Spatial, temporal and dietary overlap between harbour seals *Phoca vitulina* and fisheries in Erimo, Japan: conflict at sea?

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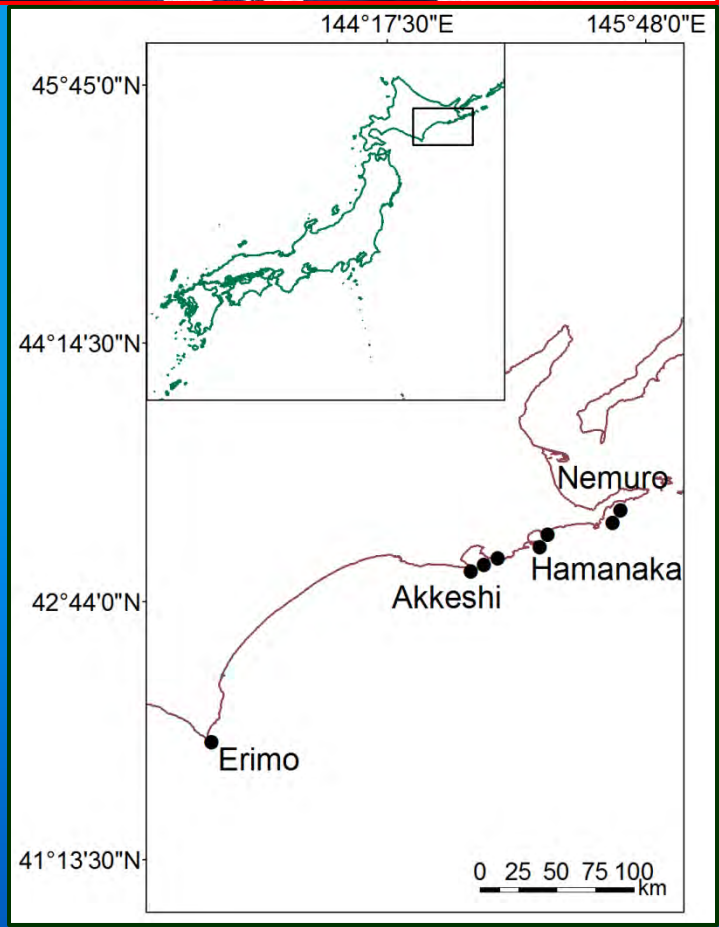
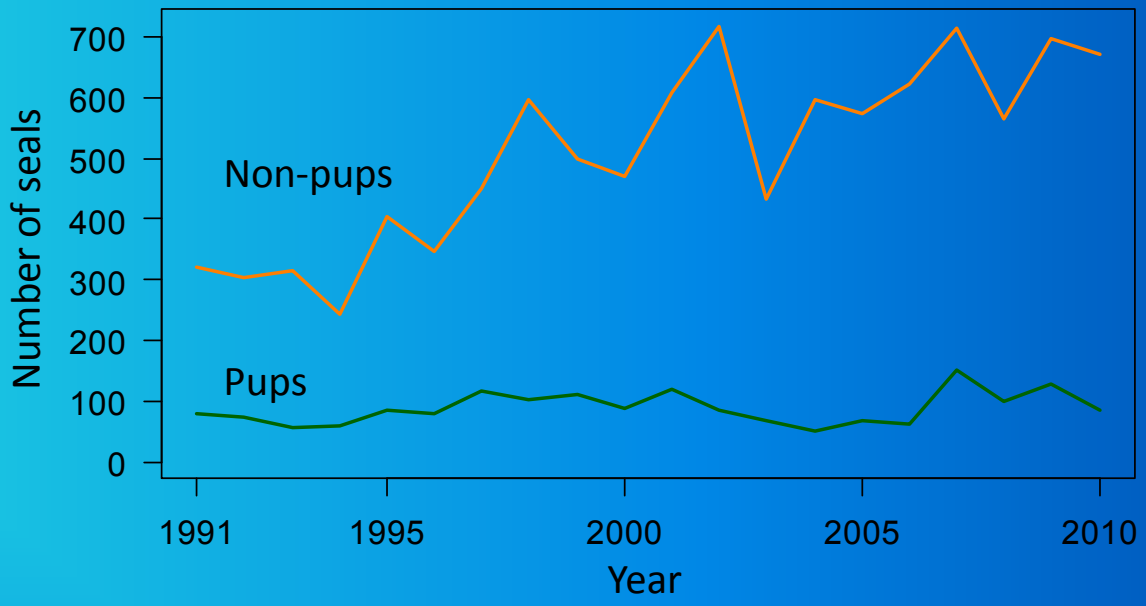
Background

