Two NOAA Coastal Ocean Program Regional Marine Ecosystem Projects:

BERING SEA
Fisheries-Oceanography Coordinated Investigations
FOCI

1991-1997

A N D

Southeast Bering Sea Carrying Capacity

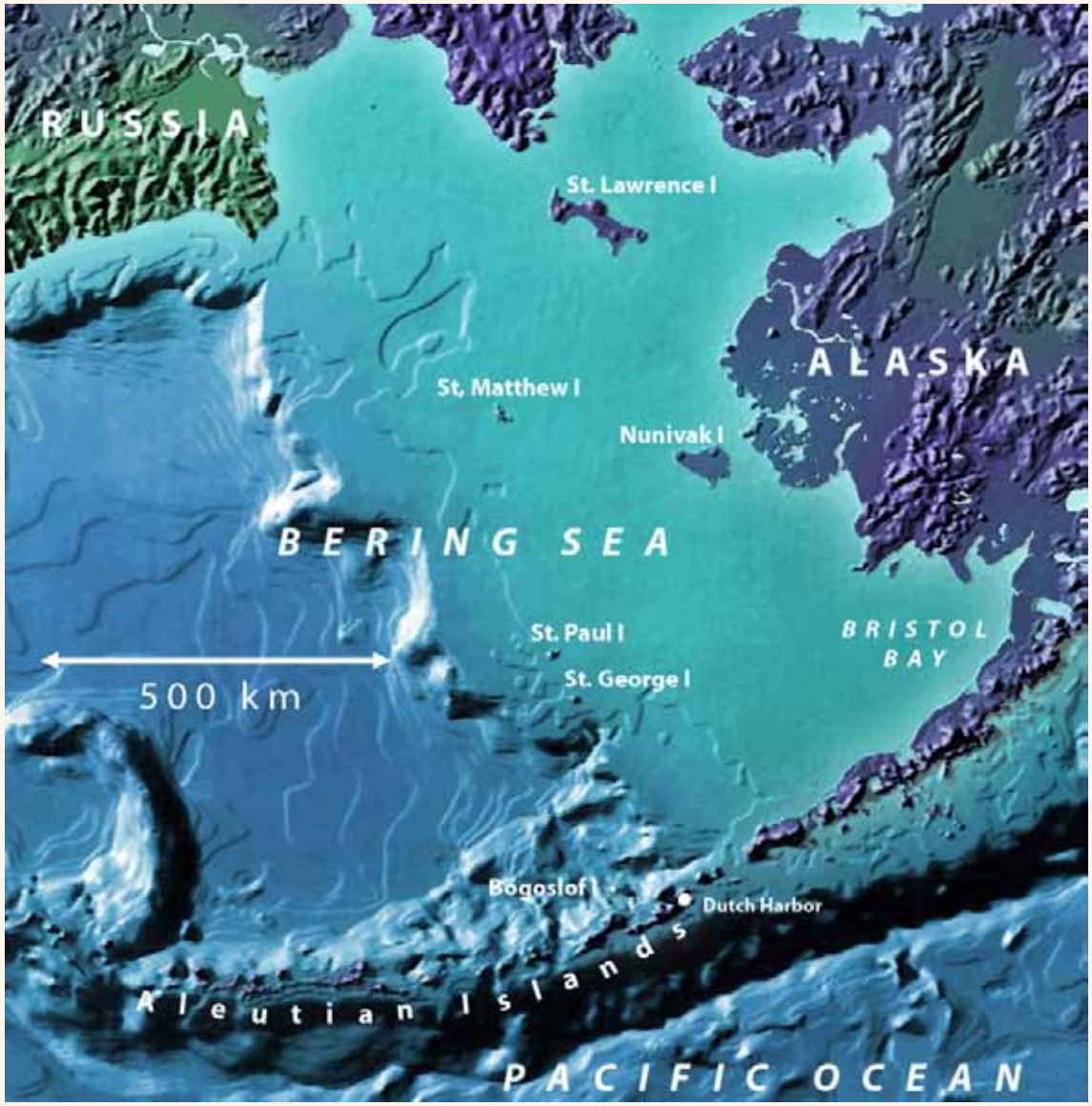
1996-2002

Anne B. Hollowed
NMFSC/AFSC

S. Allen Macklin
OAR/PMEL

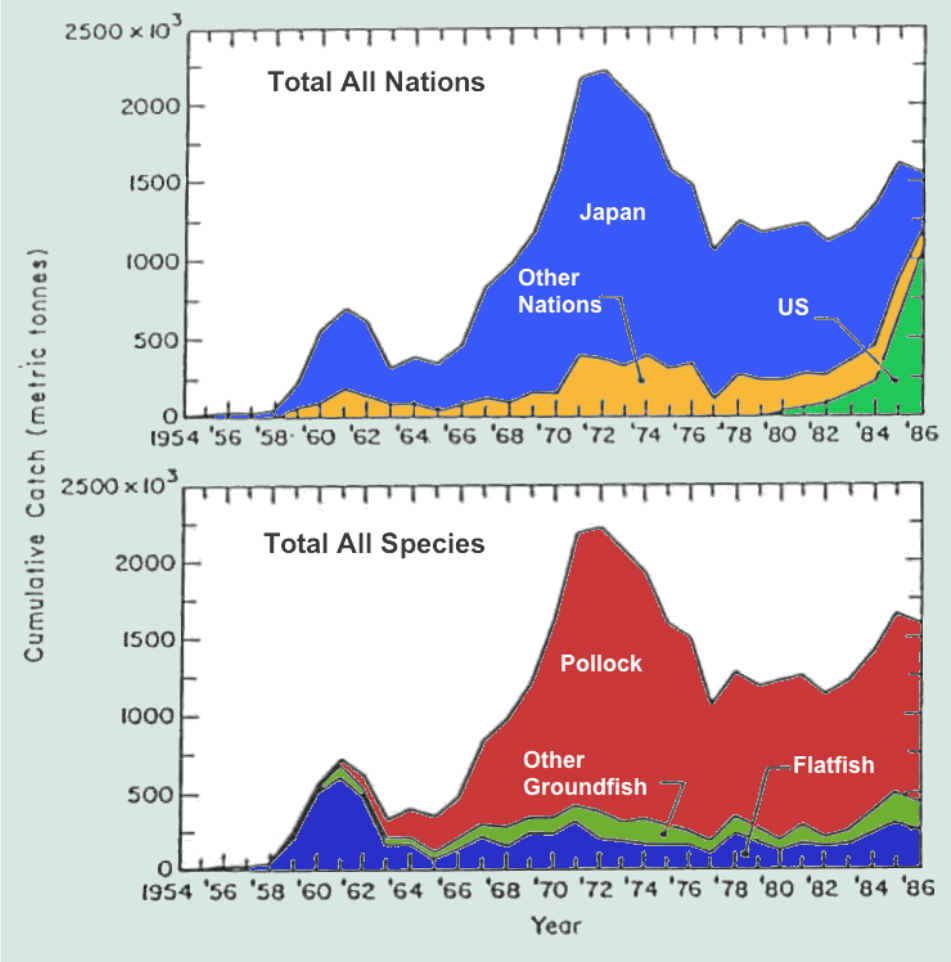
Ecosystem Research and Coastal Management: Making the Connection at the Regional Scale
May 18-19, 2009 NOAA Science Center Silver Spring, MD

