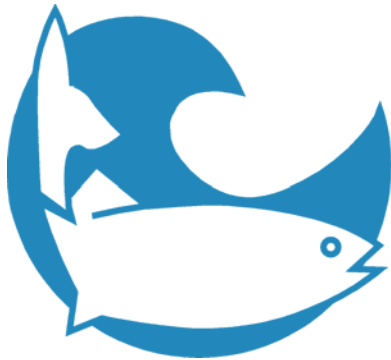


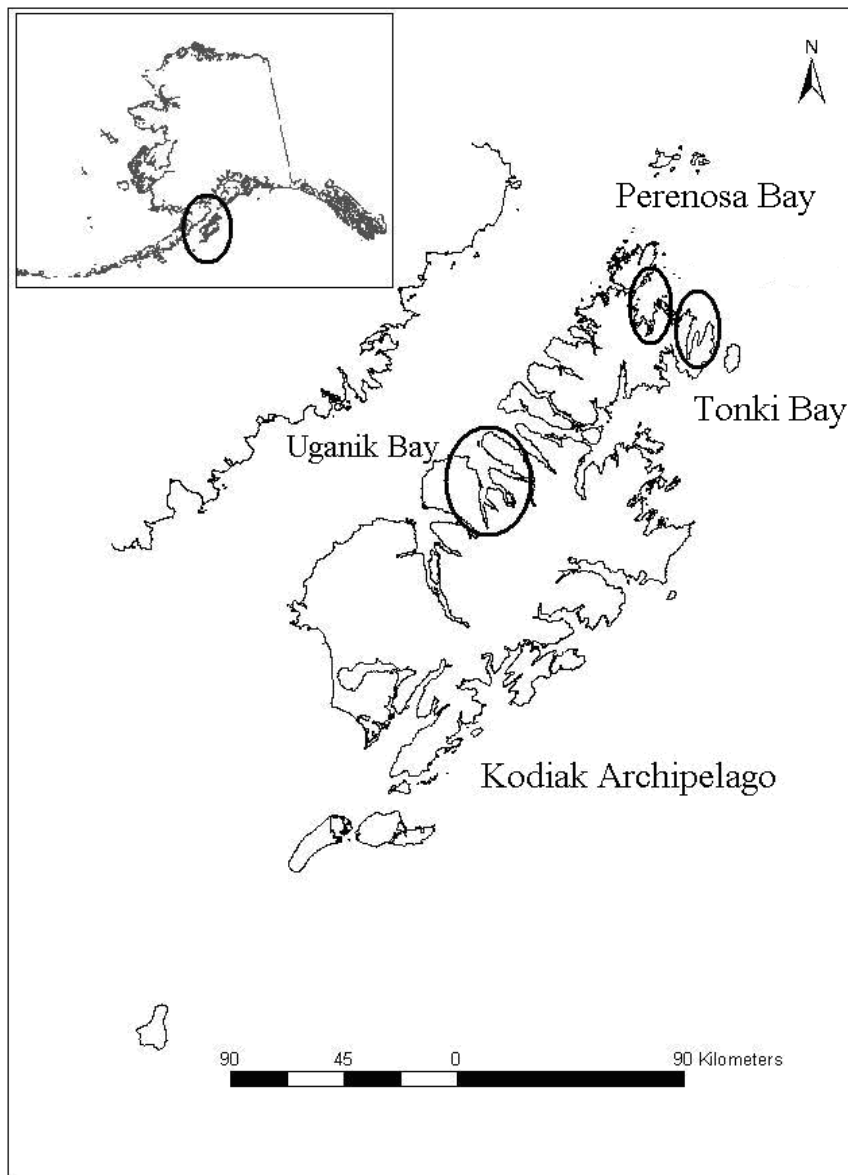
Combining Stomach Content and Fatty Acid Analyses to Assess Forage Fish Diets

Lei Guo¹, Robert Foy², Lawrence Schaufler², Kate Wynne¹

¹School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

²Alaska Fisheries Science Center, NOAA Fisheries





Gulf Apex Predator-prey Program

✚ multidisciplinary ecosystem study

✚ Kodiak Archipelago

Embayments:

✚ forage fish feeding habitats

✚ complex features leading to variable ecosystems

✚ fine-scale studies needed to increase key-process resolution

Forage Fish:

✚ spp. composition & biomass

✚ lipid & energy contents

✚ diets

2004	2005	2006	2007
May, Aug	May, Aug	Nov	Apr

forage fish diets

+ Pacific herring (*Clupea pallasii*), walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), and eulachon (*Thaleichthys pacificus*)

+ stomach content analysis

- + established and extensively used

 - + logistically easy

 - + data interpretation straightforward

- + mid-water trawls during surveys

 - + 11 m cod end with 0.1 m mesh and 0.025 m mesh liner

 - + total length 5 to 50 cm

- + results overview

 - + 38 identified taxonomy groups in 907 samples

 - + euphausiids and copepods as dominant prey

 - + low diversity

forage fish stomach content analysis

- ✚ problem I: underestimate of copepods
 - ✚ high evacuation rates of forage fish stomach contents
 - ✚ copepods digested faster than euphausiids
 - ✚ daytime sampling
- ✚ problem II: underestimate of diet diversity, resulting in low power of detecting diet differences
 - ✚ compromises in taxa and sizes
 - ✚ less information than needed to detect differences
 - ✚ strongly pulsed prey supply
 - ✚ uniform prey

solution: fatty acid (FA) analysis

✚ for problem I: natural biomarkers of calanoid copepods

- ✚ unique FA, assimilated by predators with little modification

✚ for problem II: diversified prey FA

- ✚ zooplankton's highly variable and dynamic FA profiles
- ✚ integrated view of diets from the last (up to) several weeks

