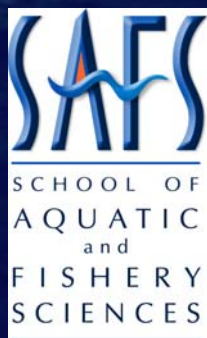
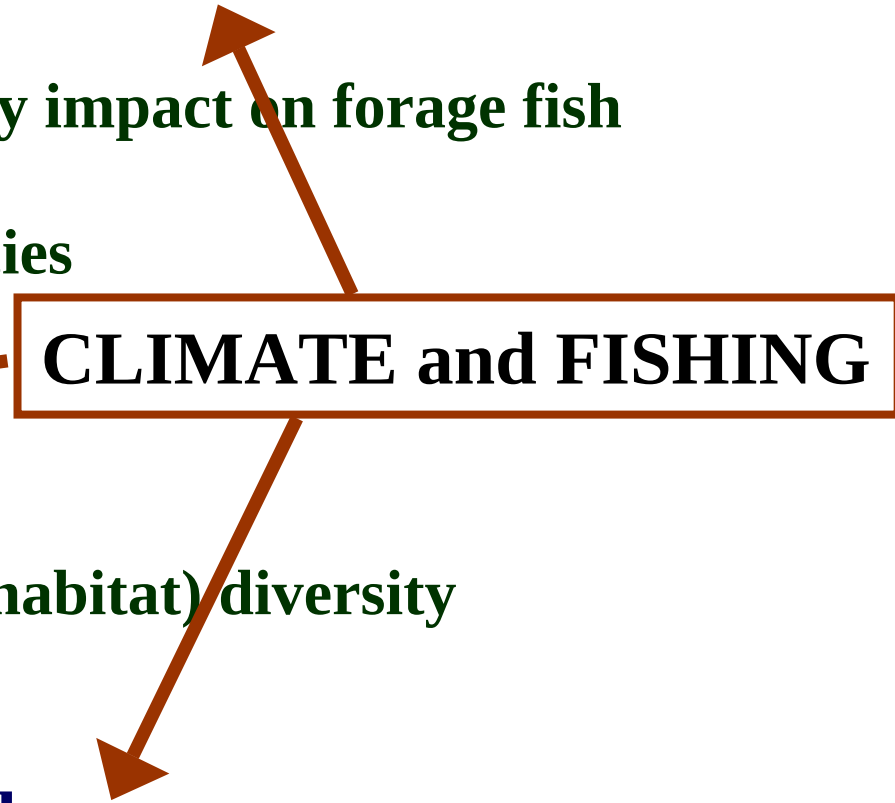
Current Status and Historical Trend Indicators of Climate Effects on the BS and GOA Ecosystems