The Eastern Bering Sea

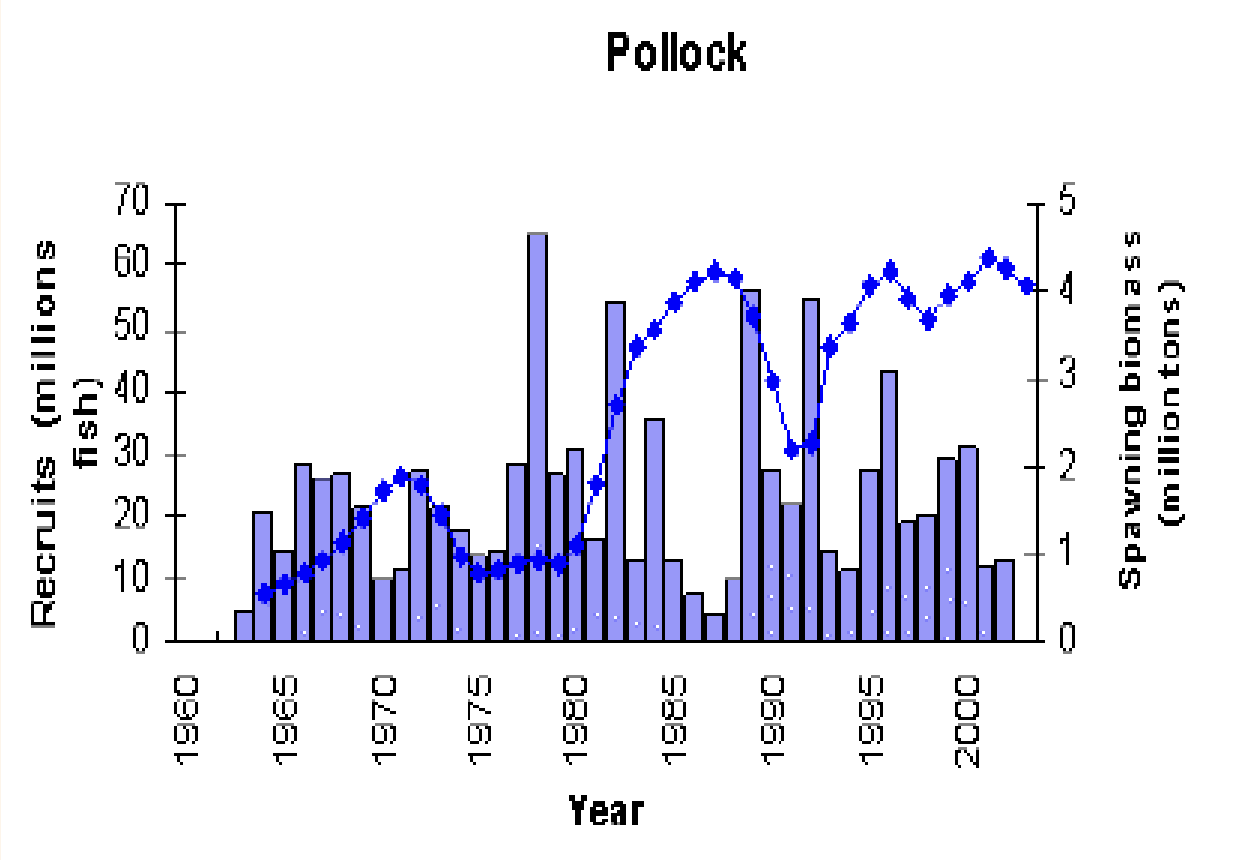


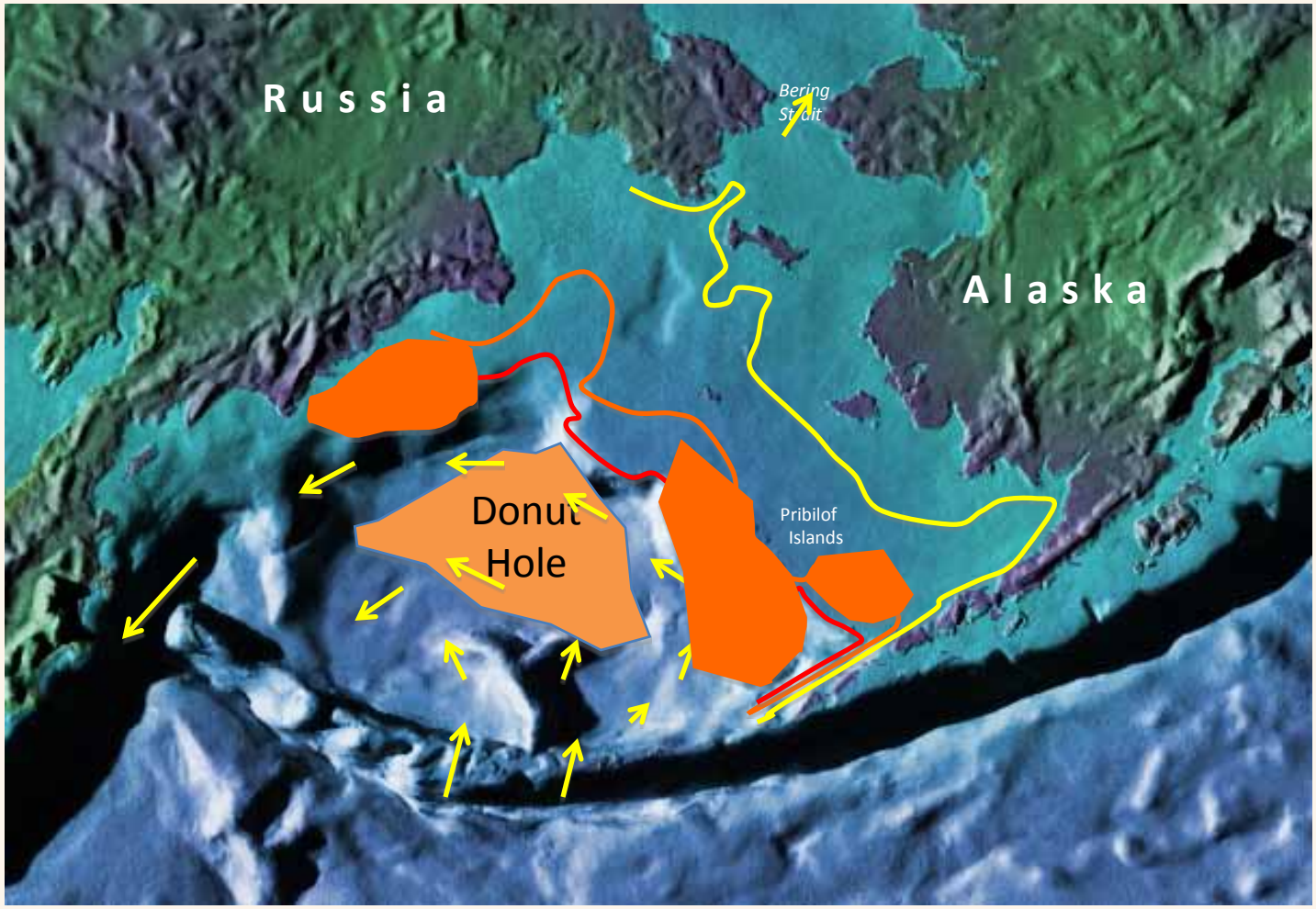
Motivation

Until ~1980, the eastern Bering Sea fishery was primarily foreign.



Bering Sea/Aleutian Islands Pollock Recruitment (bars)




Russia
Bering Strait
Alaska
Donut Hole
Pribilof Islands

BS FOCI Science Issues
(1991-1997)

Hypothesis: Transport of larval pollock from the Aleutian Basin to the continental shelf contributes to the viability of U.S. fisheries.

- **Determine biological relationships among pollock in the basin with those in other regions.**
- **Improve knowledge of ocean circulation.**
- **Understand shelf/slope exchange.**
- **Investigate match/mismatch processes for survival of pollock.**

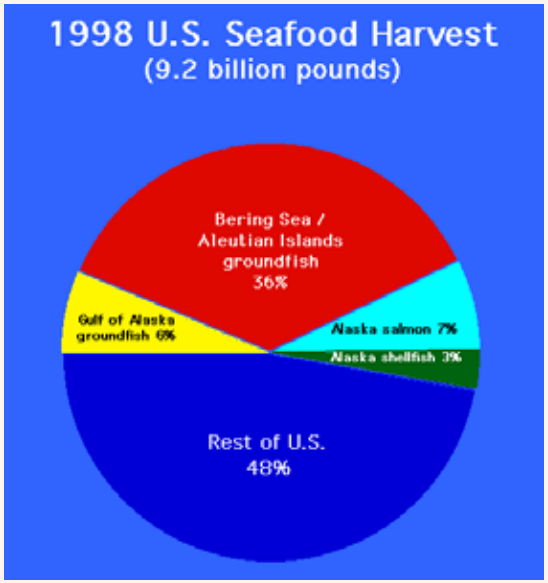
[Largely adopted from recommendations of the International Scientific Symposium on Bering Sea Fisheries, Sitka, AK, July 1988.]

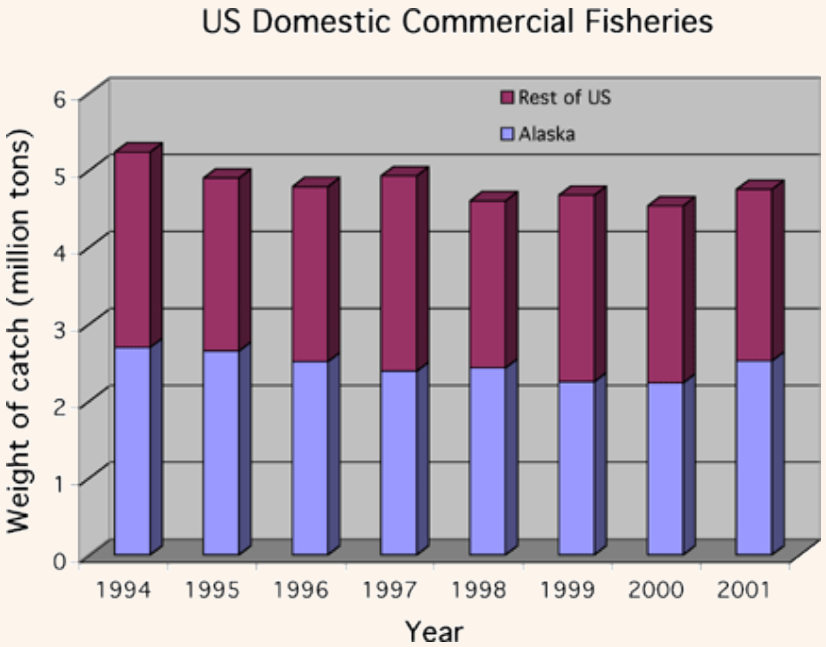
Staying on Target – BS FOCI

- Co-managed by division leaders at AFSC (Art Kendall) and PMEL (Jim Schumacher a.k.a. Two Crow)
- Executive committee including academics for evaluation of proposals
- PI group of senior investigators for contract coordination and peer review
- Technical Advisory Committee of independent scientists and managers
- Small working groups for synthesis
- Two project reviews
- Liaison with funding agency

