Summer food web structure in the eastern Bering Sea: fatty acid composition of plankton, fish, and seabirds around the Pribilof Islands

Jeffrey M. Napp[1], Lawrence E. Schaufler[2], George L. Hunt, Jr.[3] and Kathy L. Mier[1]

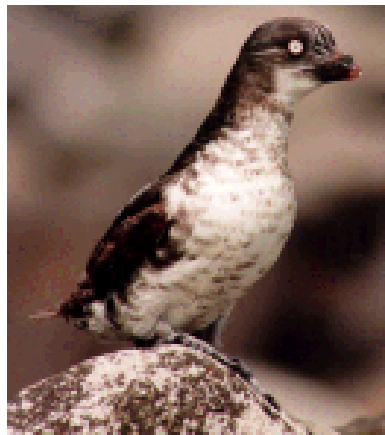
[1] NOAA – Fisheries, Alaska Fisheries Science Center, Seattle

[2] NOAA – Fisheries, Alaska Fisheries Science Center, Auke Bay Laboratory

[3] School of Aquatic and Fishery Sciences, University of Washington

“Cross-shelf Transport and Post-Bloom New Production near the Pribilof Islands“

Working Hypothesis: On-shelf flow of nutrient- and zooplankton-rich slope water enhances new production and zooplankton populations in the vicinity of the Pribilof Islands, thereby increasing the ability of the region to support juvenile fish, seabirds and marine mammals.



Investigators

- Physical Oceanography – Stabeno
- Nutrients – Mordy
- Phytoplankton – Zeeman, Sambrotto
- Microzooplankton – Strom
- Mesozooplankton – Coyle
- Birds – Hunt, Jancke
- Trophic Pathways – Napp

Temporal Dimensions

- Many measurements only indicate present conditions
  - CTD Hydrography, Nutrient Chemistry, Phytoplankton Biomass & Community Composition, Phytoplankton Nutrient Uptake, Zooplankton Biomass.
- Hypothesis requires knowledge of past and present conditions
  - Moored Observations, Trophic Markers (Fatty Acids & Stable Isotopes), Seabird Fledging Success.

Hypothesis

Organisms from sustained areas of:

- New production --- fatty acids associated with diatoms (e.g. 16:1(n-7) and 20:5(n-3))
- Production from recycled nutrients --- fatty acids associated with small phytoplankton species e.g. 14:0, 18:3(n-3), and 18:4(n-3)).