- Most widely distributed pinniped in the world
- But in Japan, only found on the eastern coast of Hokkaido
- Protected since the mid-1980s due to restricted range, low population numbers, and decimation in the past by hunting, habitat damage and being incidentally caught in fish nets

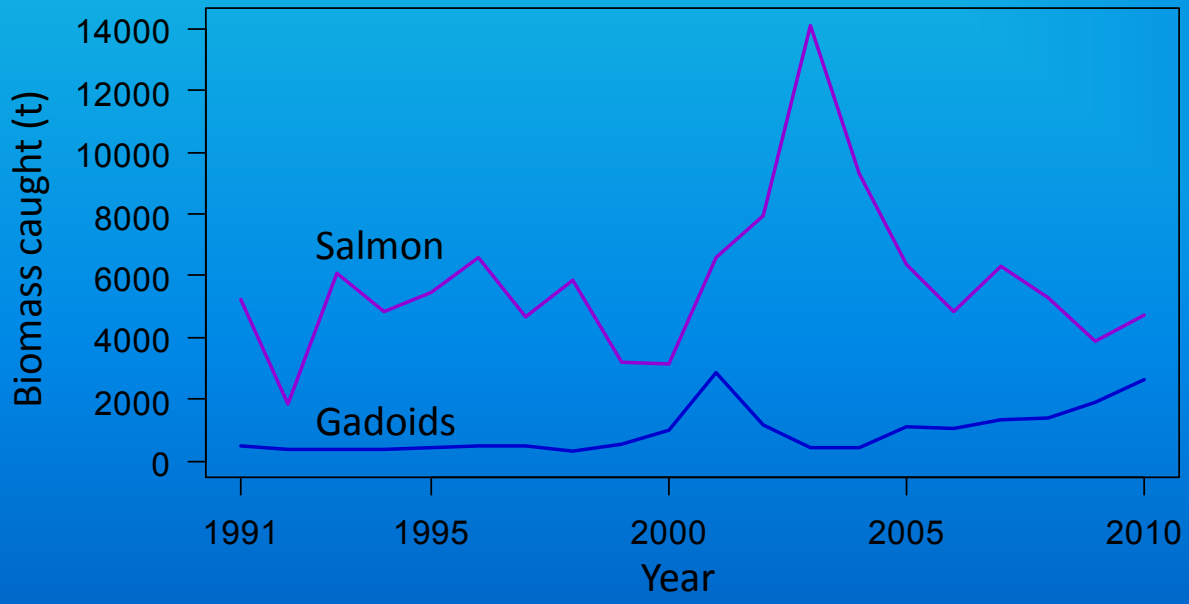


Since then, the total number of harbour seals in Japan has been rebounding…



*Data from Kobayashi, Y. (2011)

Erimo



*Data from Erimo Fisheries Cooperative (2011)

…and the amount of fish caught has been ‘unsatisfactory’.

The problem

- With the increase in seal numbers, increased conflict with fisheries has occurred
- Damage to fish caught in nets
- Competition for prey
- Seal cull proposed to minimise fish damage and increase the amount of fish available to fisheries

seal-bitten salmon

fixed net

Conflict!

- Harbour seals are a protected species and a tourist attraction
- Little is known about the foraging ecology of harbour seals in Japan
- Cannot determine whether the majority of seals target fish caught in nets
- Difficult to assess competition
- Cannot predict the impacts of a cull on harbour seals, the surrounding ecosystem and fisheries yields
- A cull could revert their populations back to historical lows

To resolve the conflict, we need to know where, when and what harbour seals eat.

