

DECREASES IN SUMMER PACK ICE EXTENT RESULT IN ANNUAL AND SEASONAL PREY SHIFTS AND LOWER BREEDING SUCCESS IN AN ARCTIC SEABIRD

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BACKGROUND

The arctic pack ice

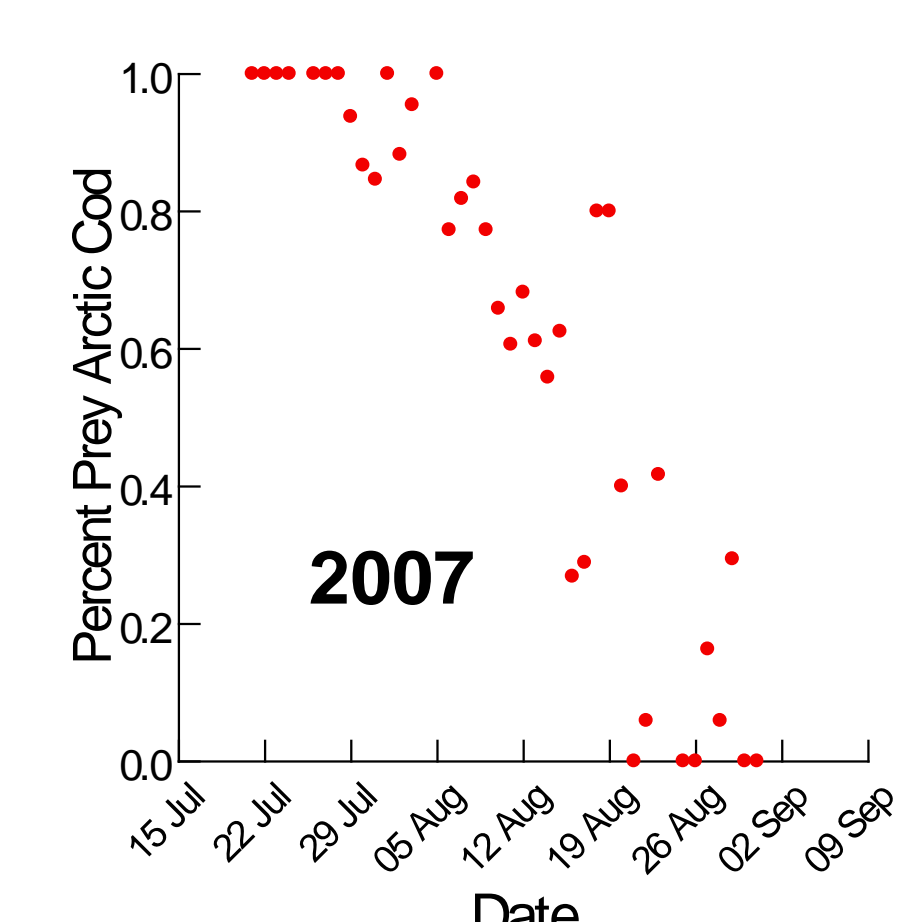
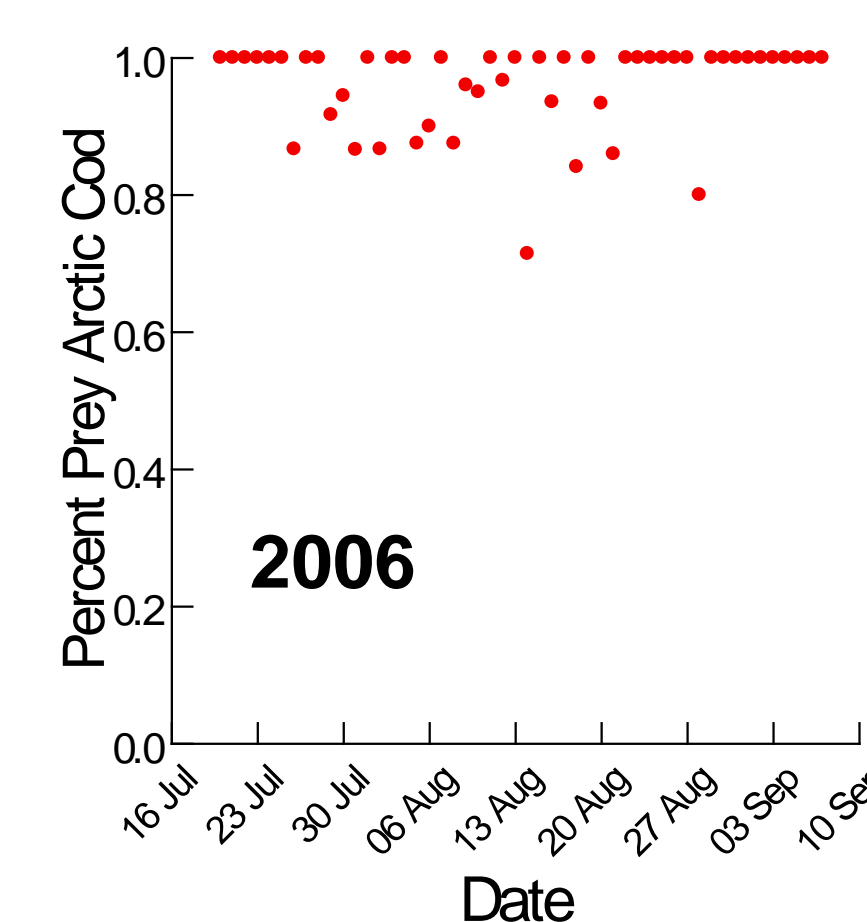
- After declining 9 percent per decade since the late 1970s, the Arctic summer pack ice underwent a record retreat in 2007 with a minimum extent 23 percent less than the previous low.
- The underside of arctic pack ice supports a sympagic community of algae, zooplankton and one fish species, Arctic Cod (*Boreogadus saida*), that are important to a populations of mammalian and avian apex predators.
- While satellite imagery provides documentation of the physical characteristics of pack ice decrease, the biological consequences are much harder to monitor.