✚ FA: building blocks of lipids



C22:6n3

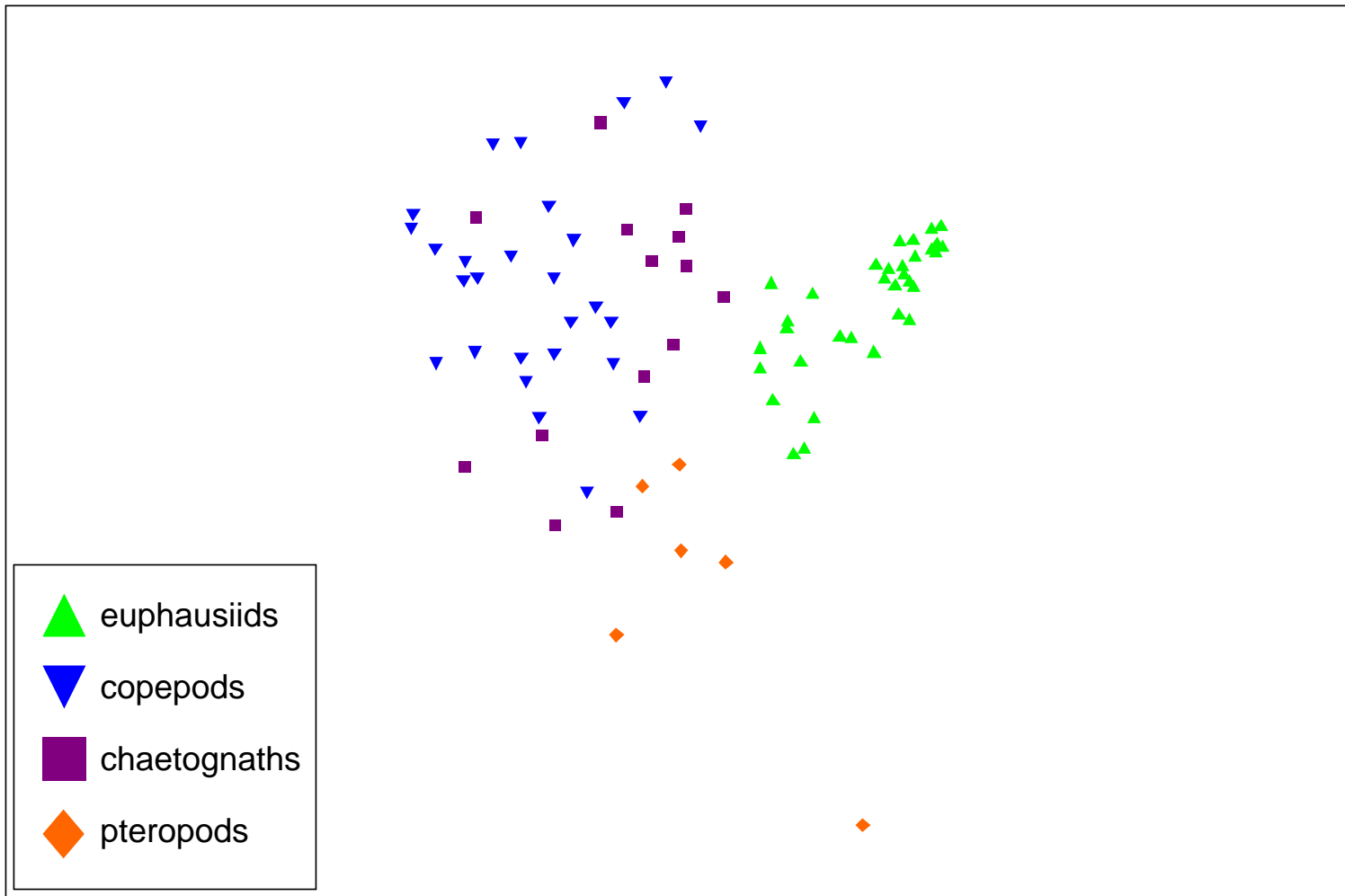
4,7,10,13,16,19-docosahexaenoic acid ('DHA')

<http://www.lipidlibrary.co.uk/>

✚ FA analysis

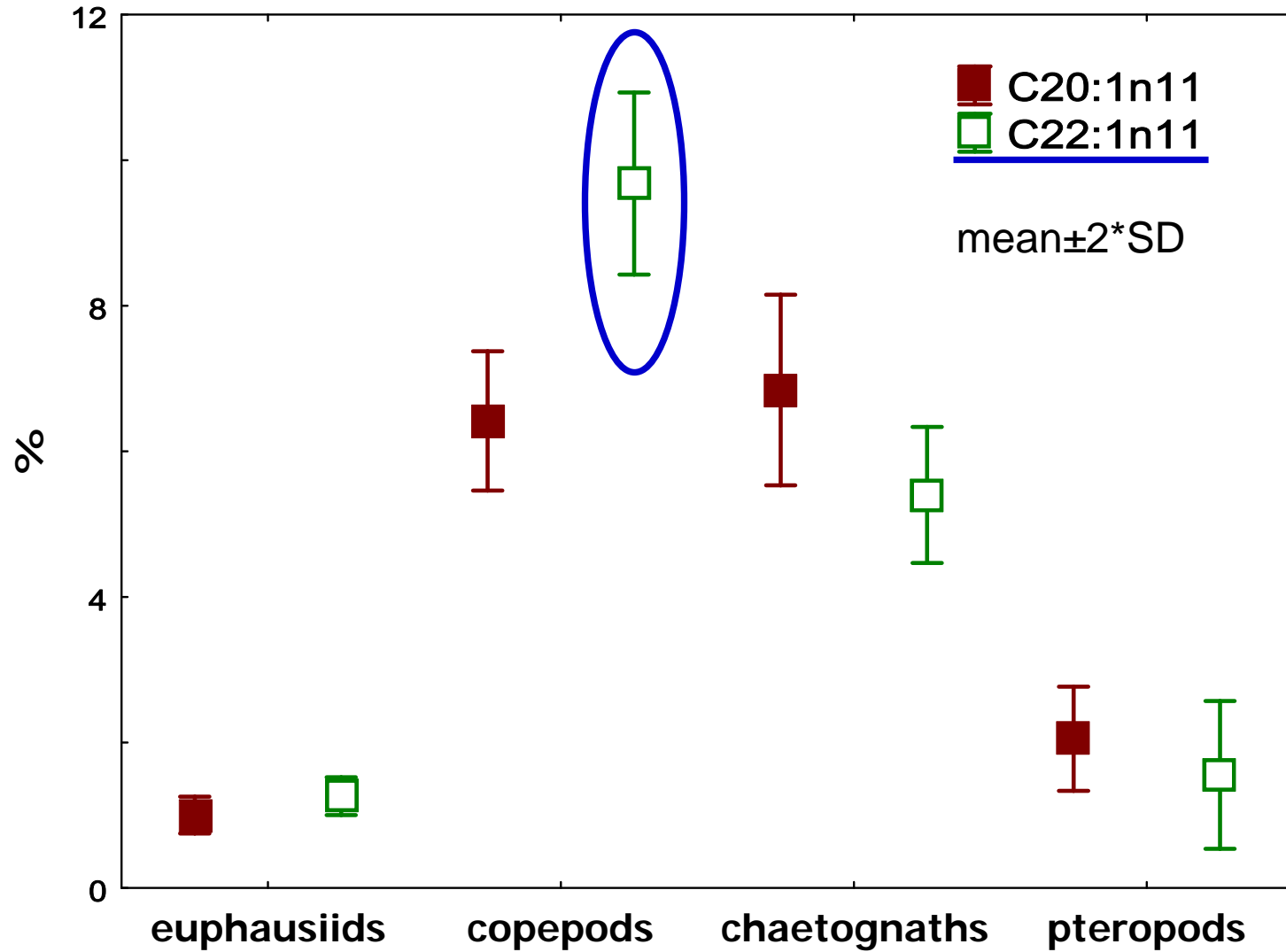
- ✚ lipid extraction: whole-body homogenates
- ✚ identification of FA methyl esters: GC-MS
- ✚ 257 fish, 80 zooplankton
- ✚ 37 FA quantified, compositional data

