Is the Bering Sea Stuck in a Warm Phase?

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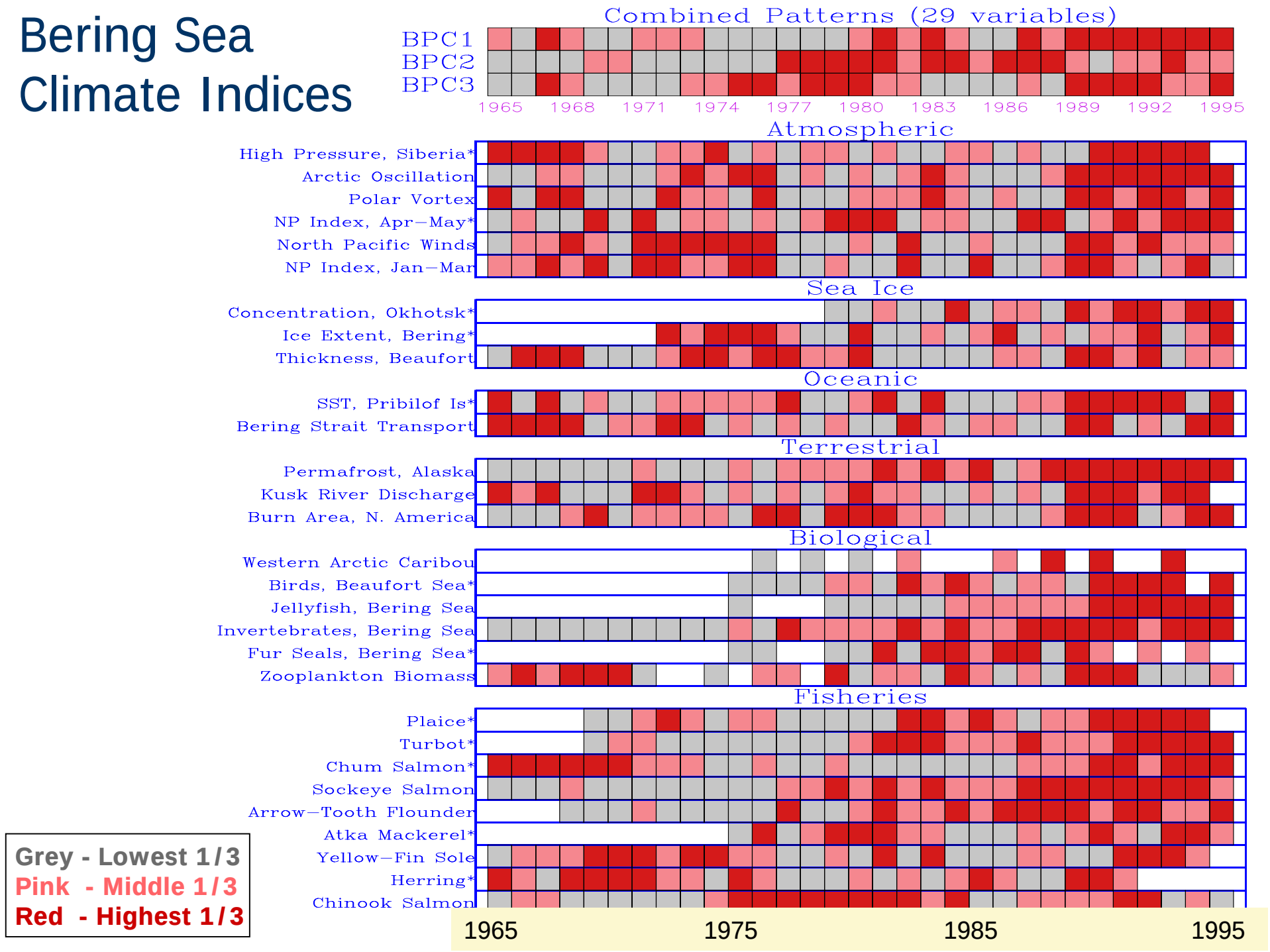
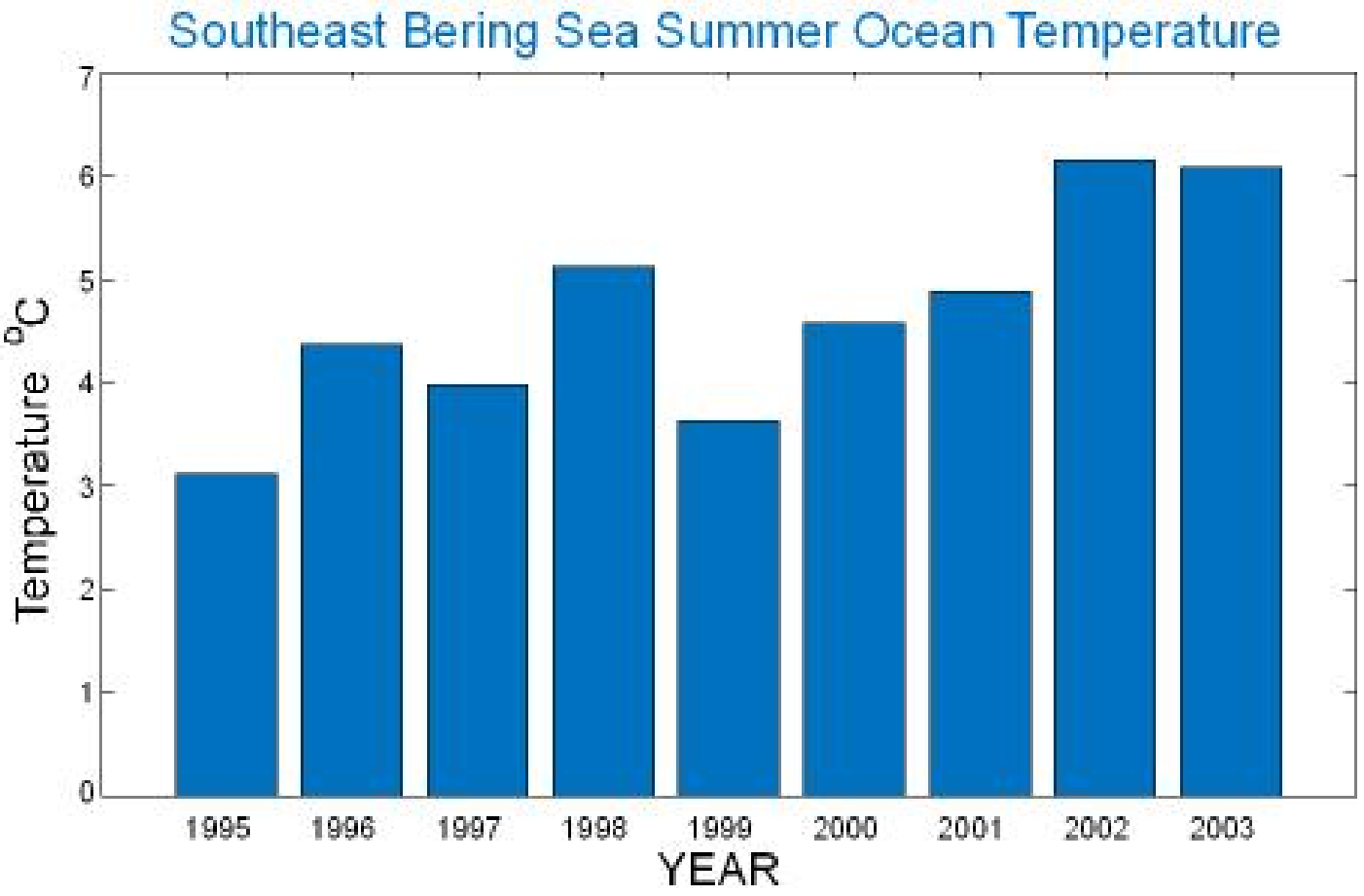
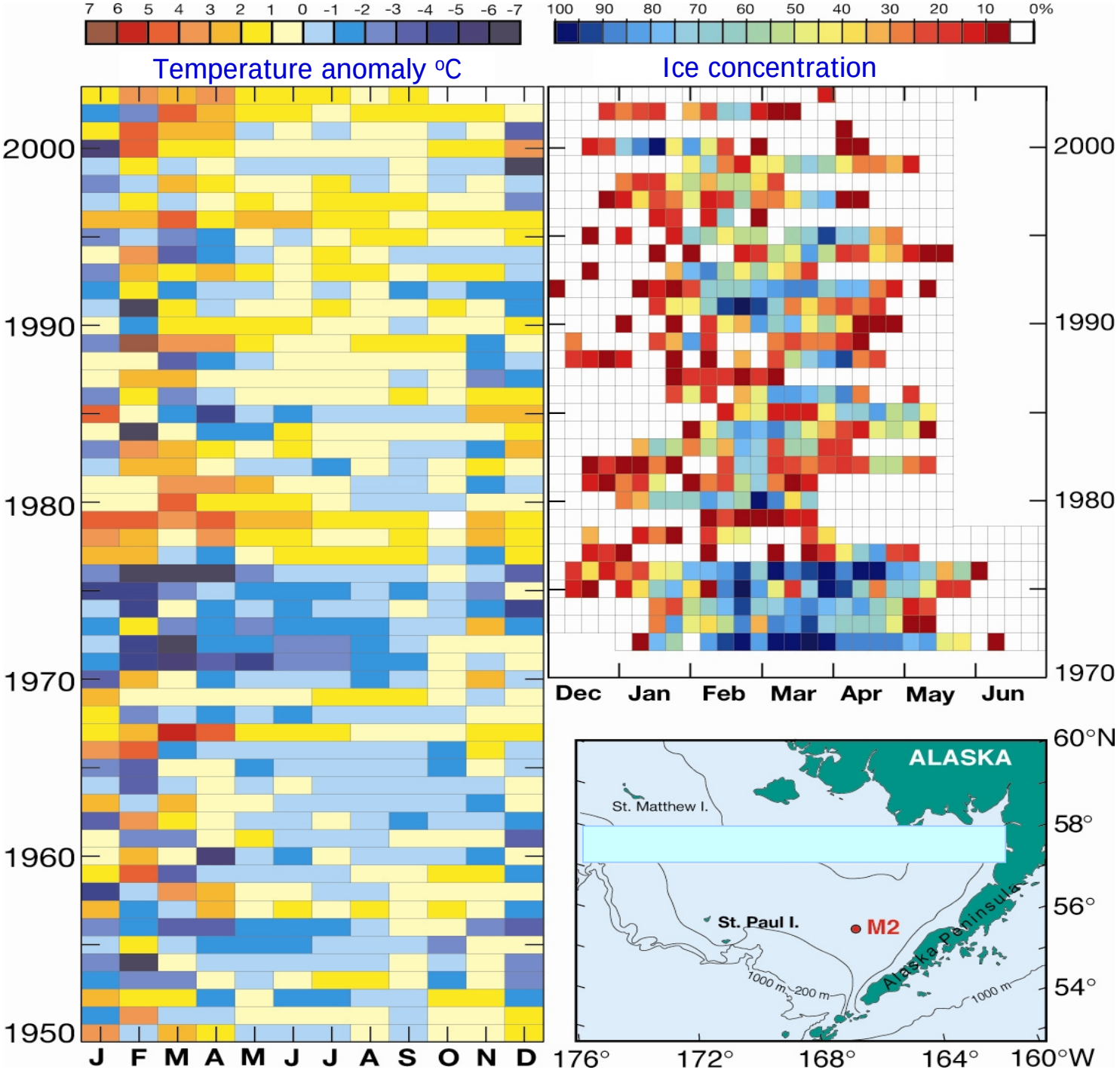
Bering Sea Climate Indices



