Reading Between the Lines: Bivalve Growth Rate and Isotopic Variations Across the Barents Sea Polar Front

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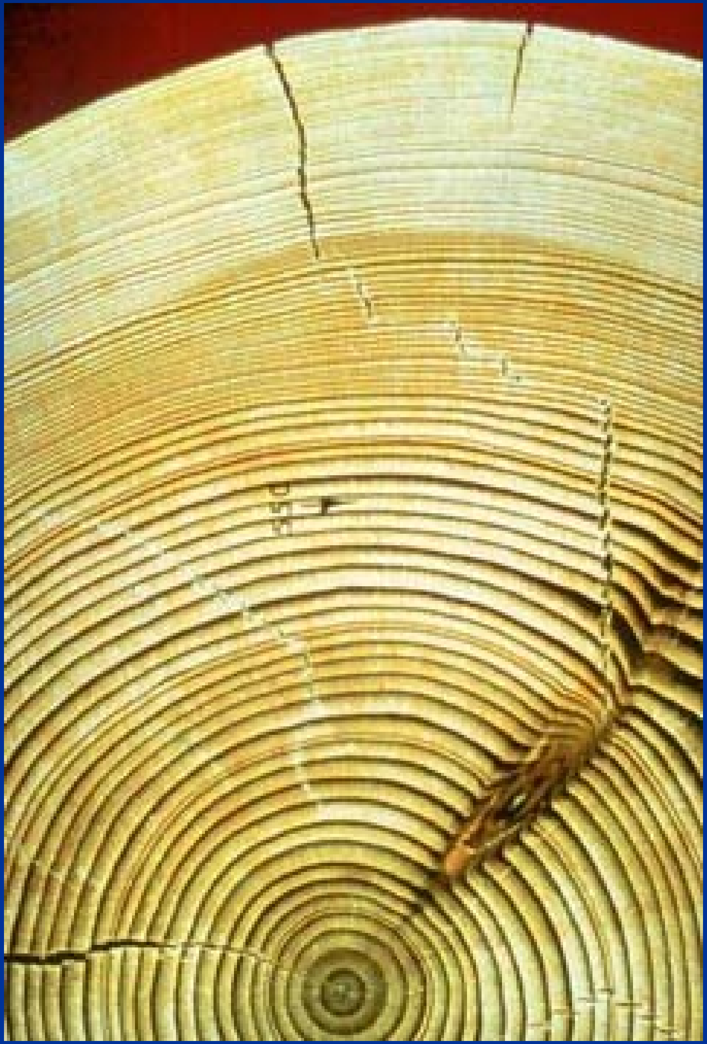
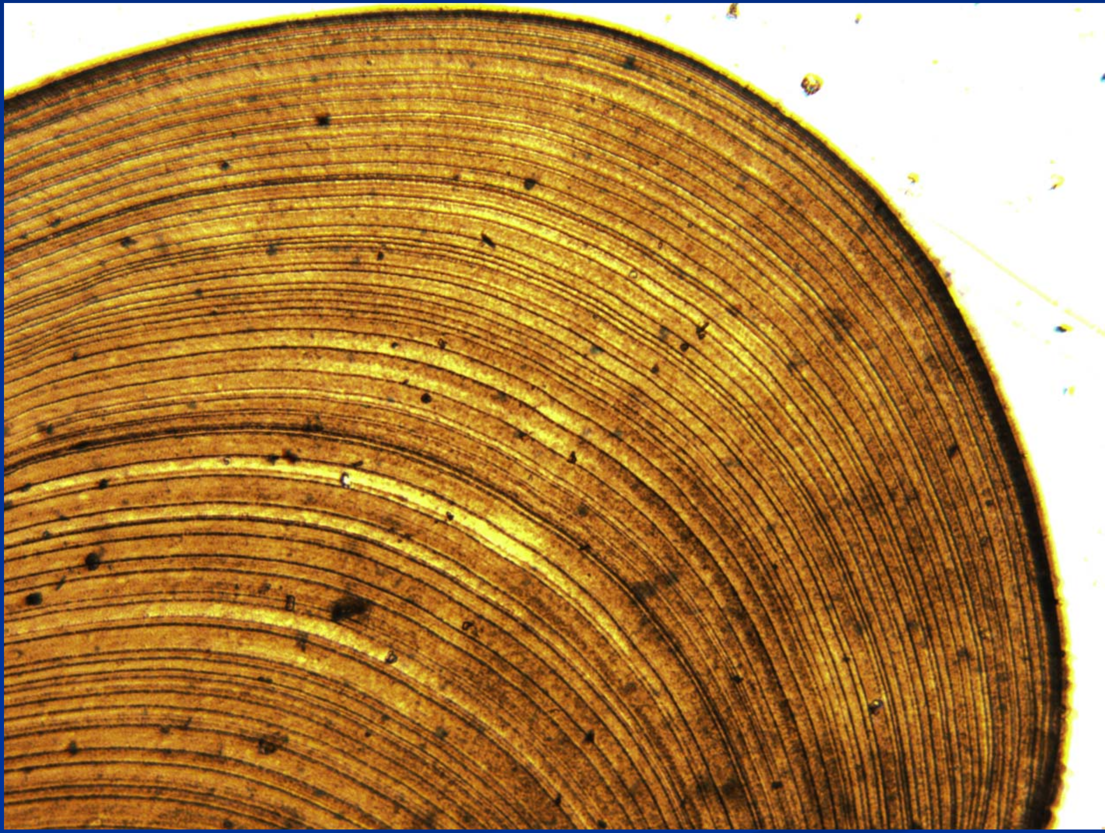
ESSAS OSM, Seattle 23 May 2011

Moving from Variability to Change

Dendrochronology



Sclerochronology



Arctica islandica (hinge cross section)