zooplankton fatty acids

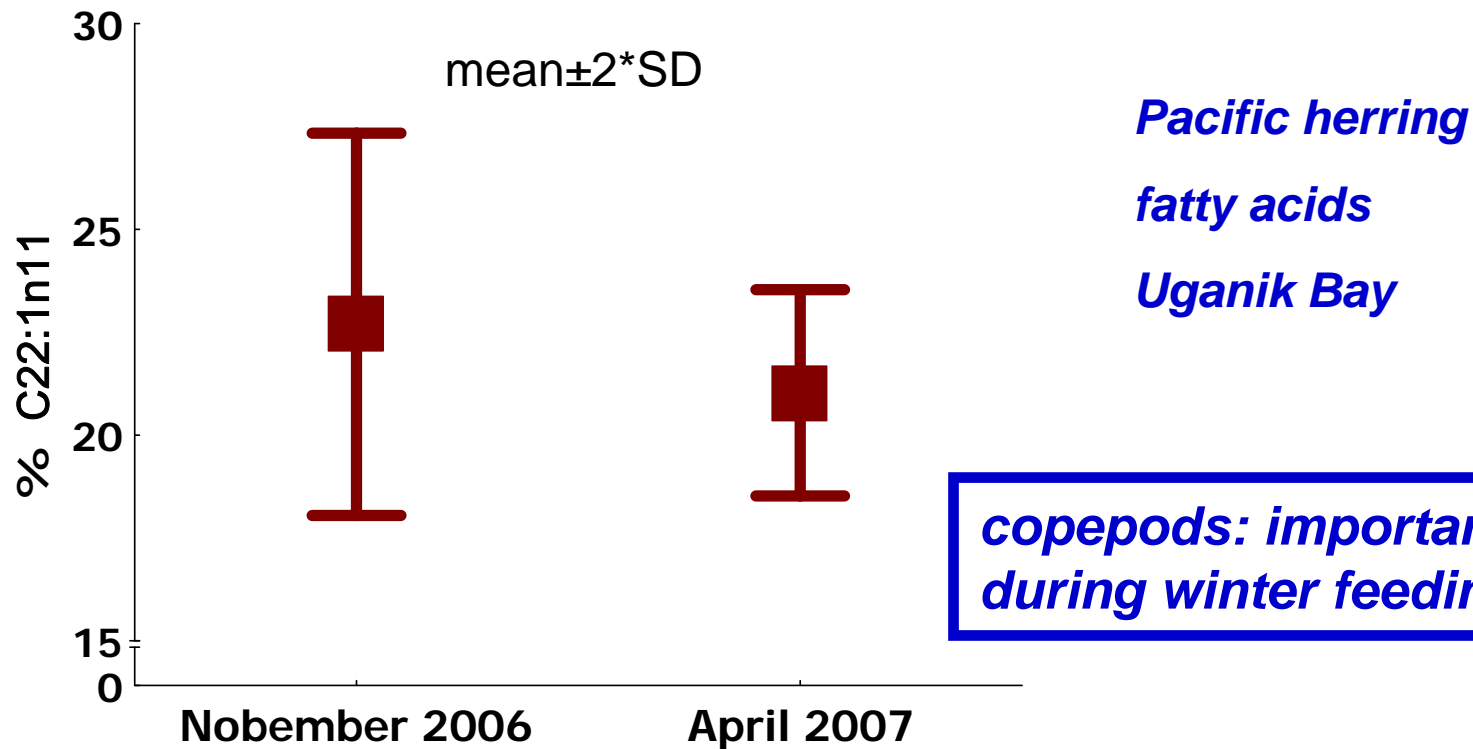
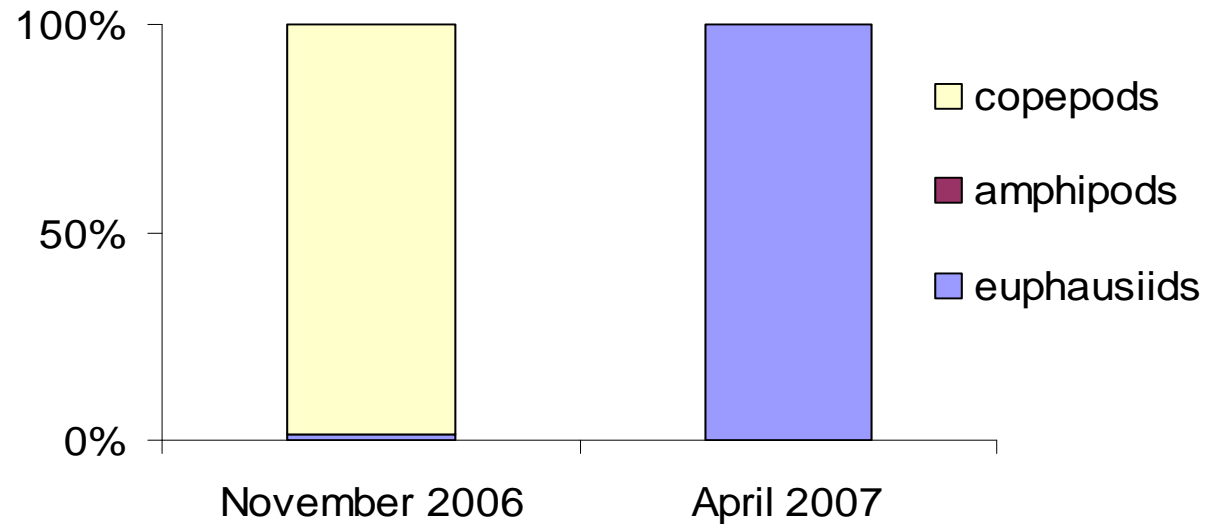