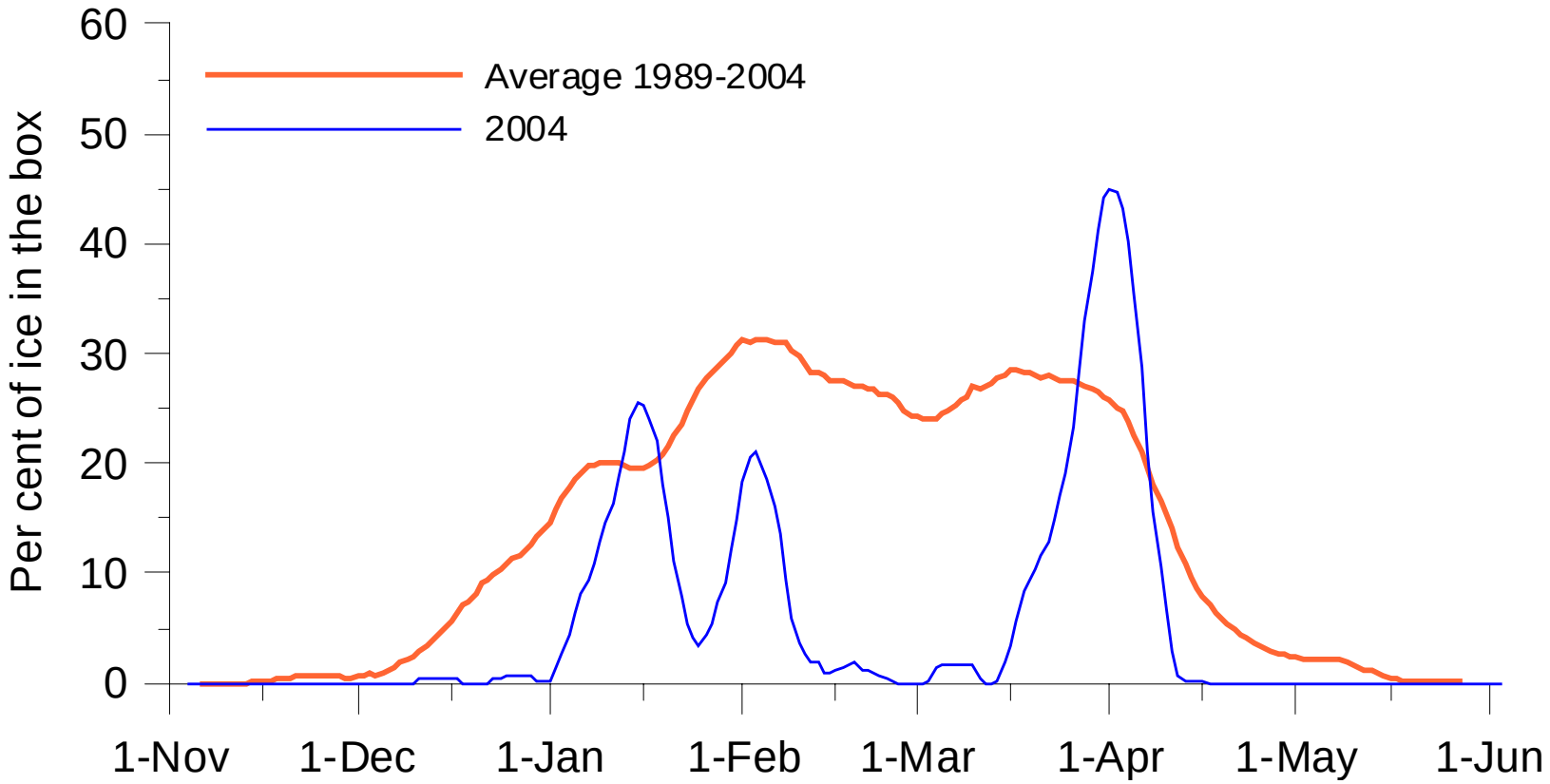
Grey - Lowest 1/3
Pink - Middle 1/3
Red - Highest 1/3

