruitment (above 50% virgin biomass for toothfish).
  - Ecological relationships between harvested, dependent, & related populations are maintained.
  - Prevention of changes in marine ecosystem which are not potentially reversible over 2-3 decades.

- Implemented through annual Conservation Measures agreed through consensus of 25 Members.

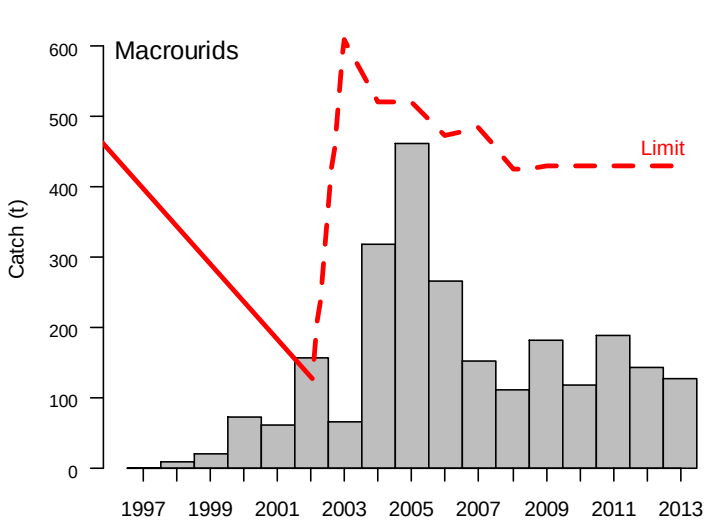
Setting catch limits

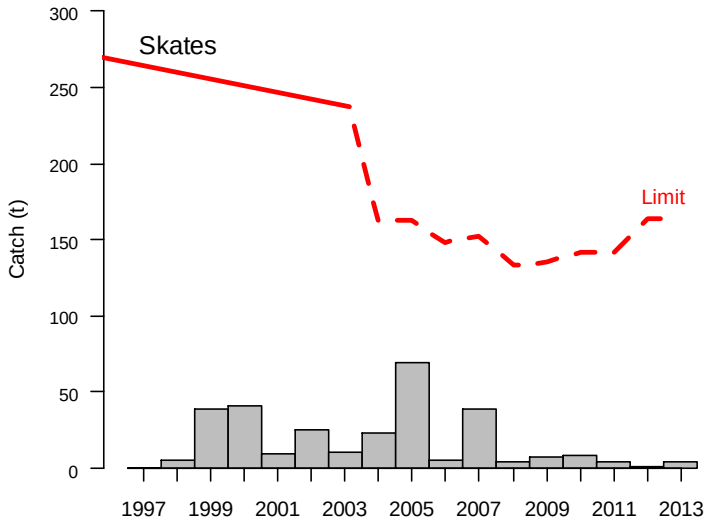
- Macrourus
  - By analogy to other areas of Southern Ocean
  - Trawl survey extrapolation
  - Acoustic survey via fishery (in progress)
- Skates
  - Percentage of toothfish catch limit
  - Tagging program
  - Preliminary stock assessment
- Other species
  - Composite 20 t catch limit (per SSRU)