Jennifer Boldt and Kerim Aydin



Objectives for Ecosystem Protection

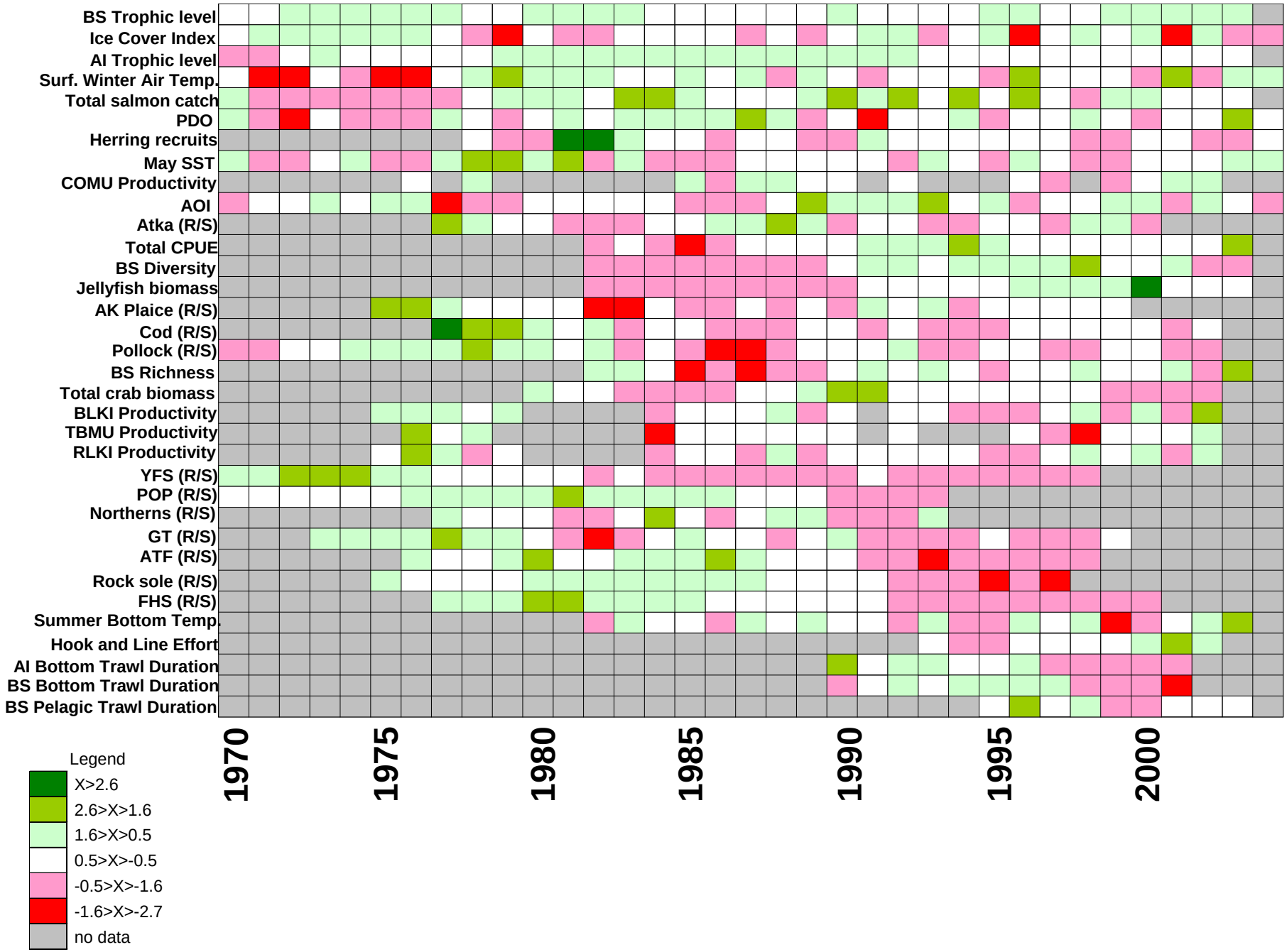
- **Maintain predator-prey relationships**
  - pelagic forage availability
  - spatial/temporal conc. of fishery impact on forage fish
  - removals of top predators
  - introduction of non-native species
- **Maintain diversity**
  - species diversity
  - functional (trophic, structural habitat) diversity
  - genetic diversity
- **Maintain energy flow and balance**
  - human-induced energy redirection
  - system impacts attributable to energy removal



