

# Occurrence of Arctic and saffron cod in the diet of ringed seals at Shishmaref, 1975–2018



Louise Biderman, Anna Bryan, Justin Crawford, John Citta, and Lori Quakenbush

Alaska Department of Fish and Game, 1300 College Road, Fairbanks, Alaska 99701, USA [louise.biderman@alaska.gov](mailto:louise.biderman@alaska.gov)

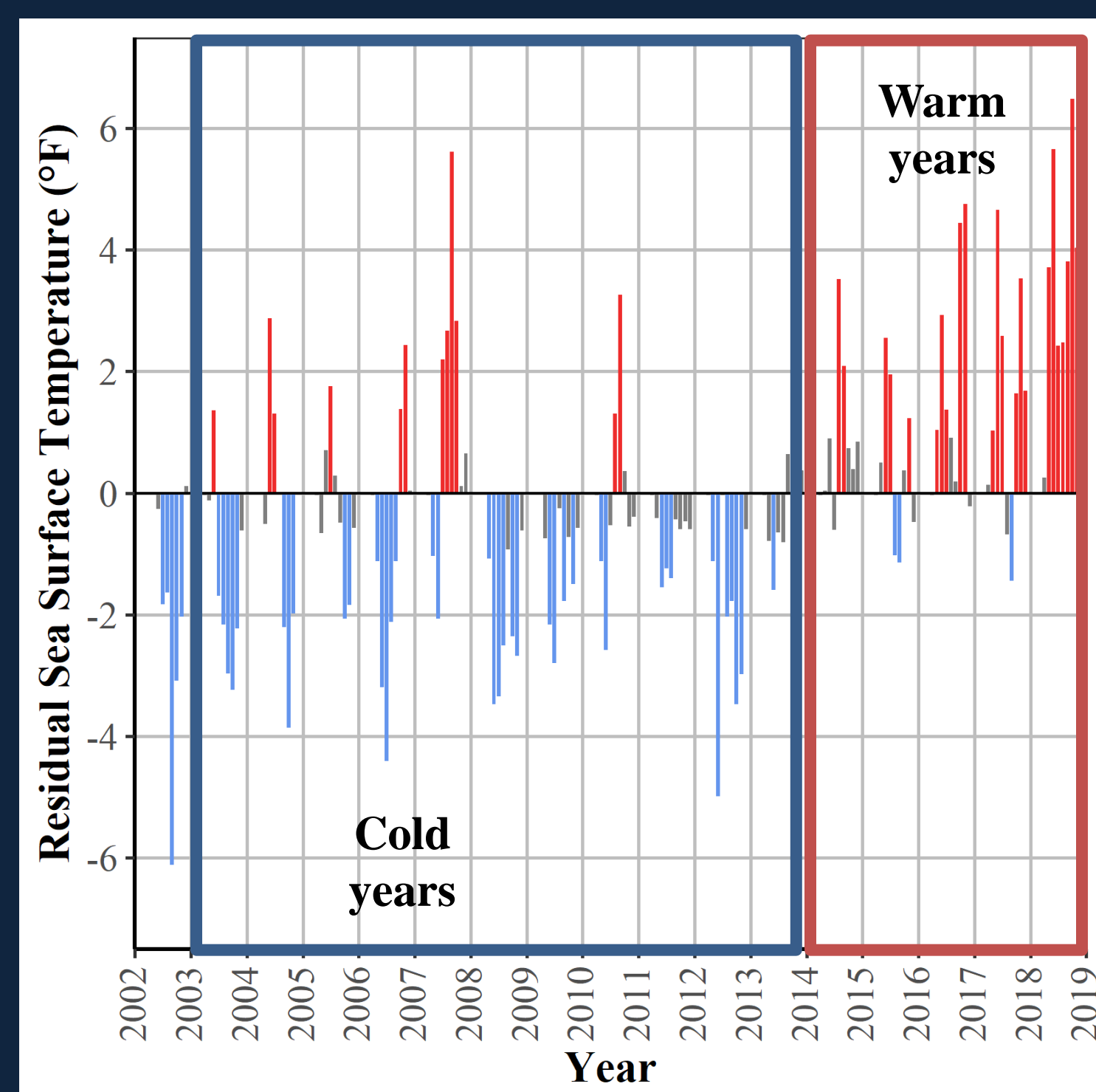


## Overview

A warming climate is expected to alter the marine food web by favoring species of fish that thrive in warmer water to the detriment of those that thrive in cooler water. As part of a long-term study of ringed seals (*Pusa hispida*) harvested near Shishmaref, Alaska, we investigated trends in the occurrence and size of the two most common fish found in their stomachs, Arctic cod (*Boreogadus saida*) and saffron cod (*Eleginus gracilis*). Arctic cod are strongly associated with sea ice and cooler waters, whereas saffron cod prefer warmer water and therefore may become more prominent in ringed seal diet as temperatures increase.

## Methods

- We examined diet from stomach contents of 757 ringed seals collected by subsistence hunters in Shishmaref, Alaska between 2003–2018. Canine teeth were collected and aged. Seals were separated by age class as pups (<1 yr. old) and non-pups (>1 yr. old).
- Stomach contents were rinsed, and prey items were identified to the lowest taxonomic level.
- Fish were identified by their species-unique otolith shape.
- Each fish has two otoliths, one on the right and one of the left side of its head. Otoliths were separated by side.
- For each fish species, the side with the greatest number of otoliths was counted, photographed, and measured (from rostrum to postrostrum) using a Leica M125 stereo microscope and MU1000 AmScope.