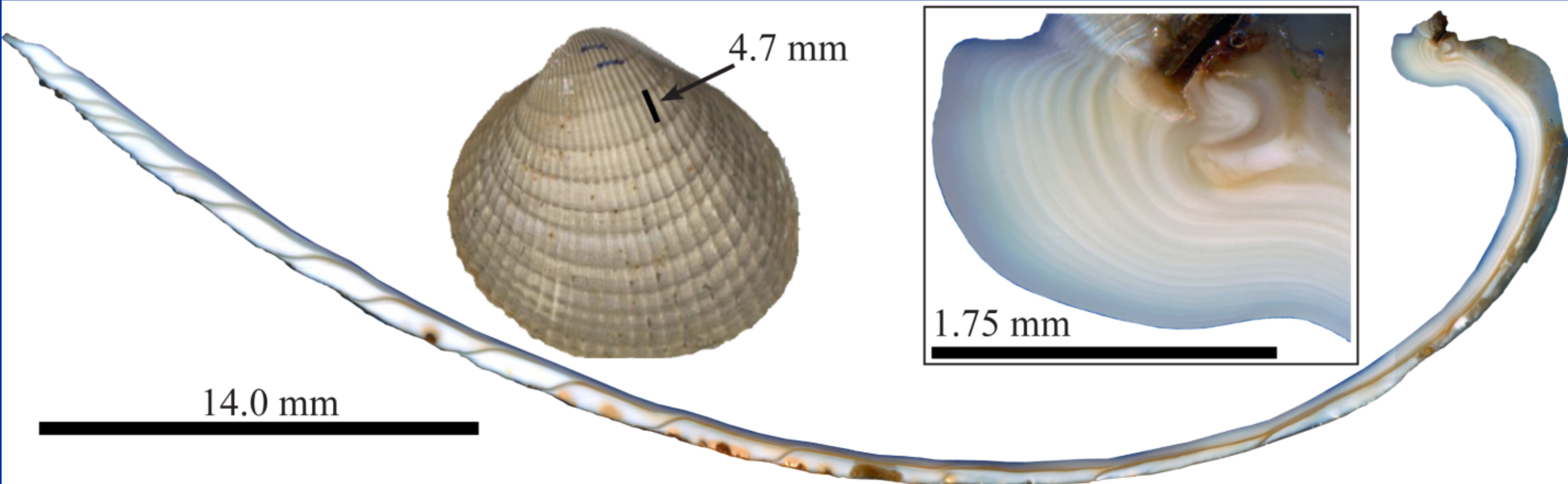
Question

What is the influence of the water mass (Polar Front) in regulating benthic ecological function in the Arctic?

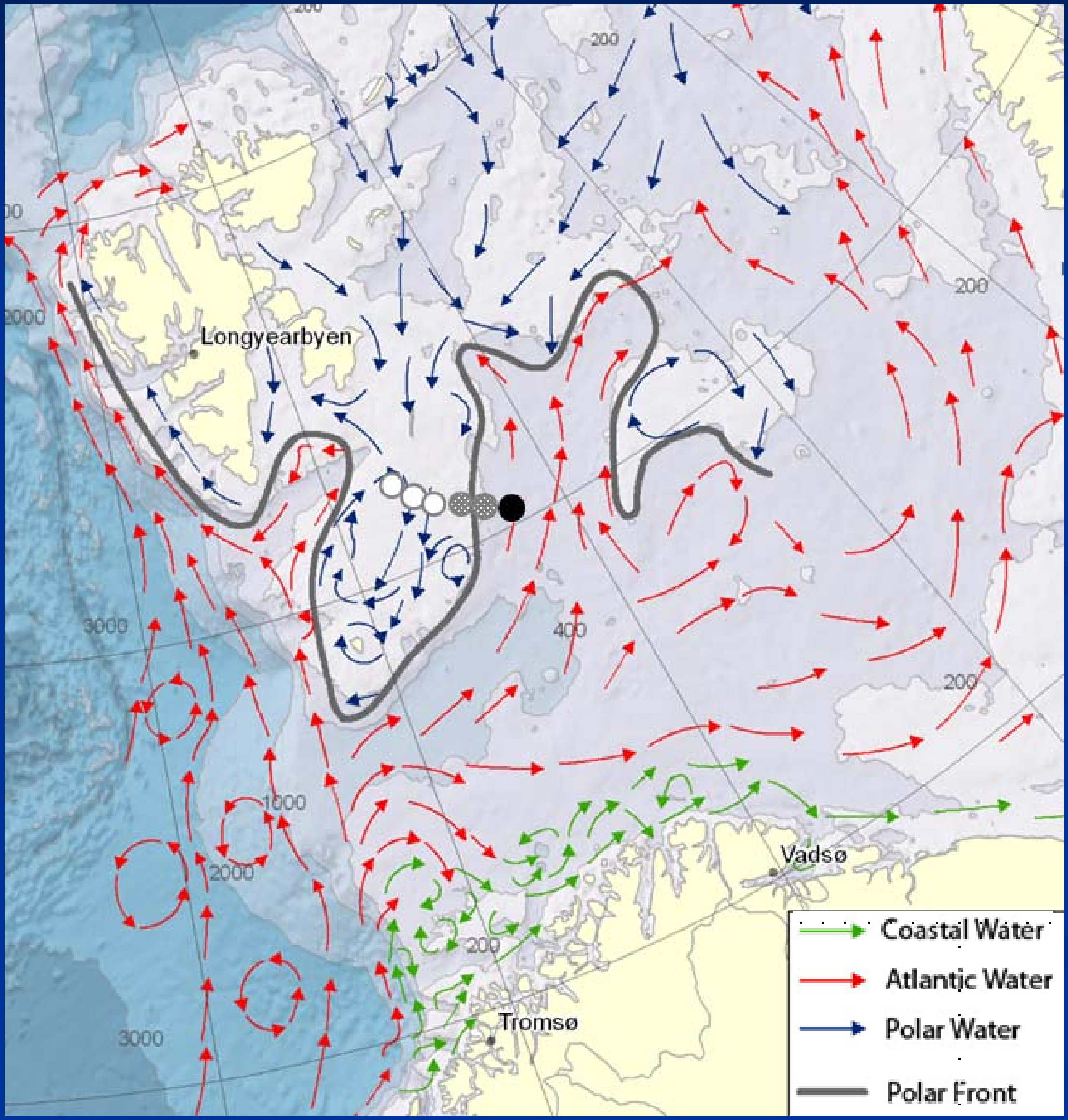
- Compare growth rates and temporal growth patterns of bivalve populations in close proximity but with different water masses
- Identify relationships between growth patterns and environmental drivers
- Assess dietary sources from tissue stable tissue isotopes