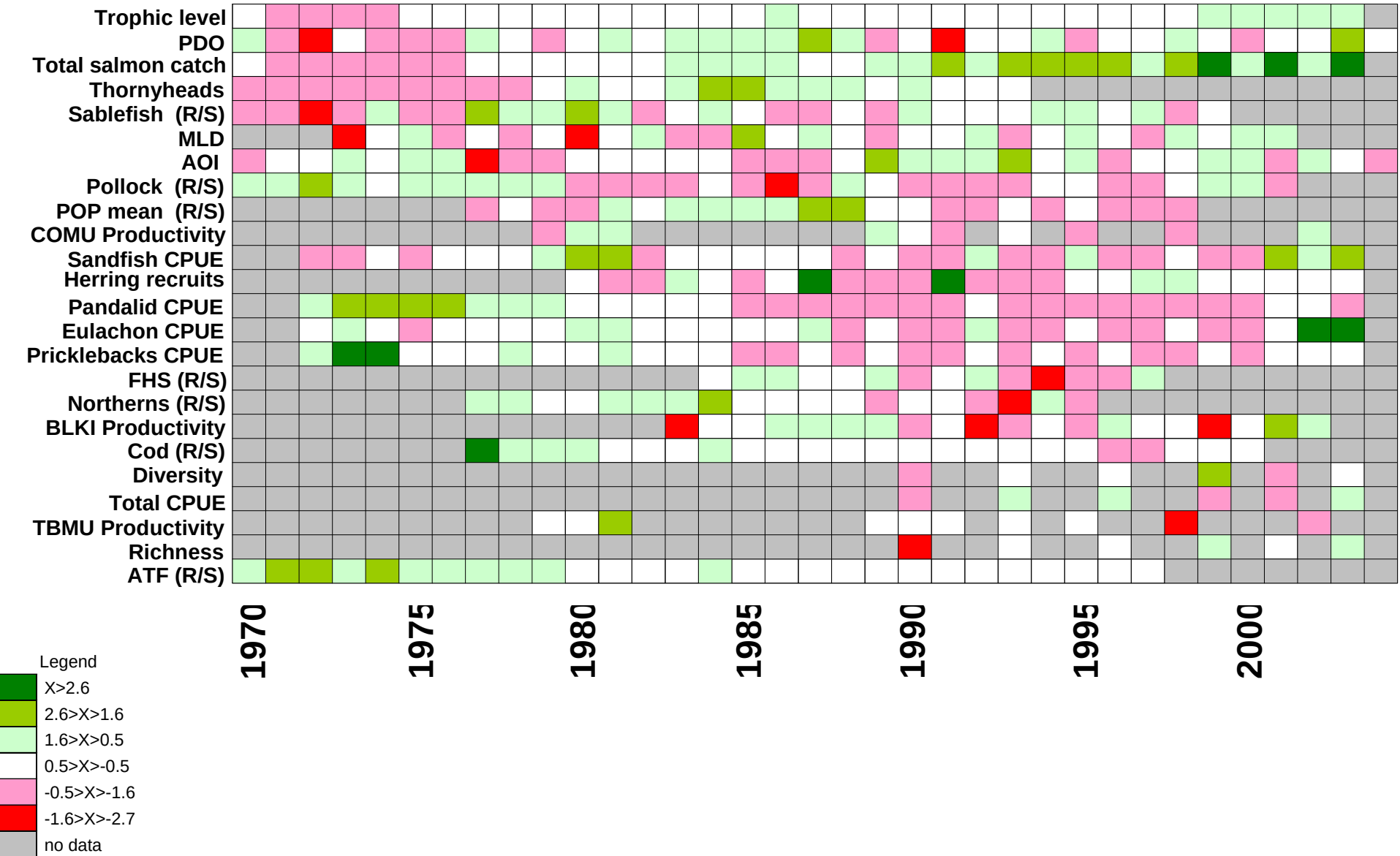
Sources of Information

- **Ecosystem Considerations** -section of the SAFE
  http://access.afsc.noaa.gov/reem/ecoweb/index.cfm
- **FATE** – Ecosystem Indicators report
  (AFSC Processed Report 2005-04)
- **PICES** – Fisheries and Ecosystem Responses
  (Sci. Rpt. No. 28 2005)
- **AFSC** Diet database