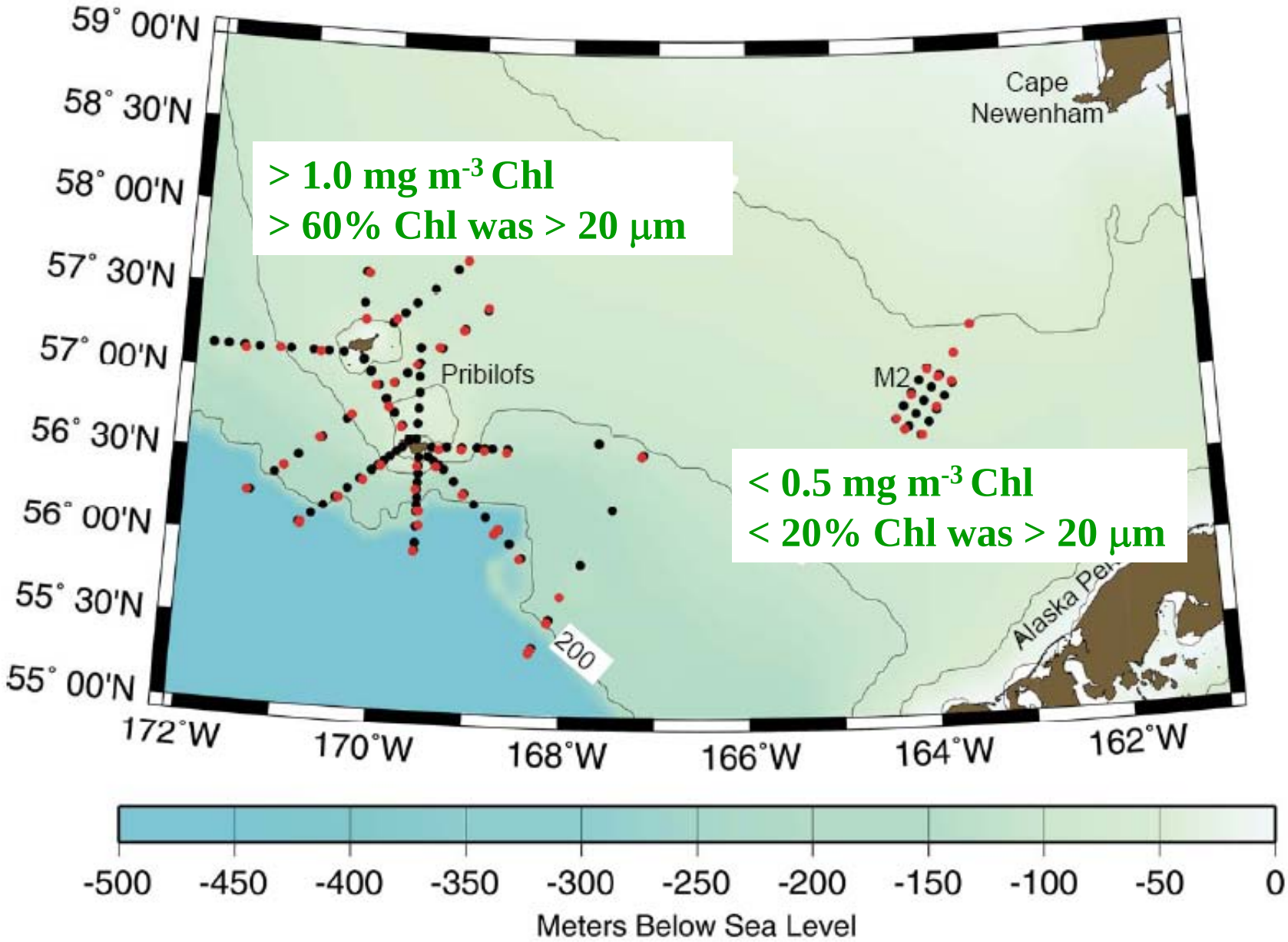
