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STUDY TITLE: Trophic Links: Forage Fish, Their Prey, and Ice Seals in the Northeast Chukchi Sea
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BACKGROUND:
This study filled a pressing need for baseline information of feeding ecology of marine fishes and ice seals in the Arctic. Previous studies have been limited to a single year and have not captured ecosystem variability over time. This project addressed variation by analyzing short- and long-term diets of Arctic predators over consecutive years, particularly during sea ice minimum years. The combined effects of sea ice habitat loss and altered food web structure leave populations of fishes and ice seals extremely vulnerable to additional disturbances, e.g., increased ship traffic, noise, and sub-Arctic species range extensions. Accurate assessment of population health and development of effective management strategies is necessary for good stewardship by oil and gas exploration. Results from this project provide enhanced understanding of adaptive responses in the rapidly changing Arctic ecosystem.

DESCRIPTION:
Feeding ecology was examined for fishes and ice seals collected from the northeast Chukchi Sea. Stomach contents and stable isotope ratios were documented for eleven fish species: Pacific Herring, Capelin, Arctic Cod, Saffron Cod, Arctic Staghorn Sculpin, Shorthorn Sculpin, Canadian Eelpout, Stout Eelblenny, Slender Eelblenny, Pacific Sand Lance, and Bering Flounder. Prey collected and identified from the stomach contents of fishes were also analyzed for stable isotope ratios. Isotope mixing models were used to show the proportional contribution of prey to the long-term diets of fishes and ice seals. Stable isotope ratios of five fish species, i.e., Arctic Cod, Arctic Staghorn Sculpin, Canadian Eelpout, Stout Eelblenny, and Bering Flounder, and the prey of those fishes, were included in isotope mixing models to assess interannual changes in diets from 2007–2010. Diets of ringed, bearded, and spotted seals were investigated using stable isotope ratios in muscle tissue collected during 2003 and 2008–2010. Long-term dietary records deposited in claws of ringed, bearded, spotted, and ribbon seals were examined for interannual variation in individual diets and among seals.

OBJECTIVES:
The overall project objective was to document necessary baseline data on diet of forage fishes in the northeast Chukchi Sea and the trophic links from fish prey to fish to predator ice seals. Specific objectives include:

(1) Determine diet composition of forage fishes
(2) Establish trophic level of forage fish species and of their prey
(3) Analyze interannual differences in diet of fishes and in the trophic level of fishes and their prey
(4) Determine trophic level of ice seals
(5) Determine ice seal trophic history
(6) Develop isotopic mixing models
(7) Compare trophic levels of forage fishes to those of ice seals

STUDY RESULTS AND SIGNIFICANT CONCLUSIONS:

Comparison of short-term and long-term diets of eleven Arctic fish species (Chapter 2) described general diets using stomach contents and stable isotope ratios for fishes for which there is little to no information. Stomach contents of these Arctic fishes mainly consisted of pelagic crustaceans and amphipods, stable isotope results indicate that higher trophic prey have a greater contribution to diets over time. Short-term diet determined by stomach content analysis and long-term integrated diet determined by stable isotope analysis show some inconsistencies indicating seasonal variability is confounded by solely using summer diet analysis. This signifies the importance of assessing feeding ecology using multiple time-scale tools.

Interannual diet variability for five Arctic fish species in the Chukchi Sea (Chapter 3) explored changes of fish diets over time using a Bayesian isotope mixing model approach. Low-trophic, pelagic prey contributed more to long-term diets of fish during 2007/2008, and the contribution of high-trophic prey increased from 2008 to 2010 (Figure 1). While trophic level (based on stable isotopes) of fish prey stayed constant during 2008-2010 (Figure 1), interannual variability observed in feeding of Arctic fishes may correspond to increased abundance of pelagic crustaceans in the Chukchi Sea during 2007, a low-ice year. Higher trophic foraging by Arctic fishes in years following 2007 is consistent with the currently accepted hypothesis of benthic-pelagic uncoupling during minimum sea ice cover. This model approach is an effective tool to identify ecosystem variability over time.

Interannual variation in the diet of ice seals assessed by isotopic mixing models (Chapter 4) examined trophic variability in apex predators, i.e., Arctic pinnipeds. Diets of bearded seals had a lower contribution of benthic prey and consequently higher contribution of benthopelagic prey from 2007 to 2010 (Figure 1), again indicative of benthic-pelagic uncoupling. Pelagic ice seals, i.e., ringed and spotted seals, capitalized on abundant low-trophic, pelagic prey, particularly during 2007–2009 for ringed seals and 2008/2009 for spotted seals (Figure 1). The three species of ice seals that we examined are opportunistic predators. As such, ice seals may not be vulnerable to changes in prey populations. If climate shifts to a pelagic-dominated ecosystem, ice seals will likely take advantage of pelagic prey sources.

Diet history of ice seals using stable isotope ratios in claw growth bands (Chapter 5) investigated long-term diet patterns of ice-associated pinnipeds. Examination of seal claws was unique in that it allowed documentation of time series up to ten years for individual seals. Stable isotope ratios within claw growth bands illustrated an increase in trophic foraging and likely more pelagic foraging by both ringed and bearded seals from 2007 to 2010 (Figure 1), affirming patterns observed in other components of this study.

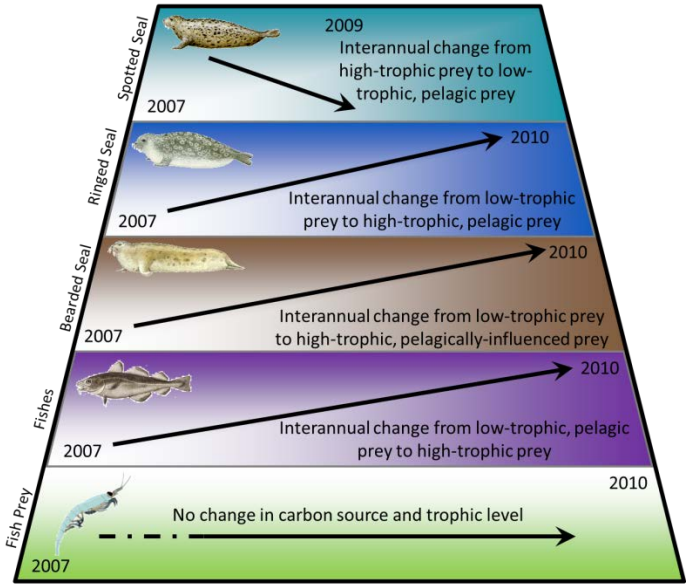

Figure 1. Summary of Conclusions. Interannual trends in diet of Arctic fishes and ice seal species. Higher trophic feeding by Arctic fishes and ice seals in years following 2007 is consistent with the currently accepted hypothesis of benthic-pelagic uncoupling during years of reduced sea ice cover in the Arctic.

STUDY PRODUCTS:

Norcross, B.L., S.S.Carroll, L. Horstmann-Dehn, B.A. Holladay, and L.E. Edenfield. 2015. Trophic Links: Forage Fish, Their Prey, and Ice Seals in the Northeast Chukchi Sea. Final Report. OCS Study BOEM 2013-00118, University of Alaska Coastal Marine Institute and USDOI, BOEM Alaska OCS Region, 152 p.

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