Heat Content of Southeast Bering Sea



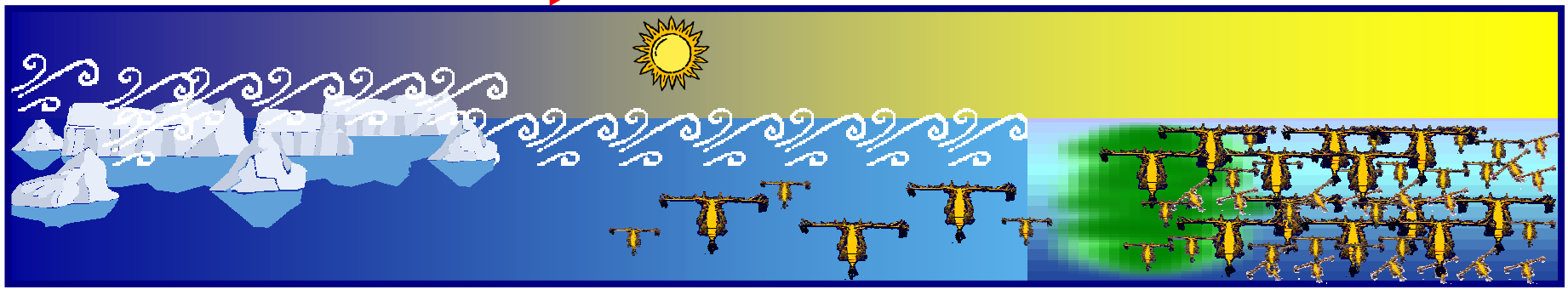

7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7
Temperature anomaly °C
100 90 80 70 60 50 40 30 20 10 0%
Ice concentration
2000
1990
1980
1970
1960
1950
J F M A M J J A S O N D
Dec Jan Feb Mar Apr May Jun
ALASKA
St. Matthew I.
St. Paul I.
M2
Alaska Peninsula
1000 m
200 m
1000 m
60°N
58°
56°
54°
176° 172° 168° 164° 160°W