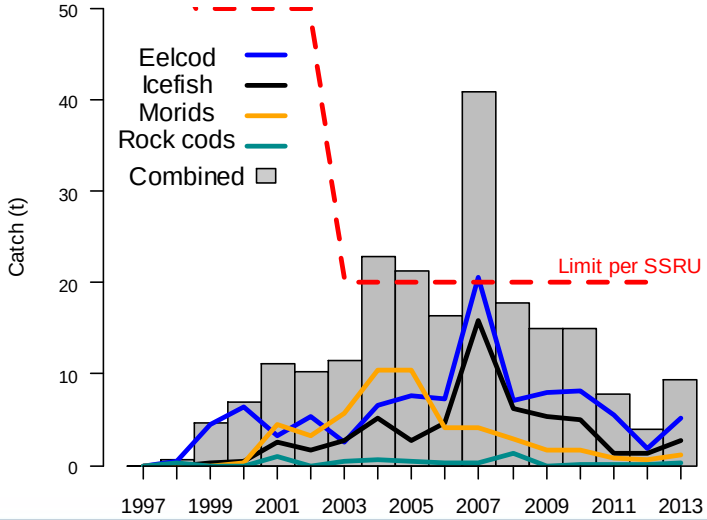
Bycatch management

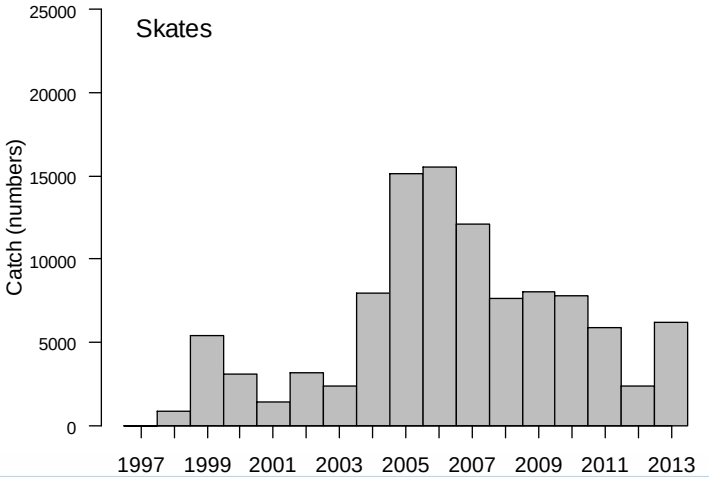
- Conservation Measure 33-03
  - 5 nm move-on rule if any species greater than 1 t per set.
  - Macrourus
    - Catch limit in 88.1 = 430 t.
    - If the catch of *Macrourus* spp. taken by a single vessel in two successive 10-day periods in a single SSRU exceeds 1 500 kg, and exceeds 16% of the catch of toothfish by that vessel, the vessel shall cease fishing in that SSRU for the remainder of the season.
  - Skates
    - 5% of toothfish catch limit by weight (~160 t dead)
    - All skates and rays must be brought on board to be checked for tags.
    - All live skates released
- Conservation Measure 41-09
  - Macrourus catch limit allocation to SSRUs based on historical proportions
- Conservation Measure 22-07 VMEs
  - Habitat forming organisms, 1 nm radius closures at 10 kg per 1200 m line segment.
- Conservation Measure 25-02 & 24-02 Seabirds
  - Streamers, sink rates, weighted lines, BEDs, offal and discard prohibition.