The Black Guillemot, a non-migratory pack ice obligate

- The subspecies of Black Guillemot (*Cephus grylle mandti*) breeding in northern Alaska is one of the few arctic pack ice obligates, preying primarily on Arctic Cod, an important prey item to many apex predators associated with pack ice.
- Black Guillemots raise 1-2 young that remain in the nest cavity for five weeks. During this time parent birds forage within 30 km of the breeding colony with parents returning with a single prey that is held cross-wise in its bill.
- The frequency of feeds (>1 per hour) and the relatively small foraging range of the parents makes Black Guillemots excellent indicators of forage fish availability within 30 km of the breeding colony

RESULTS

- Arctic Cod availability was highly correlated with annual and seasonal variation in distance to pack ice. When pack ice was <30 km from the colony, for all of the 2006 and the first part of the 2007 nestling period, Arctic Cod comprised >80 percent of the diet of nestlings.
- In 2007, when distance to ice varied from 0 to >250 km from the colony, distance to ice explained over 70 percent of the variation in the daily percentage of Arctic Cod.
- Size of Arctic Cod showed an initial seasonal increase in both 2006 and 2007. Late in the 2007 nestling period, as distance to ice increased, parent guillemots took first-year (<3 bill lengths) Arctic Cod, which have less association with pack ice than the adult cod and less individual caloric value.
- As cod decreased in the diet in 2007 a nearshore demersal, Four-horned Sculpin, increased in frequency.