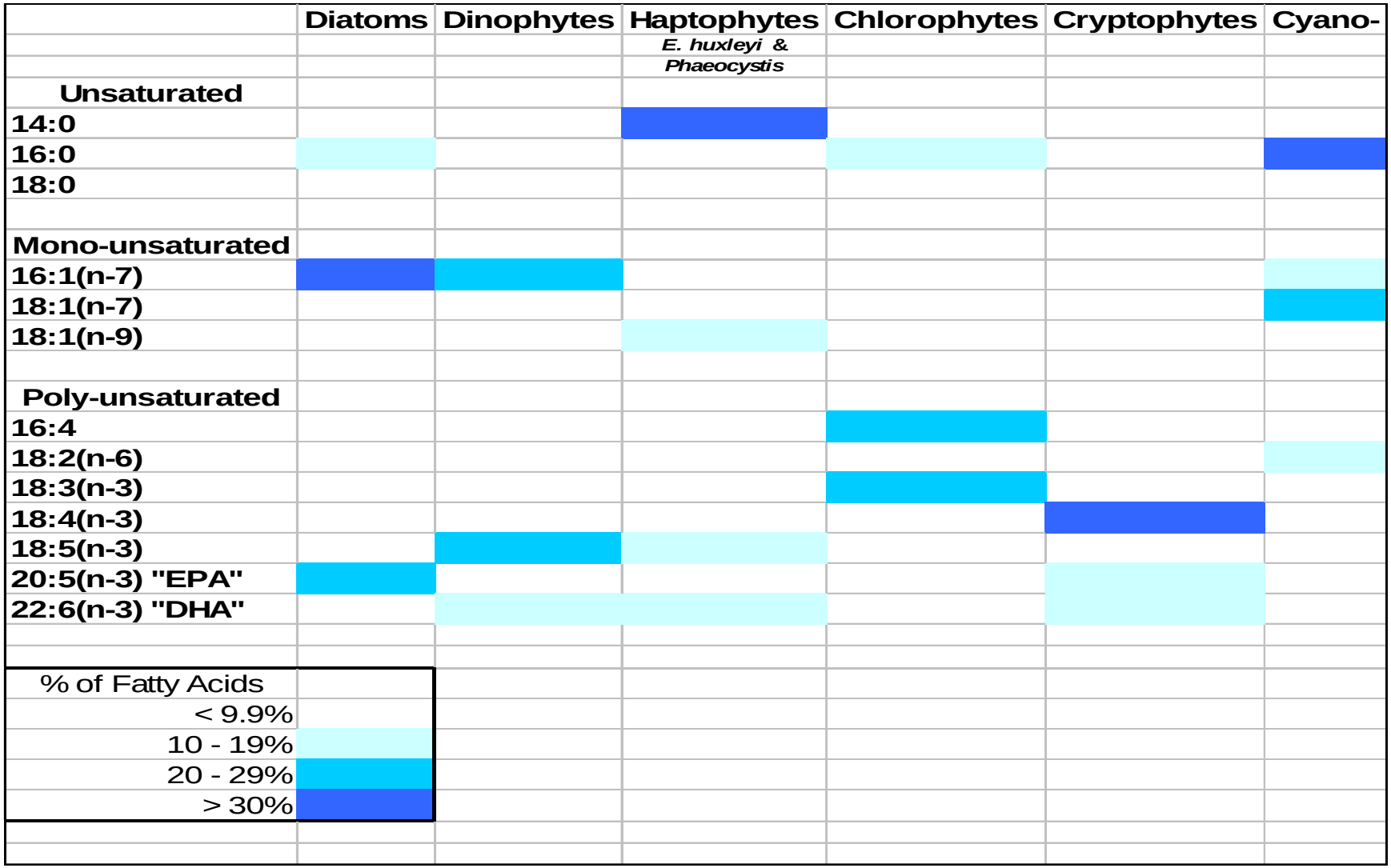