Percentage of ice cover during winter 2004 for 56-58°N, 163-165°W

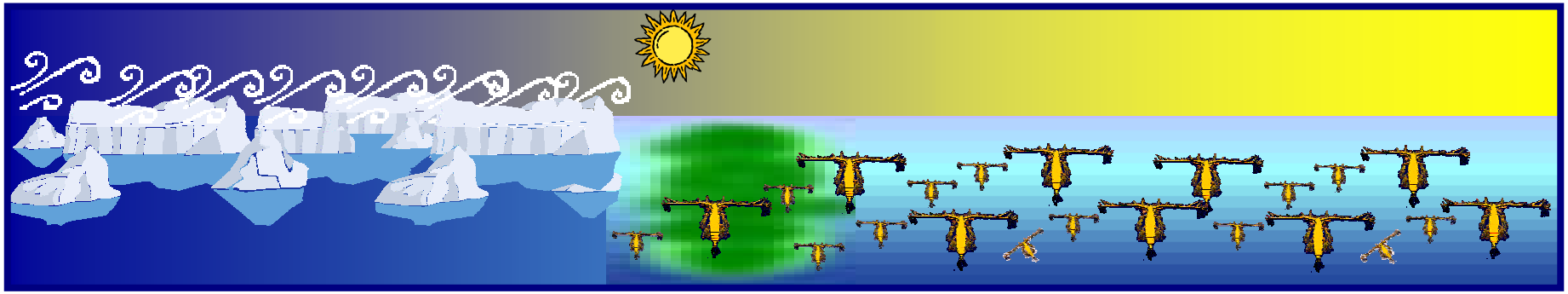


Ice, Bloom, and Copepods

Early Ice Retreat → **Late Bloom, Warm Water – Large Copepod Biomass**

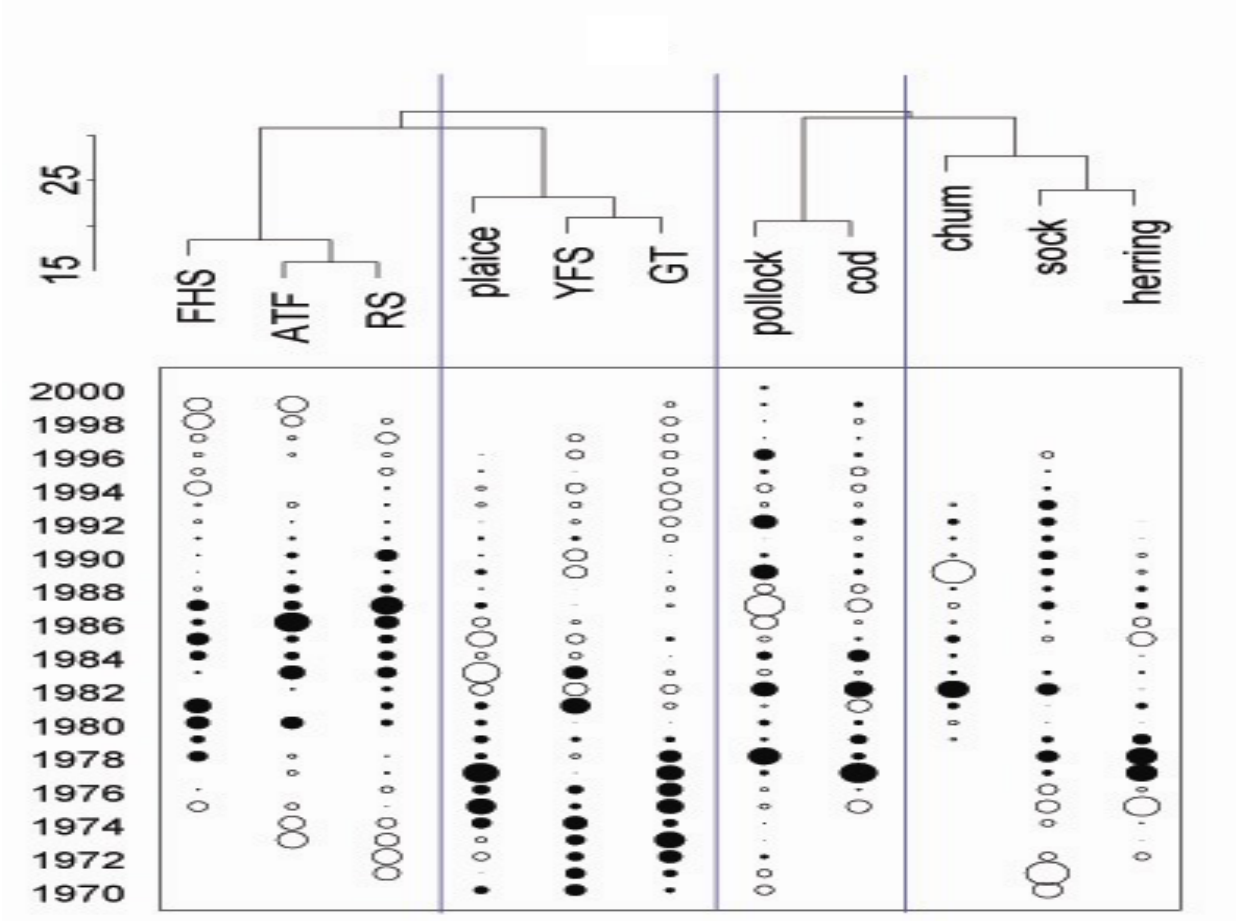


Late Ice Retreat → **Early Bloom, Cold Water – Small Copepod Biomass**

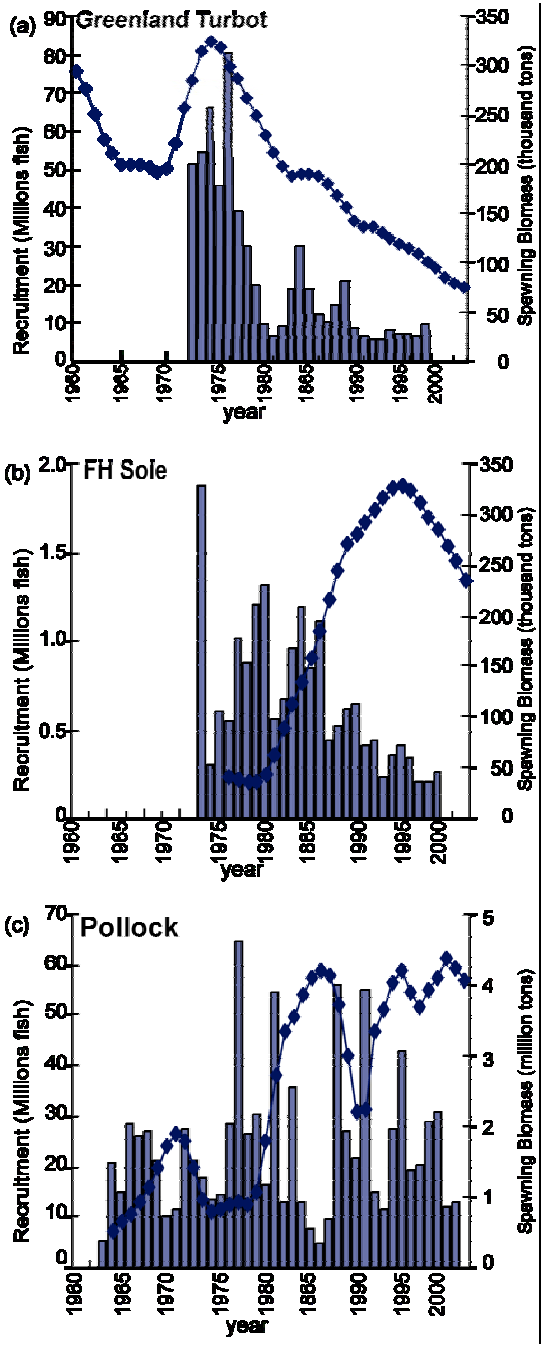


February March April May June

Dendogram of Bering Sea stocks based on hierarchical cluster analysis of pairwise Manhatten distances among standardized recruitment