Multi-Dimensional Scaling (MDS) based on Bray Curtis similarity

zooplankton fatty acids

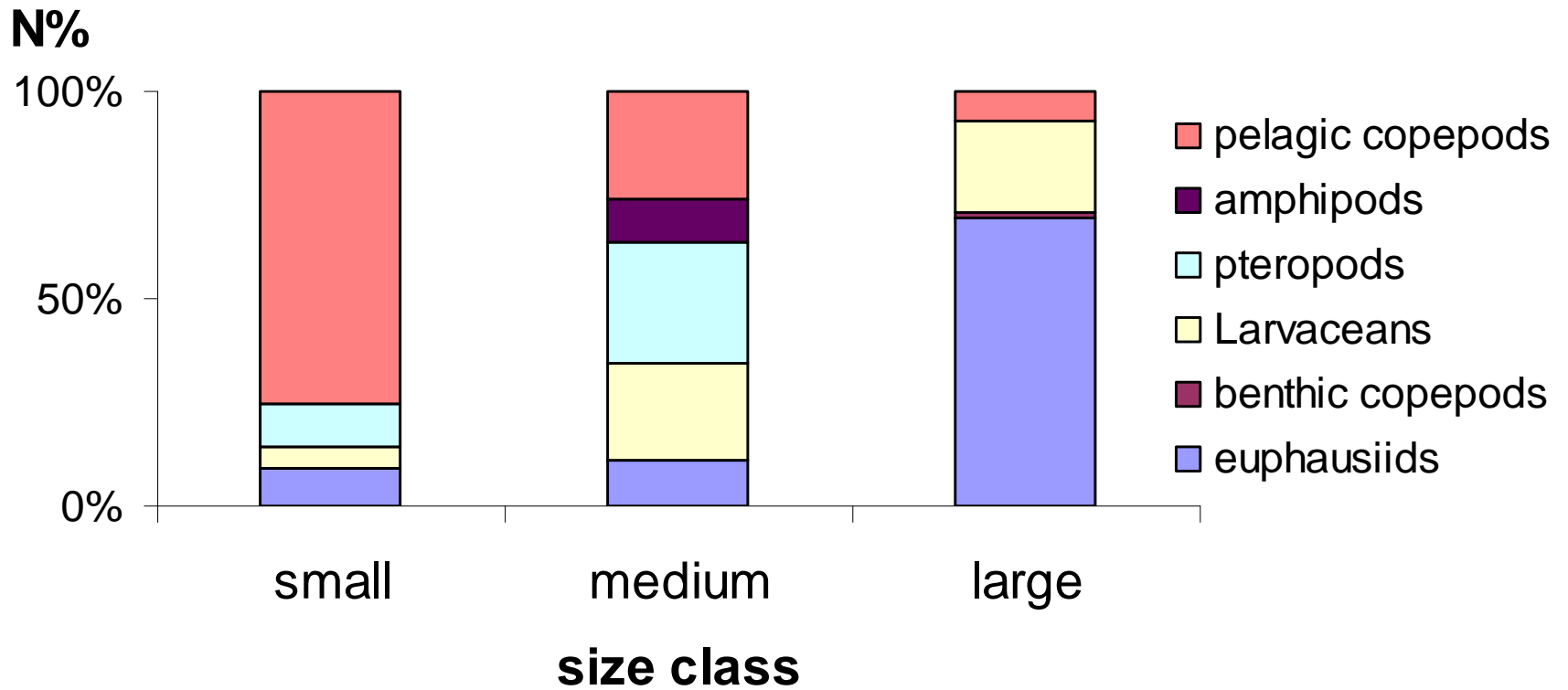


***Pacific herring
stomach contents
Uganik Bay***



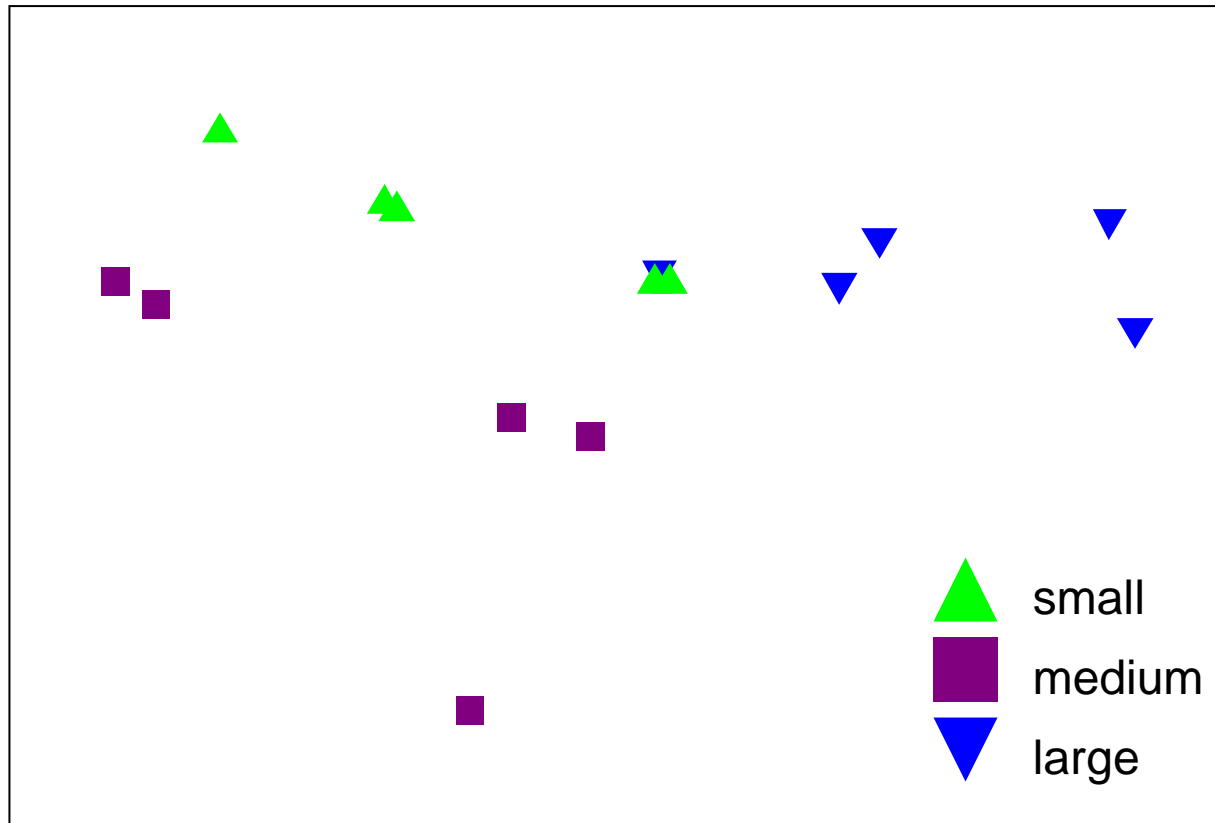
***copepods: important prey
during winter feeding***