Fig. 1. Station locations for the Pribilof Project in the southeastern Bering Sea, July – August 2004. Dots indicate CalVET and CTD stations. Red dots = locations where MOCNESS tows were also taken.

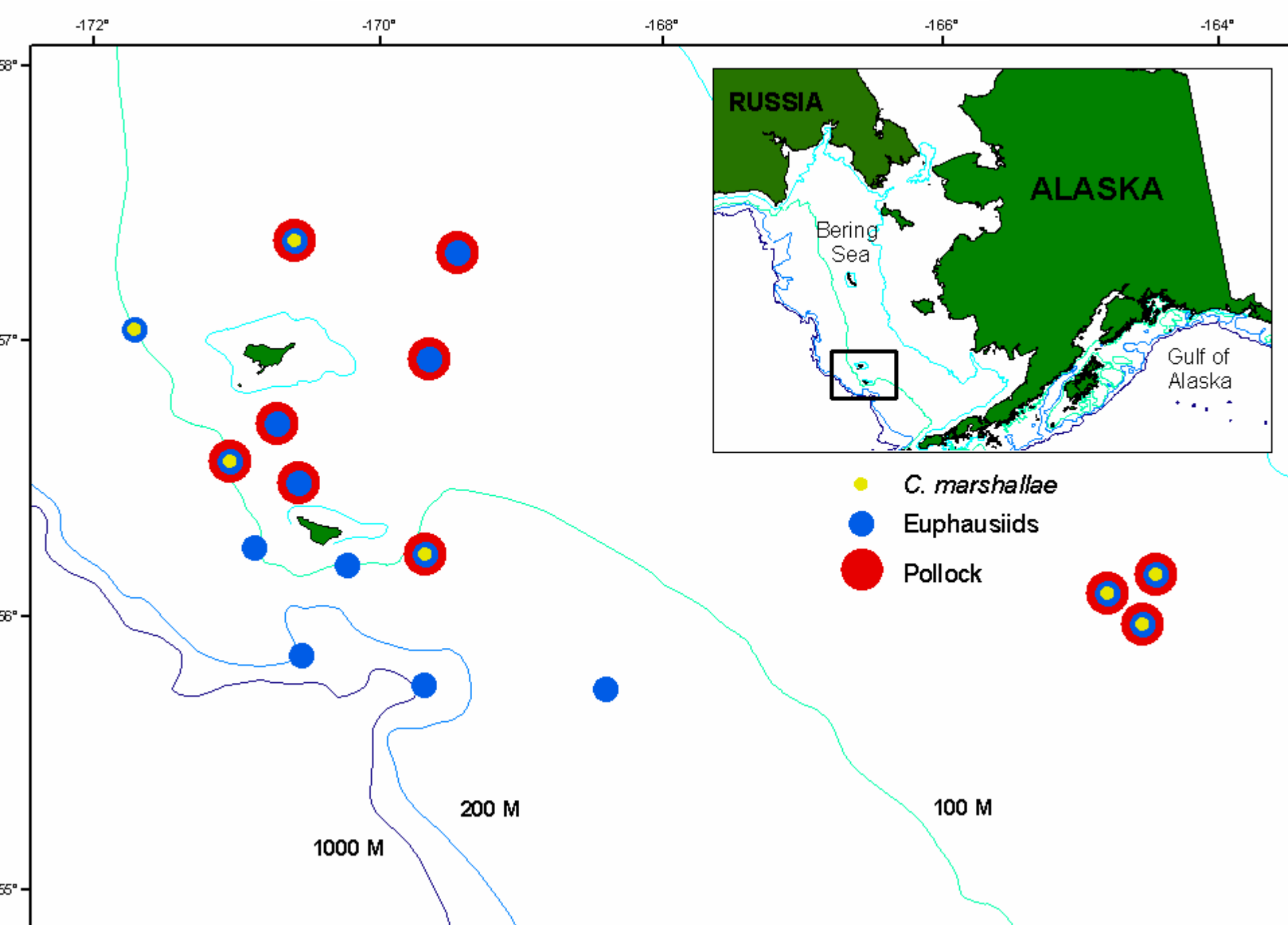
Characteristic Fatty Acids in Phytoplankton



