Beaufort Sea Transboundary (US-Canada) 2012–2014 Fish, Lower Trophic and Food Web Survey Final Results

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We present the final results of the first systematic survey of both the US and Canadian Beaufort shelf and slope to 1000 meter depths, including the Mackenzie Canyon. These results include distribution, abundance and community analysis of fish, epifauna, infauna and zooplankton, which along with diet and isotopes, provides new understanding of the Beaufort Sea foodweb. This new understanding provides the wider scientific community baseline data across multiple scales, within the Arctic, the Beaufort Region, sub regions, shelf communities, slope communities and is especially useful for documenting and understanding climate change, the biggest scientific issue of our era. BOEM will apply this new understanding to analyze potential effects, develop mitigation, regulate and monitor oil, gas and renewable energy in the federal waters of the Beaufort Sea.

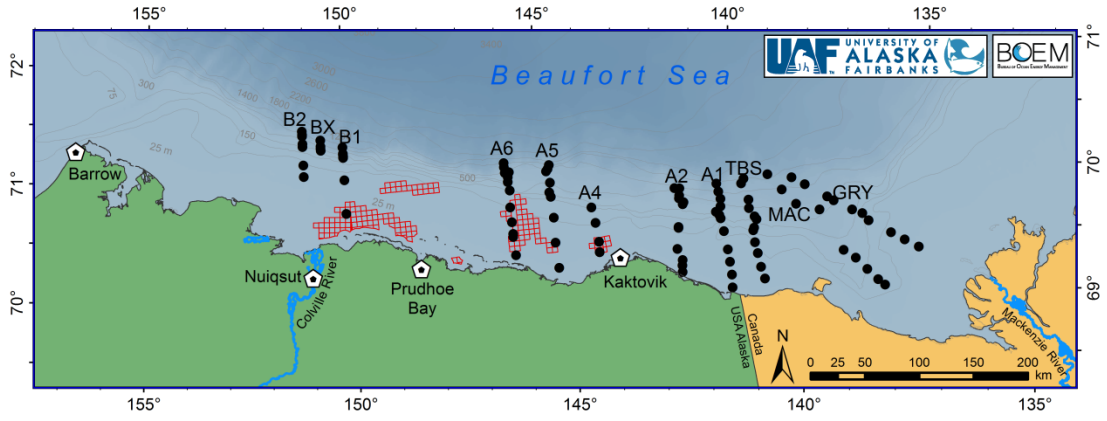
Location: Hotel Captain Cook, Anchorage, AK

Room: Aft Deck

Date: Friday, January 27th, 2017

Time: 1- 5pm

Contact: Brenda Norcross bnorcross@alaska.edu 907-474-7990, 907-479-0518



Survey Locations from the Transboundary Study

Speaker Agenda

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1300: Wedemeyer, Norcross……**Introduction**

1310: Norcross…… **US Transboundary cross-discipline synthesis**

1330: Hopcroft…….. **Physical Oceanography of the Beaufort shelf**

1345: Hopcroft**.....Structure of Beaufort Sea zooplankton communities and hydrographic associations**

1400: Hardy…… **Structure of infaunal communities on the Beaufort Sea shelf and slope**

1415: Iken…… **Epifauna communities along the Alaskan Beaufort Sea shelf and slope**

1430: Norcross…….. ..Pelagic and demersal **fish communities along the Alaskan Beaufort Sea shelf and slope**

1445: Iken…… …**Carbon sources and interannual stability of food webs across the Alaskan Beaufort Sea**

1500: Break

1510: Majewski…… **Marine fishes in the Canadian Beaufort Sea ecosystem – the Beaufort Regional Environmental Assessment, 2012–2014**

1540: Majewski, Norcross…… …**Canada/US fish synthesis, with emphasis on Arctic cod**

160: Panel Discussion (Norcross, Hardy, Hopcroft, Iken, Majewski), Question and Answer session

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Abstracts (in order of presentation, not alphabetical)

Norcross, B.L.[1], B.A. Bluhm[2], S.M. Hardy[1], R.R Hopcroft[1], K. Iken[1]. US Transboundary cross-discipline synthesis

[1]Institute of Marine Science, College of Fisheries and Ocean Sciences, University of Alaska Fairbanks

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Across-shelf structure is well recognized for many Arctic communities. There was a surprising coherence of taxonomic clustering break points across trophic levels at the shelf break depths. With few exceptions, station depth ranked as the strongest structuring variable for zooplankton, epifauna and demersal fish communities, in terms of both biomass and abundance. The 100–200 m contour, which generally corresponds to the shelf break, formed a consistent breakpoint across assemblages. Subsequent subdivisions often occurred for the shallowest stations within all three trophic levels; however, cross-discipline locations of on-shelf subdivisions were not consistent. The confounded nature of depth, temperature, salinity, and habitat variability makes it hard to determine which of these variables is most influential, and it is possible that the most significant factors differ among the three trophic community types.