Clinocardium ciliatum

- 50 year max age
- Soft-sediment dweller
- Suspension feeder



Sampling Locations



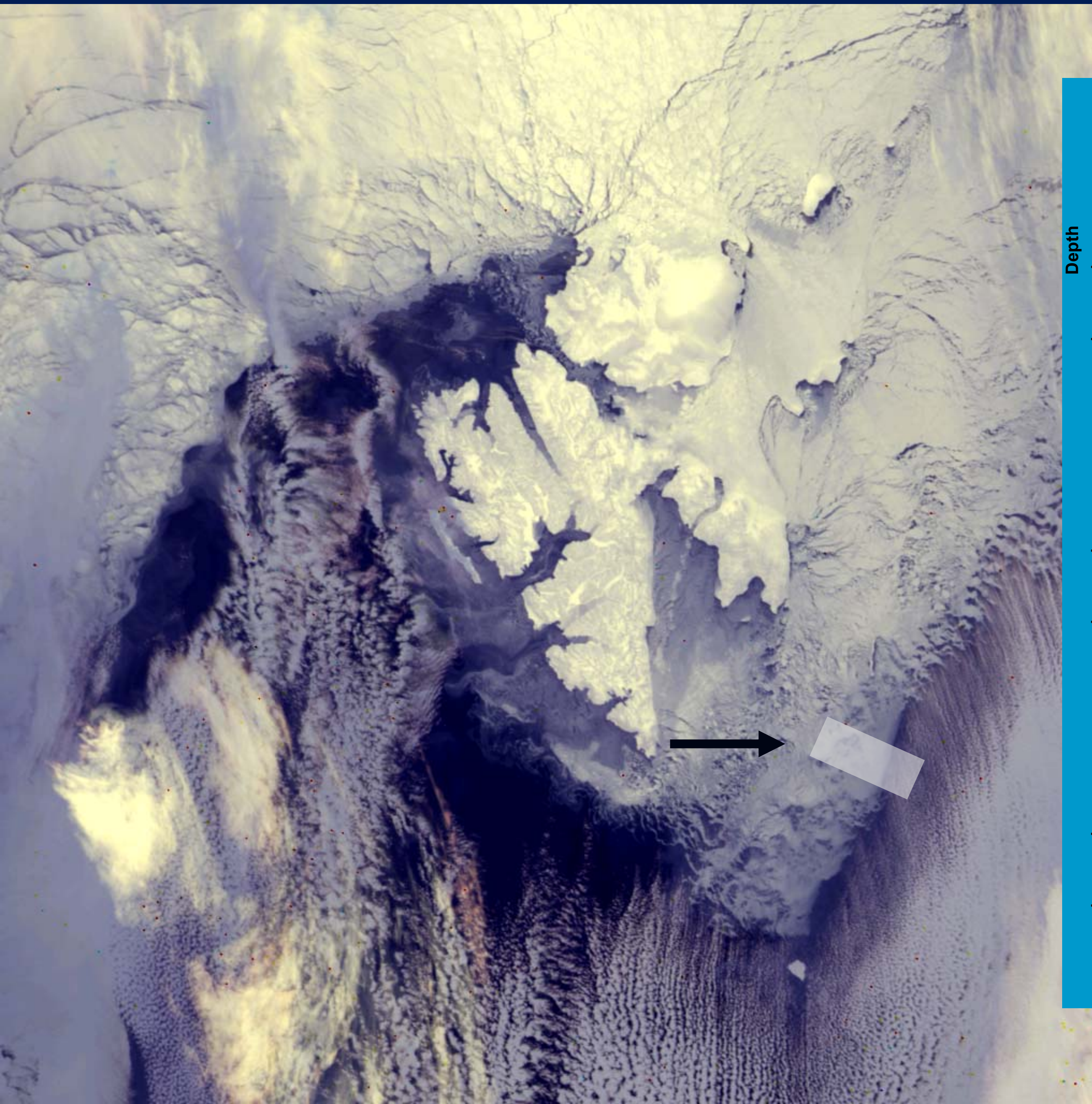
Arctic Water:
B25 – 80 m
B26 – 100 m
B27 – 120 m

Polar Front:
B28 – 140 m
B29 – 160 m

Atlantic Water:
B30 – 180 m

Sampling in May 2008, Sept. 2009
Total transect length – 70km

Physical Setting



Water Mass Properties

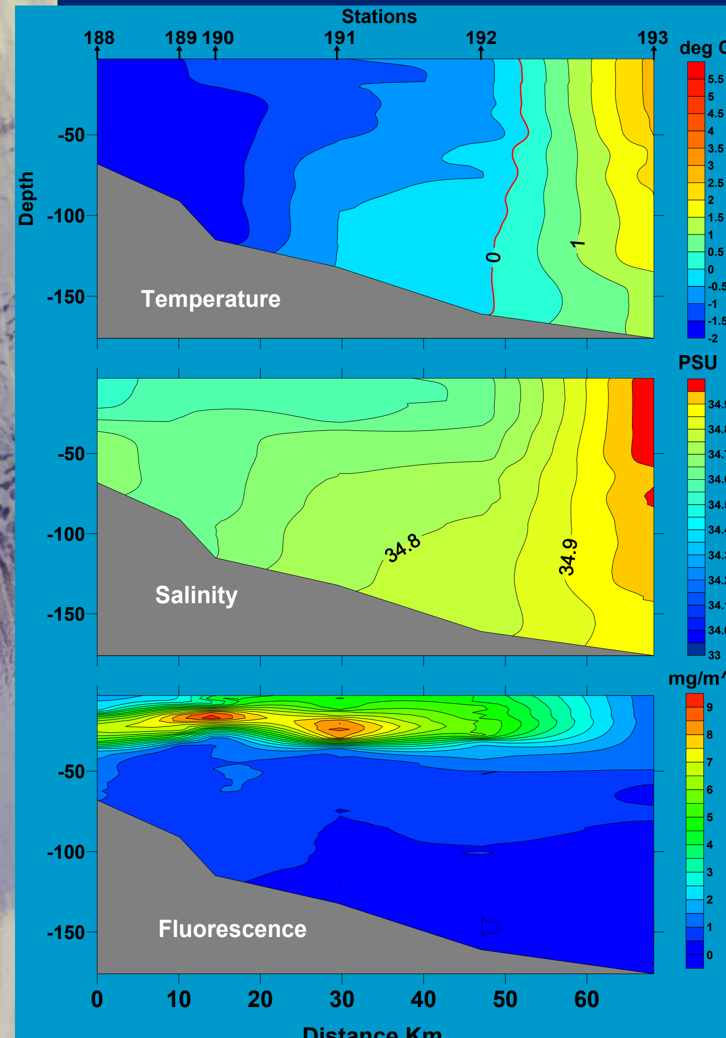
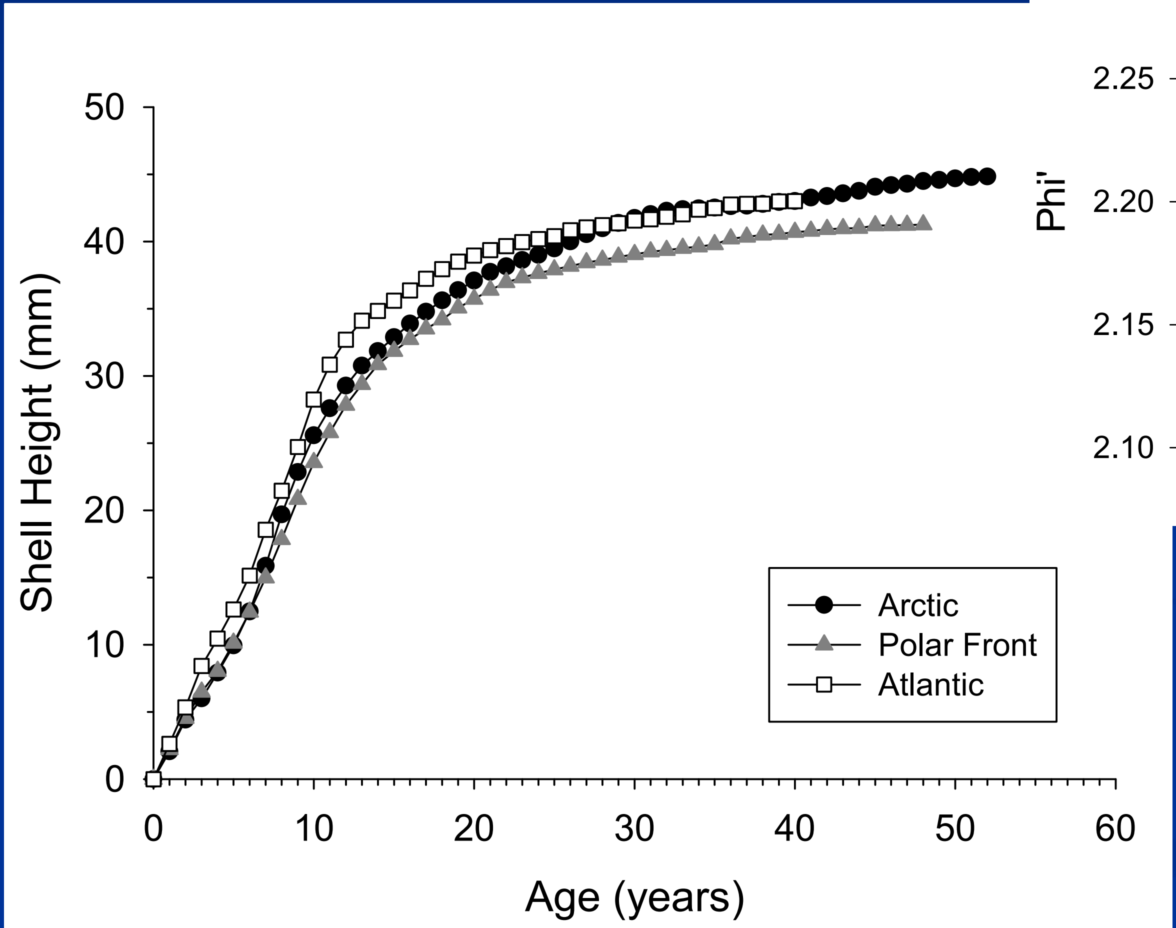
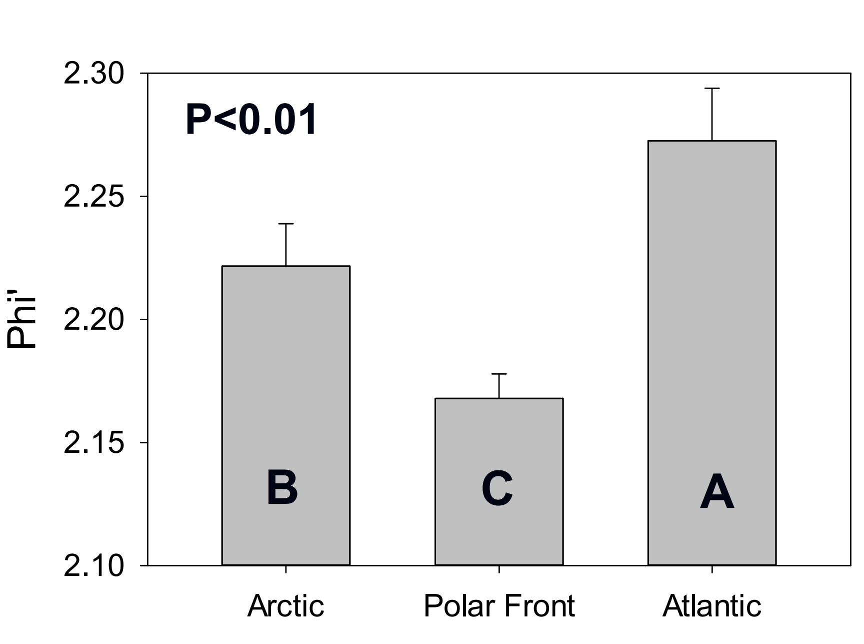