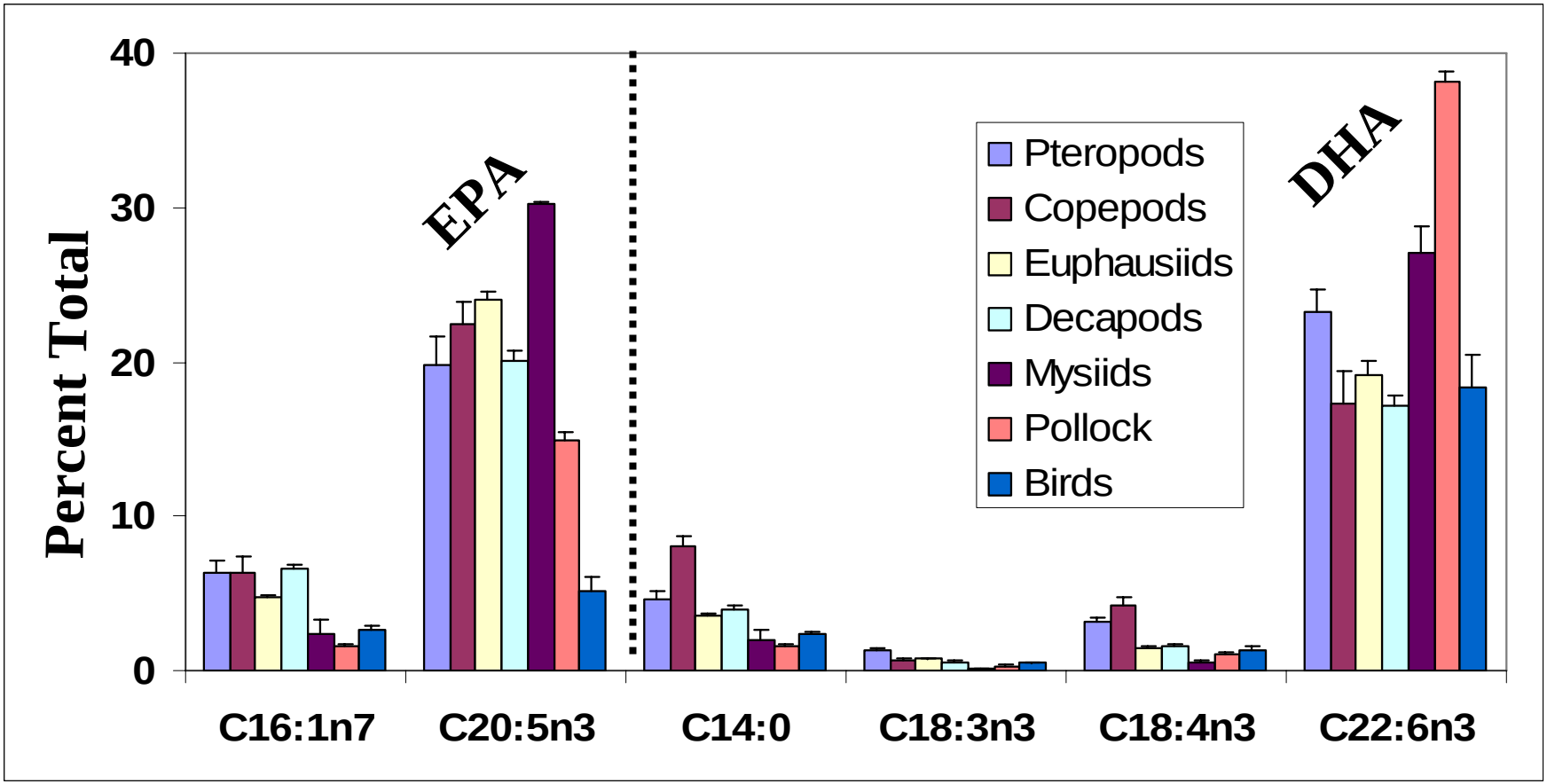
Methods

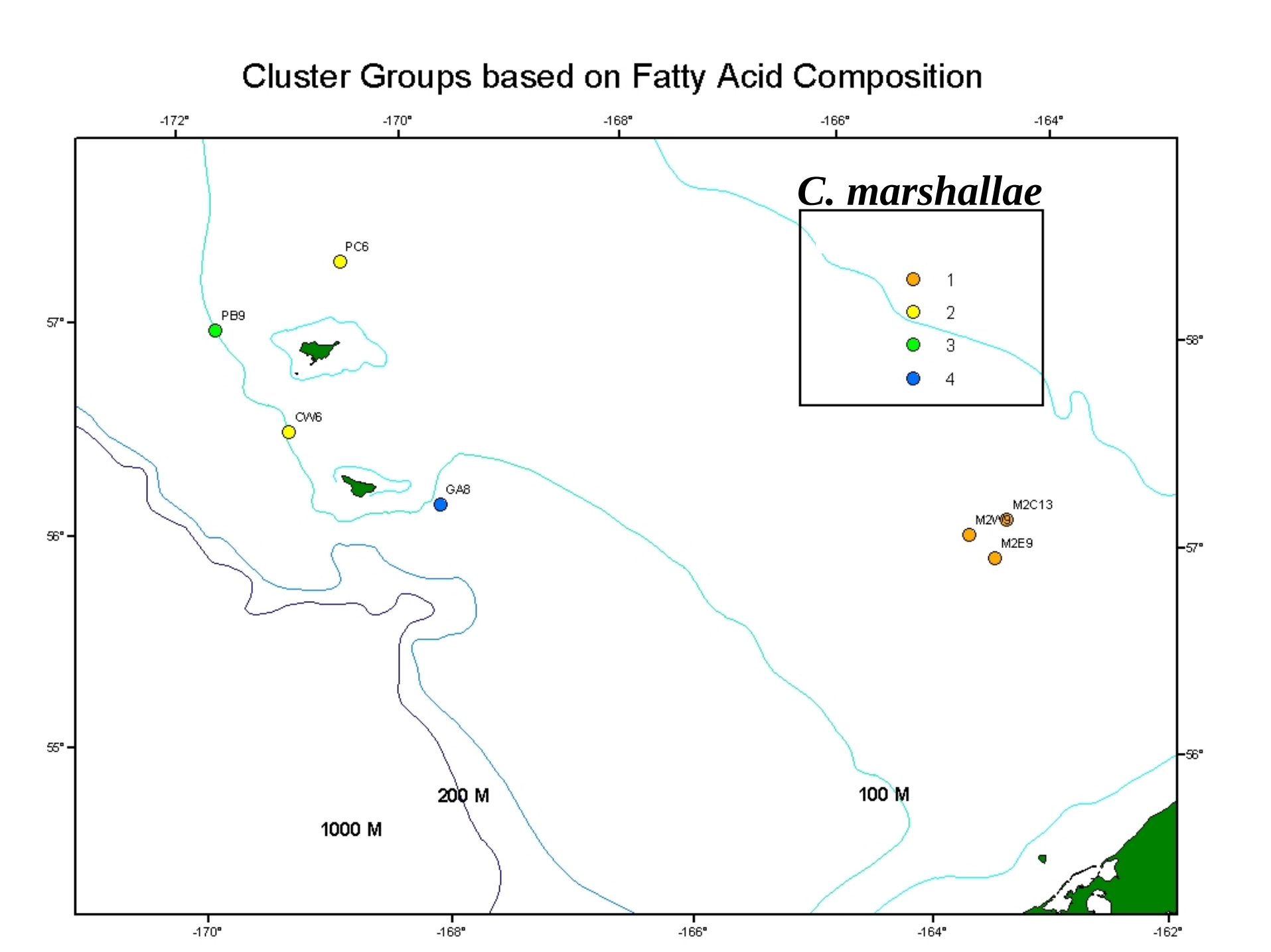
- Plankters (& age-0 pollock) captured with closed cod end MOCNESS, sorted while alive onto filters (bags), and frozen in N_2 (*l*). Birds shot, dissected onboard, tissue frozen in N_2 (*l*).
- Fatty Acid (FAME) Analysis -- Folch lipid extraction, Hilditch esterification, Varian CP Select FAME GC/MS column, commercial standards – 6 point standard curves.
- Data expressed as percent of total fatty acid, Aichison's log ratio transformation and normalization to C18:0 before multi-variate discriminate function analysis, CART, and Euclidean distance between station pairs for the same species before Ward's hierarchical cluster analysis.