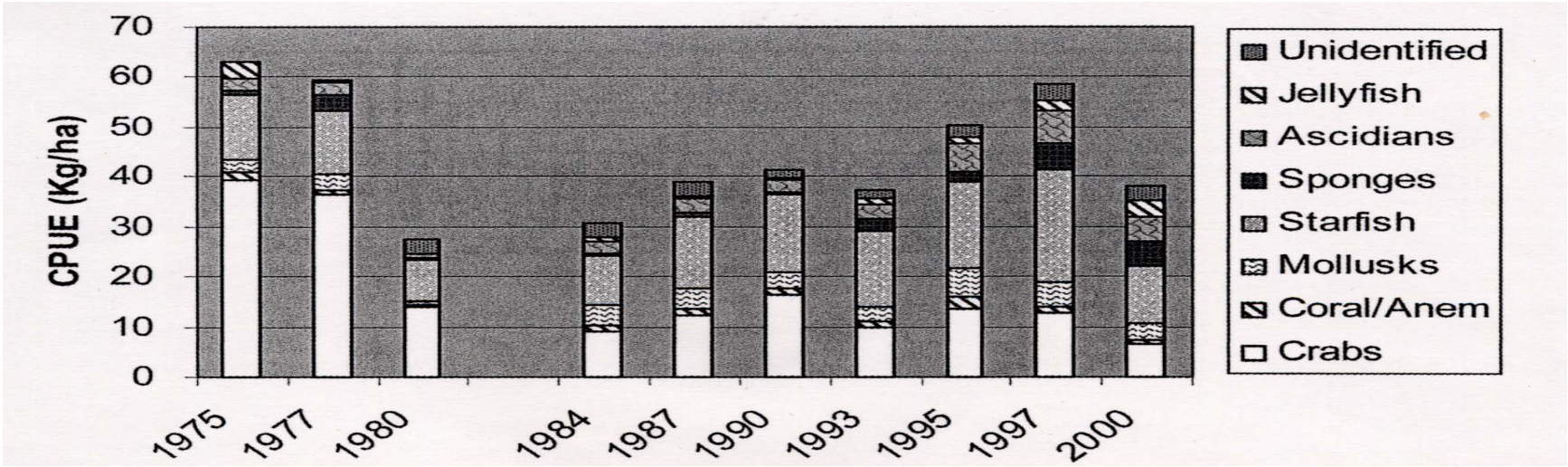


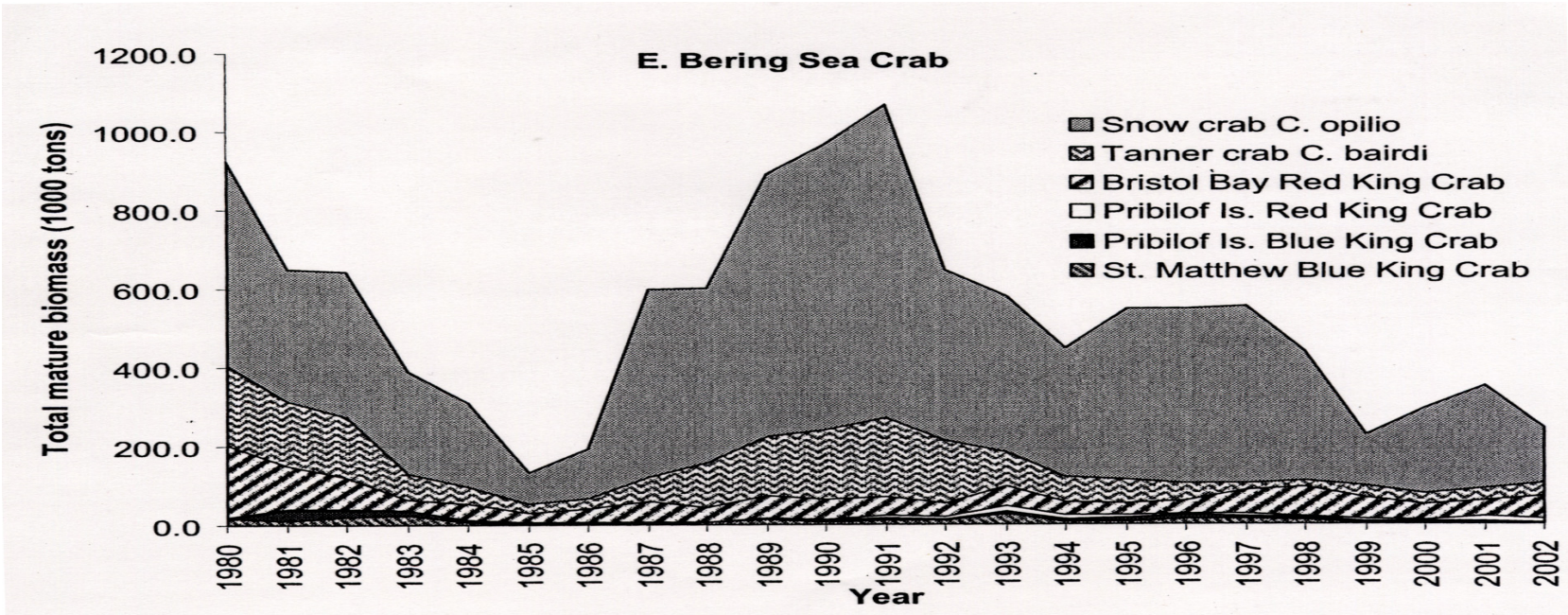
From Franz Mueter & Bern Megrey



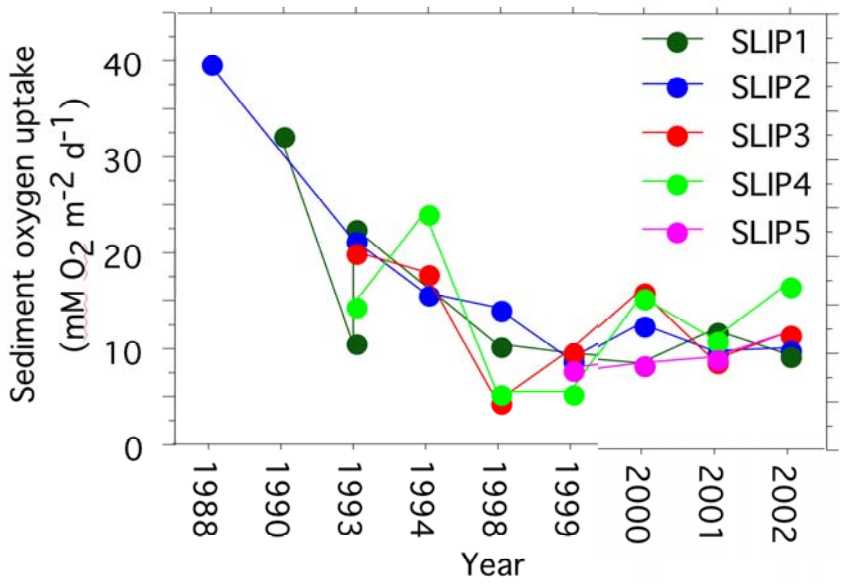
Three different responses to the 1977 regime shift