walleye pollock stomach contents, Uganik Bay, May 2004



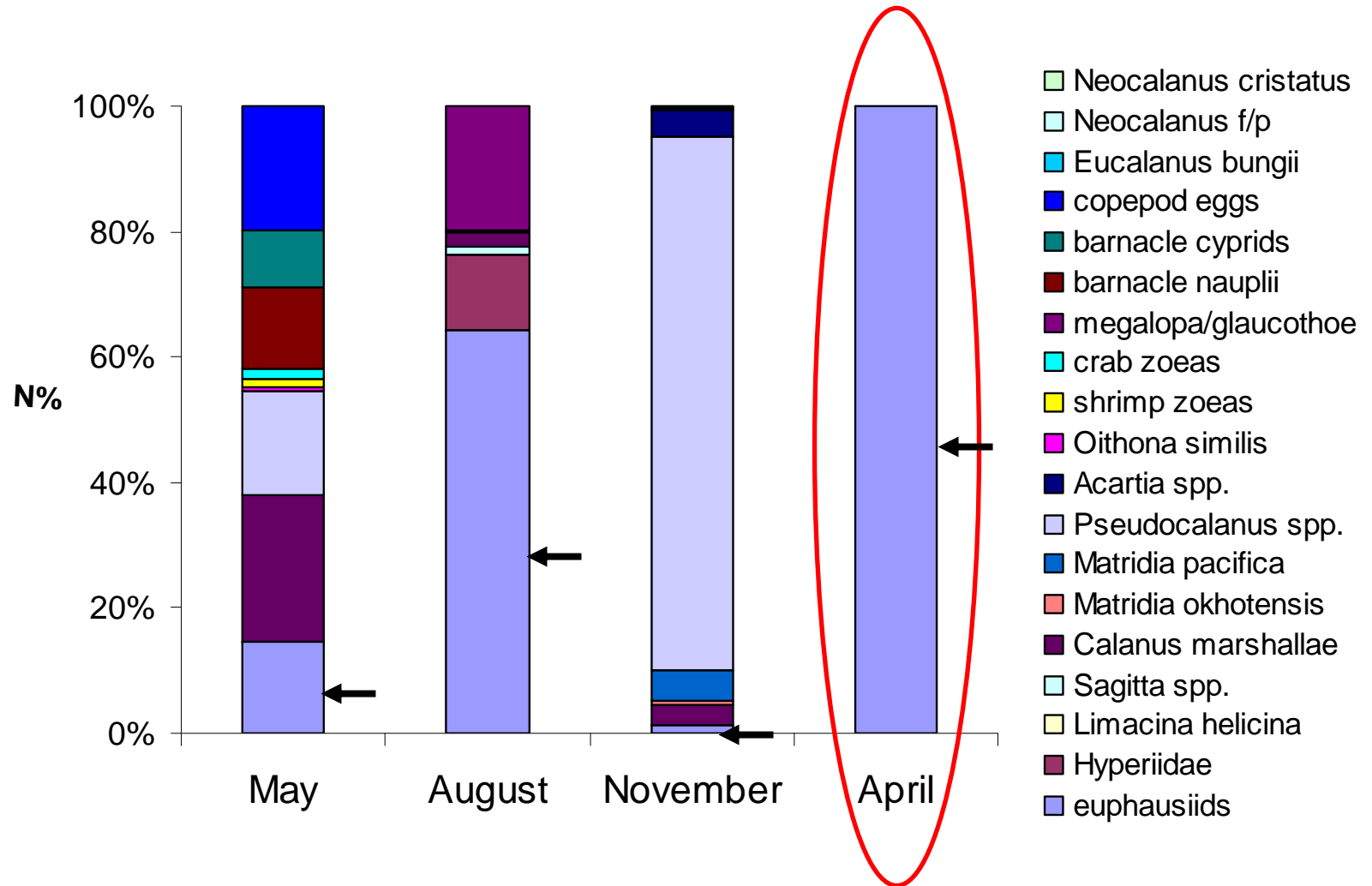
size class	small	medium	large
total length (cm)	13.6-15.5	23.6-28.9	32.5-43.5