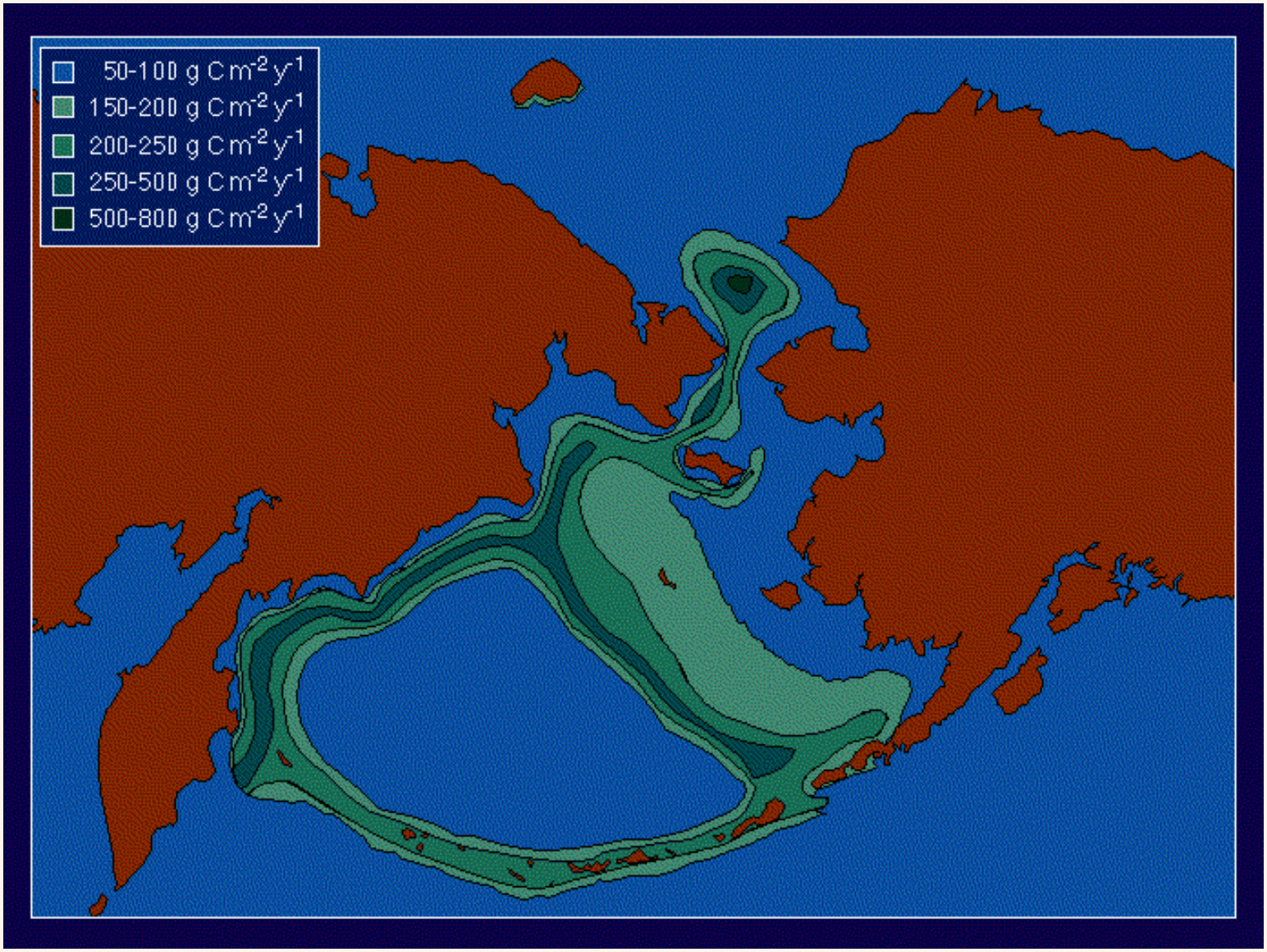
Post BS FOCI

- SE Bering Sea is key for pollock, which are a dominant species there, consuming and supplying much of the biological energy.
- Steep declines in abundance of seabirds and marine mammals suggest ecosystem stress.
- Potential for overharvest of commercial fish suggests developing an ecosystem-based management approach.

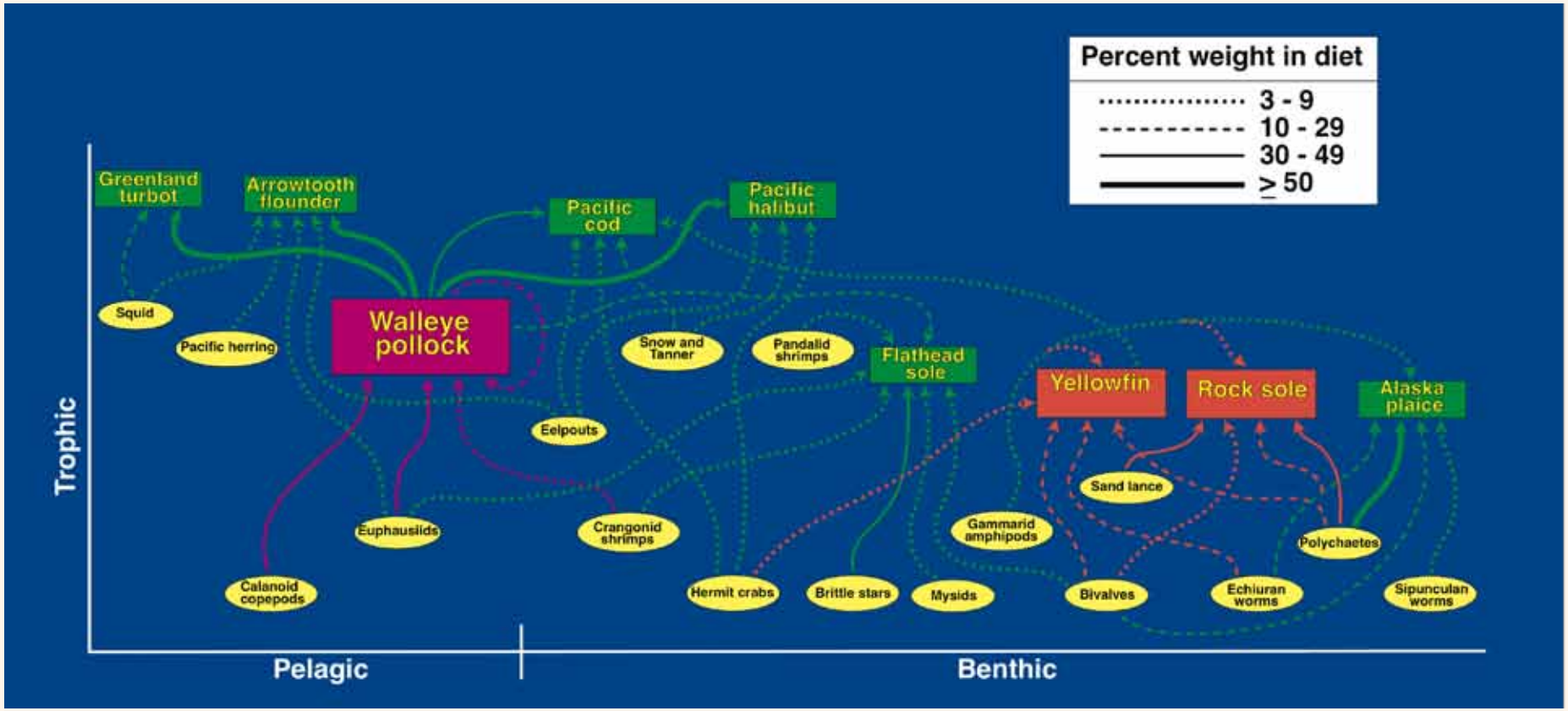




Bering Sea “Green Belt”



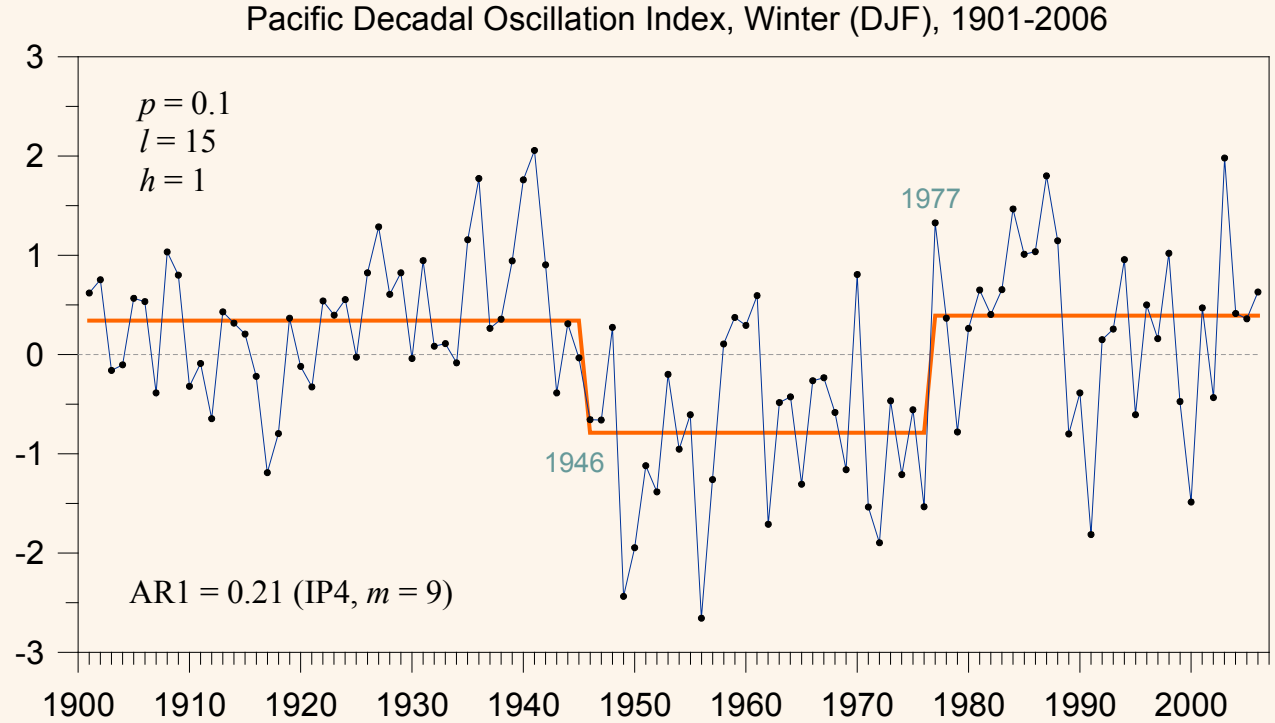
Eastern Bering Sea Food Web

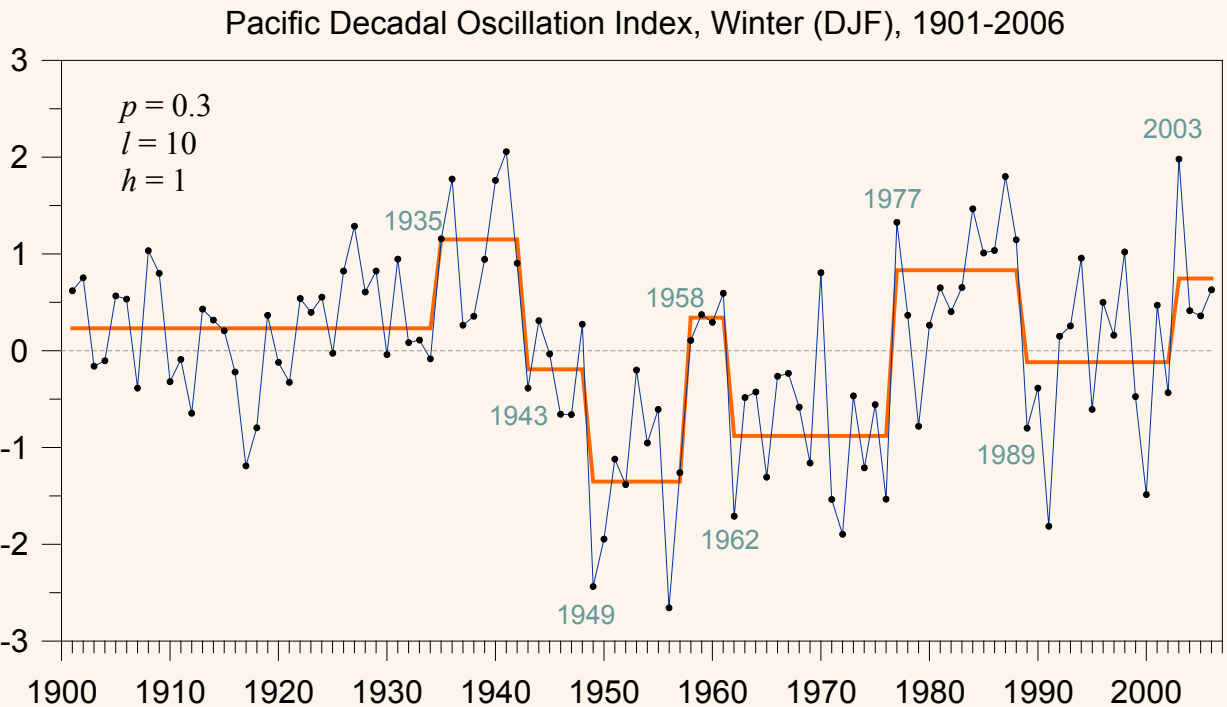


Displacement

Statistically significant shifts in means relative to within-regime variance

(Rodionov 2004)





Depends on false positive parameter ***p***, and time scale ***l***

SEBSCC Science Issues
(1996-2002)

Hypothesis: Interannual ocean variability influences the availability of prey, growth rate, predation and distribution of juvenile pollock and higher trophic level species.

