Latitudinal and ontogenetic shifts in the diet of Arctic cod (Boreogadus saida) in the Pacific Arctic and Bering Sea

Introduction

Arctic cod (Boreogadus saida) is a nodal species in Arctic marine foodwebs. They prey on a variety of zooplankton and benthic-oriented prey, and are themselves an important prey item for many birds, marine mammals, and fishes (Figure 1). They are among the most abundant of Arctic fishes found in both benthic and pelagic environments and in association with sea ice during ice-covered periods. During colder years in the Pacific Arctic, the southern limit to their summer distribution extends into the central Bering Sea.

We present observations of the summer diet of Arctic cod across a wide latitudinal range in the Pacific Arctic, and across a range of predator sizes.

Methods

• Arctic cod specimens were collected over a latitudinal range from 58.3° N in the eastern Bering Sea to 73° N in the eastern Chukchi Sea (Figure 2).

• We divided our study area into 5 subregions: the eastern Bering Sea (EBS), northern Bering Sea (NBS), southeastern Chukchi Sea (SCS), central Chukchi Sea (CCS), and the northeastern Chukchi Sea (NCS) (Table 1) based on a qualitative examination of diet composition.

• Predator specimens ranged in size from 3.4 to 26 cm (mean 11.4 cm, SD ± 3.4). Within each subregion we divided specimens into 6 length bins (Figures 3-7).

Results

• Fish may be a more important prey item in the northern Bering Sea and southern Chukchi Sea than in the other areas (Figures 3 and 4). Fish taxa frequently identified among the stomach contents collected there included Arctic cod, walleye pollock (Gadus chalcogrammus), and Pacific sand lance (Amassolutes hexapterus).

• If we assume fish prey can be considered pelagic, there appears to be a slight increase in the proportion of benthic oriented prey with predator size in the EBS, SCS, and CCS. This increase is strongest in the NCS where Arctic cod preyed heavily upon gammarid amphipods (e.g., Ampelisca macrocephala, Acrocles lutes) and decapods, including, Suchus gammarideus, E. stoneyi, and Pandalus goniurus. Decapods are more important to the Arctic cod diet in the Chukchi Sea than in the Bering Sea.

• In the NBS the trend in benthic oriented prey is opposite and benthic prey have decreasing importance with predator size.

• Hyperiid amphipods (Parathemisto libellula) were most important in the NBS. However, there was a documented increase in the Bering Sea population of hyperiid amphipods which peaked in 2010.

• The data from 2012 is the most extensive among our data set and lends itself to more detailed examination. The fullness of stomachs (expressed as % body weight [%bw]) increases with latitude (Figure 8). The proportion of euphausiids (e.g., Thysanares raschi) found in the Arctic cod diet (expressed as % weight [%W]) decreases with increasing latitude, while, the percent of copepods (Calanus glacialis/marshallae) in the diet [%W] increases. In general, we see lower %bw and lower %W of copepods in the SCS, in the CCS, we find low %bw and higher %W of copepods; and in the NCS we observe high %bw and high %W of copepods.

Conclusions

• In four of the five subregions we observed a general increase in benthic oriented prey with size. However, the opposite pattern was observed in the NBS.

• With increasing latitude in the Chukchi Sea in 2012 we observed an overall increase in the presence of copepods in the diet (by %W) and an overall increase in stomach fullness (%bw), commensurate with an observed decrease in the presence of euphausiids (by %W).

• Arctic cod are opportunistic in their feeding behavior, consuming different benthic and pelagic prey in the different subregions. The differences in observed diet of equivalent size classes in the different subregions likely reflect the flexibility of Arctic cod as a predator and reflect differing prey availability in each of the environments/subregions at the time of sampling.

• Comparisons of Arctic cod diet composition across our entire dataset are confounded by differences in the timing and location of sample collection.

• Regular sampling of Arctic cod diet (e.g., every 1 to 3 years) across the larger region will be necessary to determine if the observed trends and patterns are persistent or due to interannual variation. Sustained monitoring would permit identification of environmental and biological drivers that contribute to observed dietary variation.

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