walleye pollock fatty acids, Uganik Bay, May 2004

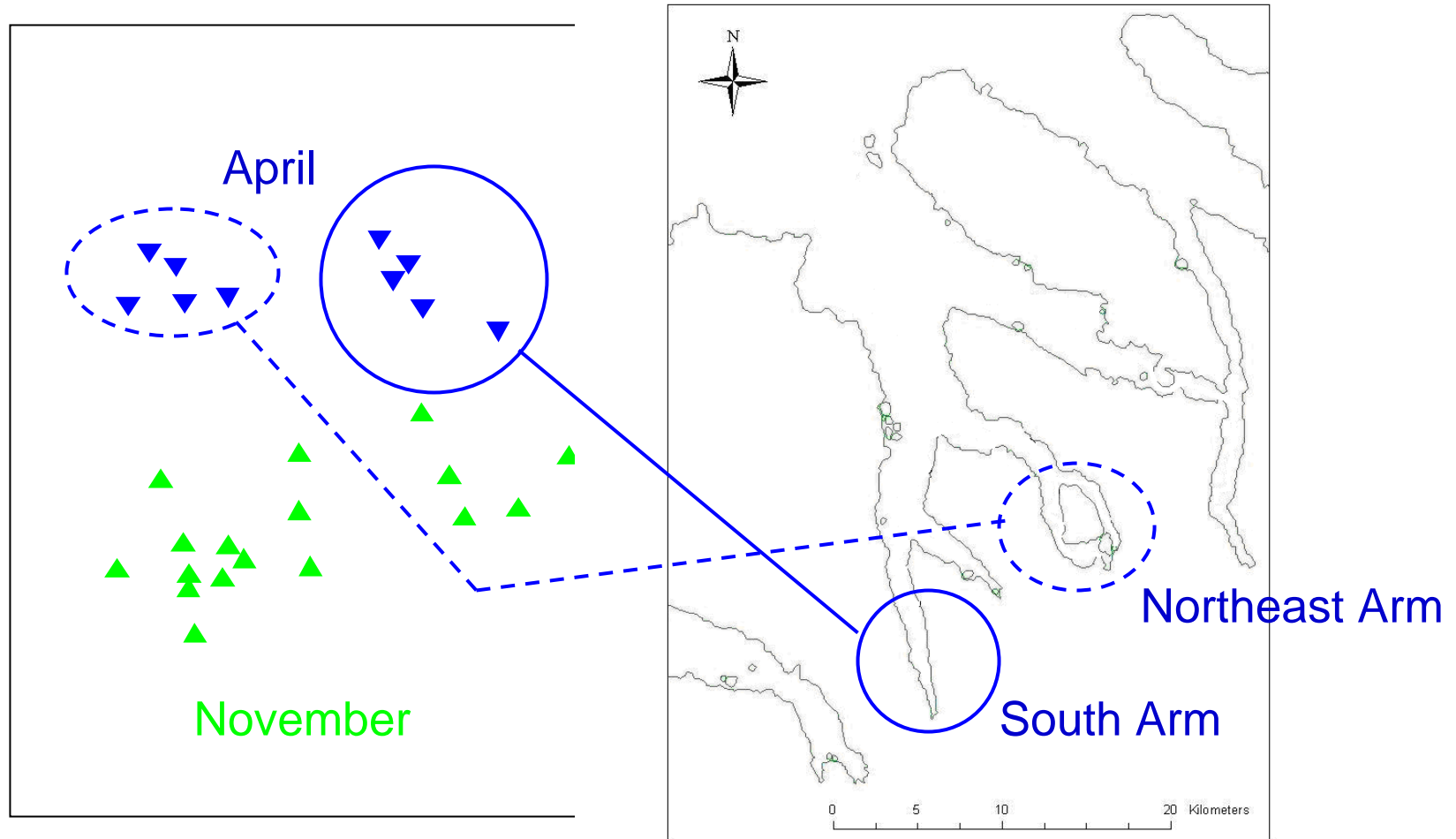


MDS based on Bray Curtis similarity

Pacific herring stomach contents, Uganik Bay

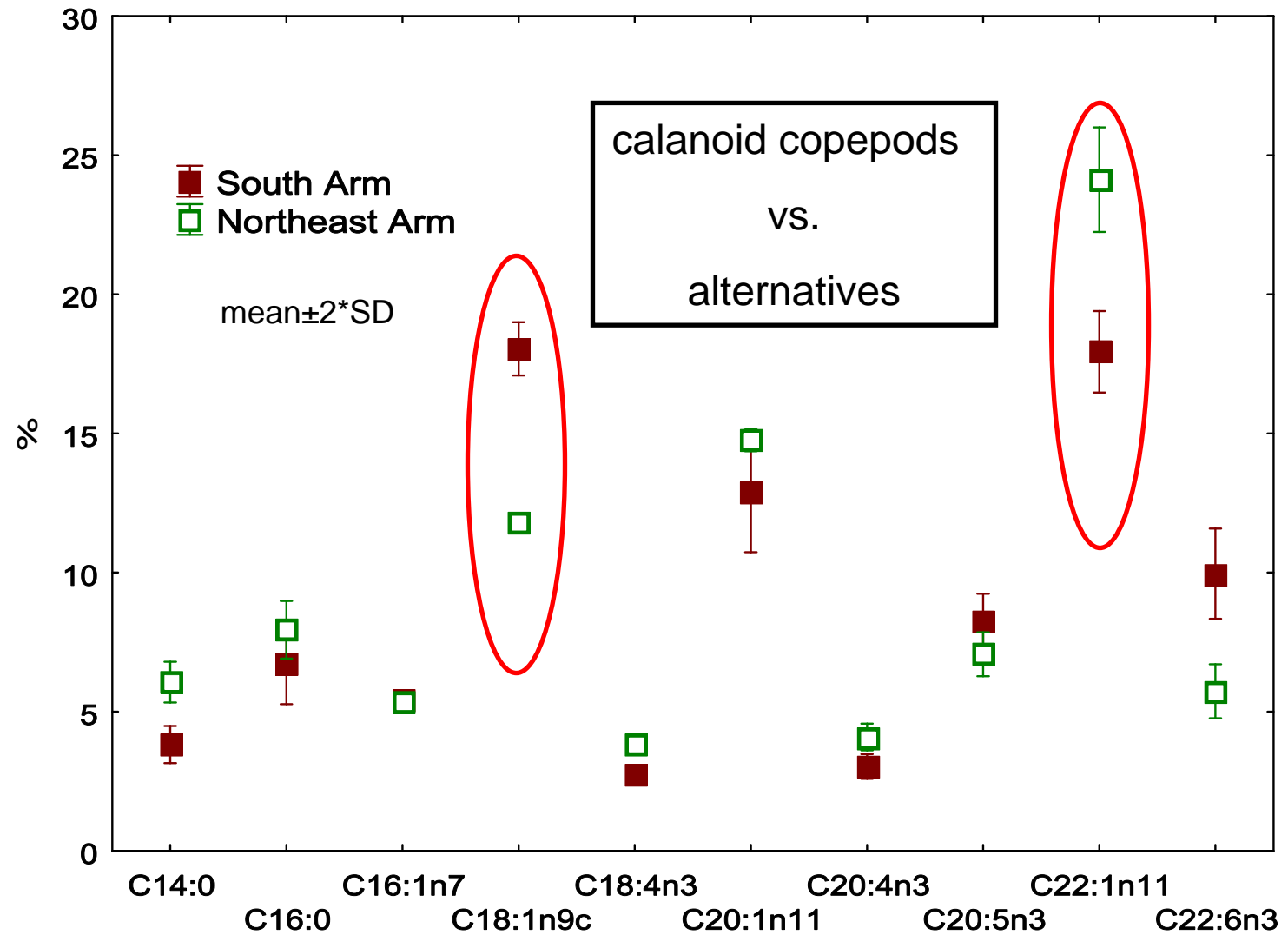


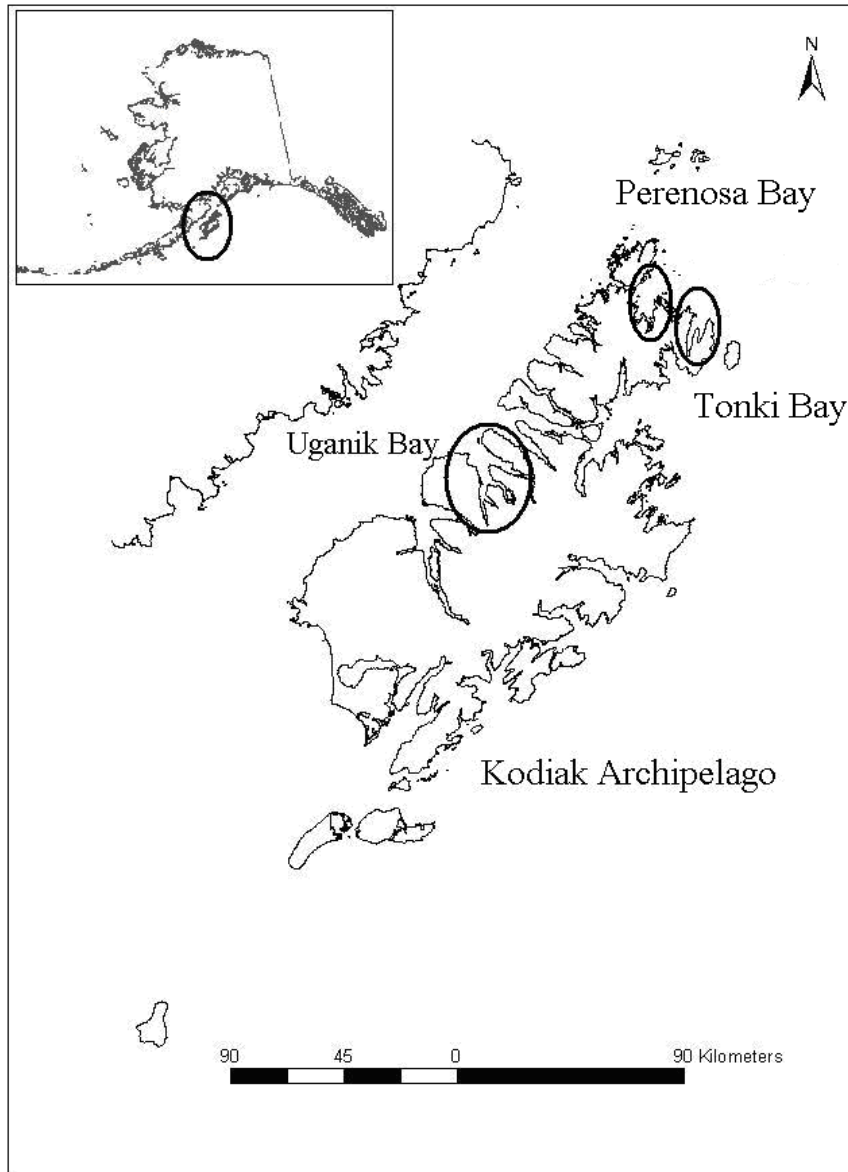
Pacific herring fa



MDS based or

Pacific herring fatty acids, Uganik Bay, April 2007



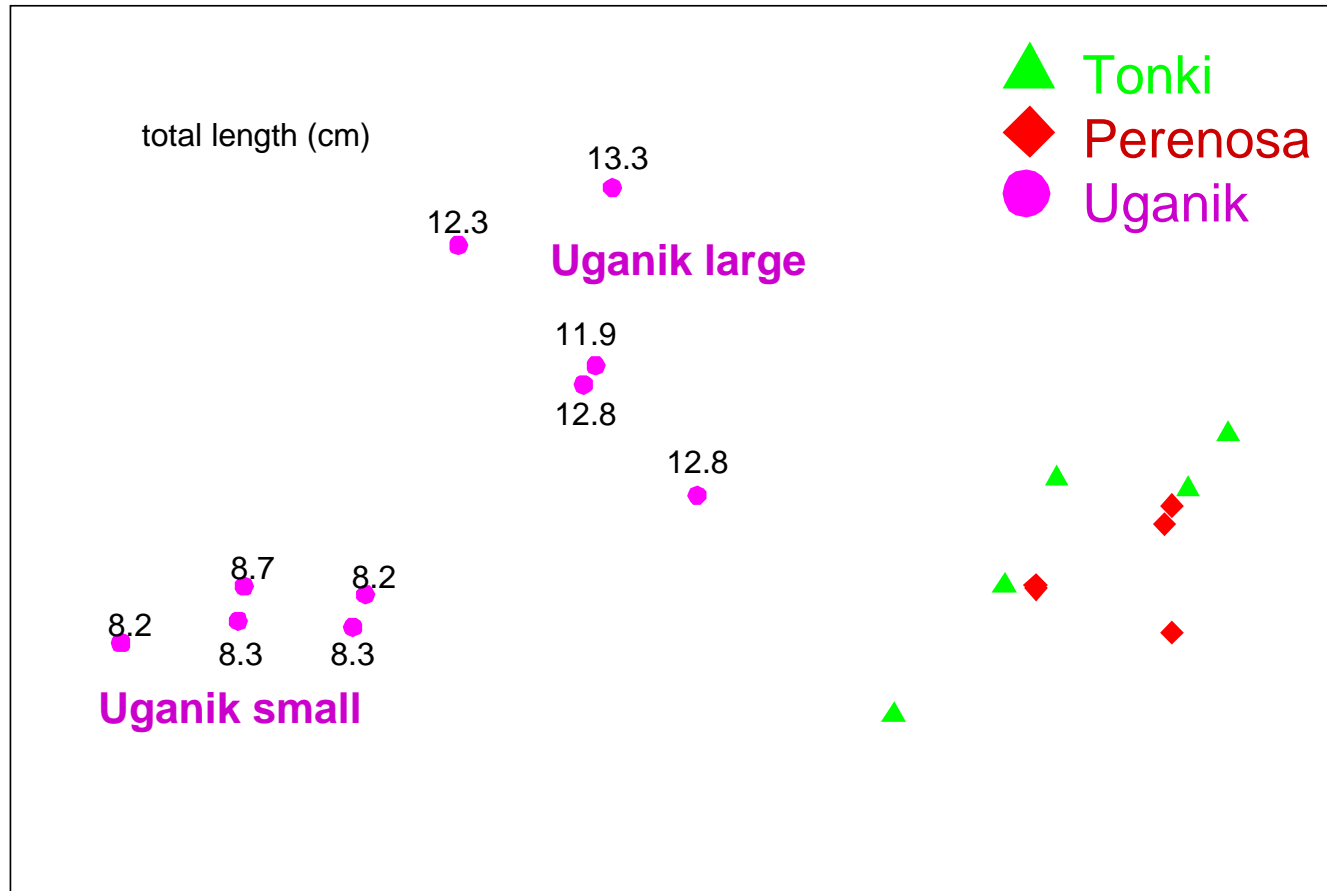


capelin, May 2005

No significant spatial difference
detected in stomach contents

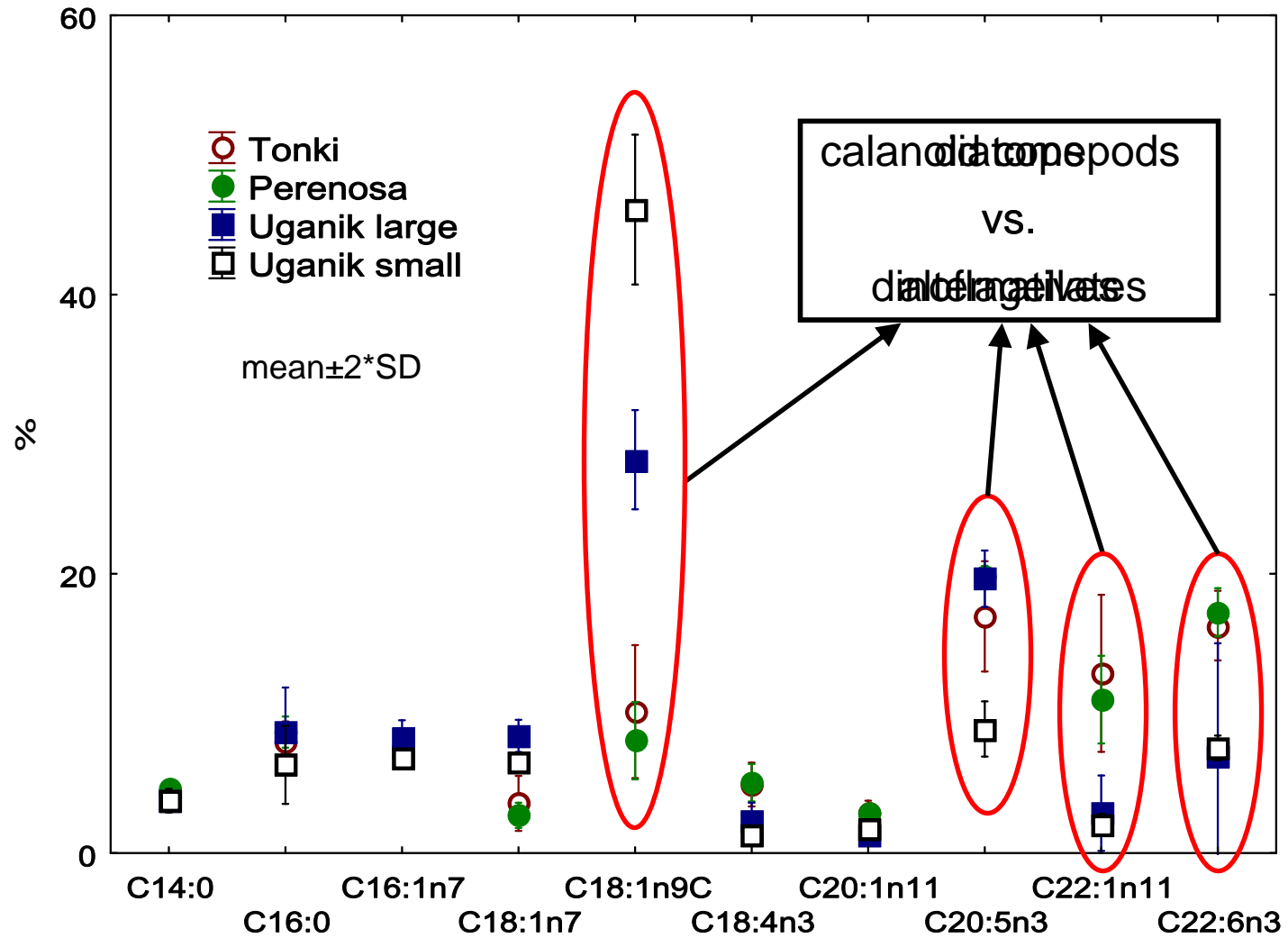


Capelin fatty acids, May 2005



MDS based on Bray-Curtis similarity

capelin, May 2005



Summary

- ✚ fatty acid analysis complementary to stomach content analysis
- ✚ ontogenetic and seasonal variations
- ✚ copepods as important prey in winter
 - ✚ high degree of spatial overlap between forage fish and copepods
 - ✚ forage fish low turnover rates making fatty acid analysis a useful tool for winter sampling
- ✚ spatial variations
 - ✚ within bays and among bays
 - ✚ differences in prey availability and food web origins

Acknowledgement

- ✚ Committee: Robert Foy (chair), Kate Wynne (chair), Lawrence Schaufler, Kenneth Coyle, and Nicola Hillgruber
- ✚ Funding: GAP, USDA, UAF Dissertation Completion Fellowship
- ✚ Captain and crew of F/V Alaskan
- ✚ Iluhi Schimetka-Tesch and Mike Trussell
- ✚ Colleagues in Nutritional Ecology Lab, TSMRI, Alaska Fisheries Science Center, NOAA Fisheries
- ✚ Staff and colleagues in Fisheries Industrial Technology Center, School of Fisheries and Ocean Science, UAF
- ✚ UAF library staff
- ✚ Friends
- ✚ My mom