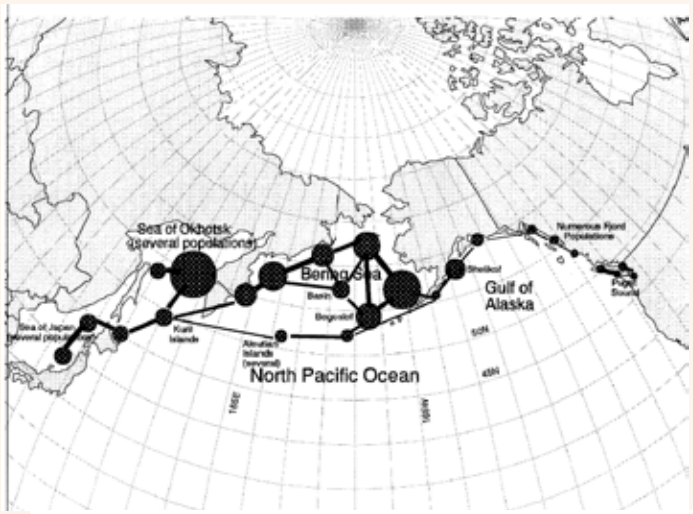
- **Understand the changing physical environment and its relationship to regional biota.**
- **Relate ecosystem understanding to variable pollock abundance.**
- **Transfer understanding to resource managers.**

[Largely adopted from recommendations of the 1994 National Research Council review of BS FOCI and the PICES-GLOBEC International Workshop on Climate Change and Carrying Capacity, April 1995.]

Staying on Target - SEBSCC

- Three-person Project Management Team from UAF (Vera Alexander – lower trophic levels), AFSC (Anne Hollowed Fish and Fisheries) and PMEL (James Overland Climate and Oceanography) to lead and assemble research team
- Technical Advisory Committee of independent scientists and managers for tuning, review and proposal evaluation
- Research Council of senior investigators from SEBSCC and cooperating projects for information exchange
- Formal synthesis groups (intra and inter-project members)
- Liaison with funding agency

Major Contributions of BSFOCI



- Stock structure – Bailey et al.
- Recognition of decadal scale variability
- Pollock larval vertical distribution
- Vital rates for juvenile pollock
- Recognition of domains of EBS
- Simple food-webs

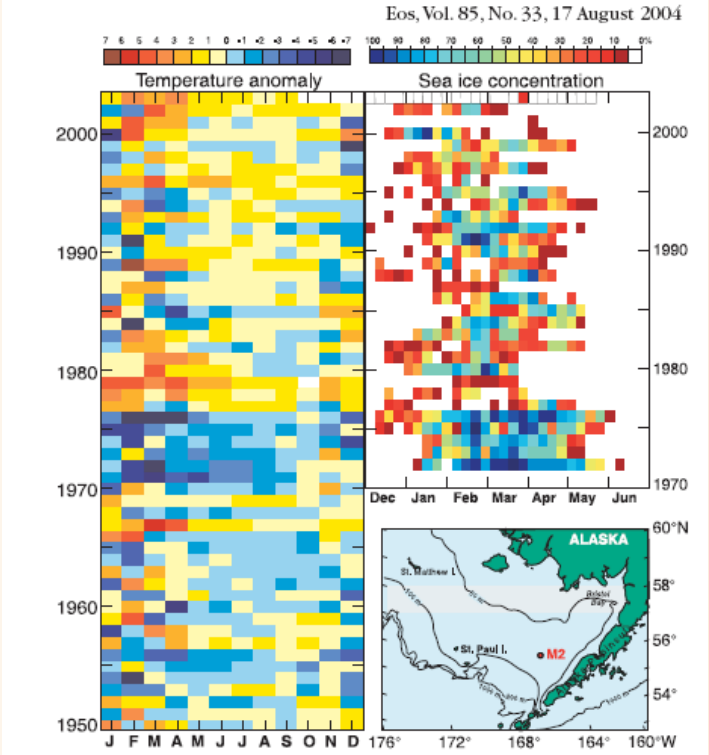
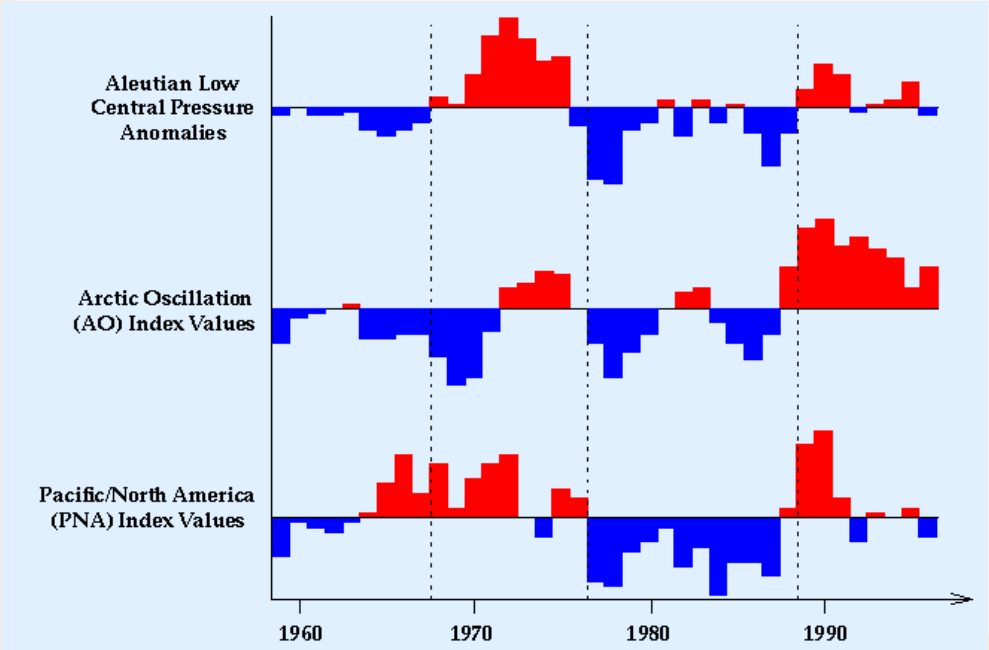


Fig. 2. (Left) Monthly air temperature anomalies at St. Paul Island as a function of month and year. The base period is 1961-1990. Note the shift to warmer temperatures both after 1976 and for the previous 4 years. (Right) Concentration (% cover) of sea ice over the southeastern Bering Sea beween latitudes 57°N and 58°N. Location chart at lower right.

Major Contributions of SSBSCC

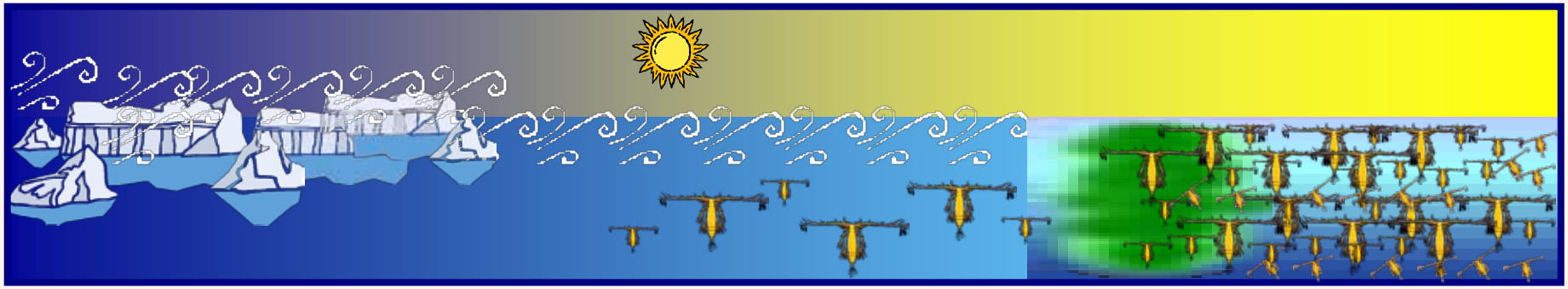
- Seasonality and bloom
- Recognition of multiple models of decadal scale variability
- Development of regional circulation models



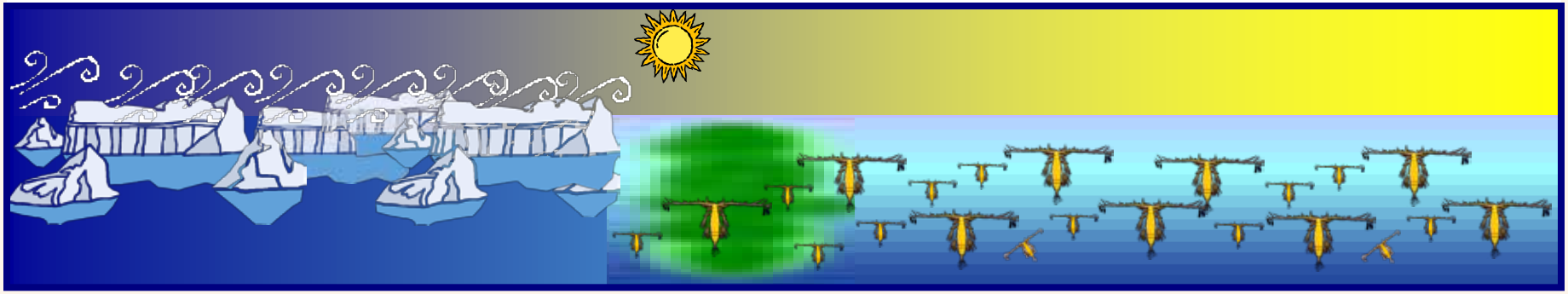
- Food web and predator prey
- Continued cannibalism research
- Advection of larvae
- Role of sea ice and cold pool