Image: Vladimir Pavlov
Norwegian Polar Institute

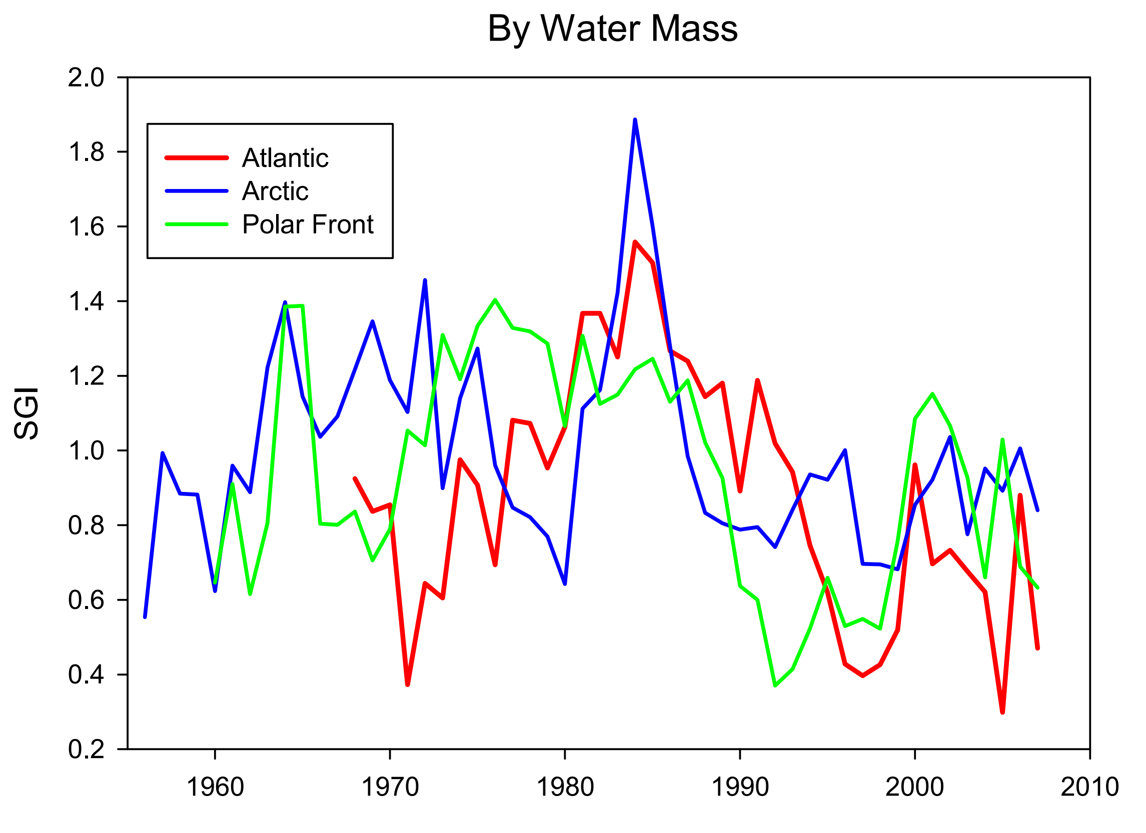
Overall Growth Rates





Growth rates LOWEST at the Polar Front

Interannual Growth Patterns (SGI)