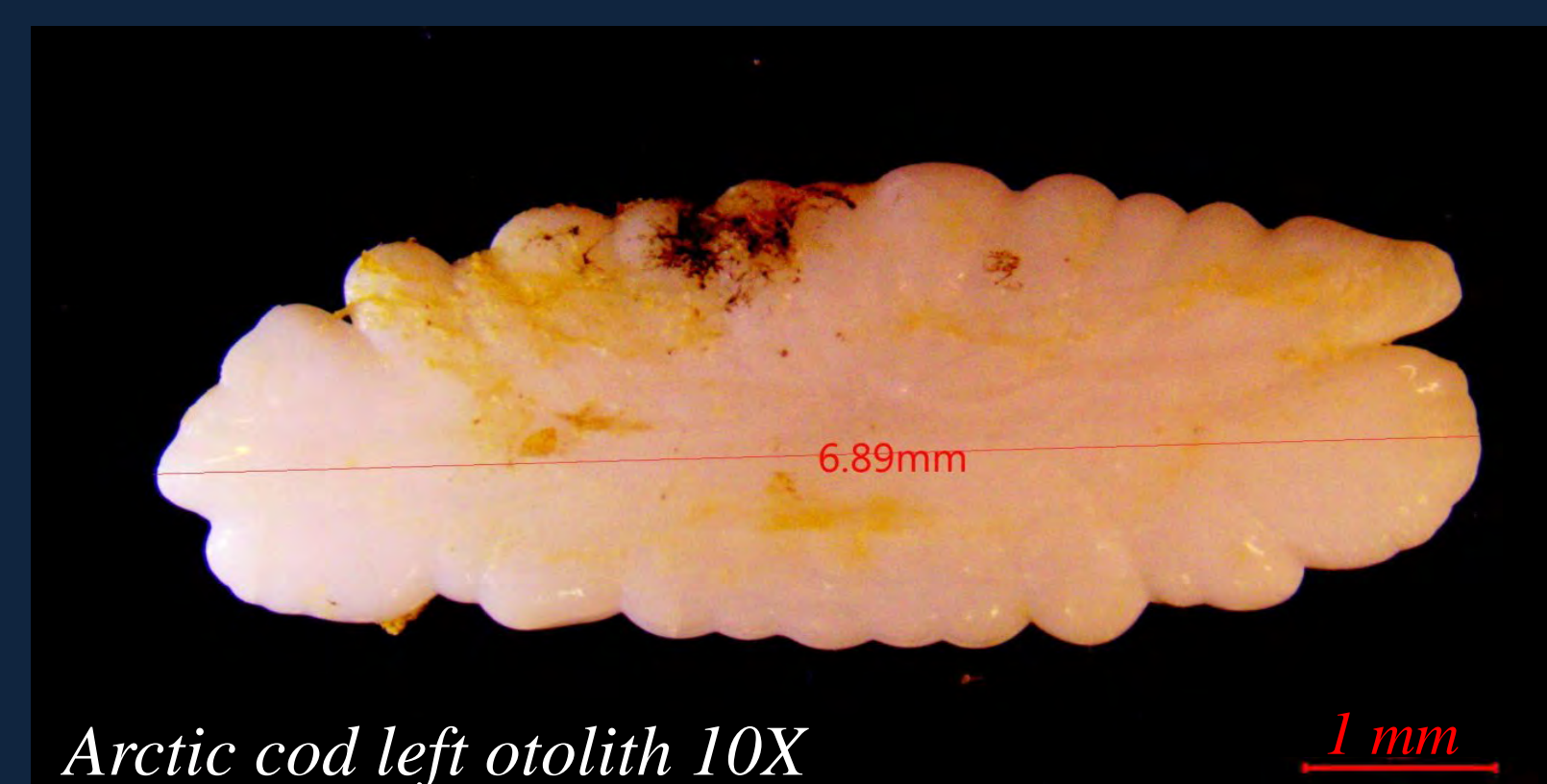


- Sea surface temperature collected near Shishmaref was used to determine warm and cold years in the 2000s and 2010s. We considered 2003–2013 to be cold years and 2014–2018 to be warm years.