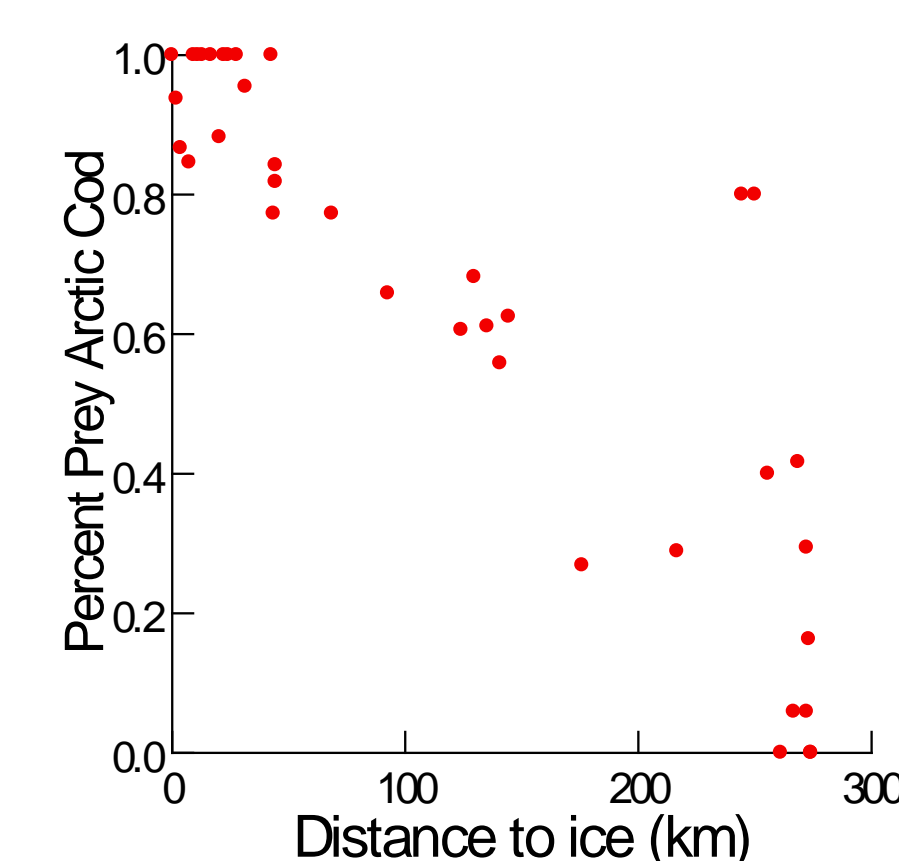
Arctic Cod comprised >80 percent of prey in 2006 and early 2007 but its importance decreased seasonally in 2007, with nearshore demersals increasing in importance

