

Beaufort Beluga Habitat Use and Diet related Mercury levels

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Abstract

Beaufort Beluga whales have some of the highest mercury (Hg) levels among Canadian beluga whale populations. Ultimately it is the prey that Beluga feed on that determine Hg levels; however, little is known about Beaufort Beluga habitat use, migration patterns, foraging behaviour, and diet. Here we evaluate foraging behaviour and try to determine diet to calculate Hg trophic level transfer. Two approaches are used to characterize beluga diet: i) a spatio-temporal approach to determine feeding regions and migratory paths using satellite telemetry, and ii) a bio-chemical approach to quantify seasonal diet by comparing stable isotopes and fatty acid signatures in beluga tissues with potential prey items; together this will provide the geographical and trophic related sources of Hg uptake. For the first time an annual summary of Beaufort Beluga satellite positions collected (2004-2005). Based on seasonal movement, prey items were collected from the summering grounds (Mackenzie Delta/Beaufort Sea) and wintering grounds (Bering Sea). In the summering grounds stable isotopes $\delta^{15}N$ and $\delta^{13}C$ and fatty acids were measured in biota including estuary fish species such as Pacific Herring, Arctic Cisco (*Clupea pallasii*), *Coregonus autumnalis*, the marine fish species Arctic Cod (*Boreogadus saida*), benthic invertebrates such as decapods (*Eualus gaimardi*) and zooplankton (*Calanus spp.*). Trophic levels were determined and used to calculate food web magnification factors (FWMFs) of Hg to beluga on summering grounds and will be compared with results for the wintering region. Arctic Cod Hg levels were higher than in most estuary species (e.g. Pacific Herring), which was supported by a higher trophic position. Preliminary results from fatty acid analysis show Beluga signatures are similar to Arctic Cod and some estuary species, but different from benthic invertebrates.

Introduction

-Beaufort Beluga whales summer in the eastern Beaufort Sea and represent an important food source to the subsistence lifestyle of the local Inuvialuit communities. Mercury (Hg) levels in this population have been increasing since the 1980's; raising concern.
 -It is the prey that Beluga feed on that determine Hg levels; however, little is known about Beaufort Beluga diet, habitat use, migration patterns, and foraging behaviour. At present we are incorporating holistic methodologies to investigate the Hg levels, foraging behaviour, habitat use and diet of the Beaufort Beluga whale to calculate Hg trophic level transfer.
 -Two approaches are used to characterize beluga diet related Hg sources: i) a spatio-temporal approach to determine feeding regions, migratory paths and dive behaviour using satellite telemetry, and ii) a bio-chemical approach to quantify seasonal diet by comparing stable isotopes and fatty acid signatures in beluga tissues with potential prey items; together this will provide the geographical and trophic related sources of Hg uptake.

What are beluga feeding on?



- Mercury (in the form of methylmercury) bioaccumulates in organisms and biomagnifies up the foodweb, thus Hg levels in diet are reflected in predator Hg levels
- Are Beluga feeding on pelagic, benthic, or estuary species? And what trophic level do beluga feed at? Invertebrate Vs. fish.
- What are Beaufort Beluga eating and what are the Hg levels in those prey items?

Where & When are beluga feeding?

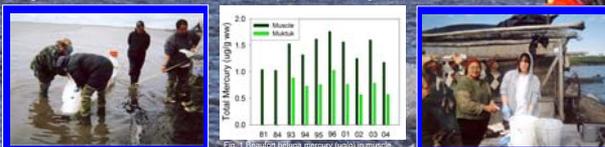
- Beaufort Beluga spend time in these regions, but where and when are they feeding?
- How does a resource such as sea ice influence habitat use and foraging behaviour?
- Do beluga forage in regions with high Hg levels?



Mercury in the Beaufort Sea Foodweb

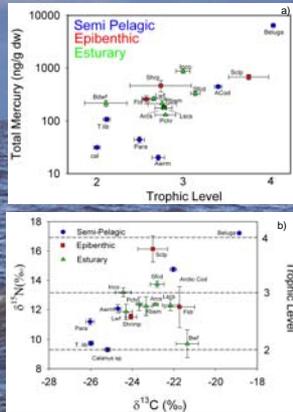
Mercury Levels in Beaufort Beluga: Community Harvest Sampling

- Beaufort Beluga whales have had some of the highest Hg levels among the arctic beluga populations. Although levels have begun to drop in recent years, levels are much higher than those observed in the 1980's (Lockhart et al., 2005).
- Therefore monitoring Hg levels (along with other contaminants) is important in documenting the temporal trends, as well as providing subsistence communities information on contaminant levels.
- Community members sample tissue from harvested whales for Hg analysis, providing a long term data set for this western arctic population (Fig 1).