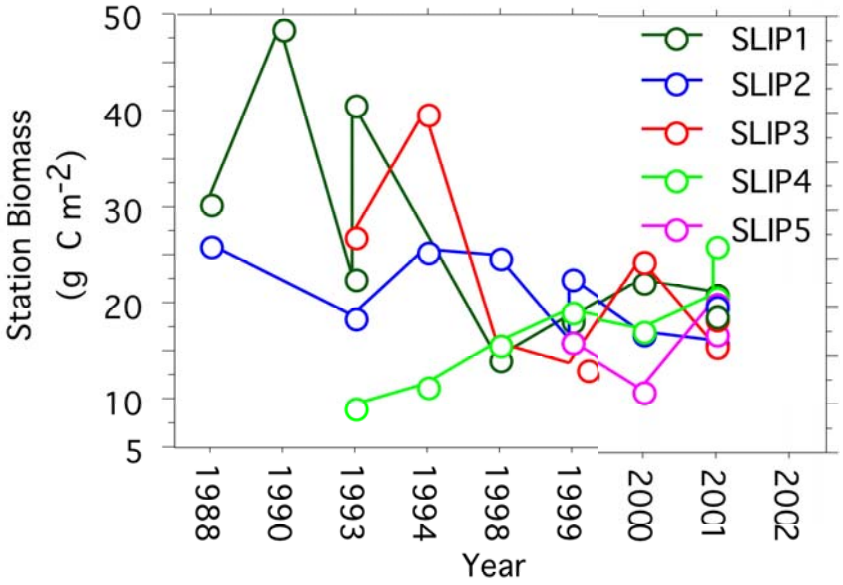
Benthic Changes

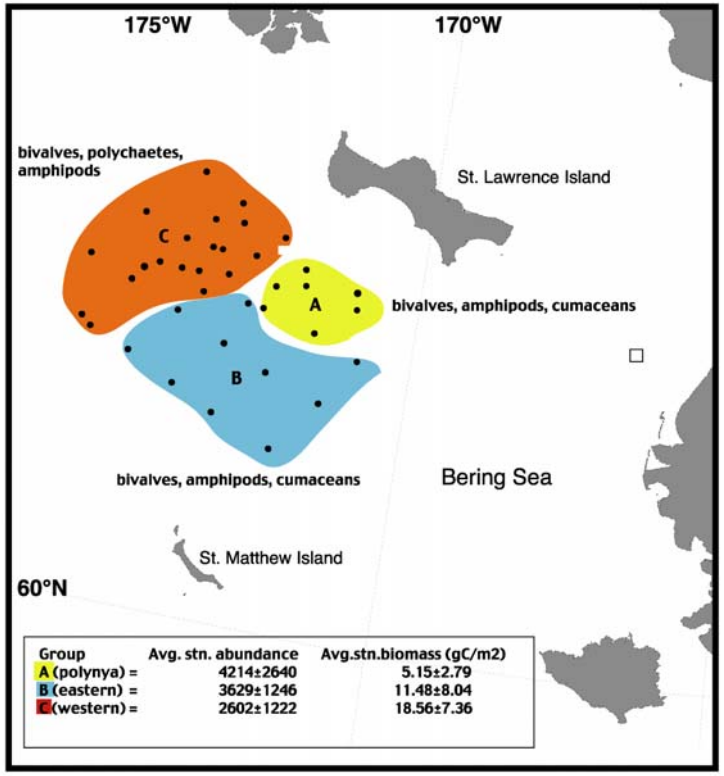




Long-term Observatory maintains sites south of St. Lawrence Island



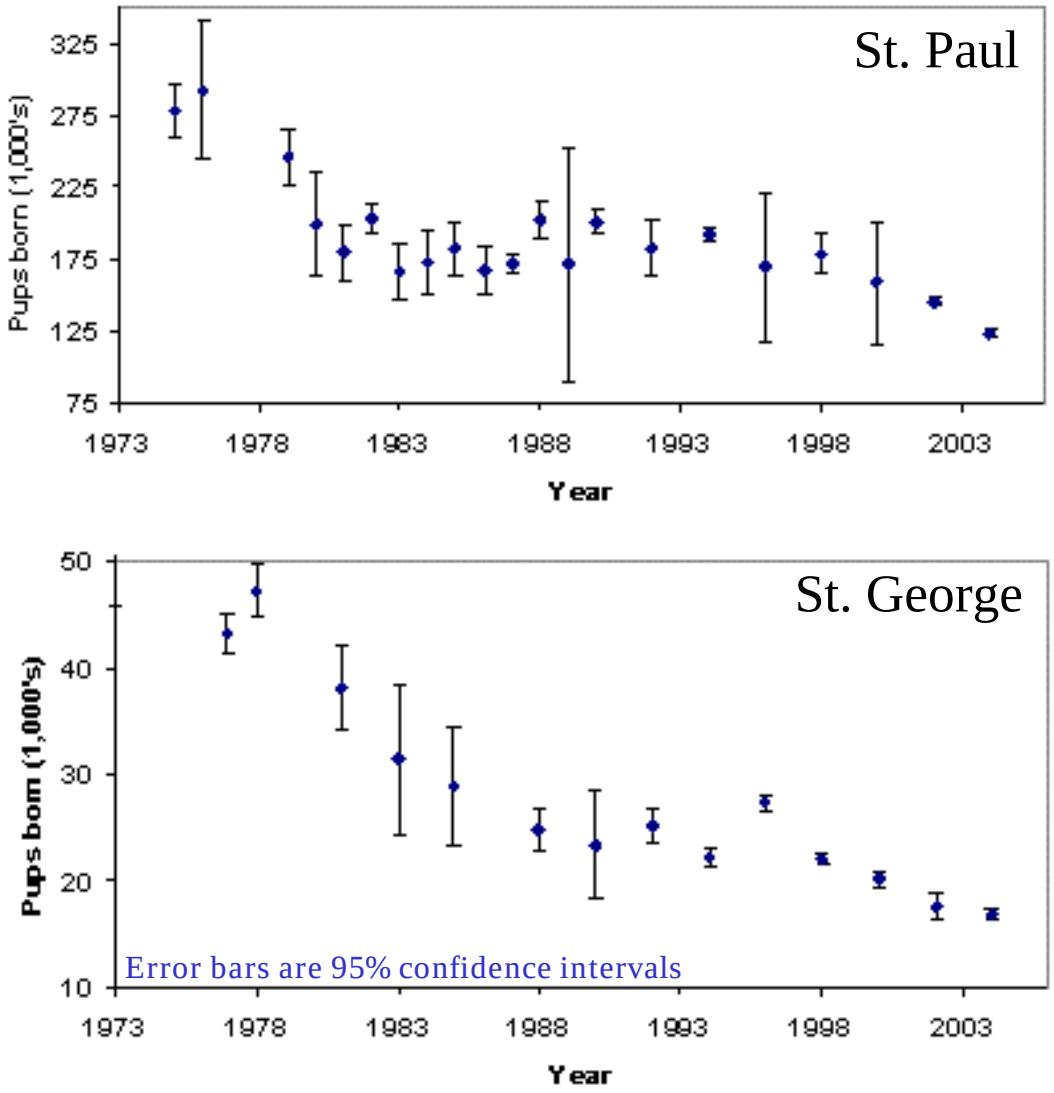




[Simpkins et al., Polar Biology, 2003]

- overall decline late 1980's to 1998, then level out in both sediment oxygen uptake (indicator of carbon flux to sediments) and overall benthic standing stock
- retrospective study indicates changes in dominant bivalve from *Macoma calcarea* to *Nuculana radiata*

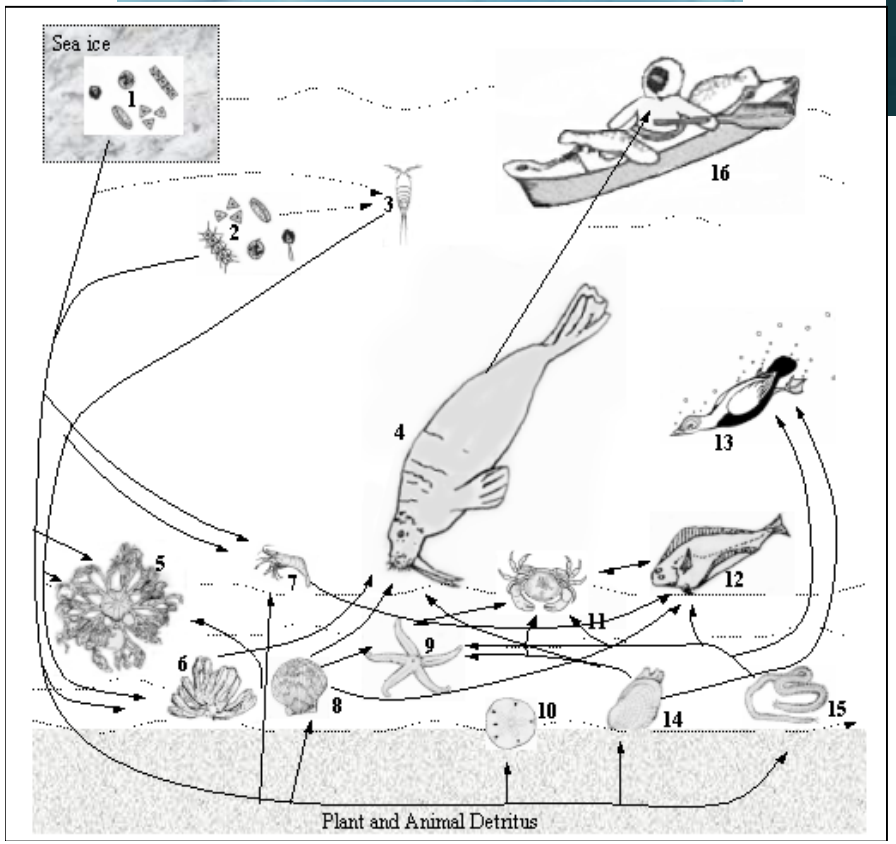
Northern fur seal pups born on Pribilof Islands



http://nmml.afsc.noaa.gov/alaskaecosystems/nfshome/survey2004pribpups.htm

Walrus herd in the Chukchi Sea– June 2002

[M. Webber-USFWS]