STRATEGY AND HYPOTHESIS

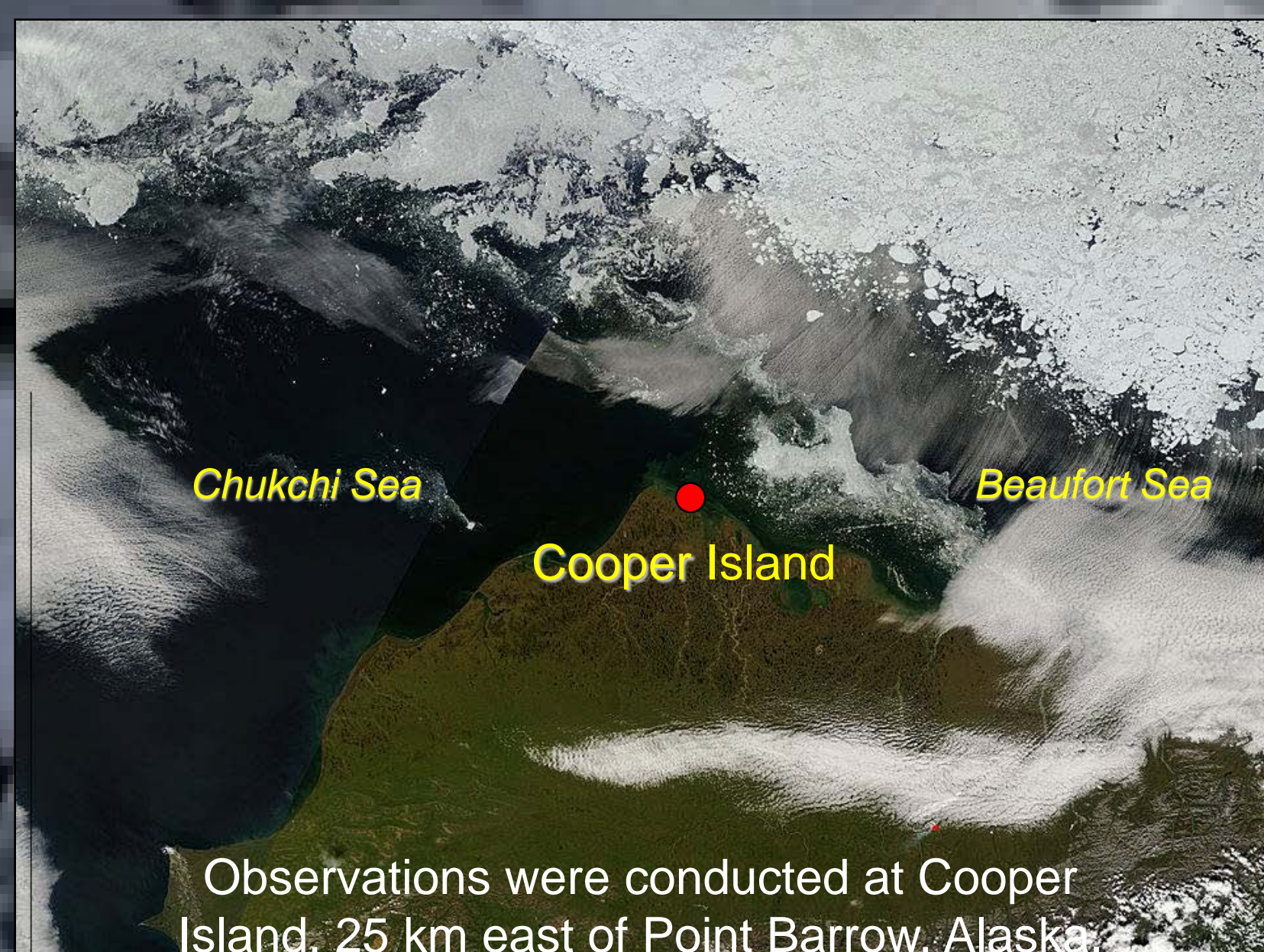
We conducted daily observations of the species and size of fish returned to Black Guillemot nestlings on Cooper Island in 2006 and 2007 to determine how proximity to pack ice modified prey availability.

We hypothesized that availability of Arctic Cod, the preferred prey of the species due to its high energy density, would decrease with increasing distance to the pack ice on both annual and seasonal scales.

Distance to ice explained over 70 percent of the daily variation in the daily percentage of Arctic Cod in nestling diet in 2007.