Diet Items: Hg Trophic Level Transfer up the Foodweb

- Trophic levels were determined using δN stable isotope ratios, where the zooplankton *calanus spp* was set at trophic level 2 (feed on algae = trophic level 1). Trophic levels were determined to calculate trophic biomagnification factors up the foodweb.
- Arctic Cod Hg and trophic levels were higher than most estuary fish species collected in the delta (avg eod length: 15 cm) (Fig 5a). Methylmercury (MeHg) represented 80% of the total Hg measured.
- Adult Arctic Cod feed benthically and large adults are cannibalistic; both characteristics may explain the higher trophic level and Hg concentrations relative to estuary fish species.
- Benthic invertebrates ranged trophically but all had relatively high levels of Hg, however the percent of MeHg has not been determined.
- For beluga the choice between feeding on two similar schooling fish (i.e. Arctic Cod Vs. Pacific Herring) can result large differences in Hg uptake.
- Carbon stable isotope ratios can be used to tease out the location or ecology of fish, however in this case the ratios do not clearly show which fish beluga might be feeding on (i.e. benthic vs. pelagic, estuary vs. oceanic) (Fig 5b).



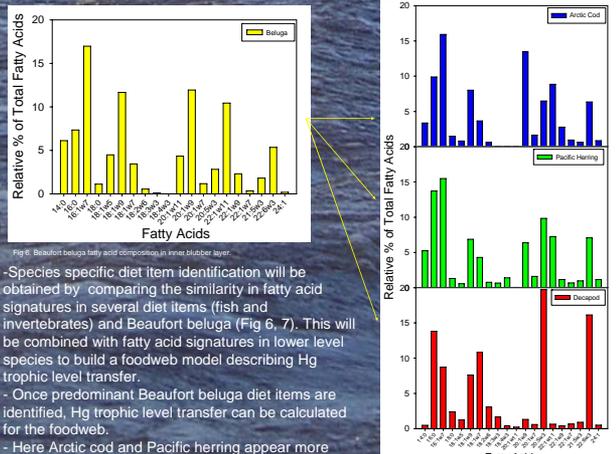
Seasonal Diet Item Effects on Hg levels: Tagging Project

- For the first time tags deployed on Beaufort beluga in 2004 lasted a year, revealing the Bering Sea to be the wintering grounds (Fig 2).
- Based on movement results from the tracking program prey sample collection has been focused in their wintering and summering regions, where feeding may be prevalent.
- Possible beluga prey items were collected in the summer habitats in 2004 and 2005 and have been analyzed for Hg; samples collected from the wintering region are currently being evaluated to enable a comparison of Hg levels in diet.
- In 2005 time depth recorders were deployed to receive dive data (along with temperature and salinity), that will provide more insight to feeding behaviour



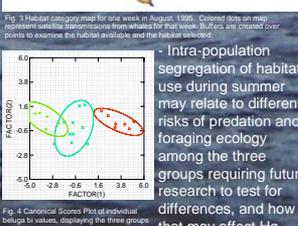
Identifying Prey Items: Semi-Pelagic, estuary, benthic, & Seasonal comparisons

- Species specific diet item identification will be obtained by comparing the similarity in fatty acid signatures in several diet items (fish and invertebrates) and Beaufort beluga (Fig 6, 7). This will be combined with fatty acid signatures in lower level species to build a foodweb model describing Hg trophic level transfer.
- Once predominant Beaufort beluga diet items are identified, Hg trophic level transfer can be calculated for the foodweb.
- Here Arctic cod and Pacific herring appear more important than decapods in Beaufort beluga diet.



Habitat Use: Intrapopulation Sexual Segregation

- 1 Open water, away from shelf
- 2 Mixed ice concentrations
- 3 Heavy ice concentrations
- 4 Open water in shelf



- To understand beluga habitat use, and migration patterns, satellite telemetry tags were deployed on whales in the Mackenzie Delta region that provided locations from late summer to early fall in 1993, 1995 and 1997.
- We tested for differences in habitat use from resource selection models according to ice concentration and shelf habitats (Fig 3).
- Beluga whales differed in habitat selection depending on age, sex, and reproductive condition (females with or without a calf).
- Three groups were defined by their habitat use (described below, Fig 4). Variation in habitat use has implications for feeding and Hg uptake.

Open water:
(5 females, 3 w calves, 4 small males),

Ice edge:
(10 males; 2 females)

Heavy ice concentration:
(5 males; included 3 largest)

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Future Work

- We hope to couple the diving behaviour from satellite tags deployed in 2005 with diet related Hg levels in prey in winter and summering habitats.
- Once Hg uptake through diet is more clearly defined we hope to combine these findings with habitat use to understand how a changing climate can affect the foraging behaviour and Hg uptake to the Beaufort beluga whales.
- Continue working with northern students and have them present findings back to classrooms and communities.