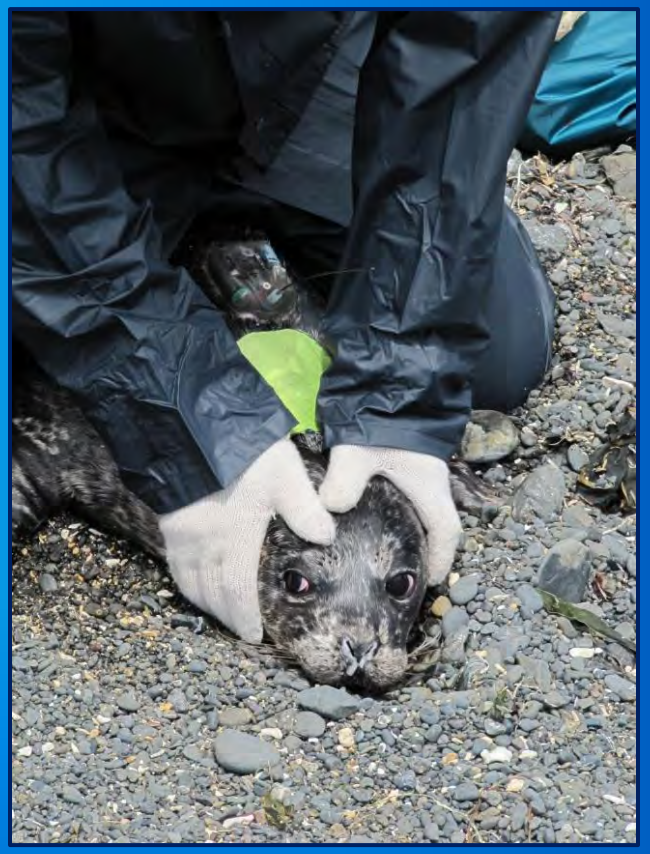
Objectives:

1. Determine harbour seal foraging range
2. Determine harbour seal diet
3. Examine spatial, temporal and dietary overlap between harbour seals and fisheries

Where do harbour seals forage?