Climate affects the ecosystem through sea ice

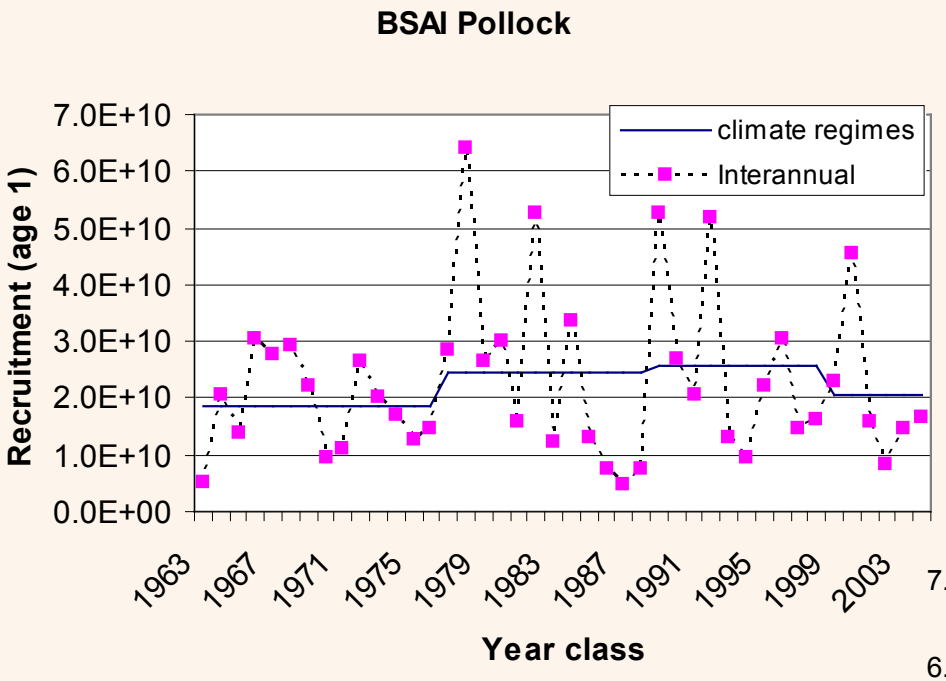
Early Ice Retreat → **Late Bloom, Warm Water – Large Copepod Biomass**



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

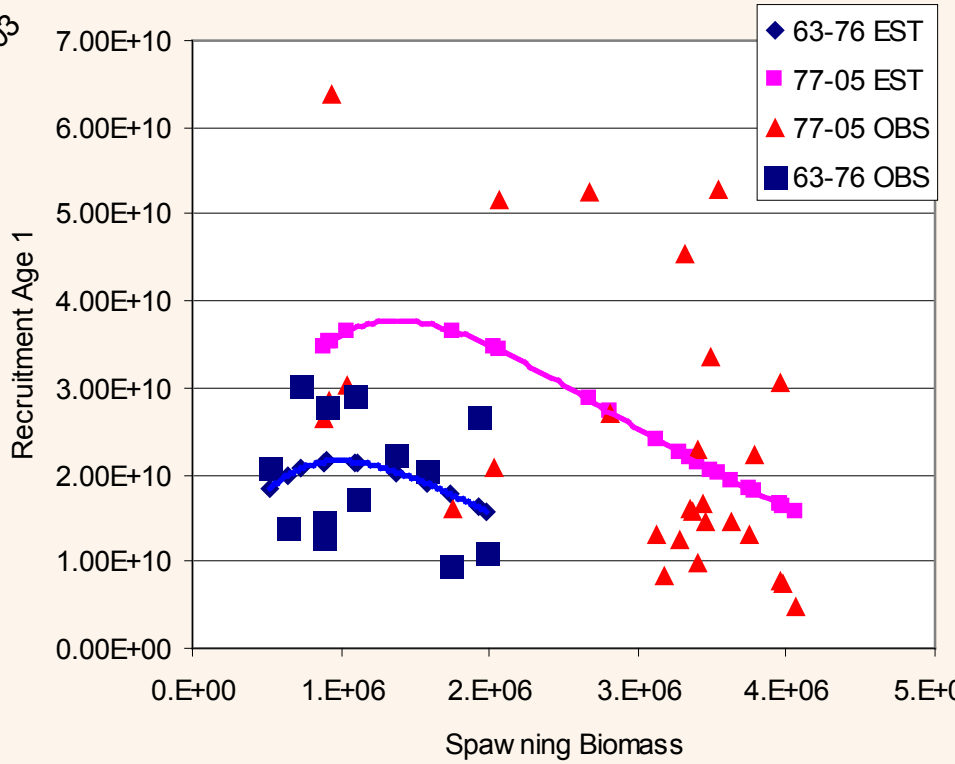


February March April May June

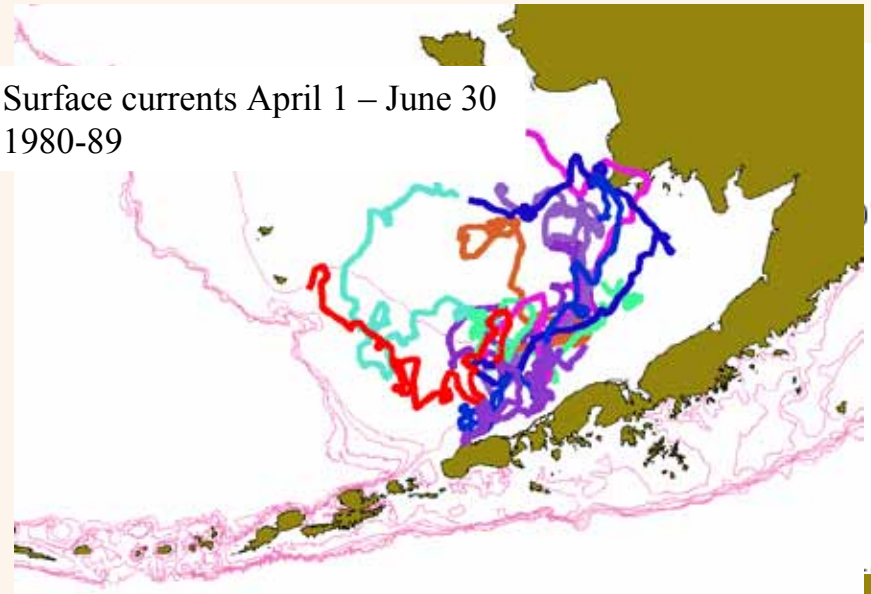


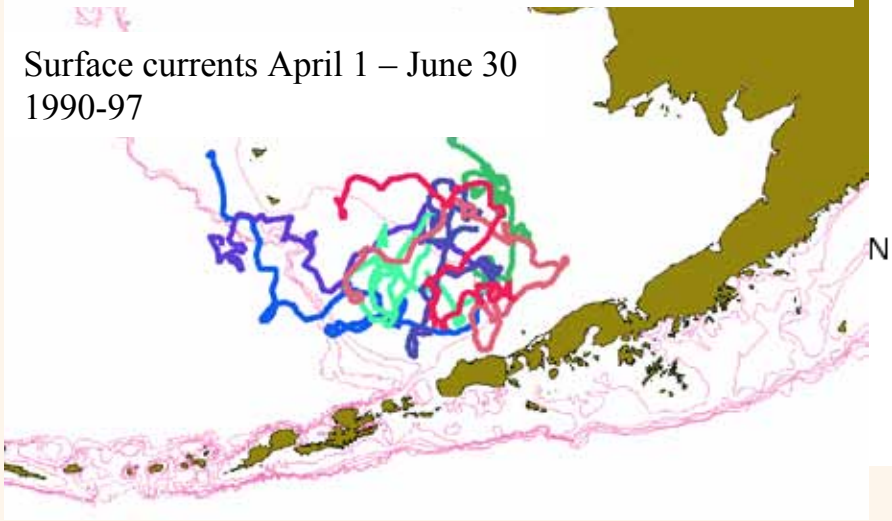
Predicting Pollock Recruitment In a changing climate

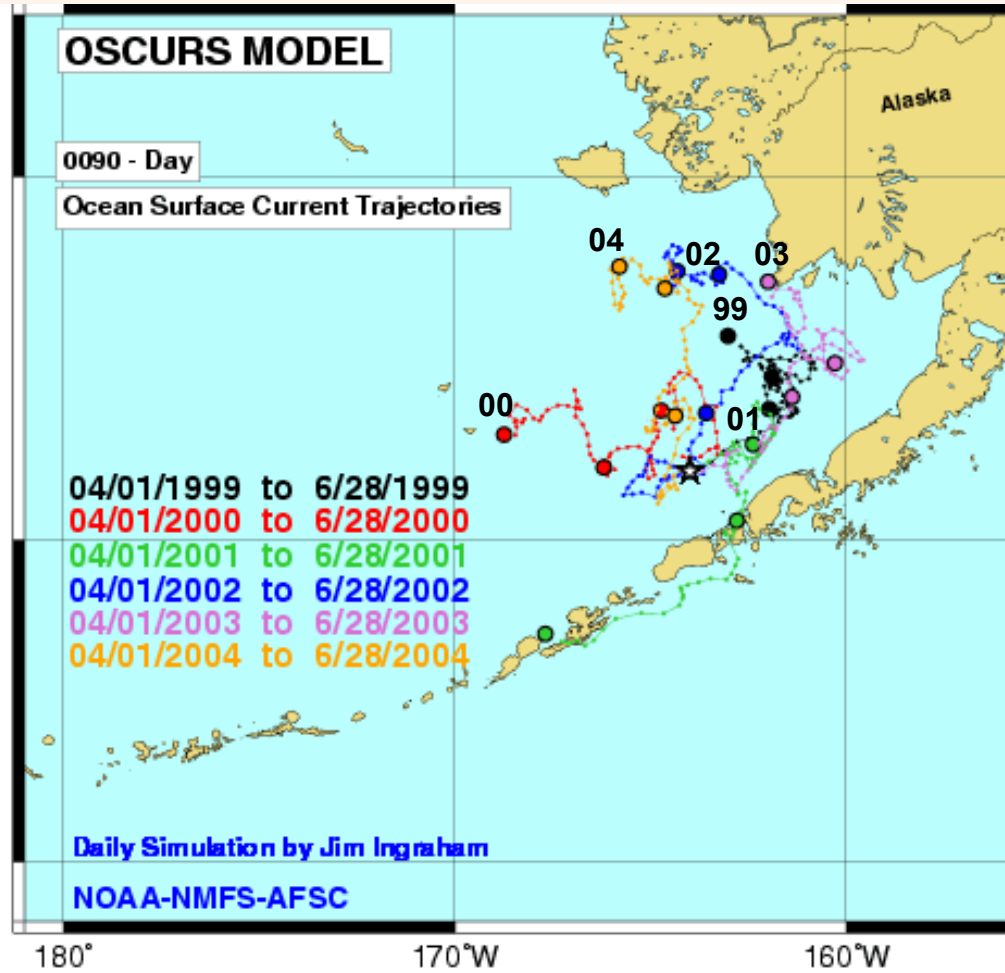
Climate and density dependence?