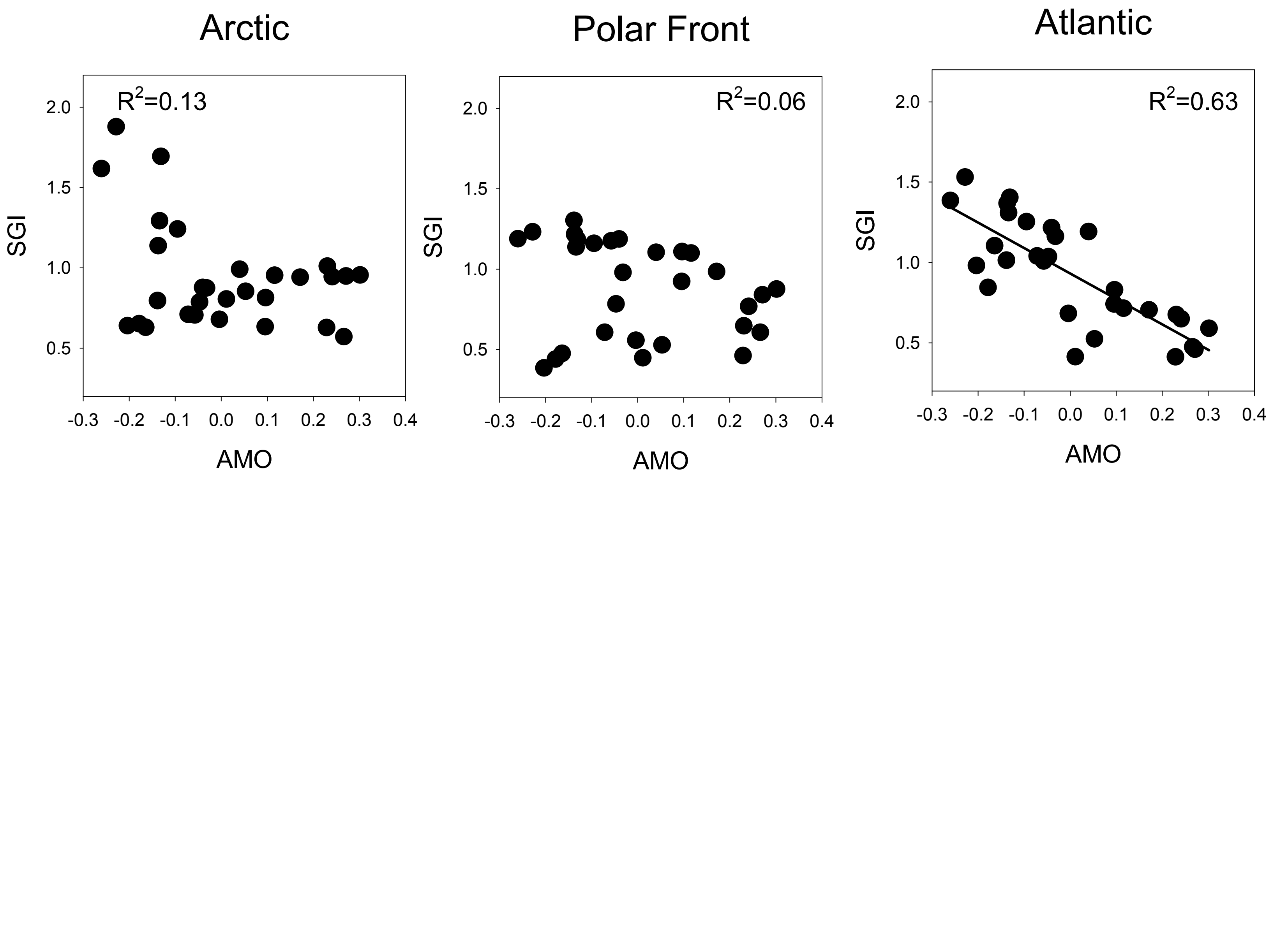


Similarity of SGI pattern: Arctic→Atlantic→Polar Front

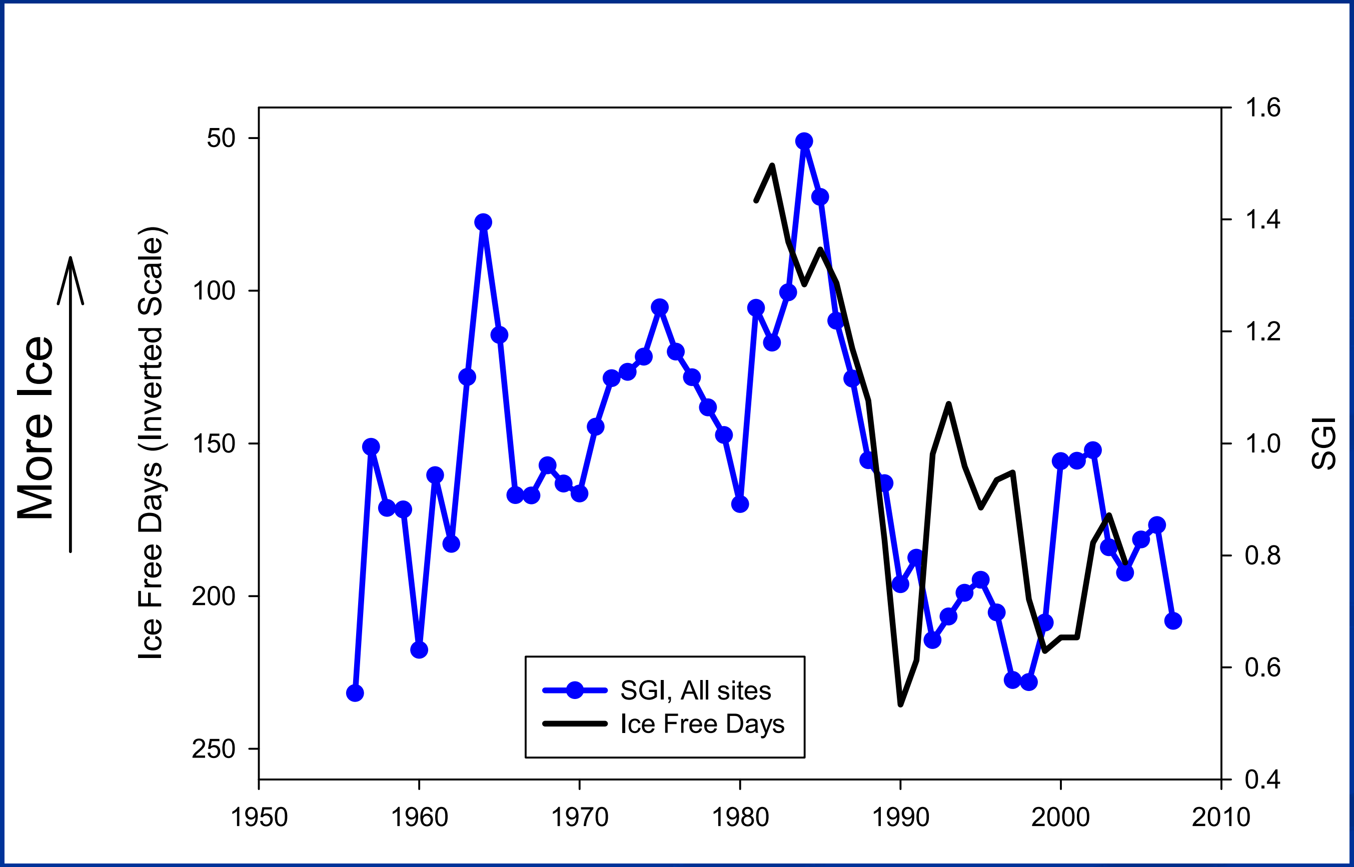
Environmental Drivers (time series)