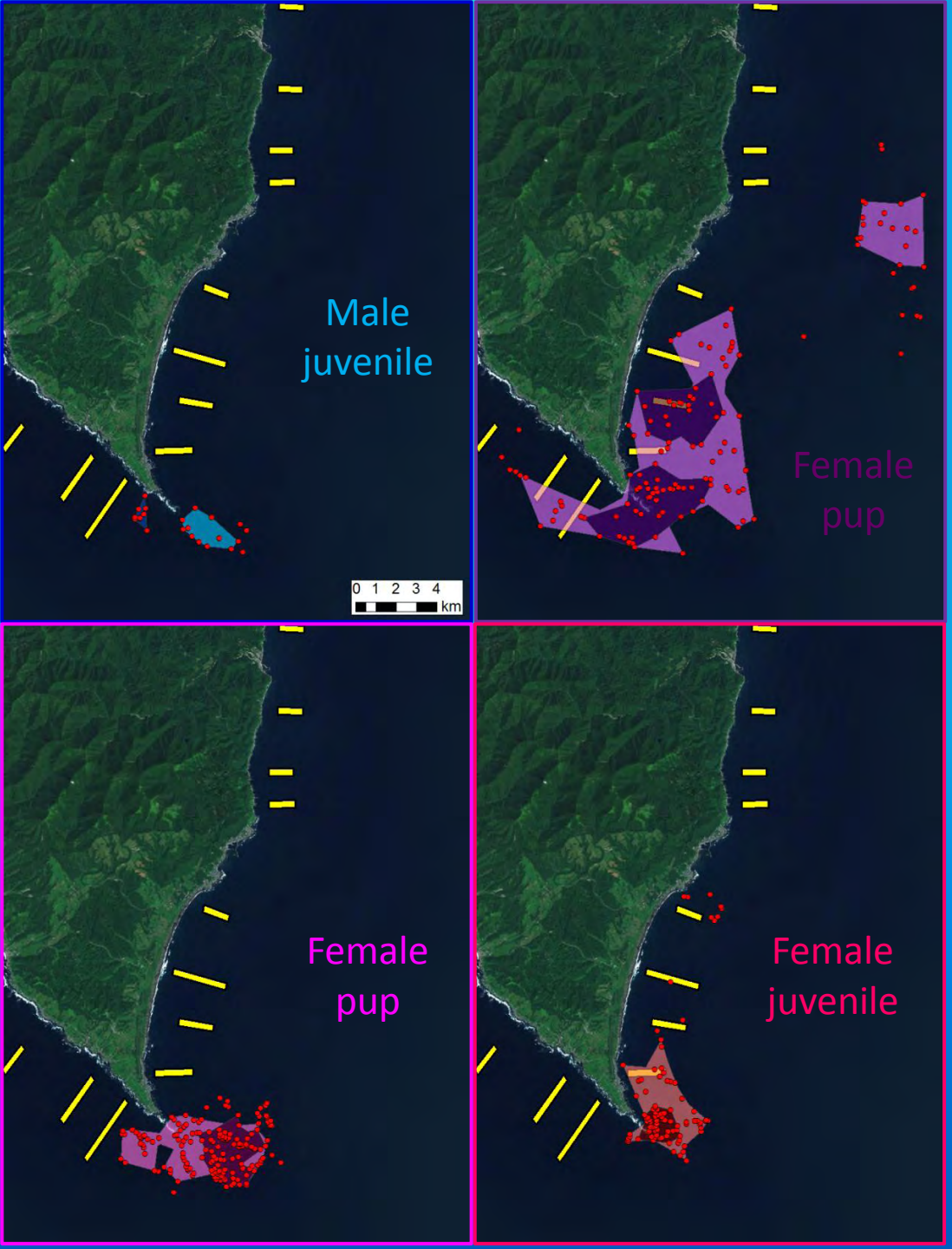
Satellite tracking

- SPOT5 Argos attached to 1 male pup in July 2011
- Set to attempt a location fix every 45 s when dry
- TGM4310 GPS attached to 1 male juvenile, 1 female juvenile and 2 female pups in June 2012
- Set to attempt a location fix every 15 min



Foraging range analysis

- Adaptive local convex hulls (LoCoH)
- Non-parametric method based on a generalisation of the MCP
- Performs well around coastal boundaries
- Especially suitable for analysing location-dense datasets such as those obtained from satellite tags
- Argos - locations with accuracy classes 1 (500-1,500 m), 2 (250-500 m) or 3 (<250 m)
- Eliminated locations associated with haulout behaviour



Differences between individual seals (GPS tags)

- Regular transmissions from 24 Jun – 17 Jul 2012 (non-fishing season)
- 90% foraging ranges of 2 seals overlapped nets
- 50% core range of 1 seal overlapped nets
- No visible differences between ages
- Foraging range size: 3.5-63.9 km^2
- Farthest distance from rookery: 21 km

Differences between seasons (Argos tag)