Main bycatch species

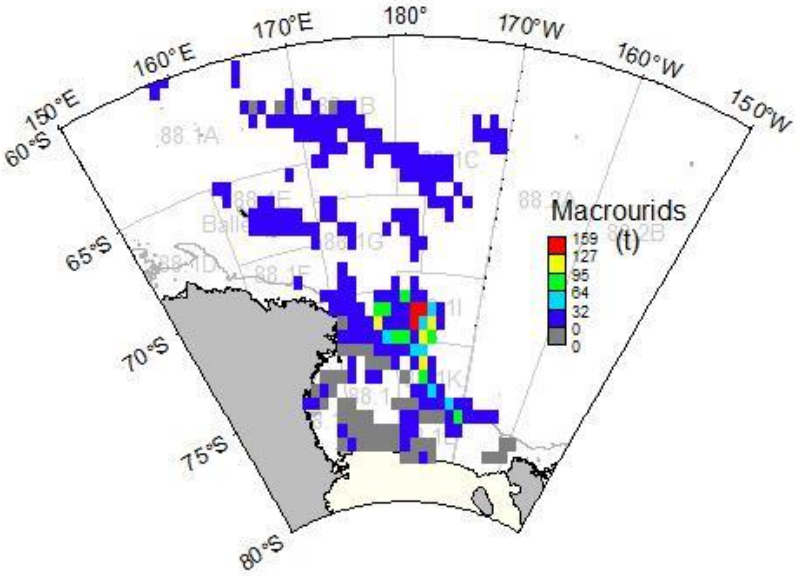


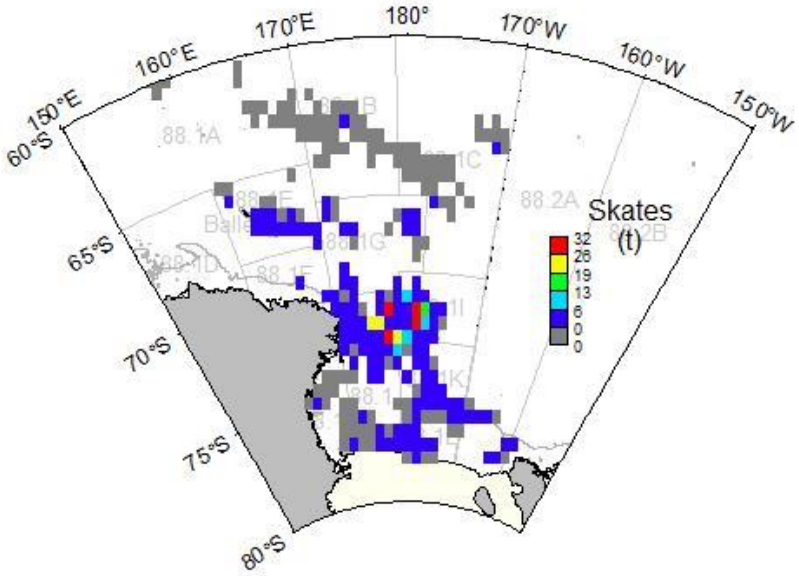


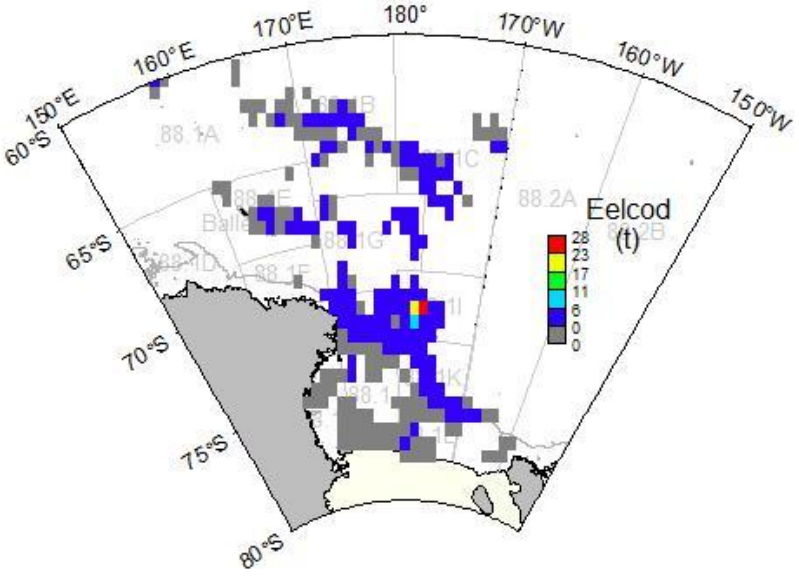


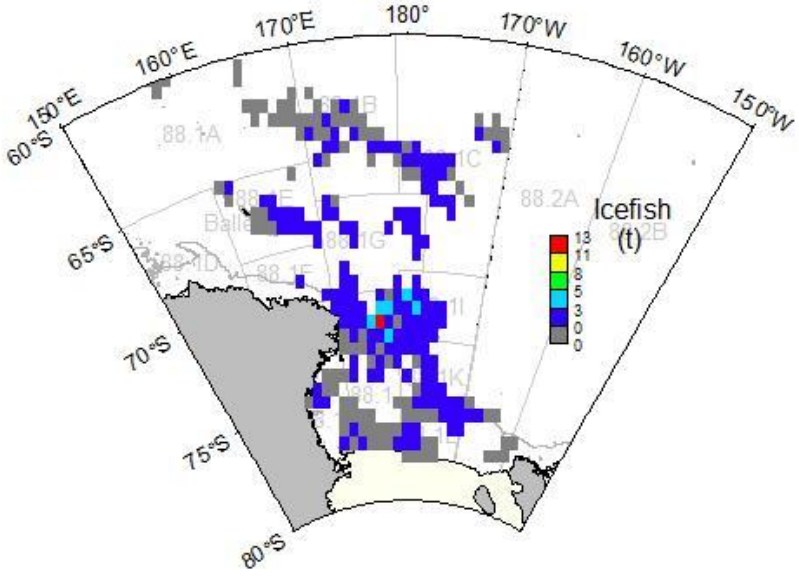


Spatial distribution of catch









Macrourus
Risk factors

- Abundance-based catch limits well above catch
- Population large by comparison with others
- Vulnerable life histories, esp 1 species
- Stable recent CPUE, but active avoidance, gear change
- Ice conditions (and potentially management) could force vessels to fish in high catch rate areas
- Ecologically a key slope demersal species