- Atmospheric (large-scale)
  - NAO, AO, AMO, Arctic Climatic Regime Index (ACRI)
- Oceanographic Time Series
  - Sea Temp. (Kola Time Series, West Spitsbergen Current), Sea Ice Cover
- Meteorological Variables
  - Air Temp., Pressure, Precipitation

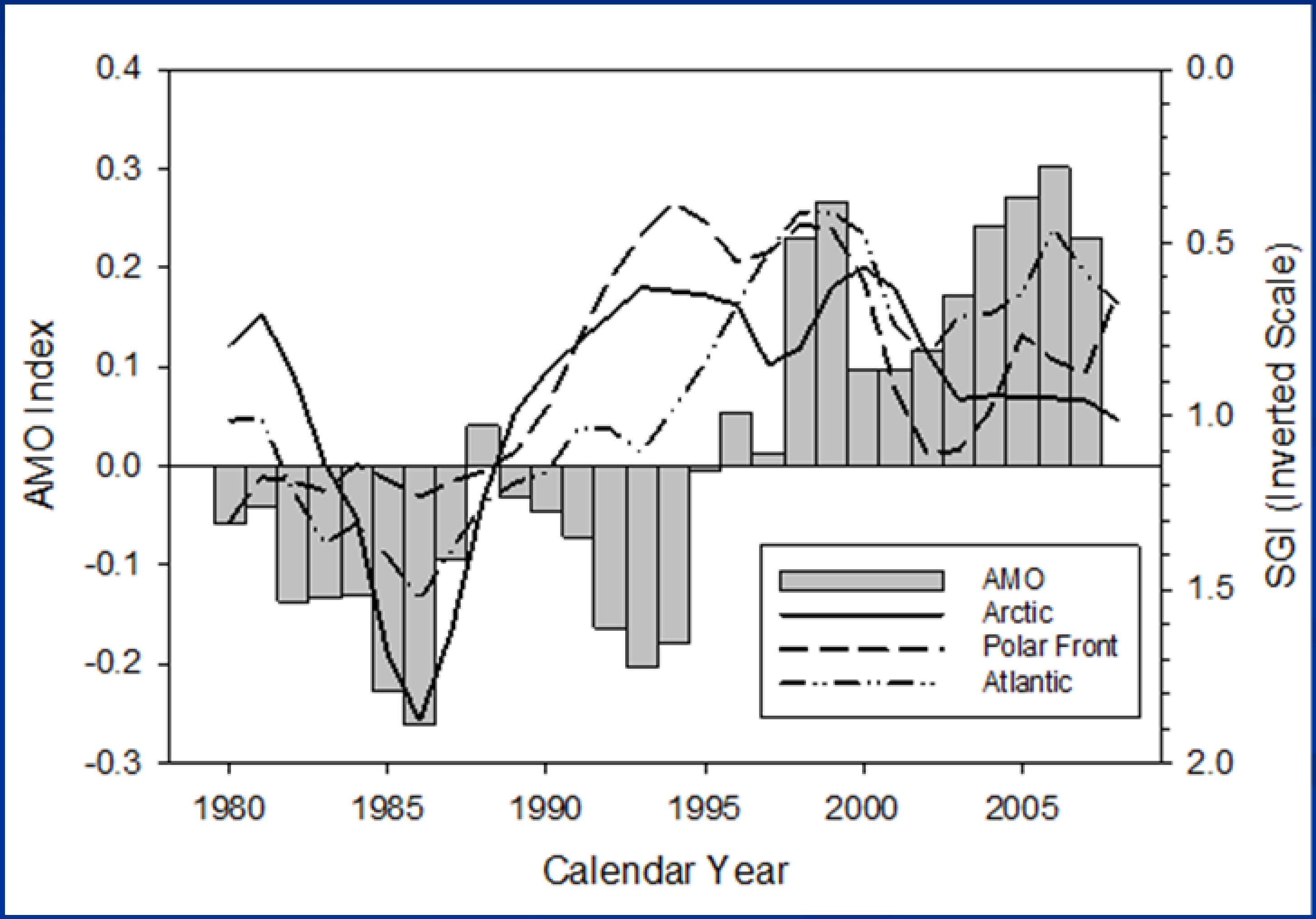
Environmental Relationships



Sea Ice Influence on Growth



AMO Influence on Growth



Statistical Model

- GLM, Multiple regression (Forward Stepwise)