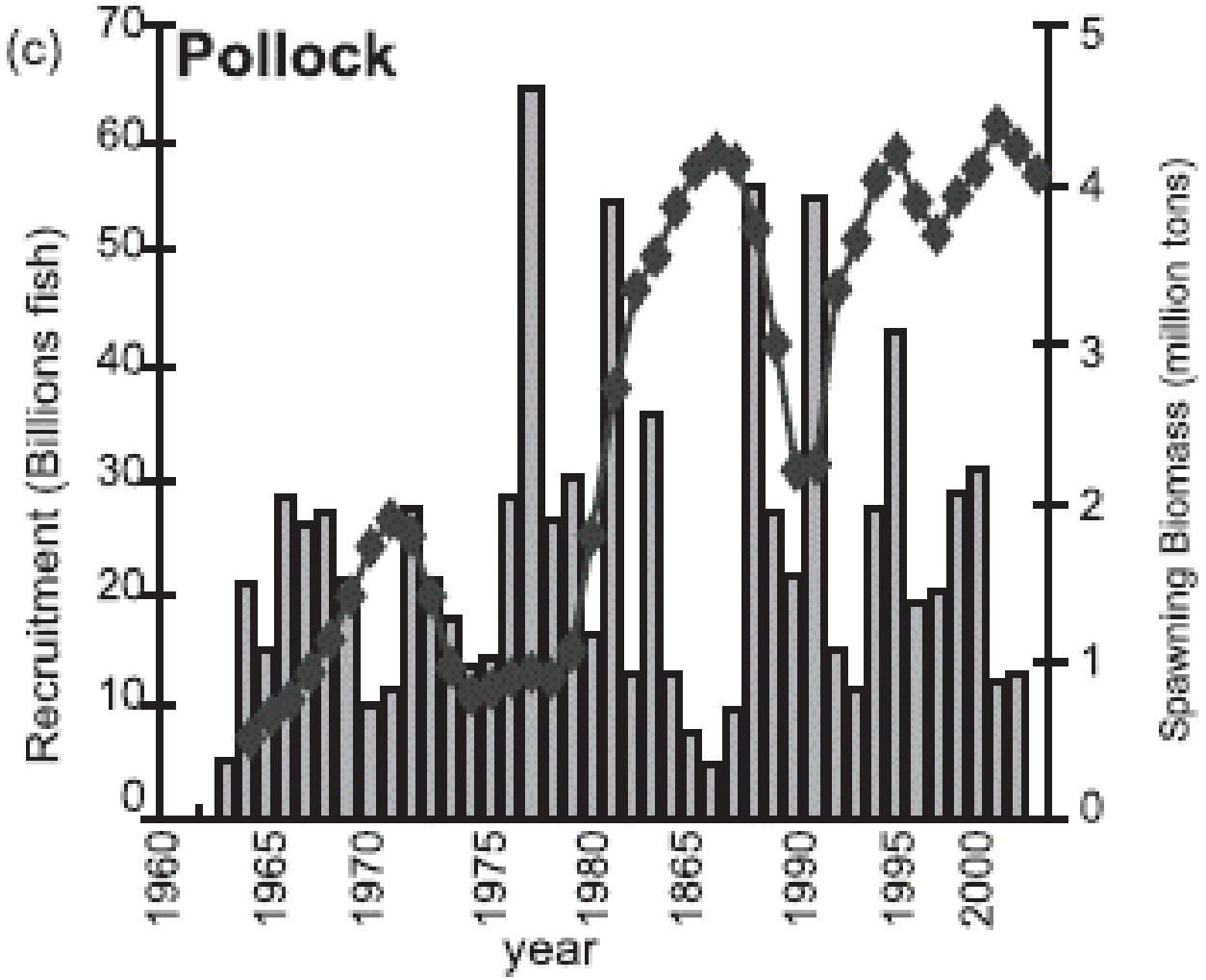
Clam food in walrus stomachs →

[photos courtesy G. Sheffield

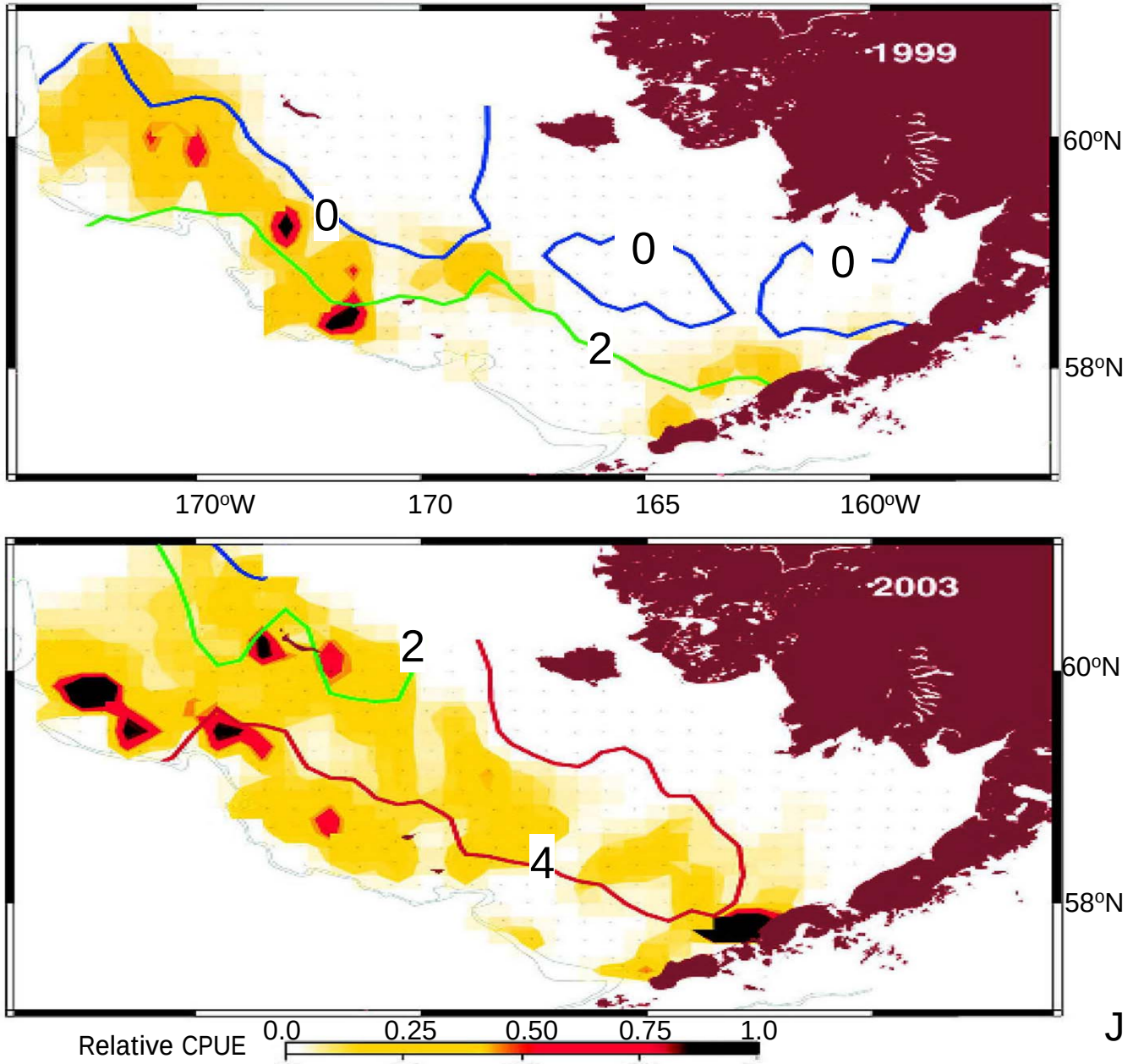
← Schematic of food web in the northern Bering and Chukchi Seas

[Grebmeier and Dunton 2000]