Skates
Risk factors

- Most released alive
- Tagging program uncertainties
  - Species identification
  - Release mortality
  - Movement patterns
- Species identification issues
- Vulnerable and uncertain life histories
- Catch limits not biologically based
- Declining trend in catch

Other species: Muraenolepis, Channichthyids, Antimora, Notothenioids Risk factors

- Small catches (typically < 5 t)
- Recent declining trends (through 2012), but likely spatially driven
- More productive life histories, but limited information
- Catch limits not biologically based

Three species spatial population models

Criteria:

- Interaction with toothfish (prey)
- Important (50% of diet)
- Directly impacted via the fishery
- Different life histories

Next most important fish
~ 12% diet

Toothfish

Macrourid

Icefish

Building spatial components

- Biomass of prey spatially (using spatial CPUE values)

  + biomass of toothfish spatially (toothfish spatial model)

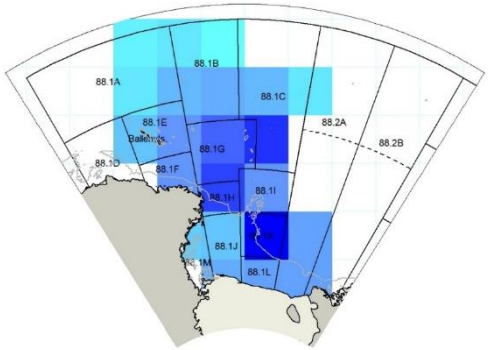
  + electivity of toothfish (based on stomach contents)

  + residual mortality of prey species

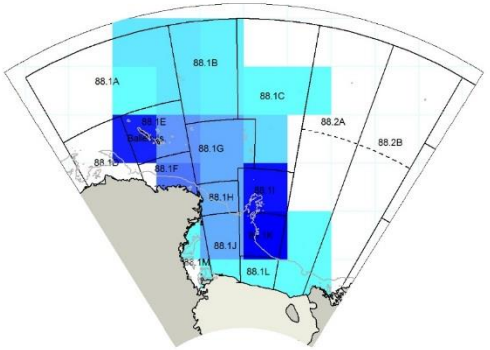
  + fishery removals spatially

  + selectivity of the fishery (derived from observed length)

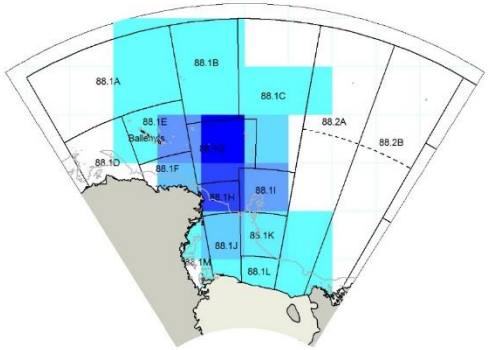
  = spatial model of the three species through time