Distinct patterns were seen within and among years. The zooplankton collections were most similar to each other within a year, although larger interannual differences occurred. In contrast, the epifauna and fish community clusters formed at a much lower level of similarity, but their community composition tended to be more similar across years. This suggests the planktonic habitat is generally smoother and less variable than the benthic and demersal habitats. Accordingly, it should be easier to link plankton to environmental gradients on an annual basis. In contrast, the benthic and demersal habitats tended to be more heterogeneous at the scale of sampling, however, the epibenthic and fish communities still responded to larger scale environmental gradients at lower statistical linkages. As such, these ecosystem components are likely excellent indicators of longer-term, persistent changes in environmental conditions.

Hopcroft, R.R and S. Danielson. Physical Oceanography of the Beaufort shelf

Arctic waters can undergo pronounced changes during the seasonal ice-free period. We describe observations of temperature and salinity on the Beaufort shelf and slope during the 2011-2014 period obtained through the Beaufish and Transboundary programs. In general, 4 basic water layers can be distinguished: a shallow (<10m thick) layer freshened by sea ice melt or river water, a subzero Polar Mixed Layer extending from it to approximately 50 m, Arctic Halocline Water extending from 50 m to ~ 200 m also characterized by cold temperatures, and Atlantic Water beginning between 200–300 m characterized by high salinities (~34) and above zero temperatures. During summer the shallow freshened surface layer traps most of the solar energy, and can warm to as much as 10°C, with considerable spatial and temporal variability. The layers

below it show relatively consistent attributes We compare these observations to those going back more than 60 years to illustrate how this freshened surface layer has changed.

Smoot, C.A. and R.R. Hopcroft. Structure of Beaufort Sea zooplankton communities and hydrographic associations

Despite their critical role as trophic intermediaries, zooplankton in the Beaufort Sea are poorly characterized. Epipelagic (0-200 m) zooplankton samples were collected from Point Barrow, AK to the Mackenzie River during August and September from 2010-14. Additionally, mesopelagic (200-1000 m) samples were collected during the US-Canada Transboundary project (2012-14). Zooplankton communities were structured along three major spatial axes: along-shelf, across-shelf, and depth-related. This structure reflected the influence of different water masses and hydrographic features. With respect to depth-related structure, distinct communities were associated with the main water masses in the study area: the Polar Mixed Layer (PML; 0-50 m), Arctic Halocline Water (AHW; 50-200 m), and Atlantic Water (AW; 200-1000 m). Epipelagic communities (e.g., Calanus and Oithona) in the PML and upper AHW transitioned to mesopelagic communities (e.g., Spinocalanus) in lower AHW and AW. Within the epipelagic realm, more nuanced across-shelf and along-shelf patterns were evident. Gradients associated with across-shelf transitions from neritic communities (e.g. Pseudocalanus) to oceanic communities (e.g. Calanus hyperboreus) intersected along-shelf gradients of communities associated with localized hydrographic features such as the Pacific-origin waters (e.g., Neocalanus) and the Mackenzie River (e.g., Eurytemora). Temperature and salinity were highly correlated with community structure, suggesting that future changes in the physical environment will be manifested by concurrent shifts in the distribution of Beaufort Sea zooplankton communities.

Hardy, S.M. Structure of infaunal communities on the Beaufort Sea shelf and slope

Rapid change is occurring in the Arctic concurrently with increased human activity, yet our knowledge of the structure and function of high-Arctic sediment communities is still rudimentary. The Beaufort Sea is particularly poorly sampled, and largely unexplored at slope depths, providing little information with which to assess the impacts of petroleum exploration activities in this area. I investigated diversity and community structure of macrobenthic infauna on the continental shelf and slope of the Beaufort Sea across a range of depths (50 to 1000 m). Food resources are variable across the region, with very high sediment chlorophyll concentrations at 350 m depth in some areas. Macrofaunal communities showed variable community structure among transects, with high abundance and high dominance in polychaete assemblages coincident with the chlorophyll maximum.

Iken K., B.A. Bluhm and L.E. Bell. Epifauna communities along the Alaskan Beaufort Sea shelf and slope

Arctic shelf ecosystems are often dominated by rich benthic communities as a result of the tight coupling to primary production in the overlying water column. These benthic shelf

communities play vital roles in ecosystem functioning, such as remineralization processes, and as food for higher trophic levels. Here, we investigated the epibenthos on the central and eastern US Beaufort Sea shelf and slope to produce a basic understanding of these communities and how they might be structured depth and oceanographic conditions. Samples were collected along transects perpendicular to shore from 20 – 1000 m depth. Highest species richness was contained in arthropods (mostly amphipods and decapods), mollusks (mostly gastropods), and echinoderms (mostly asteroids and ophiuroids). Total biomass was dominated by echinoderms at most stations and depth strata. Abundance patterns were similar to biomass patterns except that many of the deep stations (750 and 1000 m) were dominated by arthropods and occasionally cnidarians. Absolute community biomass and abundance was typically highest in the 50 and 100 m depth range, with significantly lower values at greater depths. Depth as a proxy for environmental conditions and water masses was most likely related to dynamic and stressful environmental conditions in very shallow waters, abundant food supply on shelf depths, and increasing food limitation at greater depth. This strong depth effect was also noticeable in overall community composition, which was the single-strongest driver of epibenthic community composition. Strong community composition turnover between the central and eastern Beaufort Sea may represent a biogeographic break. Epibenthic community structure seemed stable over at least 2 years, likely related to the longevity of most Arctic benthic species, which may create some resilience to changing conditions caused by climate changes or anthropogenic influences.