## Arctic cod



Sheiko & Mecklenburg

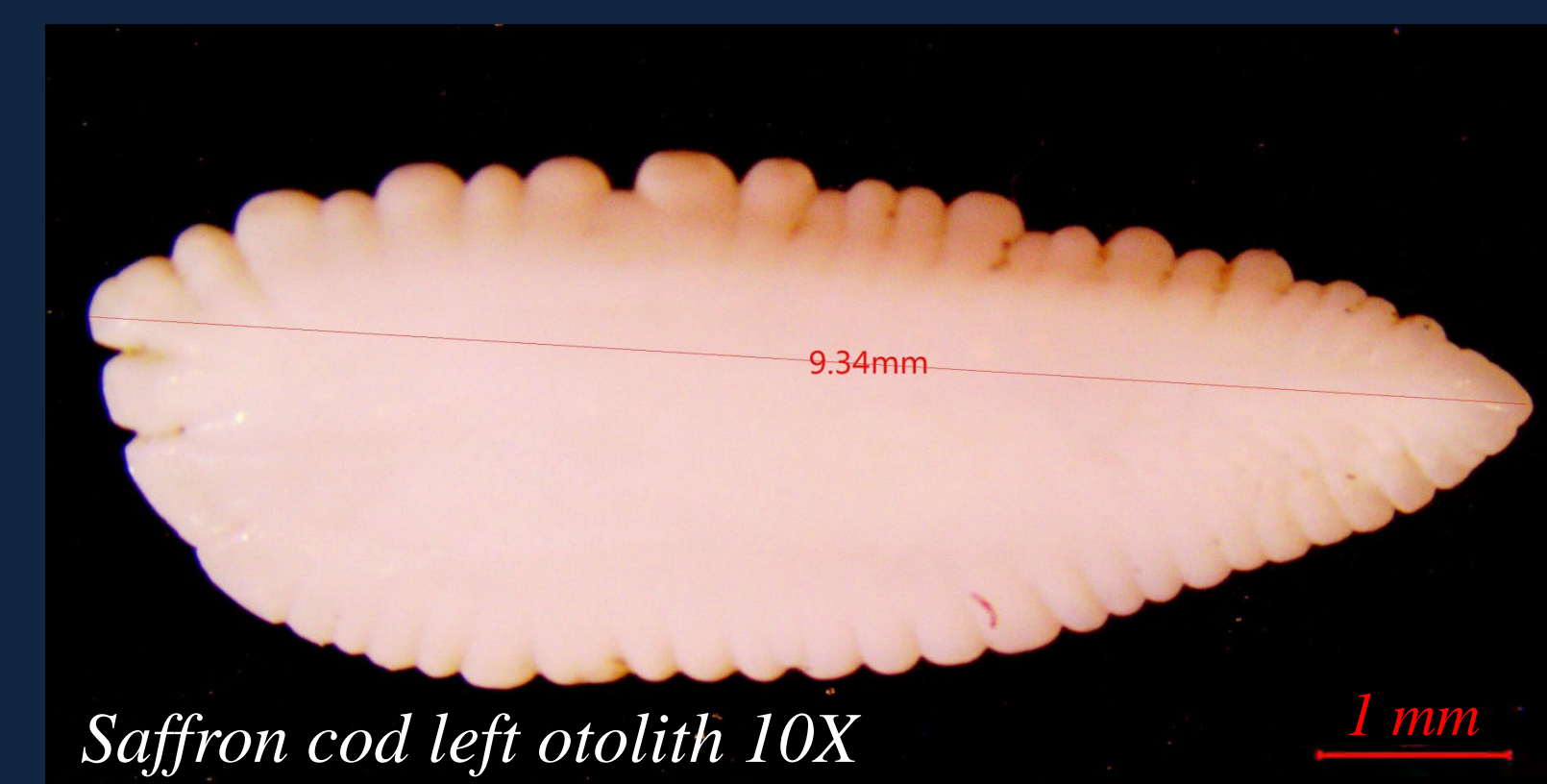


Arctic cod left otolith 10X

## Saffron cod



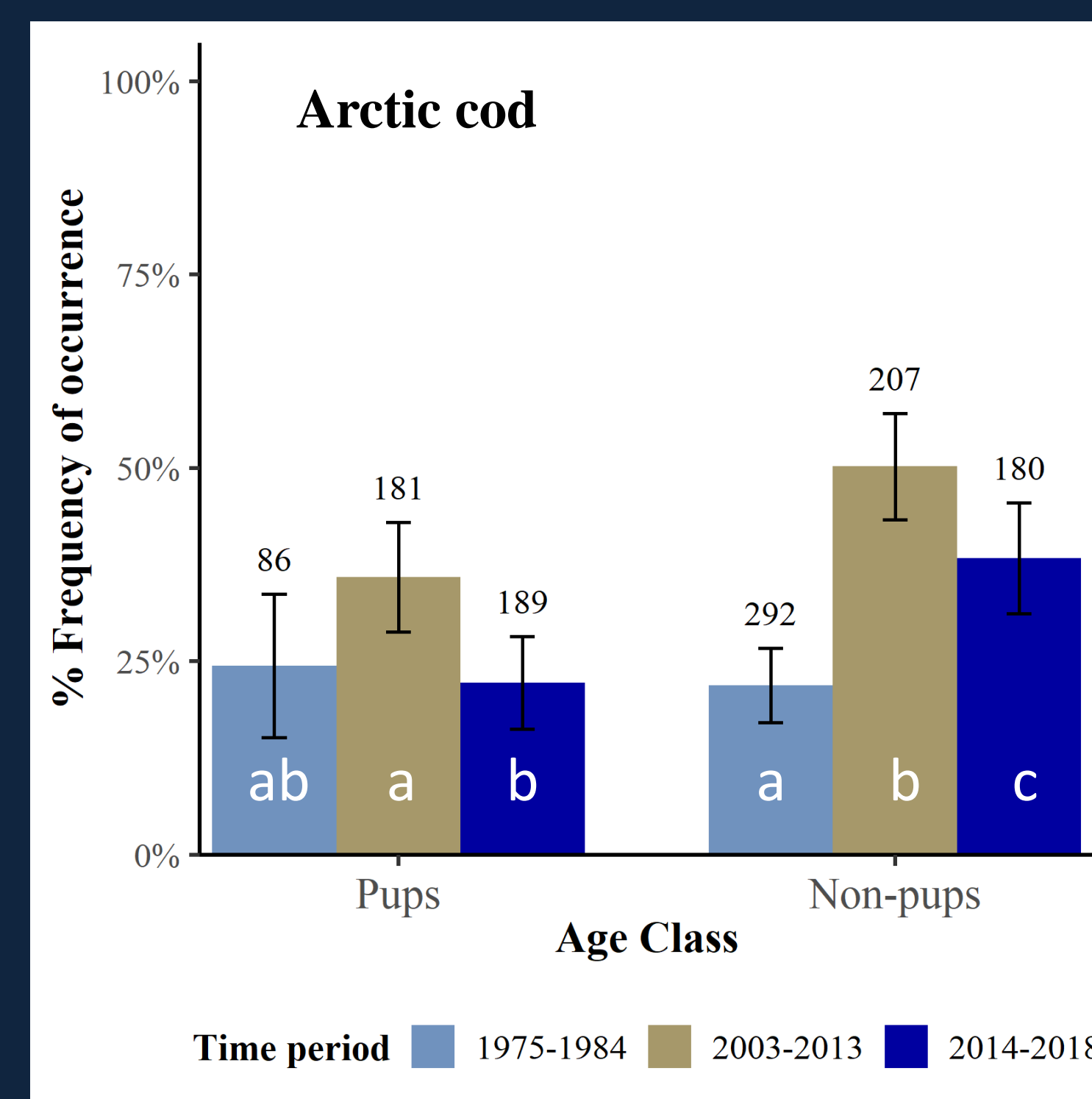
Sheiko & Mecklenburg



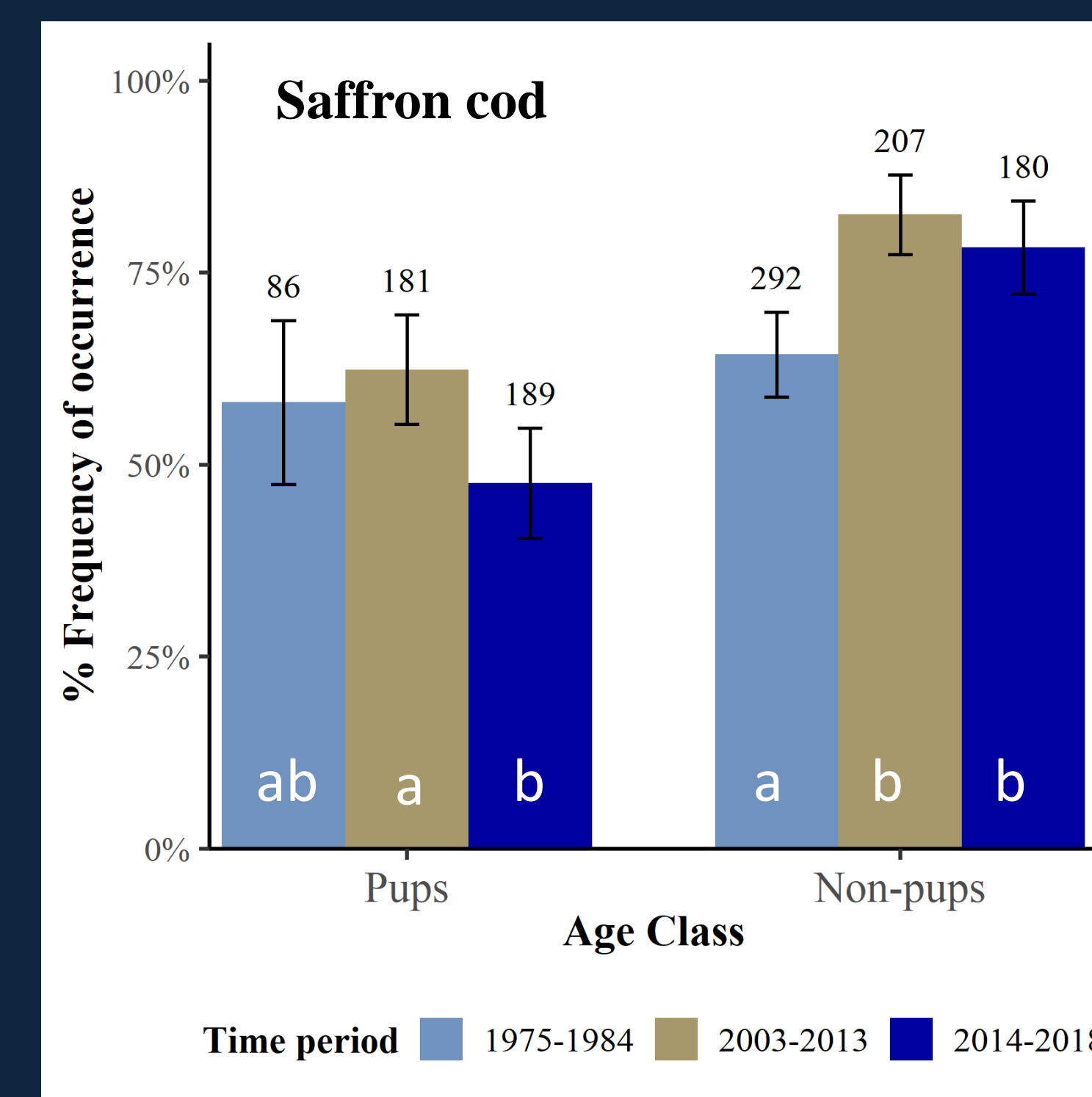
Saffron cod left otolith 10X

## Frequency of occurrence

Frequency of occurrence (FO) was calculated by dividing the number of stomachs containing each cod species, by the number of stomachs containing any prey item. Frequencies during 2003–2013 and 2014–2018 were compared to frequencies during 1975–1984.



The FO of Arctic cod was lowest in 1975–1984 and highest in 2003–2013. Significant differences are indicated on graph with different letter labels ( $p < 0.05$ ).