toothfish

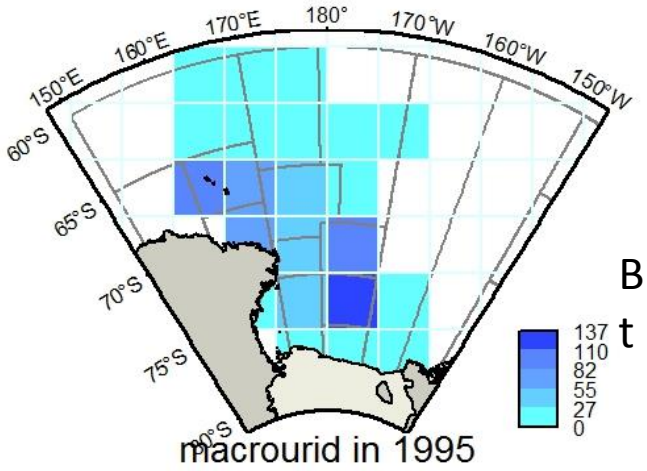


macrourid



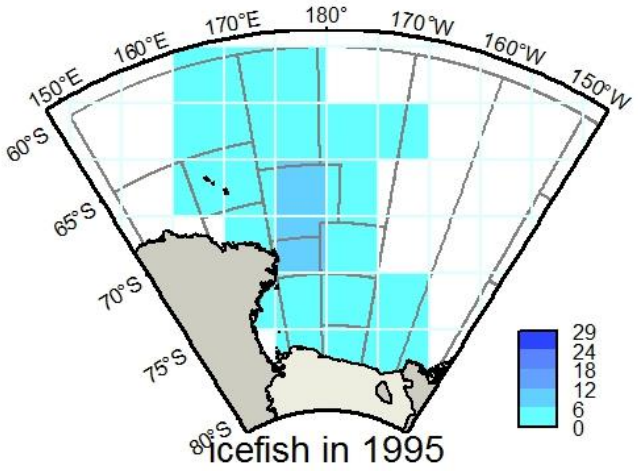
icefish

Estimated spatial temporal trends

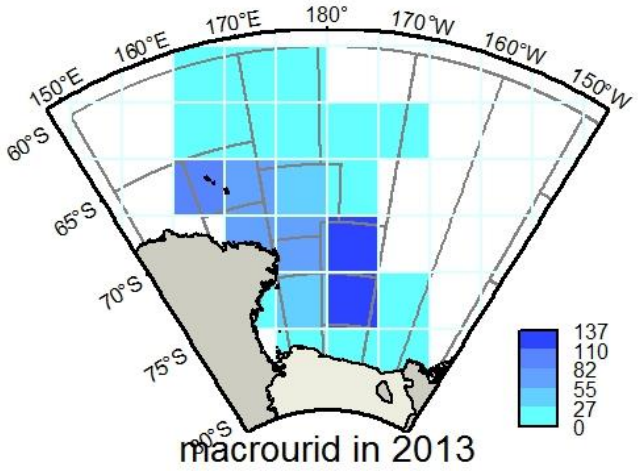


macrourid in 1995

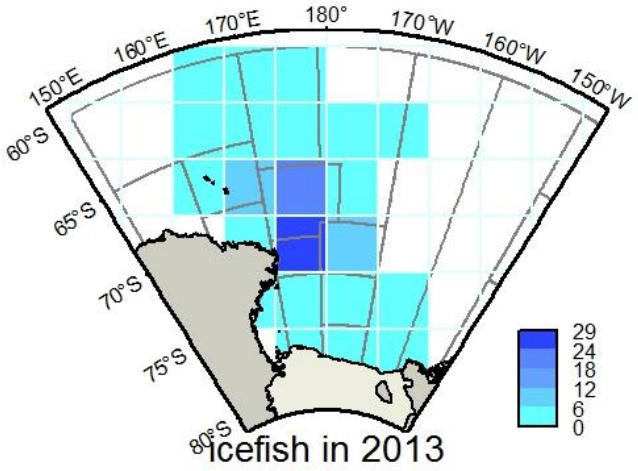
Biomass t



icefish in 1995

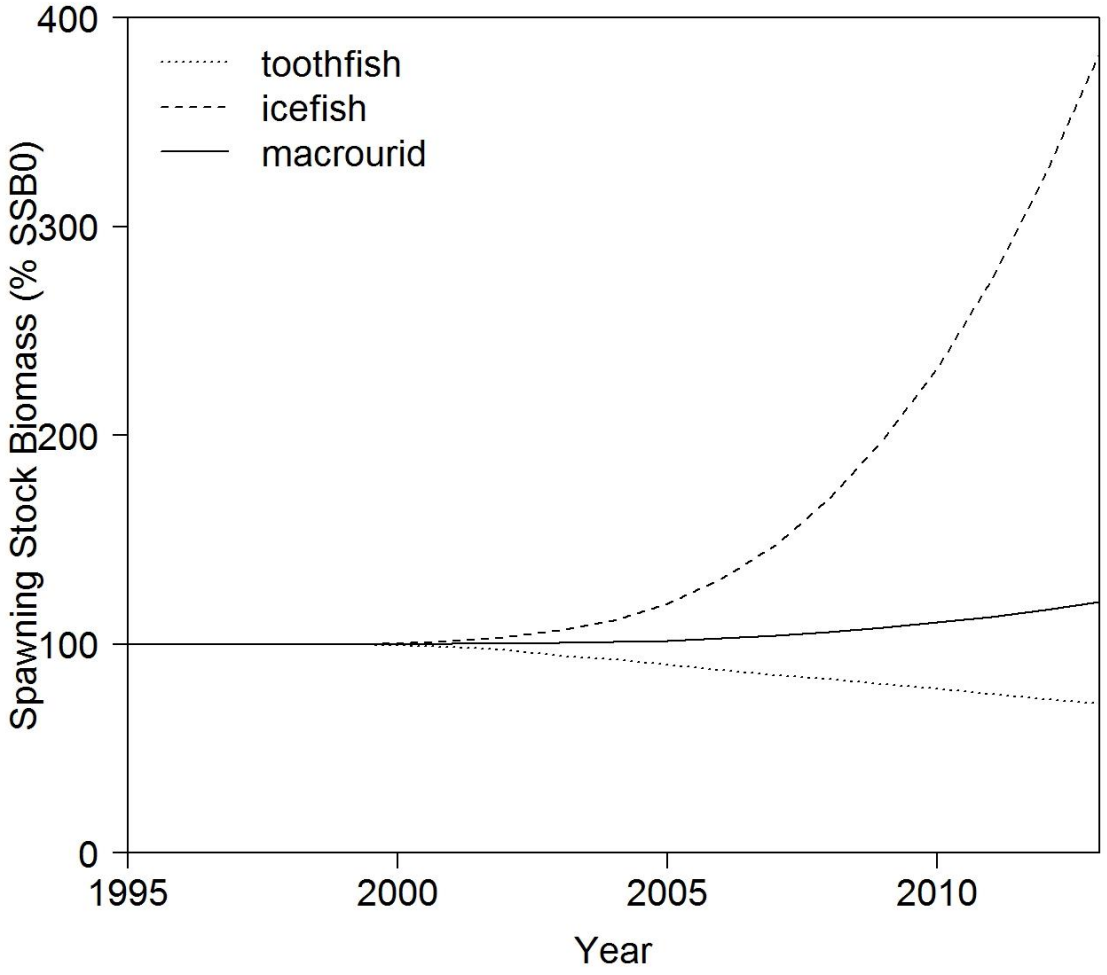


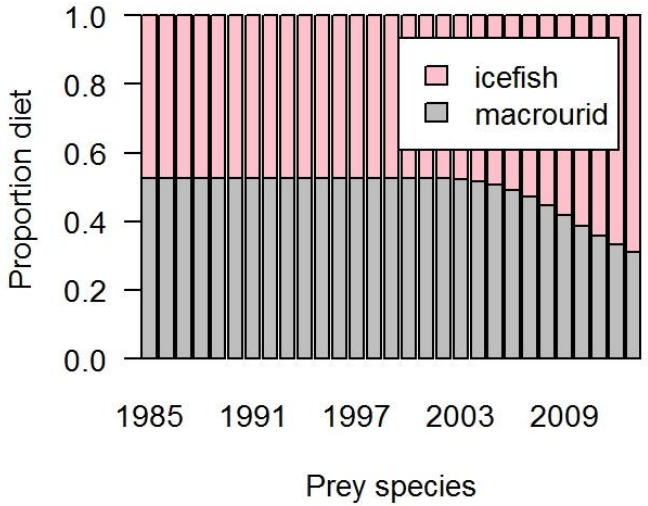
macrourid in 2013



icefish in 2013

Biomass trends and prey switching





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Summary

- Ross Sea toothfish fishery uses large closed areas, catch limits, move-on rule, CPUE monitoring to control bycatch.
- Observers provide good monitoring of species catch.
  - Skate exception (ID and release mortality)
- Catch is heavily influenced by location, gear type.
- Impacts of fishing on bycatch populations are dependent on:
  - Spatial distribution
  - Understanding life histories
  - Ecosystem response to fishing (direct and indirect)
- Expected interactions with fishery via multi-species spatial models.
  - Useful for designing and assessing monitoring tools for prey species.
  - Provide testable hypotheses for system dynamics.

Acknowledgements

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