Biological Response to Climate
Surface currents and flatfish recruitment (Wilderbuer et al. 2001)

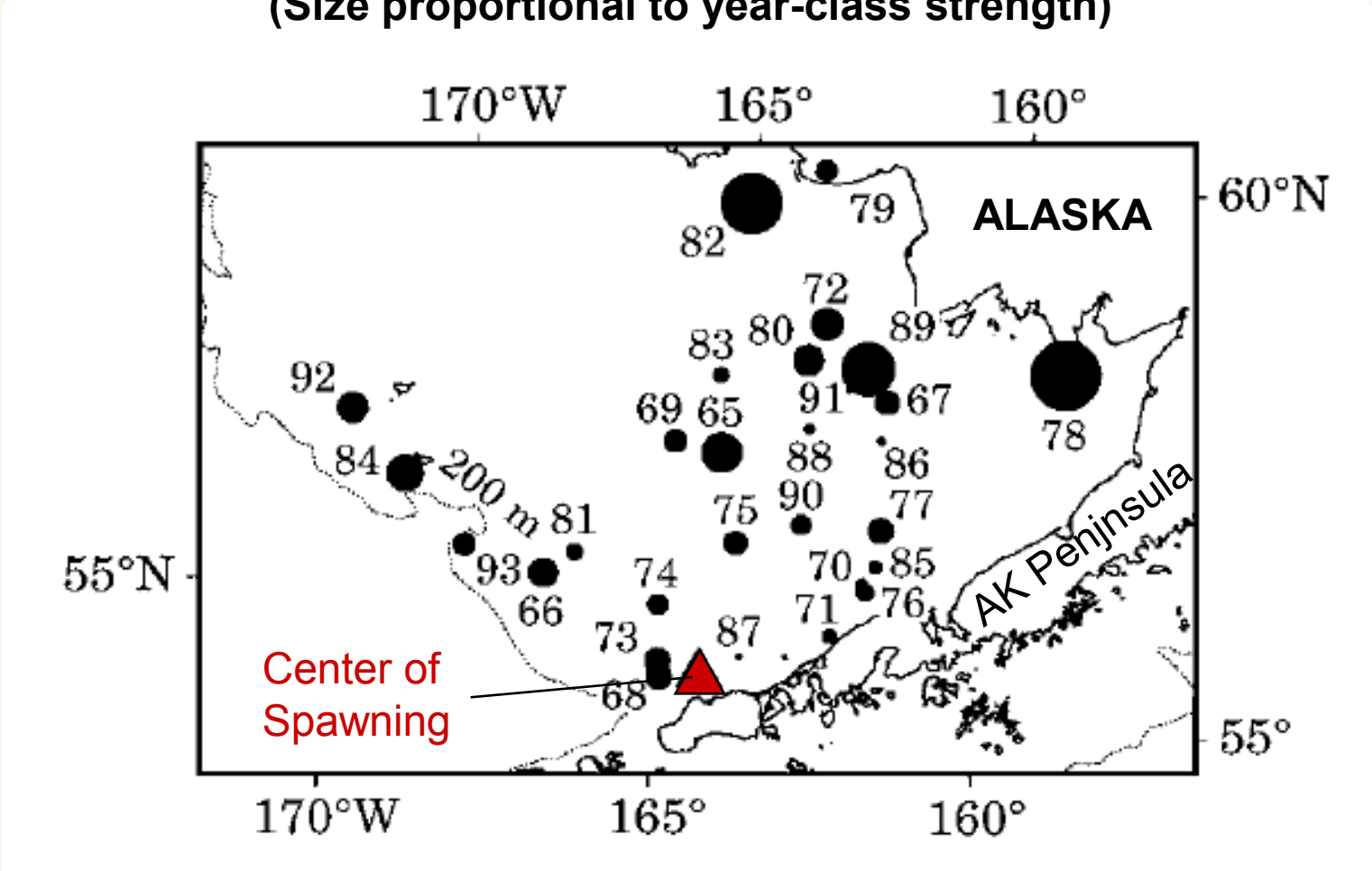






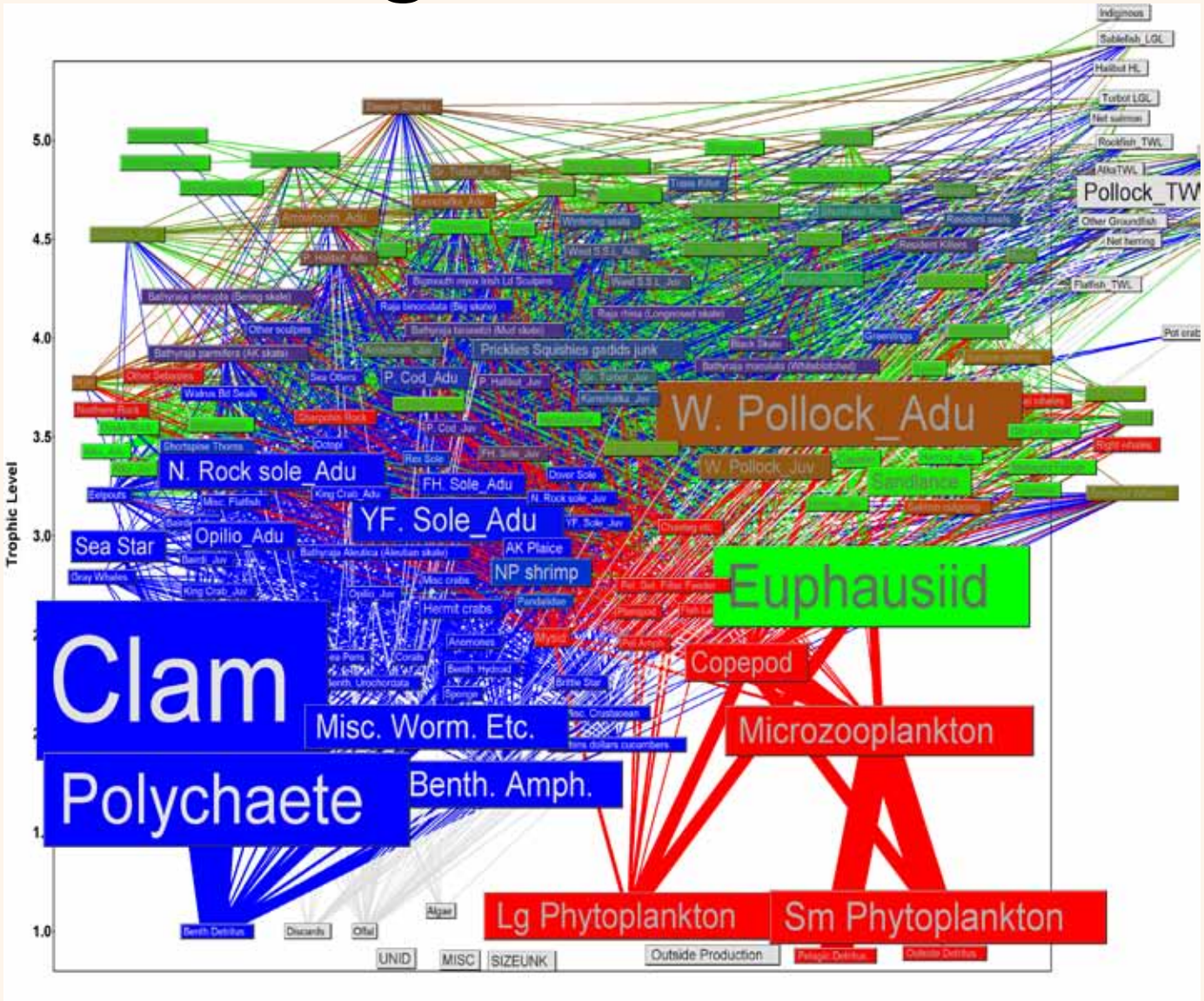
Advection / pollock larval transport

Simulated endpoints of 90-day larval drift (April1 – June 30)
(Size proportional to year-class strength)