Station Locations



Mean (±SE) Fatty Acid Content




Cluster Groups based on Fatty Acid Composition
C. marshallae
1
2
3
4
PC6
PB9
CW6
GA8
M2C13
M2W9
M2E9
200 M
100 M
1000 M
-172°
-170°
-168°
-166°
-164°
-162°
57°
56°
55°
58°

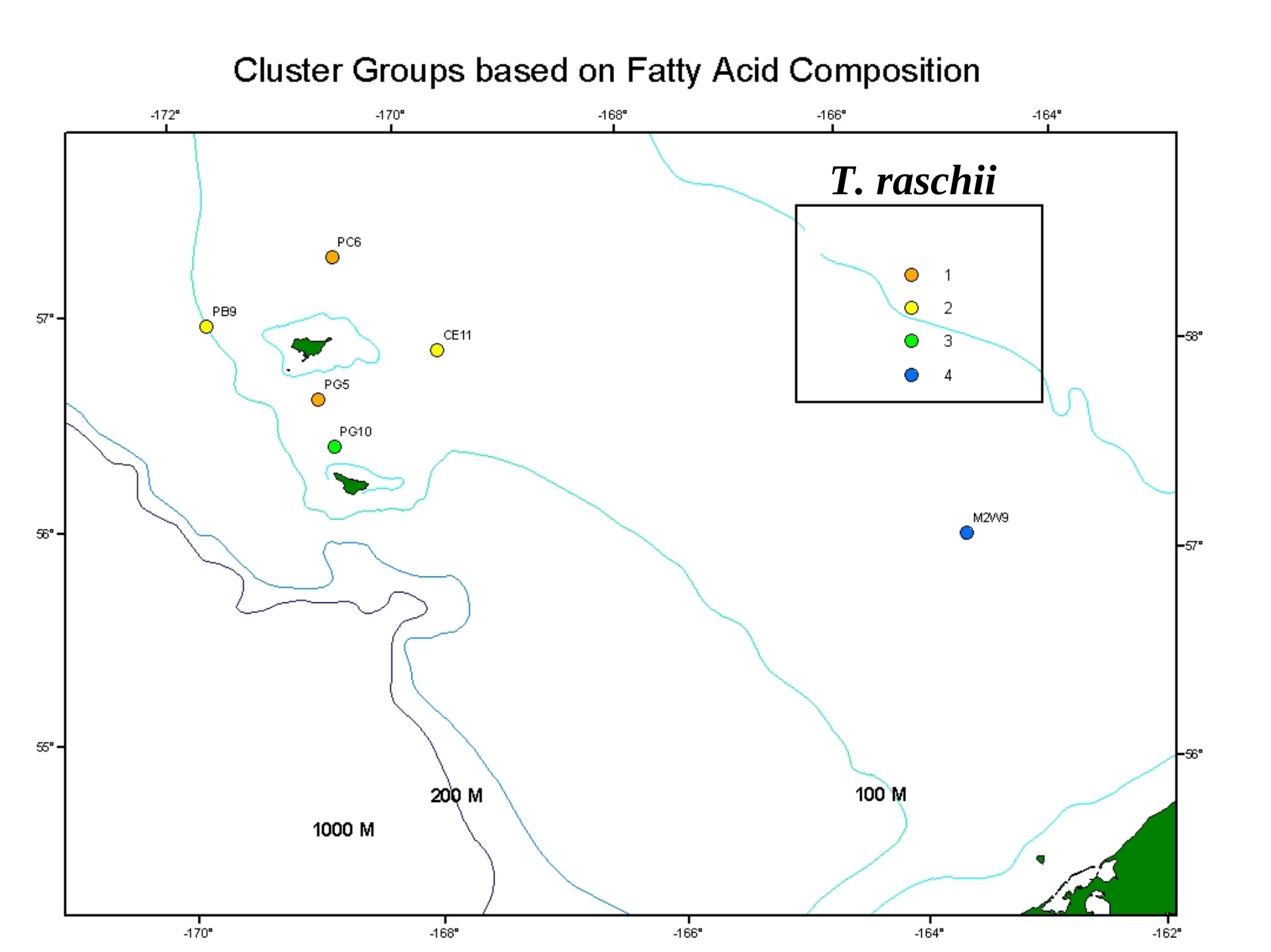
C. marshallae Fatty Acid Composition (Mean ±SE)

	New Production		Regenerated Production		
	16:1(n-7)	**20:5(n-3)**	**14:0**	**18:1(n-7)**	**22:6(n-3)**
Pribilof Is.	10.4 (±01.34)	18.4 (±0.823)	11.0 (±0.620)	0.800 (±0.030)	13.0 (±1.48)
SE Middle Shelf (M2)	11.8 (±0.276)	9.00 (±1.14)	10.5 (±0.281)	0.947 (±0.012)	6.86 (±0.268)
	Diatoms Dino- Cyano-	Diatoms Crypto-	Hapto-	Cyano-	Dino- Hapto- Crypto-

18:1(n-9c) M2 > Pribilof Is. Haptophytes

18:4(n-3) Pribilof Is. > M2 Cryptophytes

20:1(n-9) M2 > Pribilof Is.


Cluster Groups based on Fatty Acid Composition
T. raschii
1
2
3
4
PC6
PB9
CE11
PG5
PG10
MZW9
200 M
100 M
1000 M
-172°
-170°
-168°
-166°
-164°
-162°
57°
56°
55°
58°

Middle Shelf Furcilia Fatty Acid Composition (Mean ±SE)

	New Production		Regenerated Production		
	16:1(n-7)	**20:5(n-3)**	**14:0**	**18:1(n-7)**	**22:6(n-3)**
Pribilof Is.	5.37 (±0.329)	24.8 (±0.634)	3.92 (±0.264)	8.38 (±0.284)	21.6 (±0.846)
SE Middle Shelf (M2)	2.01 (±0.186)	28.5 (±0.840)	1.64 (±0.173)	4.94 (±0.237)	29.3 (±0.932)
	Diatoms Dino- Cyano-	Diatoms Crypto-	Hapto-	Cyano-	Dino- Hapto- Crypto-