Bering Sea Pollock

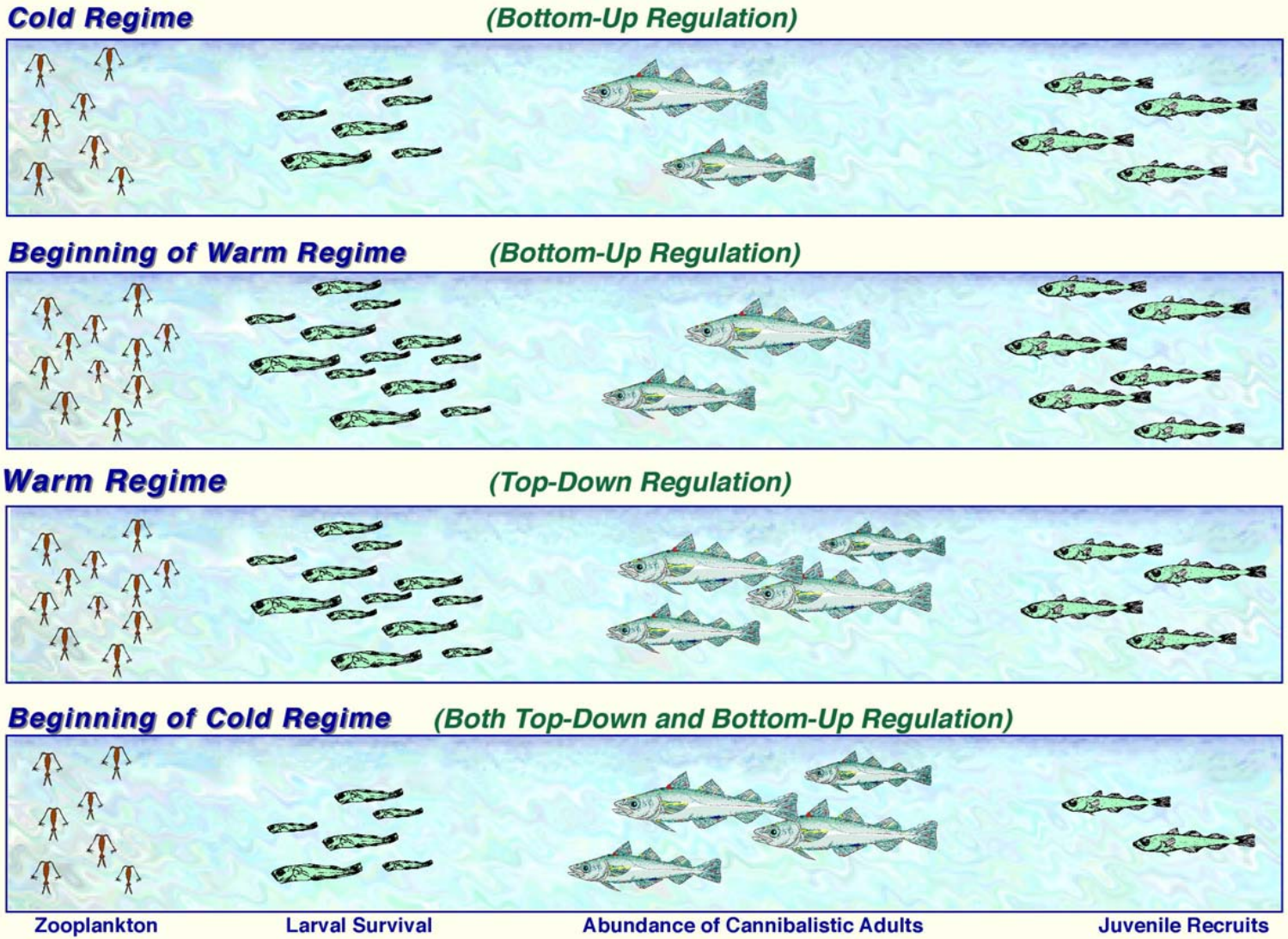


Pollock and Bottom Temperature



J Ianelli

Oscillating Control Hypothesis



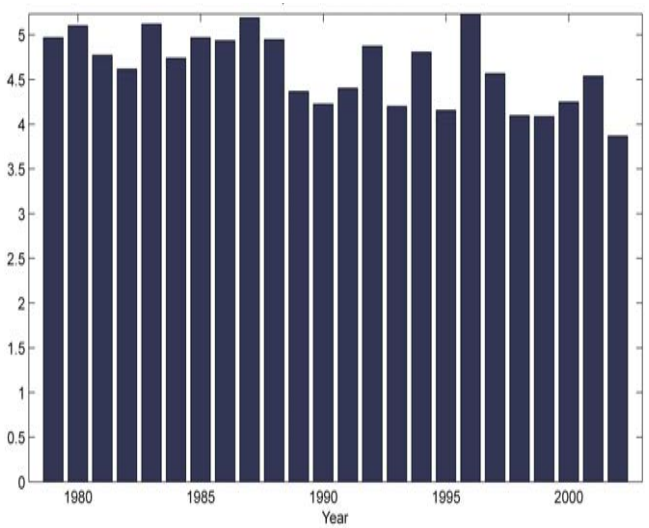
Hunt et al., 2002

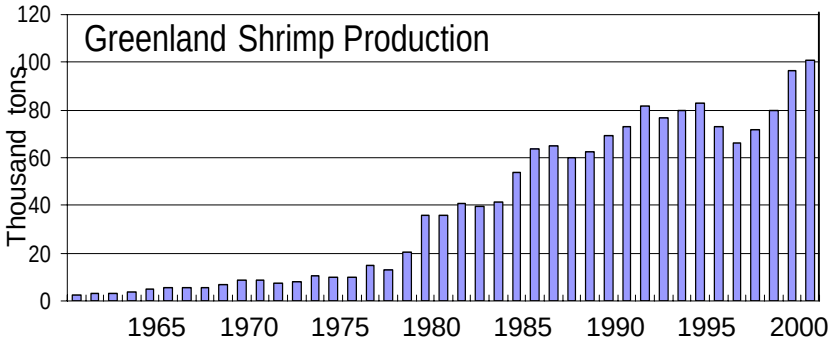
Permafrost degradation on the Tanana Flats

Jorgenson et al., 2001, Climatic Change

Arctic Changes

Sea Ice Area Coverage – Central Arctic
September

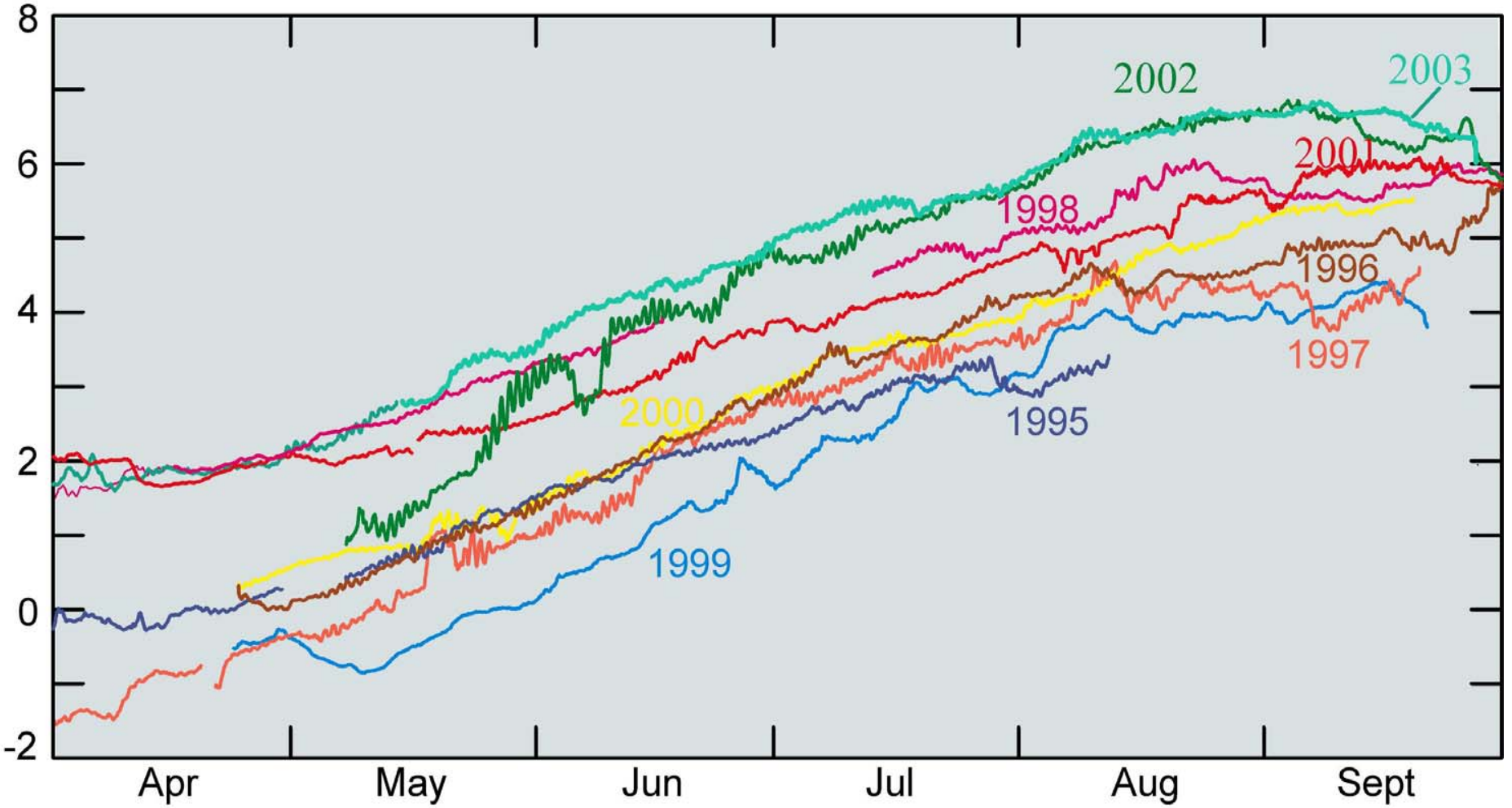




Bering Sea Summary

- Major reorganization after 1976 shift (especially summer)
- Switched from long-term (170 yr) stable cold Arctic system to sub-Arctic ecosystem
- Last four years: Continued warm ocean and atmosphere and no ice at M2, despite major PDO and AO variability
- Stuck in “warm phase” due to Arctic climate change? Favor pollock over Arctic species? Top-down?

Depth-Averaged Temperature in the SE Bering Sea



Pollock Recruitment with
Summer Wind Mixing & Winter Surface Temperature