Norcross, B.L. and B.A. Holladay. Pelagic and demersal fish communities along the Alaskan Beaufort Sea shelf and slope

Shelf–slope processes had different effects on the pelagic and demersal fish communities. Pelagic fish (sampled by midwater trawl, 1 mm mesh codend) community structure was less affected by shelf-slope processes than demersal fish communities. In the central (Camden Bay) region, there was no shelf-slope component to the pelagic community, which was represented, almost equally, by Arctic Cod, snailfish and prickleback larvae and juveniles. In contrast, the eastern area was almost wholly Arctic Cod on the slope and half as many pricklebacks as Arctic Cod on the shelf. Demersal fish (sampled by 10 m beam trawl, 4 mm mesh codend) communities displayed distinct differences between shelf and slope habitats, with 200 m being a transition zone. Demersal fish communities along the shelf had a higher abundance of smaller fishes; whereas, slope communities had fewer but larger, individuals. Throughout all demersal shelf communities examined, each had the common components of *B. saida*, *G. tricuspis*, and *I. spatula*. Depending on sampling year, and possibly spatial factors, a poacher, snailfish, or an eelpout was included in these shelf communities. Shelf fishes typically have shorter lifespans of about 5–7 years. Slope communities were defined by *B. saida* and *Lycodes* spp., the latter with life spans of more than 20 years. Depth, which is closely correlated by the environmental variables of temperature, salinity, and water mass, is the easiest factor to measure to estimate the distribution of these communities. In the US Beaufort Sea, as for all adjacent Arctic Seas, continental shelf communities are different from those on slopes.

Iken K., L.E. Bell and B.A. Bluhm. Carbon sources and interannual stability of food webs across the Alaskan Beaufort Sea

Benthic food web structure based on stable isotope analysis was investigated for the central and eastern Beaufort Sea shelf and slope. Parts of the Beaufort Sea shelf receive large inputs of terrestrial matter from land discharge, which contributes to structuring benthic food webs. Concurrent with high terrestrial matter influence, shelf and slope food webs in the eastern Beaufort Sea were characterized by comparatively longer food webs and a greater proportion of epibenthic consumer biomass at higher trophic levels compared with central Beaufort Sea food webs. This is likely because of an additional trophic step from microbial processing of the terrestrial matter. Benthic food web structure over two study years was relatively stable, confirming that benthic consumers are good integrators of short-term variability in surface production. It is likely that the microbial processing of the terrestrial matter source also contributes to this food web stability.

Majewski, A.[1], J. Eert[2], S. MacPhee[1], W. Walkusz[1], C. Michel[1], P. Archambault[3], M. Geoffroy[4], L. Fortier[4], A. Stasko[5], C. Giraldo[5], R. Young[1], and J. Reist[1]. Marine fishes in the Canadian Beaufort Sea ecosystem – the Beaufort Regional Environmental Assessment, 2012–2014

[1]Freshwater Institute, Fisheries and Oceans Canada, Winnipeg, Manitoba R3T 2N6
[2]Institute of Ocean Sciences, Fisheries and Oceans Canada, Sidney, British Columbia V8L 4B2
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[4]Québec-Océan, Université Laval, Québec City, Québec G1V 0A6
[5]Biology Department, University of Waterloo, Waterloo, Ontario N2L 3G1

Marine fishes in the Canadian Beaufort Sea have complex interactions with habitats and prey, and occupy a pivotal position in the food web by transferring energy between lower- and upper-trophic levels, and also within and among habitats. The community structure, habitat associations, and ecological linkages of most Beaufort Sea marine fishes, however, are unknown thus precluding effective regulatory management of emerging offshore industries in the region (e.g., hydrocarbon development, shipping, and fisheries). Between 2012 and 2014, Fisheries and Oceans Canada conducted the first baseline survey of offshore marine fishes, their habitats, and ecological relationships in the Canadian Beaufort Sea as part of the Beaufort Regional Environmental Assessment (BREA). Transect-based benthic and pelagic trawling was conducted in conjunction with hydroacoustics at stations spanning 20-1500 m depths across shelf and slope habitats, and selected stations were sampled for inter-annual variability. Concurrent sampling of oceanographic parameters, food-web components, and sediment composition was conducted at each station. We examined fish diversity, assemblage structure, and habitat and diet linkages on a regional scale to better understand the roles of marine fishes in the Beaufort Sea ecosystem. Results indicate that the fish community was strongly depth-structured and assemblages were closely associated with vertical water mass distributions. Similar depth-structuring was observed in the zooplankton community, and follow-on analyses of trophic dynamics have revealed complex depth mediated food-web interactions including benthic-pelagic coupling. Establishing knowledge baselines and understanding ecological linkages of Beaufort Sea marine fishes will

support mitigation and conservation efforts by enhancing our ability to predict, detect and monitor the effects of offshore industrial development and climate change on this pivotal ecosystem component.

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