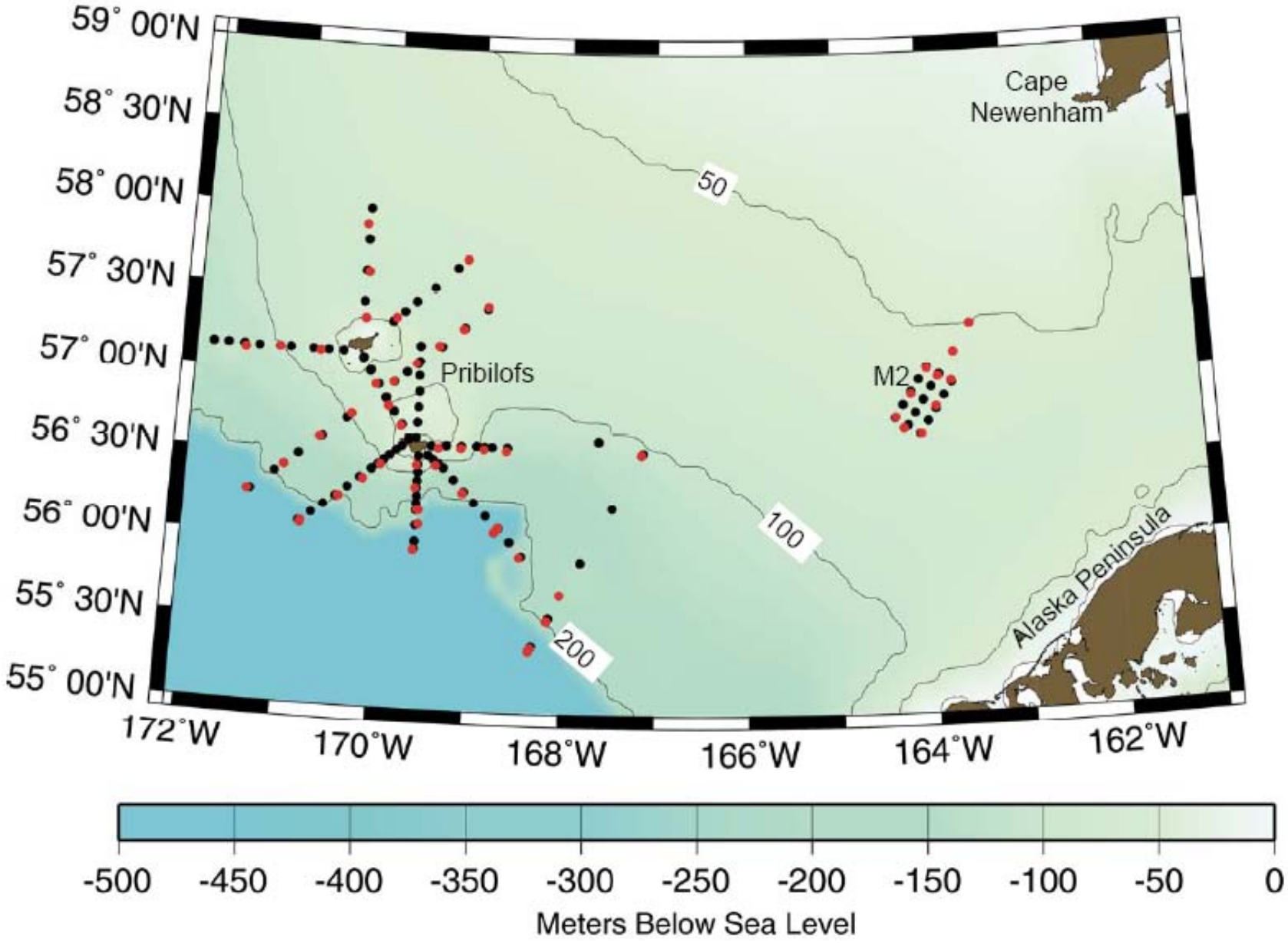


Fig. 1. Station locations for the Pribilof Project in the southeastern Bering Sea, July – August 2004. Dots indicate CalVET and CTD stations. Red dots = locations where MOCNESS tows were also taken.

Coyle et al., unpublished

Conclusions

- Fatty acids signatures for individual taxa were different between the Pribilof Islands and SE Middle Domain.
- Some, but not all, observed differences in FA supported our hypothesis. Stable isotope data may strengthen our conclusions.
- Similarities in FA among Pribilof Island stations agrees with circulation and community composition results.
- Continuation of recent conditions (low summer winds, high surface heat flux) may have altered food webs of the southeastern shelf and may impact production by higher trophic levels over the shelf.