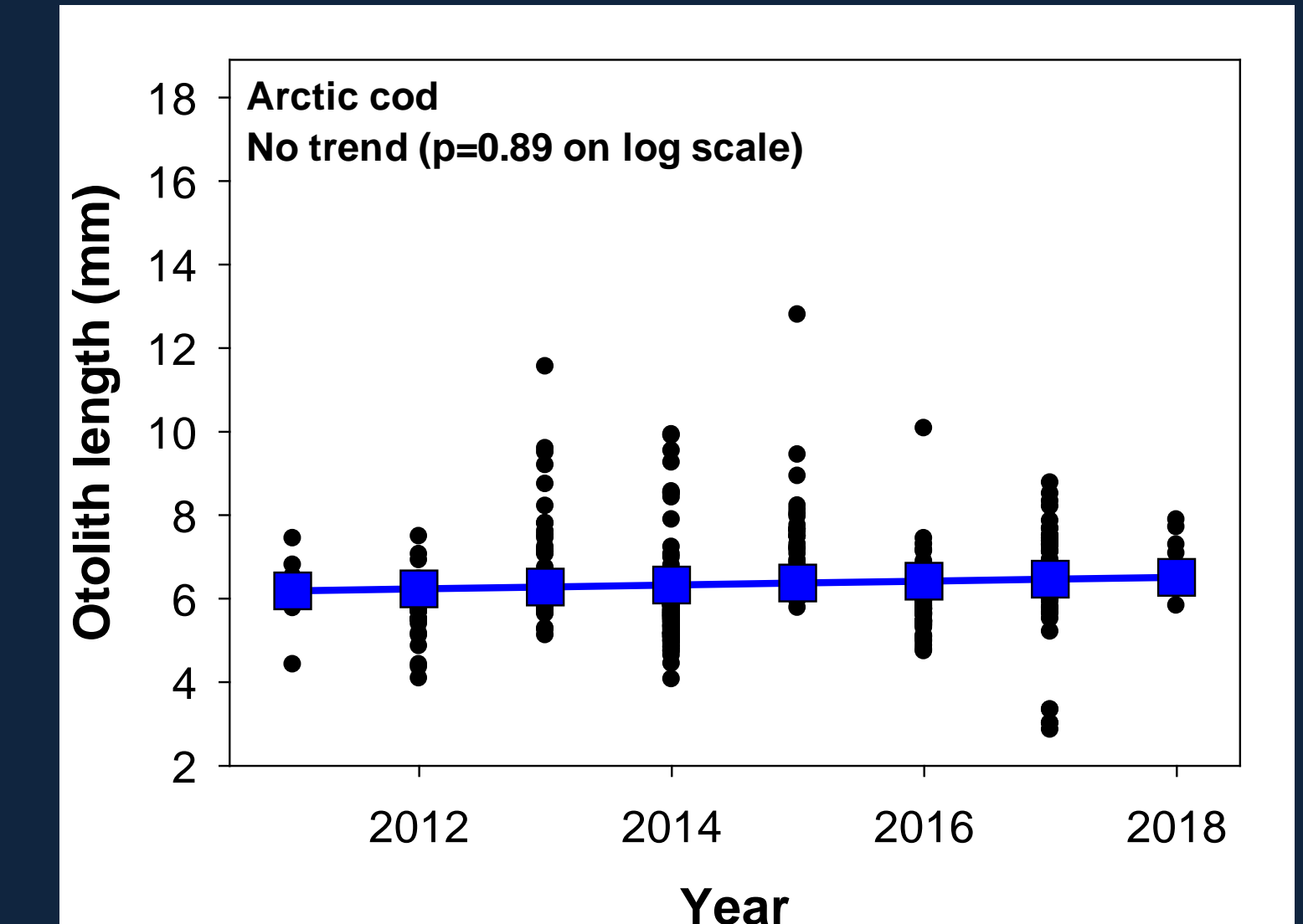


The FO of saffron cod was lowest in 2014–2018 for pups and 1975–1984 for non-pups. It was highest in 2003–2013 for both age classes. Significant differences are indicated on graph with different letter labels ( $p < 0.05$ ).