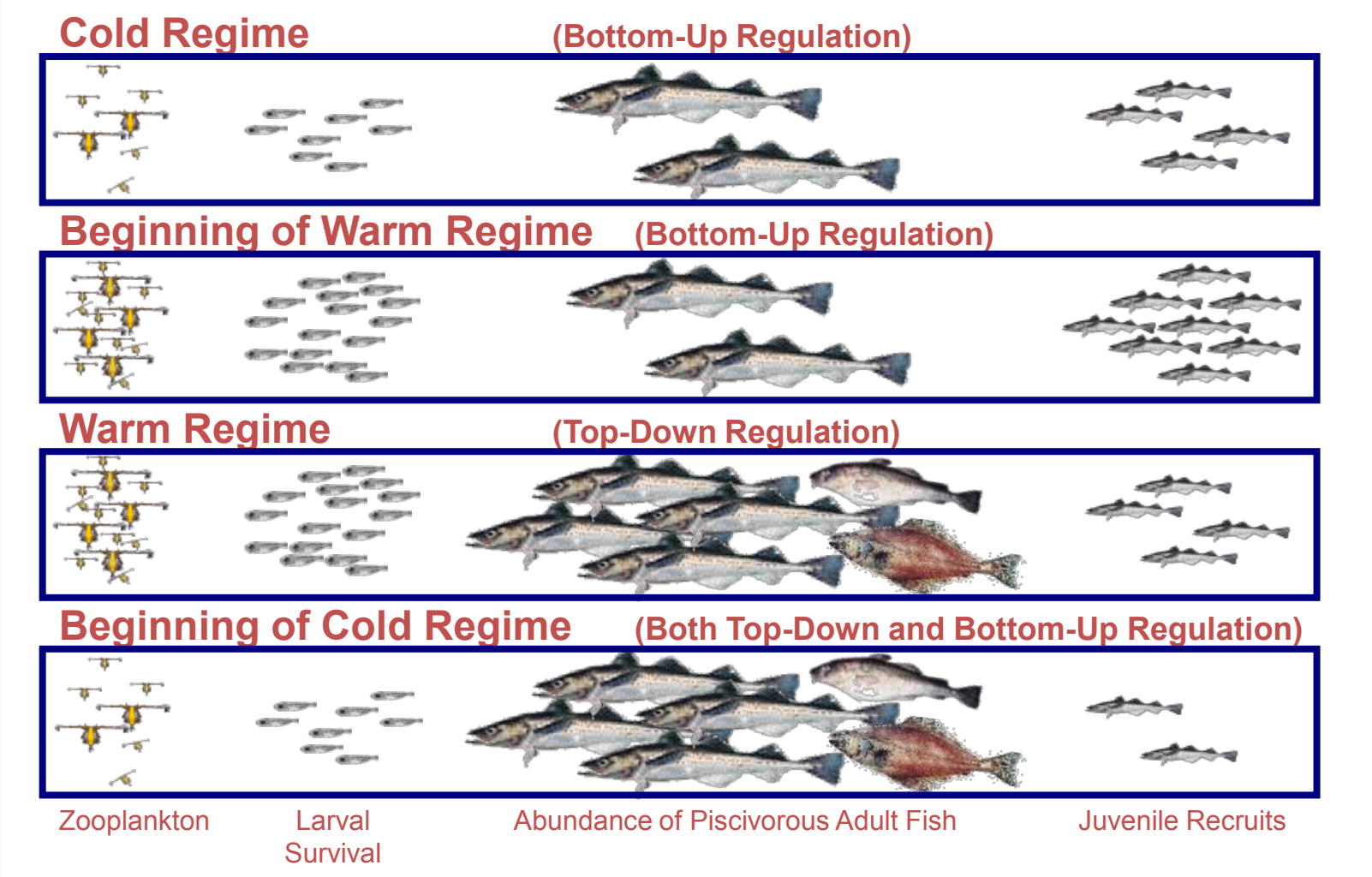


From: Wespestad et al. (2000). ICES J. Mar. Sci 57:272-278

Bering Sea Food Web

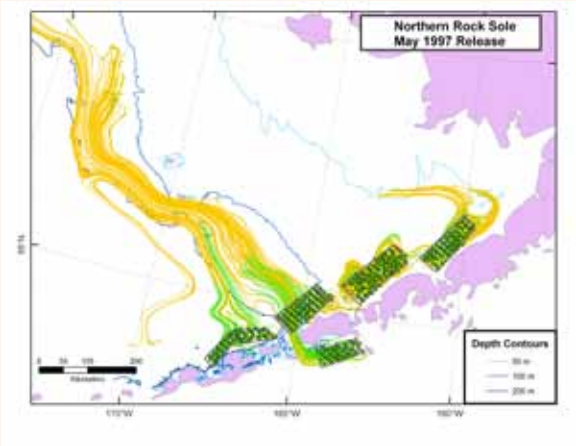


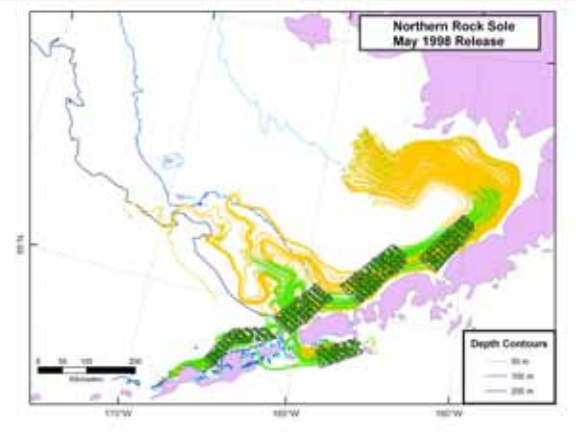
Oscillating Control Hypothesis

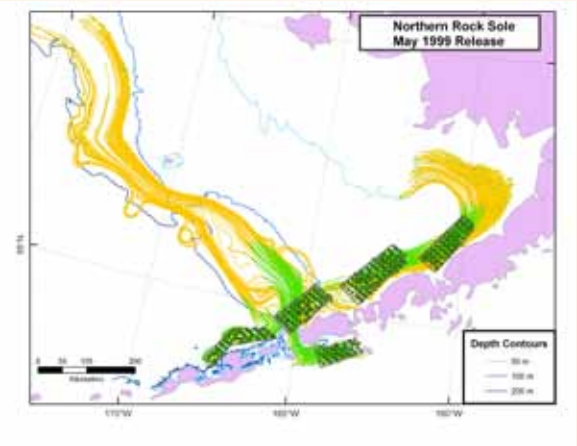


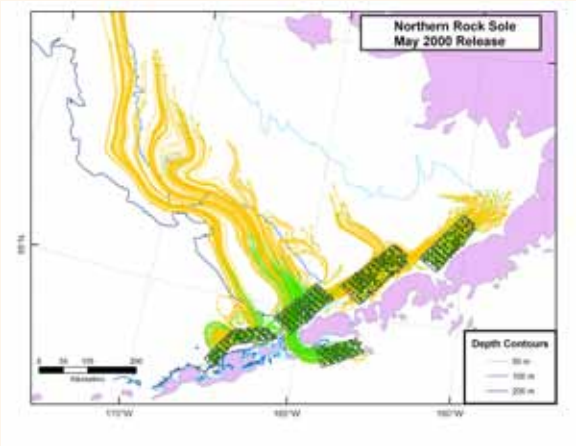
Hunt, GL Jr., P. Stabeno, G. Walters, E. Sinclair, R.D. Brodeur, J.M. Napp, N.A. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. Deep-Sea Res. 49: 5821-5853.

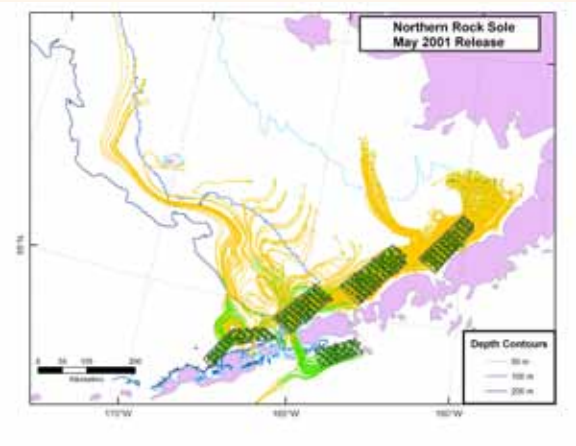
Post-Program Developments: Coupled Bio-Physical model forecasts