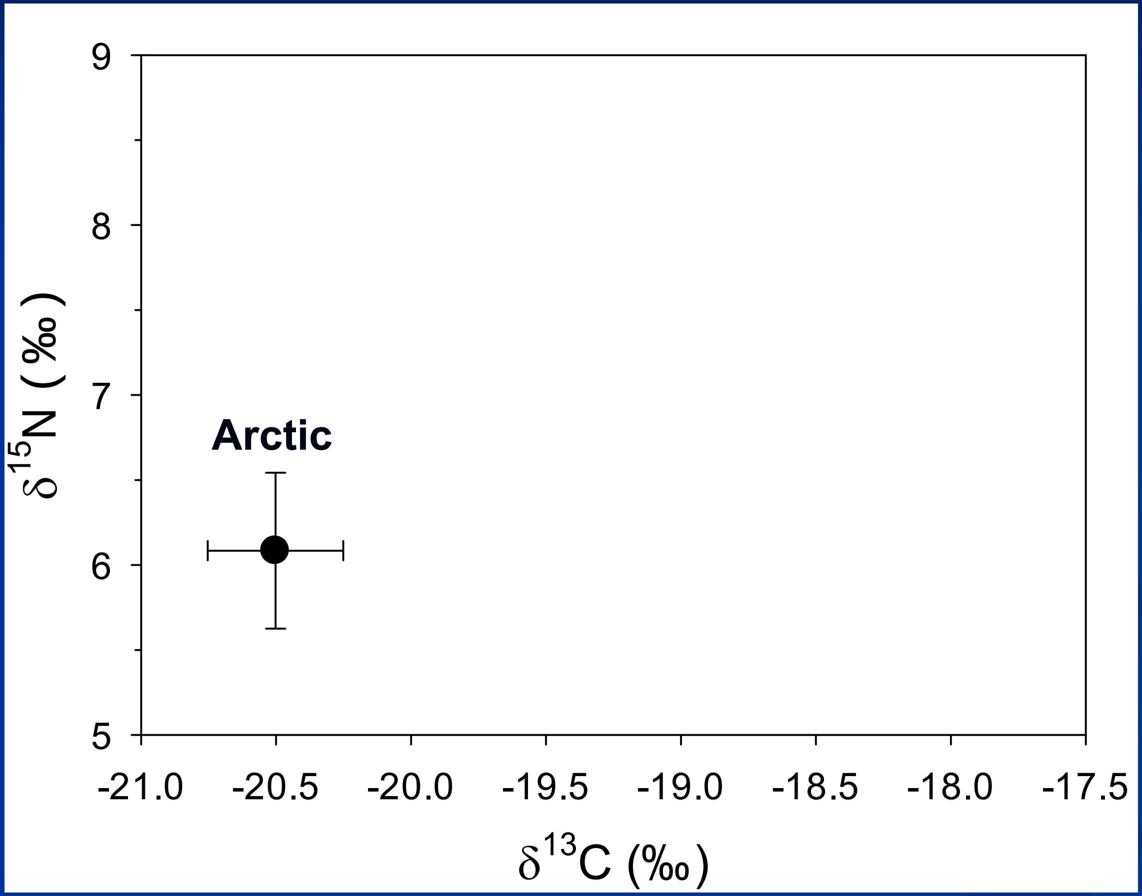
	Arctic	Polar Front	Atlantic
Ice Free Days	- - *	- -	- -
AMO	-		- - - *
NAO		- - *	
Kola Sea Temp.		-	
Bjørnøya Precip.		- -	- - -
Total Variability Explained (R^2)	0.35	0.57	0.64

Stable Isotopes in Food Web Studies

- Consumers are enriched in heavy Nitrogen isotopes compared to their diet.
  - $^{15}N/^{14}N$ generally increases (3–4 ‰) with trophic position.
- For Carbon, there is little frattionation with trophic position.
  - $^{13}C/^{12}C$ can thus be used to trace carbon sources in systems where two isotopically distinct carbon sources are present

"YOU ARE WHAT YOU EAT!"