STUDY AREA AND METHODS



Observations were conducted at Cooper Island, 25 km east of Point Barrow, Alaska

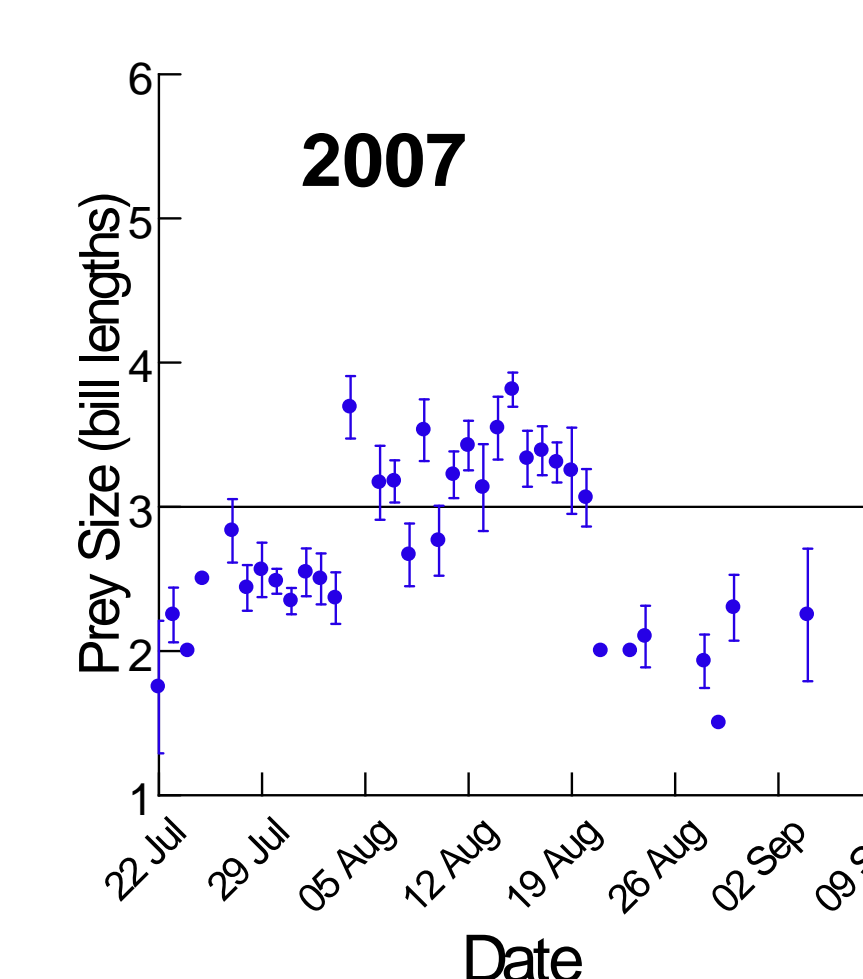
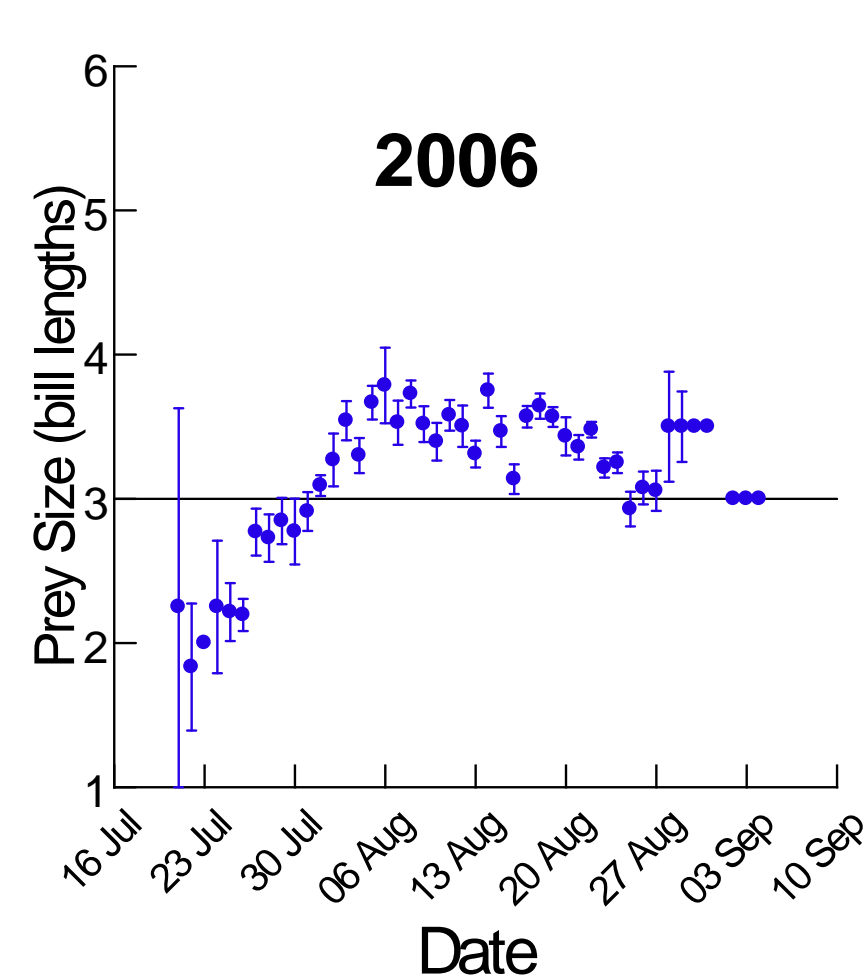