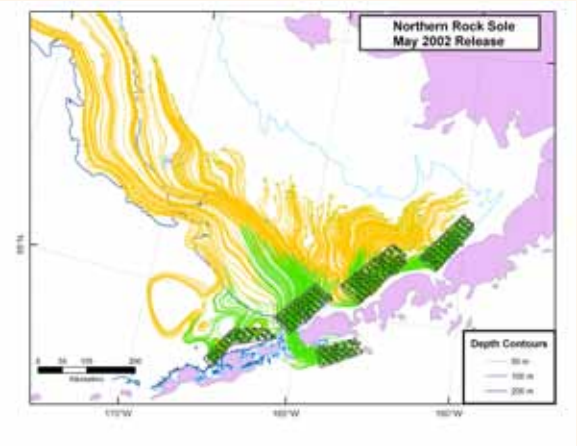


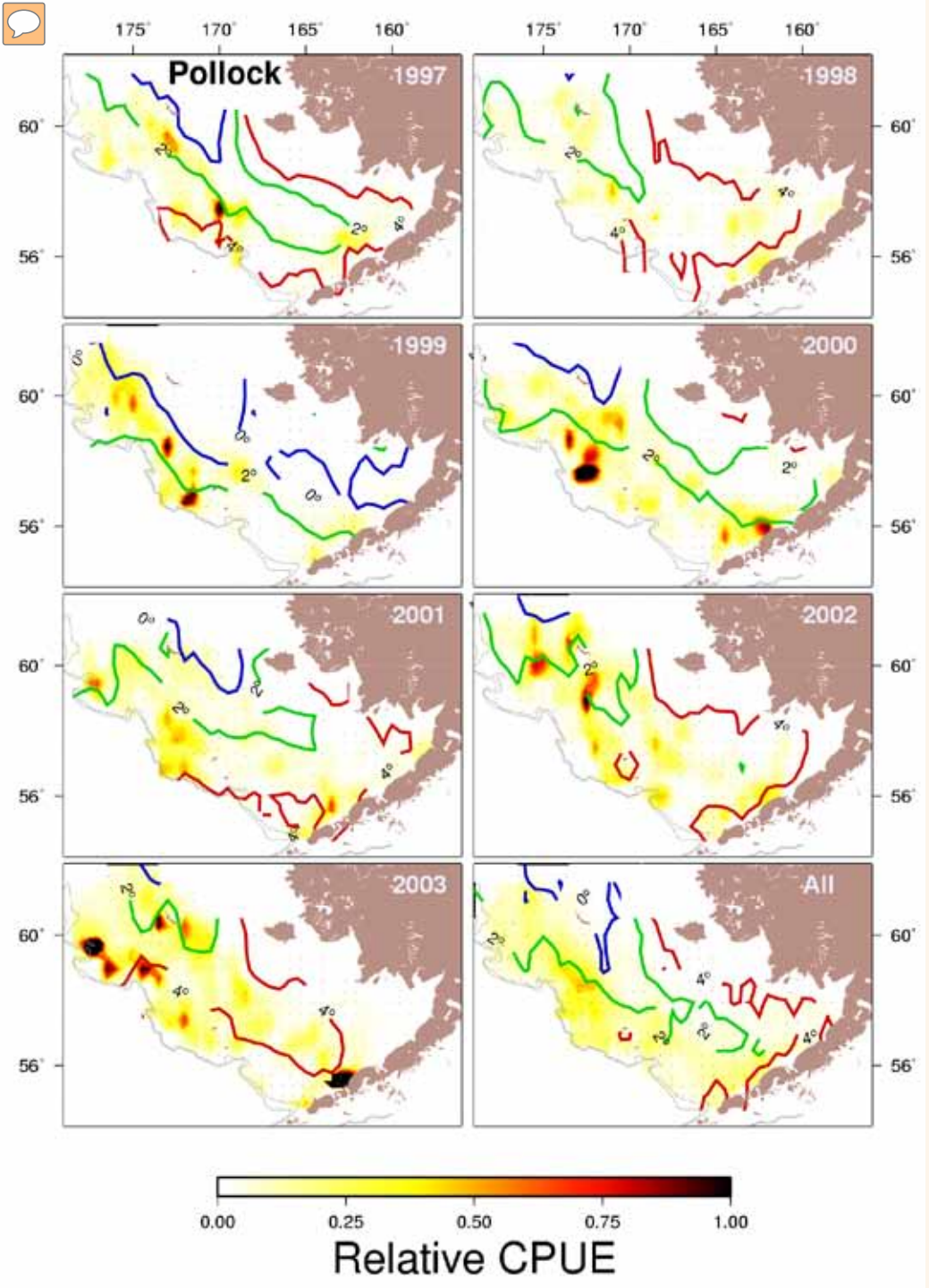












Post-Program recognition of the role of the cold pool influence on spatial distribution of pollock

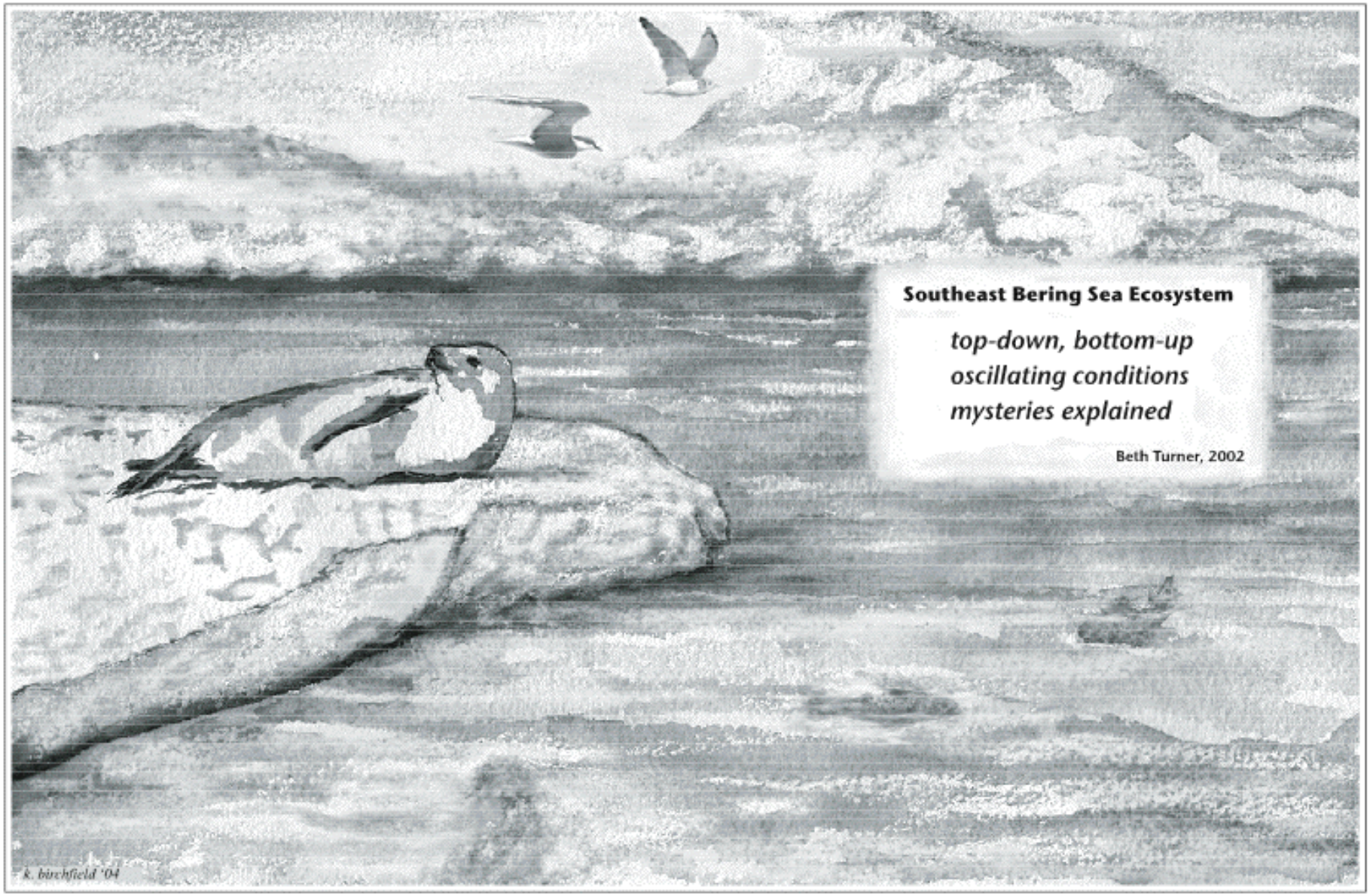
(Ianelli)

Lessons Learned

- Set reasonable expectations
- Be flexible – accept new hypotheses
- Remember interdisciplinary programs lead to acceleration of understanding but they may not provide operational products.
- Transfer to operational products requires stable funding
- When planning to use a regional circulation model, set long time horizons for development and testing
- Co-location of a core group of PIs was very helpful

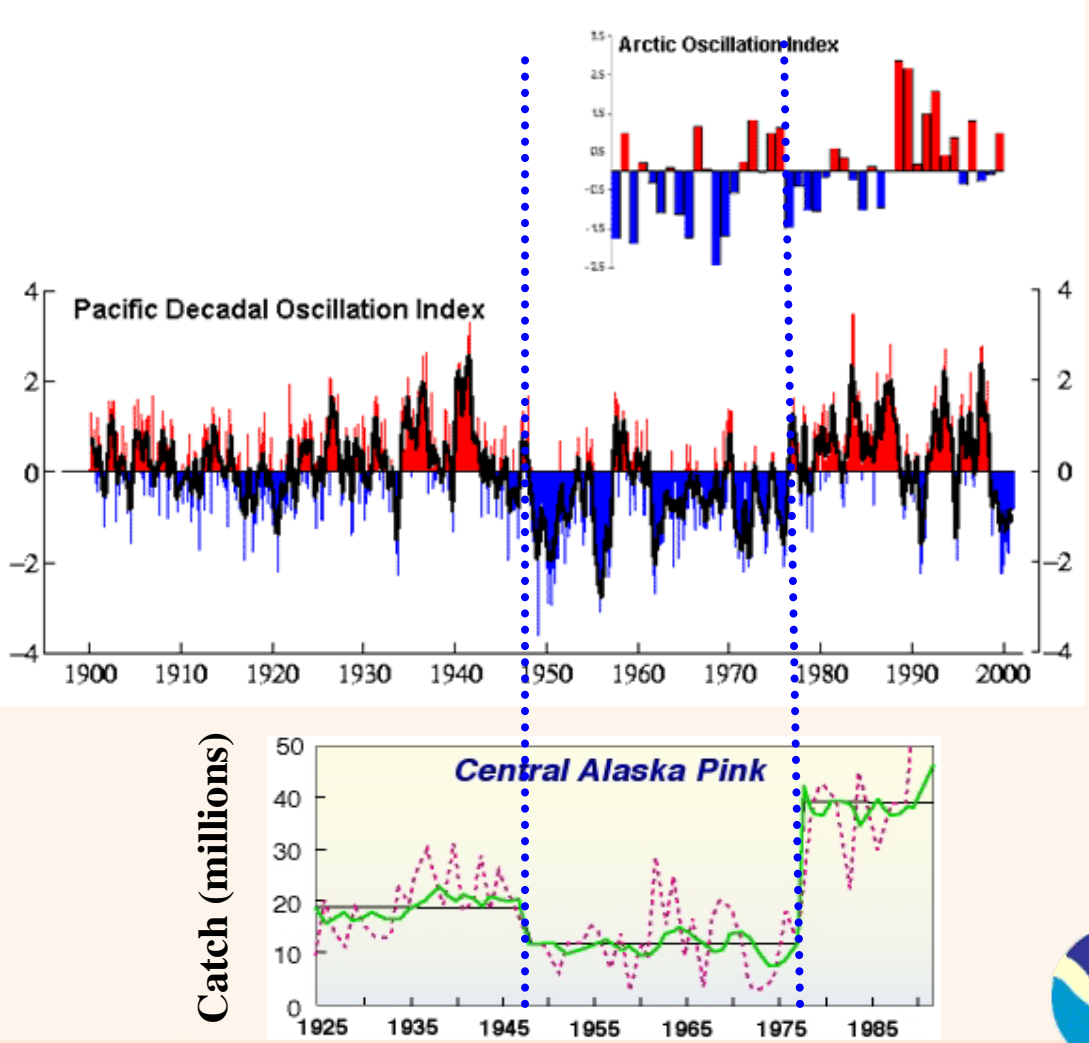
Lessons Learned (management)

- Strong project coordinator was critical (A. Macklin)
- At least one member of the program should have interdisciplinary training (e.g. J. Schumacher and G. Hunt)
- Tensions arose from real and perceived savings due to NOAA in-kind contributions
- Reliance on NOAA funding resulted in academic partnerships but the many academic partners played role as graduate student advisors. (exception – G. Hunt and G. Swartzman)
- For small (~$1M per year programs) NOAA in-kind contributions were critical
- Legacy of previous programs lead to more focused research. Thus, maintain core monitoring but stagger process oriented research to allow for synthesis.


Southeast Bering Sea Ecosystem
top-down, bottom-up
oscillating conditions
mysteries explained
Beth Turner, 2002
k. birchfield '04

Impact of Quasi-Decadal Climate Patterns on Salmon

Time history of PDO and AO indices (top) and associated changes in biological populations (bottom).



Hare and Mantua, 2000