Clinocardium Tissue Stable Isotope

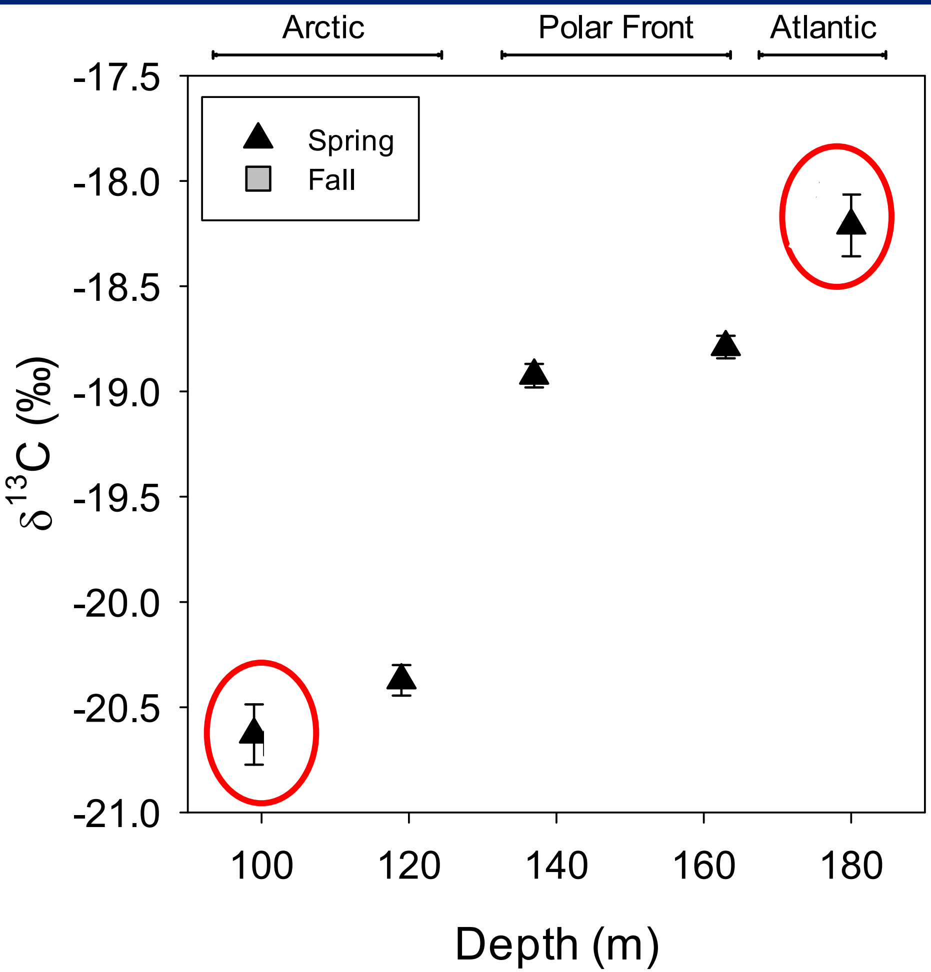


2.2 ‰

P<0.01

2.3 ‰

Seasonality in Food Supply



Food source most seasonally variable at Polar Front

Trophic level seasonally variable at Polar Front and Atlantic

Food Sources for Bivalve Growth

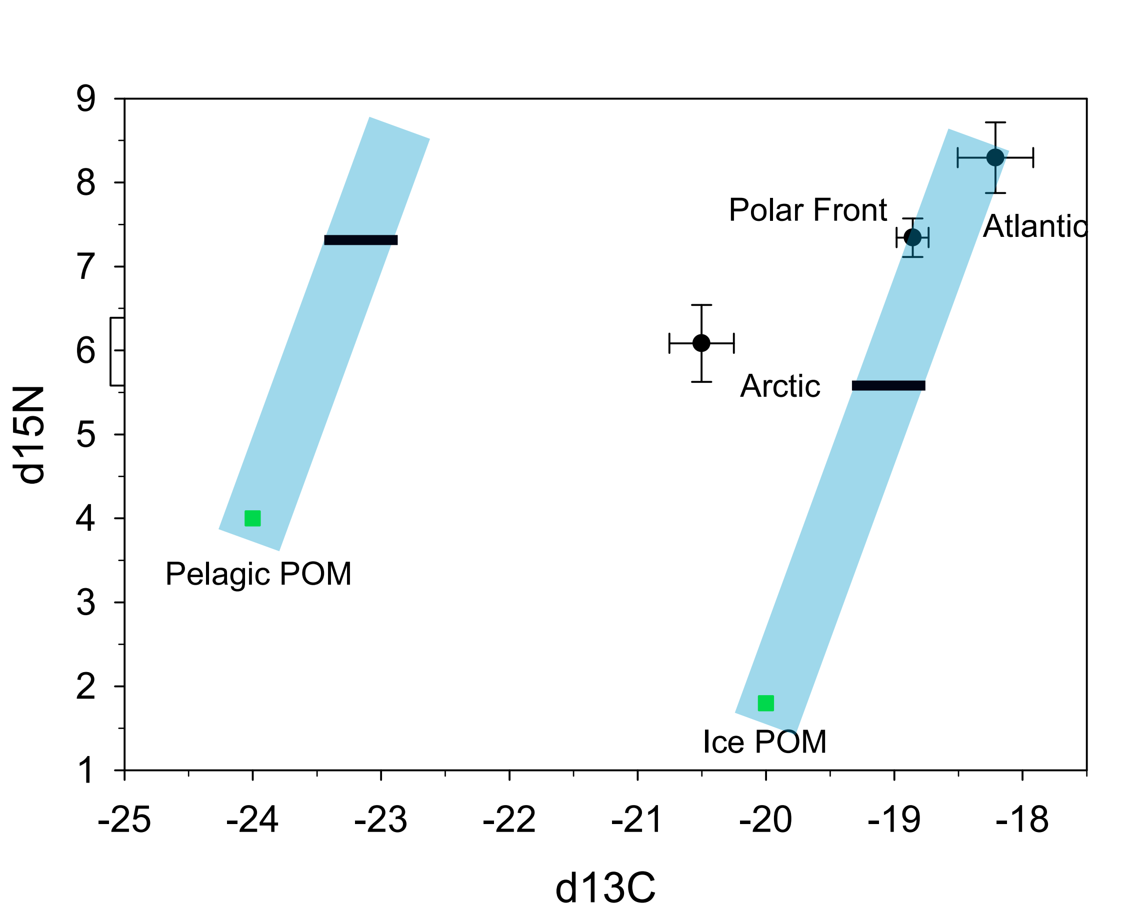
- Phytoplankton
- $\delta^{13}C$ -24, $\delta^{15}N$ 4.0

Ice Algae

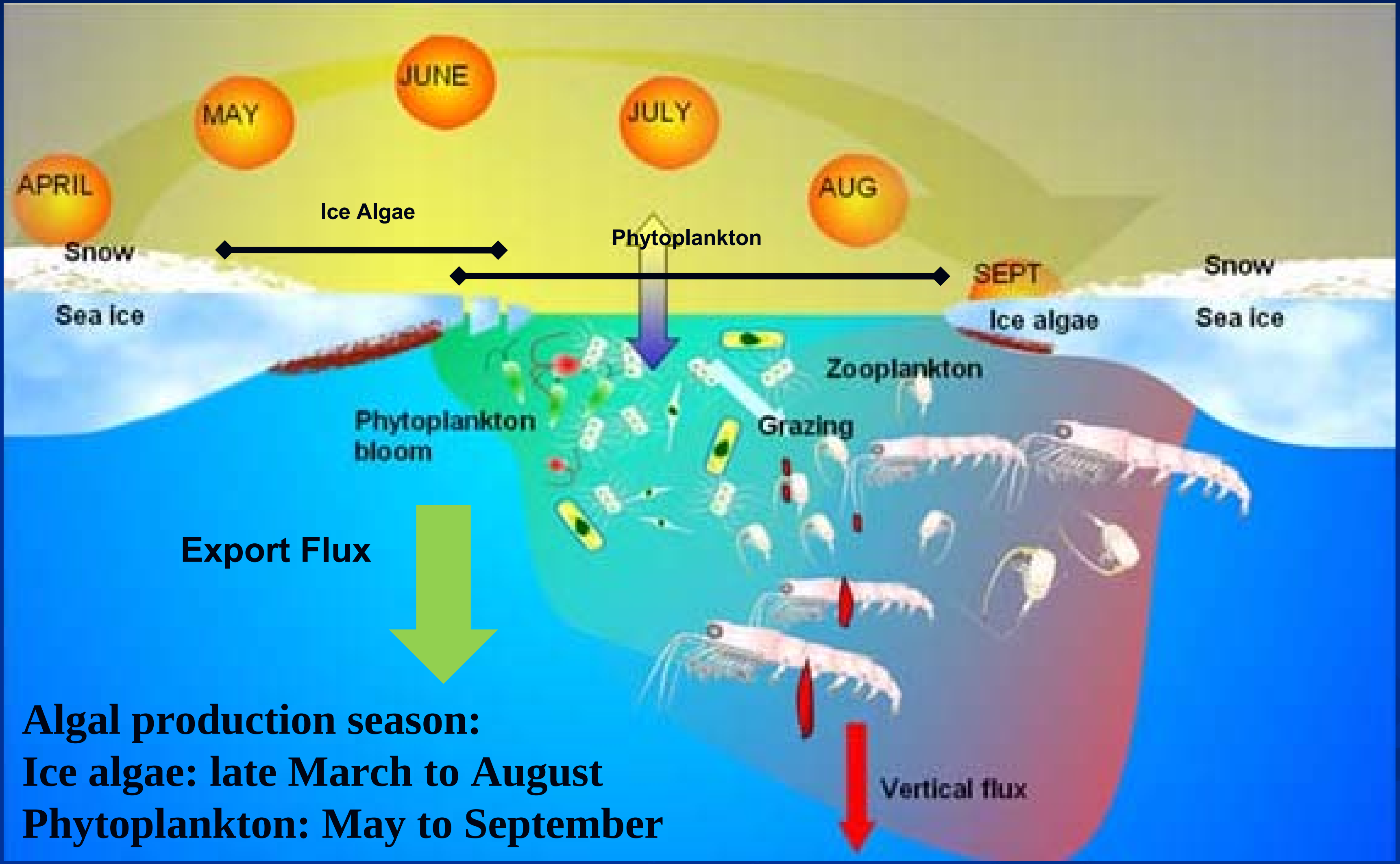
$\delta^{13}C$ -20, $\delta^{15}N$ 1.8

- Søreide et al. 2006
- Tamelander et al. 2006

Trophic Step:
$\delta^{13}C$ = 0.6 ‰
$\delta^{15}N$ = 3.4 ‰



The Arctic Annual Cycle



www.nfh.uit.no/arctos/

Summary

- Overall growth rates are highest in the Atlantic domain and lowest at the Polar Front in the Barents Sea
- Interannual growth patterns reflect variation in cyclic oscillatory climatic modes and sea ice
  - Atlantic populations appear more sensitive to environmental variability
  - Periods with colder conditions were associated with enhanced growth
- Tissue stable isotope signatures reveal different food sources and seasonality patterns among water masses
- The combined response to sea ice and the isotopic signatures suggests that ice algae might be a key food source to this species
- Continued sea ice attenuation as predicted by climate models could lead to poorer performance of benthos