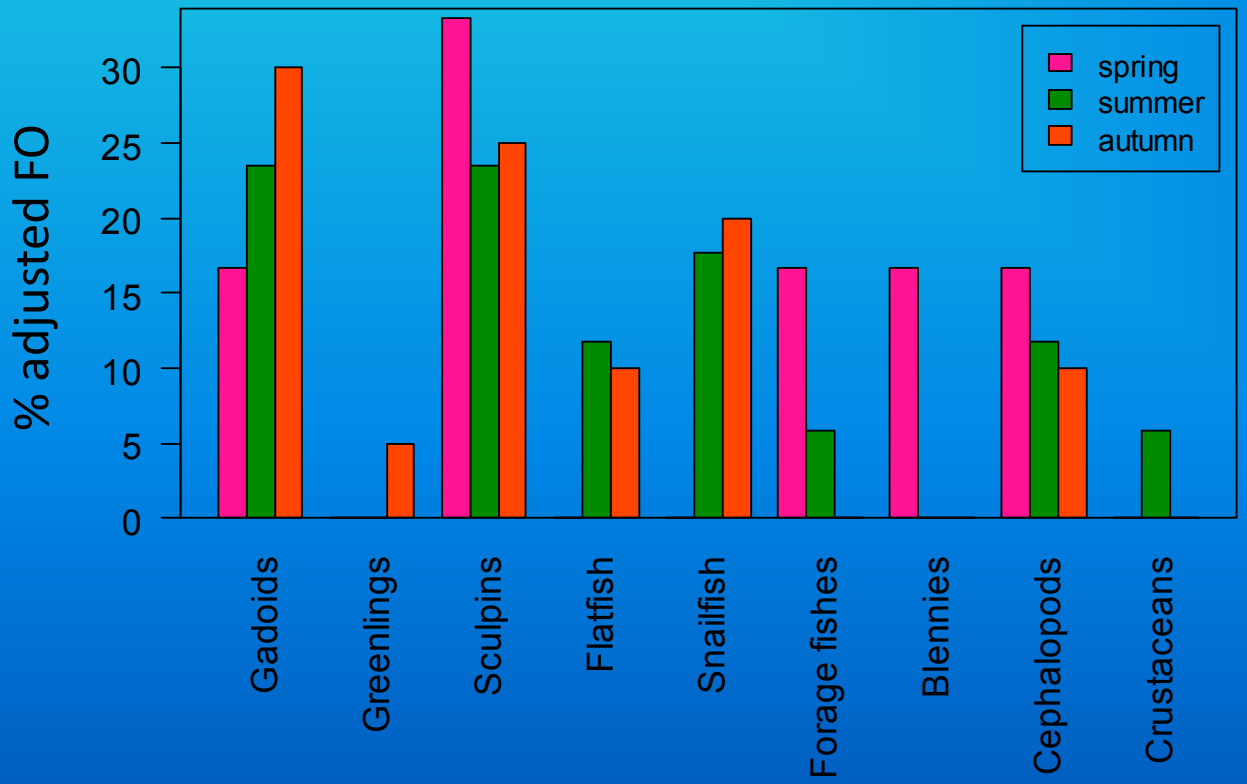
- Regular transmissions from 2 Jul 2011 – 8 Jan 2012
- 90% foraging range overlapped nets in summer and autumn
- 50% core range overlapped in summer only
- Largest foraging range size in summer (58.6 km^2), smallest in winter (5 km^2)
- Farthest distance from rookery: 14.8 km (summer)

What do harbour seals eat?

- Collected 56 scats from Jul-Oct 2011, April 2012
- Scats washed through 0.5 mm sieves
- Prey identified to the lowest possible taxon from hard parts (e.g., otoliths, cephalopod beaks, crustacean shells)
- Calculated percentage adjusted frequency of occurrence for each prey type