Black Guillemot with Arctic Cod, the preferred prey species and typically associated with pack ice.

Prey were observed and/or photographed daily during the nestling period (approximately 25 July to 10 Sept.) in 2006 and 2007.



Black Guillemot with a Four-horned Sculpin, a nearshore demersal not associated with pack ice.

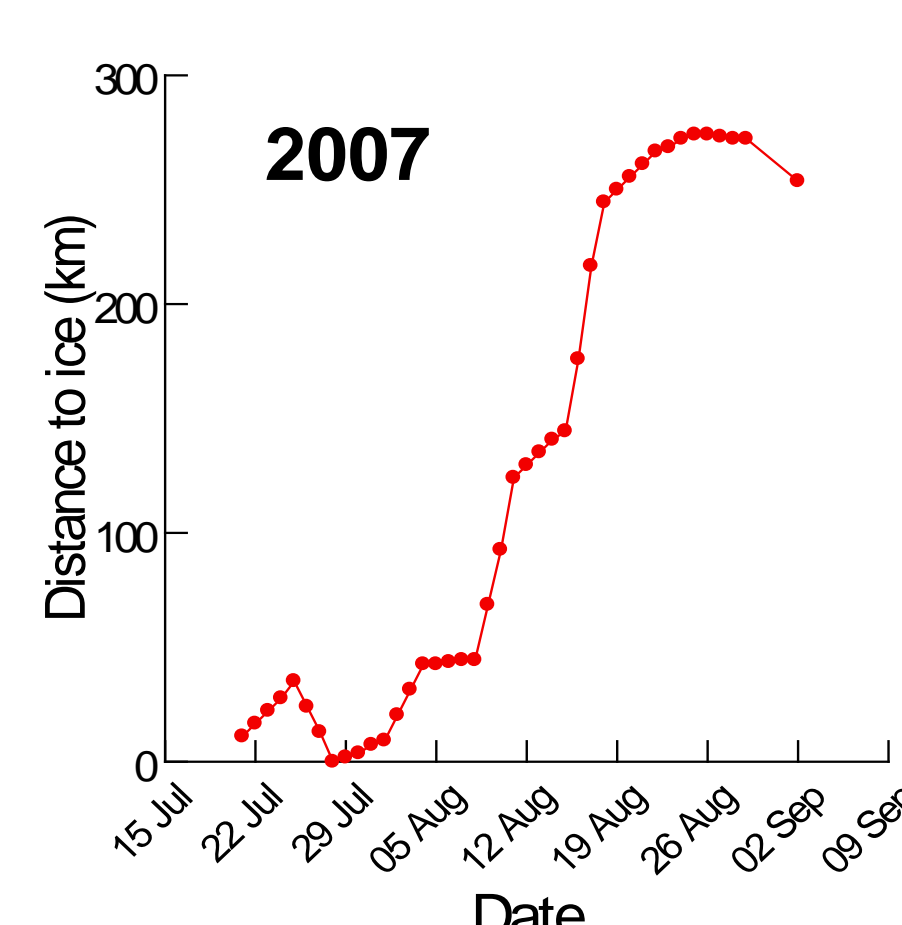
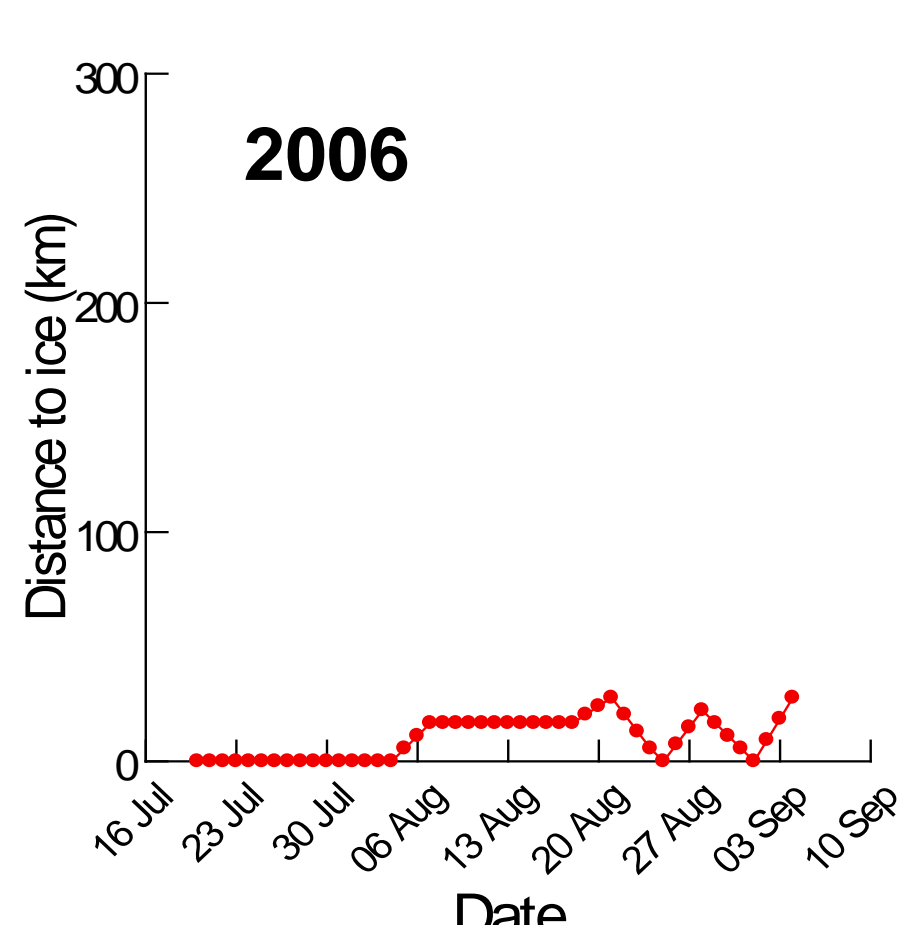


In both 2006 and 2007 first-year cod (<3 bill lengths) were fed to chicks early in the season. In late 2007 adults switched back to first-year cod as lack of pack ice apparently limited abundance or availability of adult cod.

CONCLUSIONS

- The daily percentage of Arctic Cod in the diet of Black Guillemot nestlings showed annual and seasonal variation correlated with distance to the pack ice.
- When pack ice is absent from the nearshore Beaufort Sea, guillemots turned to lower quality prey, primarily sculpin but also first-year Arctic Cod.
- The decrease and predicted disappearance of pack ice from the Arctic Basin in summer should have major effects on the distribution and abundance of species relying on Arctic Cod.
- Northward expansion of subarctic invertebrates and forage fish, with SST increases in the Arctic, could provide alternate prey for some species currently dependent on sympagic, under-ice, prey.
- While loss of summer pack ice will have major effects on marine mammals that utilize ice as a substrate, concurrent decreases in Arctic Cod availability will have trophic impacts for all arctic pack ice obligates.

Distance of pack ice from Cooper Island



Pack ice remained close to the Cooper Island Black Guillemot colony through the entire nestling period in 2006 but retreated to outside the 30 km foraging range midway through the 2007 nestling period.

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