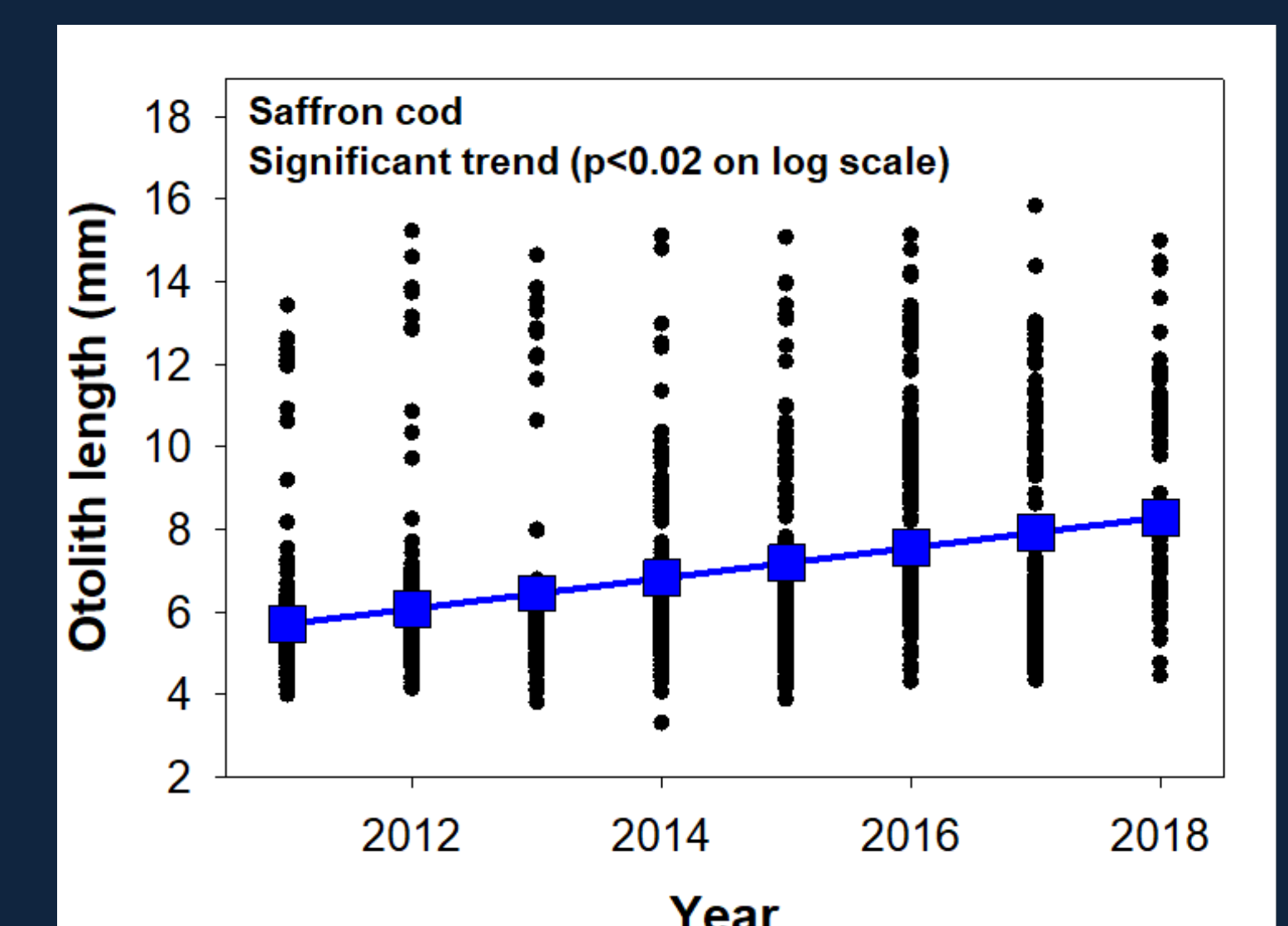
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## Otolith length

Otolith lengths were compared by age of seal and year of harvest. On average, otoliths in pup stomachs were approximately 1mm shorter than non-pups. However, there was no evidence that trends through time differed by age class.



Average length of Arctic cod otoliths did not change over time.



Average length of saffron cod otoliths increased significantly over time.

## Conclusion

- As of 2018 Arctic cod are still present in the diet of ringed seals for both age classes.
- The trend toward larger saffron cod otoliths may indicate recent environmental conditions support the growth of larger saffron cod.
- Continued monitoring is needed to detect possible changes in the occurrence and size of prey species as the environment changes.

## Next steps

- Examine ringed seal stomachs from 2019 for the presence of Arctic cod.
- Collect ocean-surveyed fish of size classes that are consumed by seals. Use these to develop length regressions that more accurately represent the size of fish consumed by seals.