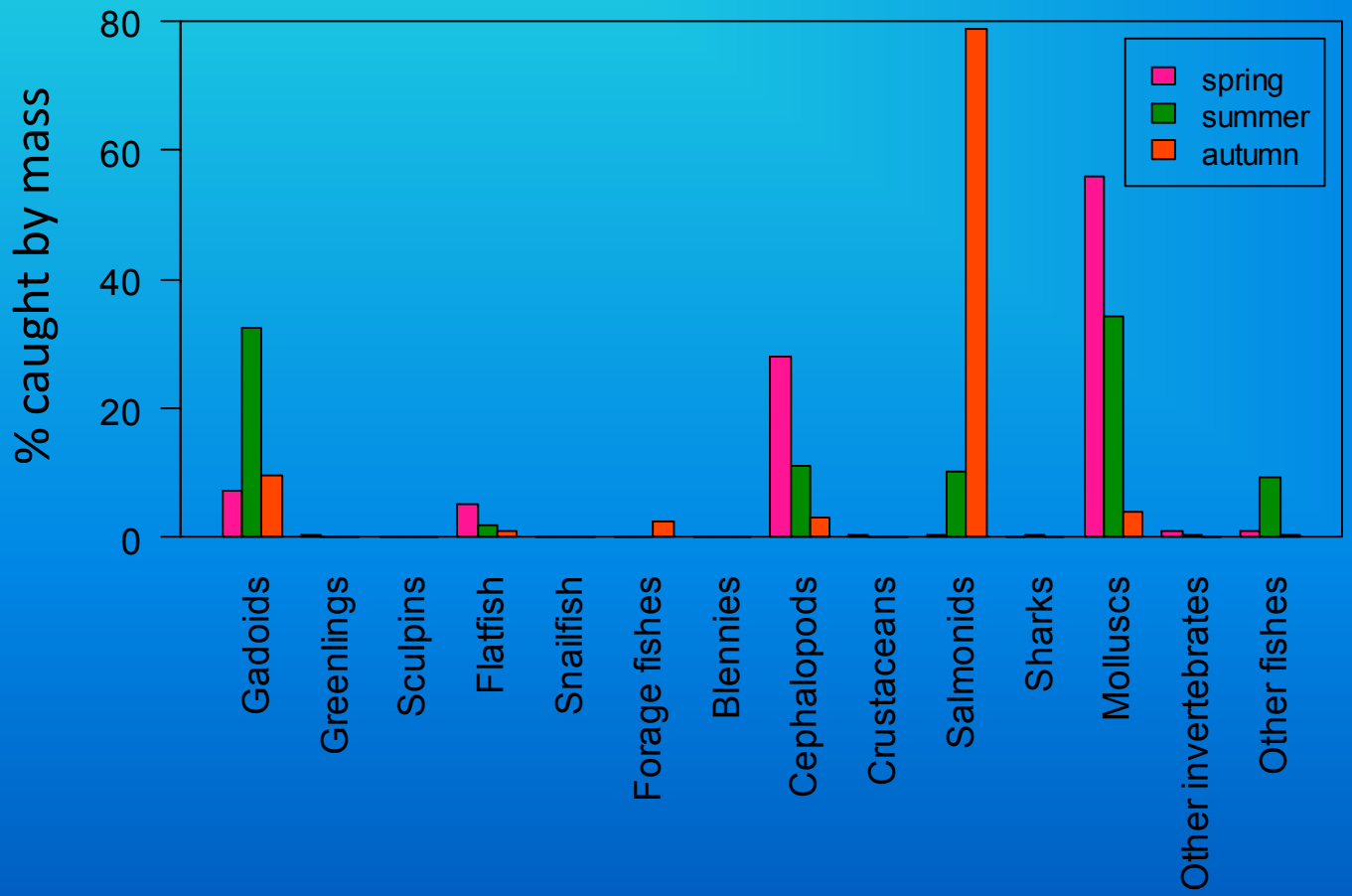
Harbour seal diet

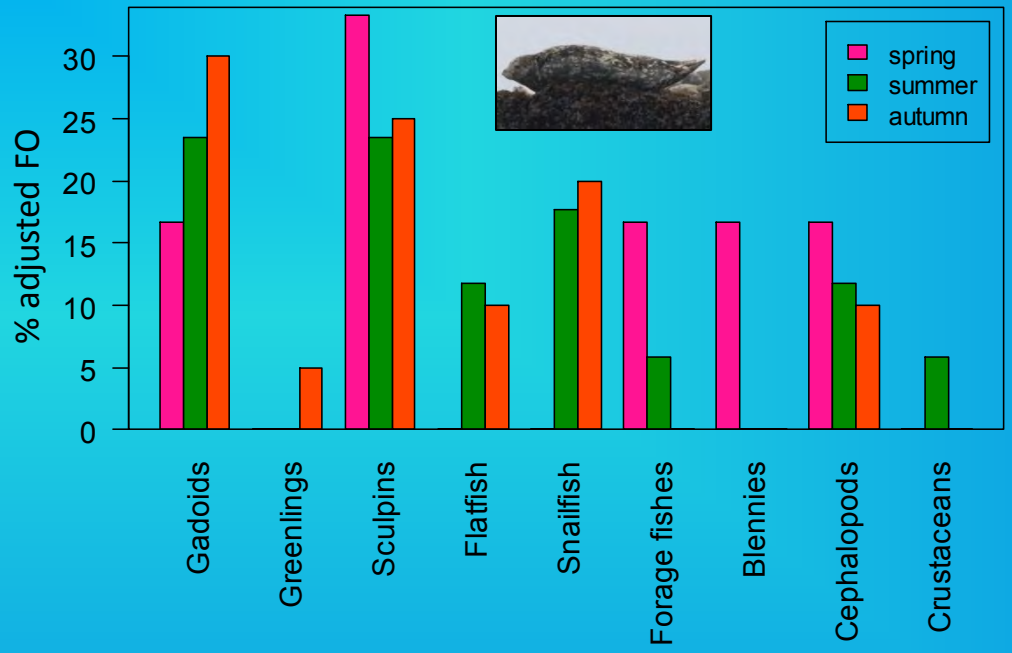
- No salmon (39 scats with identifiable prey remains)
- Main prey items all year round are gadoids, sculpins and cephalopods 
- Flatfish and snailfish important in summer and autumn
- Forage fishes and blennies preyed on in spring

