Food Web Structure in the Canadian Sub-Arctic: Implications for Harp Seals

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Is this a CASE studentship? YES

If so, please state intended CASE partner: Department of Fisheries and Oceans, Canada

Motivation and Wider Context:

The Arctic Ocean is undergoing unprecedented rates of environmental change, with multiple concurrent stressors. The Arctic Ocean is warming twice as fast as the global average (Hoegh-Guldberg and Bruno, 2010) leading to changes in Arctic communities and food webs, for example the northward expansion of boreal fish species (Fosshein et al. 2015). Overall, Arctic primary production has increased by 30% from 1998-2012 (Arrigo and van Dijken 2015) with regional changes in phytoplankton community size structure and diversity at the base of the food web (Li et al. 2009). These changes, both at the base of the food web and at higher trophic levels, will have implications for food web structure and function, and will ultimately impact higher predators such as seals and polar bears. Understanding how complete food webs are being reshaped over different spatial and temporal scales in response to these stressors is crucial in addressing the impacts of future change on biodiversity and ecosystem services (Eamer et al. 2013).

The Northwest Atlantic harp seal, *Pagophilus groenlandicus,* is an excellent indicator species of food web functioning (Laidre et al. 2008). They have a wide distribution across the Atlantic and adjacent Arctic, long range migrations and flexible foraging patterns. This population summers in the Canadian Arctic and west Greenland, and migrates each autumn to the Gulf of St. Lawrence, southern Labrador and northern Newfoundland where they give birth on drifting pack ice in Feb/March. Northwest Atlantic harp seals feed on a variety of prey items including forage fish (e.g. capelin, Arctic cod) and invertebrates such as the amphipod *Thermisto libellula* (Figure 1, Lawson et al. 1998, Hammill and Stenson 2000). Fisheries and Oceans Canada have been monitoring Northwest Atlantic food webs and harp seal populations for many years. Data obtained as part of these monitoring programmes can be used to unravel the effects of environmental change on Arctic ecosystems.

Aims of Studentship

The overarching question of this PhD is: In light of environmental change in the Arctic, can we detect temporal shifts Arctic shelf sea food webs? How are Northwest Atlantic harp seals affected by environmental change?

In order to address these questions, this PhD will examine a large database (>5000 data points) of stable carbon and nitrogen isotope values of fish and invertebrates collated by the Department for Fisheries and Oceans (Canada). The regions sampled include the Newfoundland and Labrador shelves and Flemish cap (Figure 2). Samples have been collected since 2012 during both the spring and autumn. The overall objective of this PhD is to characterise the food web structure and quantify temporal and spatial changes in the food web using the existing database. You will also have access to the samples collected and will use ^{15}N-amino acids in consumer tissues to constrain the base of the food web and determine the trophic position of each species using this approach (Lorrain et al. 2015). The stable isotope data obtained will be examined in conjunction with environmental parameters (e.g. ice cover and phytoplankton biomass), which will give insight into the processes driving isotopic signatures in food webs. You will also examine the coupling between Northwest Atlantic harp seals and the Newfoundland/Labrador Shelf food web (using both stable isotopes and harp seal stomach content data).

This PhD project will be closely aligned to the Changing Arctic Ocean project ARISE (https://arcticarise.wordpress.com). One of the objectives of the ARISE project is to determine how sensitive Arctic predators e.g. harp seals are to changes at the base of the food web.

Work Plan:

You will be based at the University of Liverpool where you will have access to the Liverpool Isotope Facility for Environmental Research (LIFER lab). You will also spend time at Fisheries and Oceans, Canada alongside Drs. R. Anderson and G. Stenson.

Year One: You will start your PhD at the University of Liverpool and undertake induction and training courses specific to the EAO DTP during the first three months. You will also have basic training in stable isotope analysis during this time. Following this you will spend 6-12 months at Department of Fisheries and Oceans (DFO), Canada alongside Drs. R. Anderson and G. Stenson. Here you will start to interrogate the stable isotope database and seal stomach content database. You will have the opportunity to participate on a research cruise collecting samples for isotope analysis. Finally you will select samples for ^{15}N-amino acid analysis from the archive samples stored at DFO to be analysed in Liverpool.

Year Two: During year two you will return to Liverpool to analyse selected samples for ^{15}N-amino acids in the LIFER laboratory. You will compare these data to the bulk stable isotope data set. You will continue to build on your PhD training by attending DTP courses. You will attend and present at conferences in the UK and Canada.

Year Three: You will be expected to present your results at an International conference and finish your analytical work. You will start to write publications and write up your thesis.

Training: You will participate in training programmes as part of the EAO DTP and School of Environmental Sciences, University of Liverpool. There will be an opportunity to participate in NERC postgraduate training courses and relevant statistical/stable isotope courses. You will receive training in stable isotope analysis and ^{15}N-amino acid analysis in the LIFER lab at the University of Liverpool.

Background of Applicant:

Students will need to have a good degree (1st or upper second) in Biology, Biological Sciences, Ecology, Marine Biology or Oceanography.

Funding for the studentship is only available via NERC and so is restricted to UK and EU nationals who fulfil NERC's eligibility requirements (https://www.liverpool.ac.uk/studentships-earth-atmosphere-ocean/how-to-apply/).

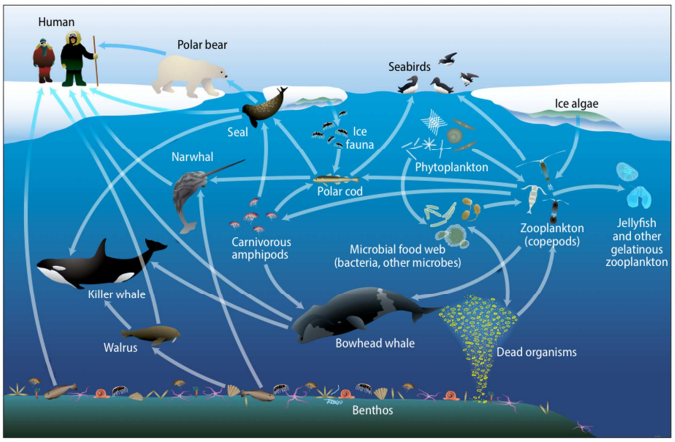

Image 1 - Arctic marine food web (Eamer et al. 2013).

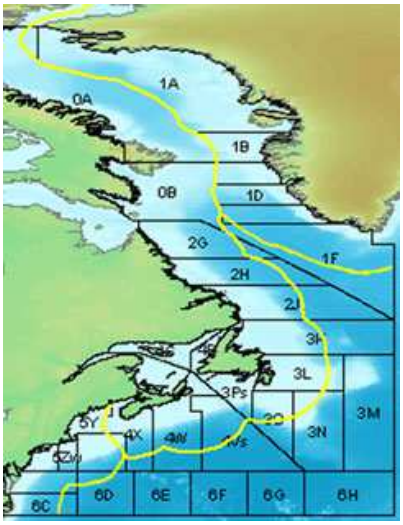

Image 2 – Northwest Atlantic Fisheries Organisation fishing areas sampled by the Department of Fisheries and Oceans, Canada.

References

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