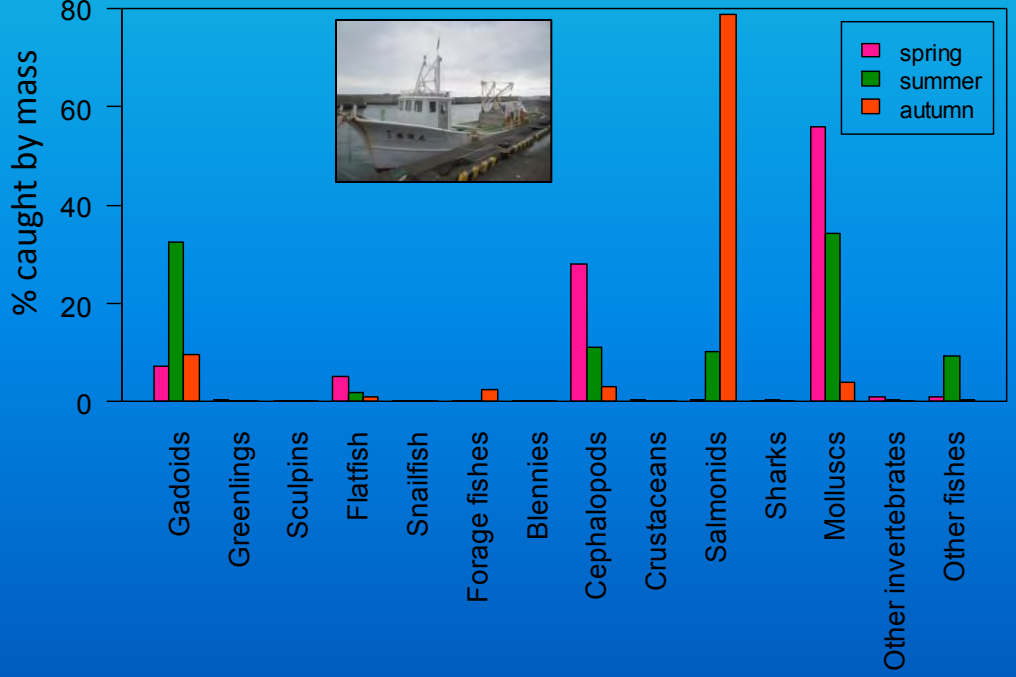


Fisheries catches

- Salmon is by far the most important (4,461 t), followed by molluscs, gadoids and cephalopods
- Cephalopods and molluscs mainly harvested in spring, gadoids in summer and salmon is almost exclusively caught in autumn







Seals and fisheries compared

- Many species common in the harbour seal's diet are not targeted by fisheries
- May be some competition for gadoids in summer and cephalopods in spring

Dietary overlap

Pianka niche overlap index

$$\alpha = \frac{\sum_i P_{ij}.P_{ik}}{\sqrt{\sum_i (P_{ij})^2 . \sum_i (P_{ik})^2}}$$

- Measure of qualitative resource overlap between 2 species
- Assess similarity between seal prey and fisheries catches
- *i*-prey species, *j*-seals, *k*-fisheries
- Spring: 0.003, Summer: 0.008, Autumn: 0.002

Conclusions

- The foraging range of harbour seals overlaps with fisheries in summer and autumn
- However, the main prey items of harbour seals are gadoids, sculpins and cephalopods, while the main species caught by fisheries is salmon
- Harbour seals appear to be foraging in the same areas as fisheries, but eat mostly different prey species
- Competition is highly unlikely between harbour seals and fisheries in Erimo
- Depredation is probably unique to the few seals which have learned the behaviour

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