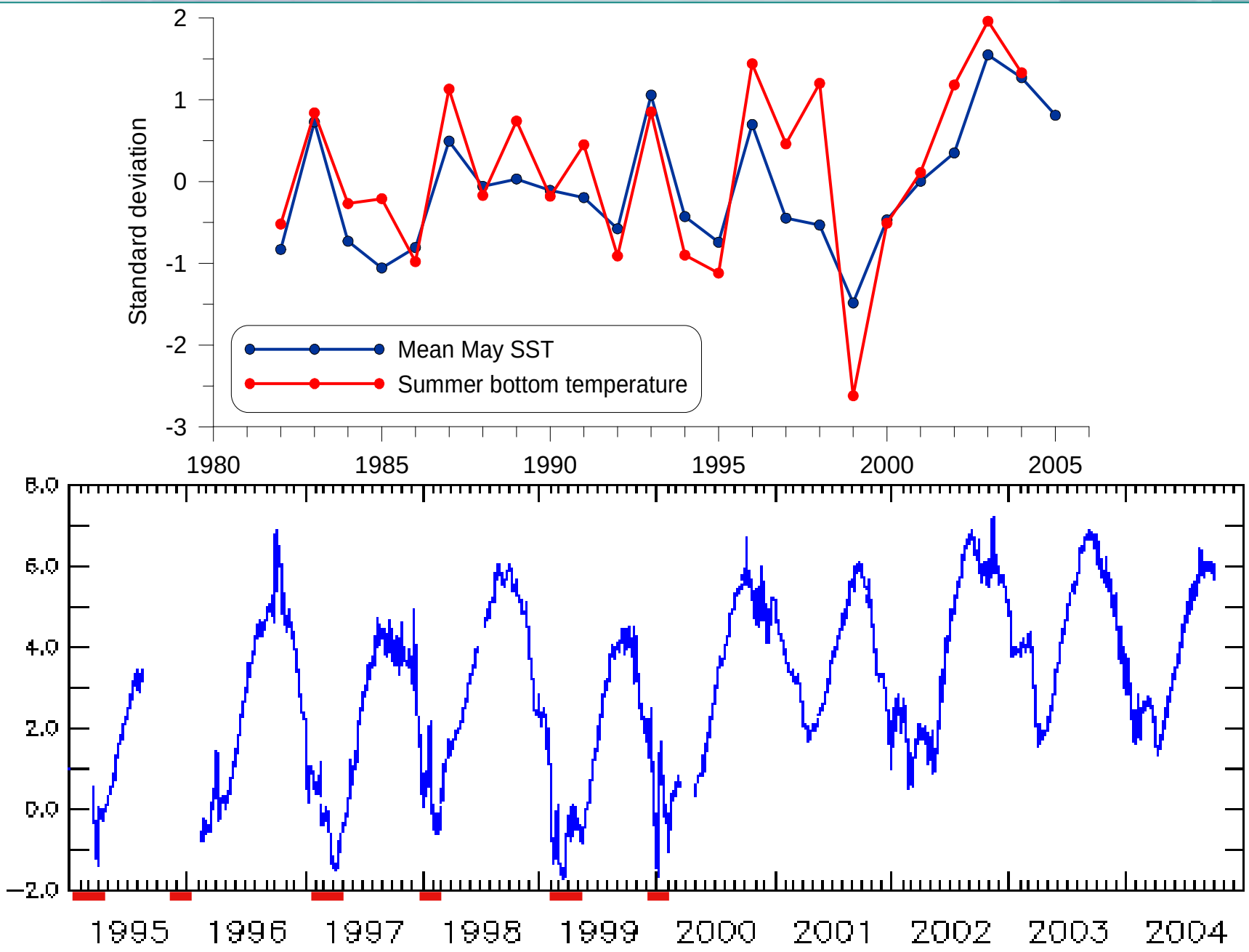
Bering Sea/Aleutian Islands



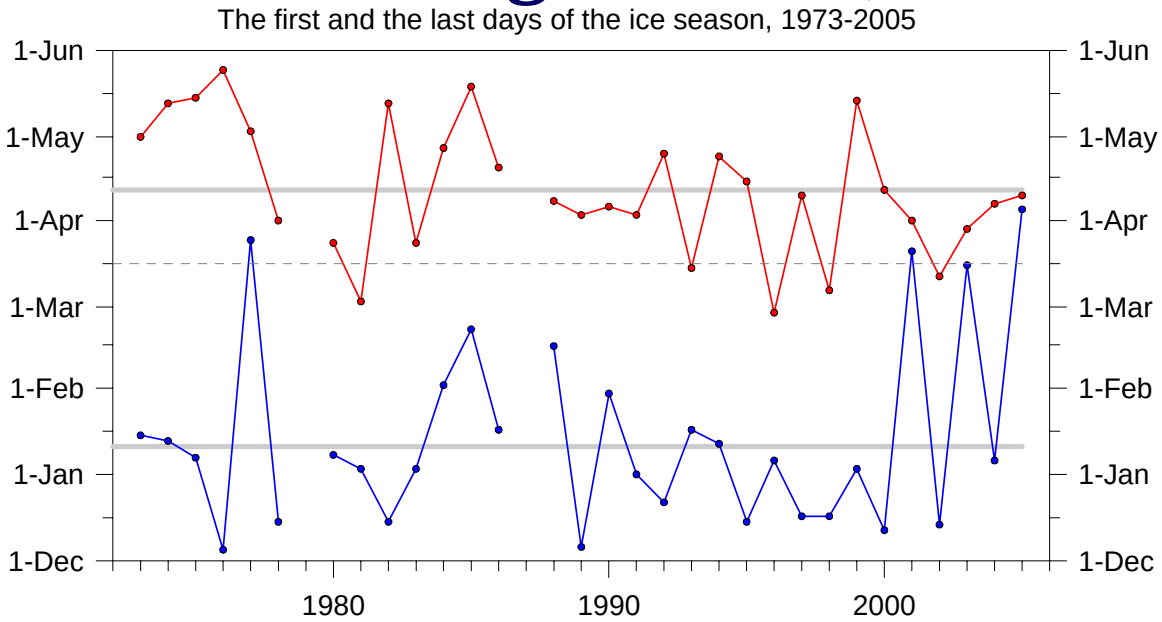
Gulf of Alaska

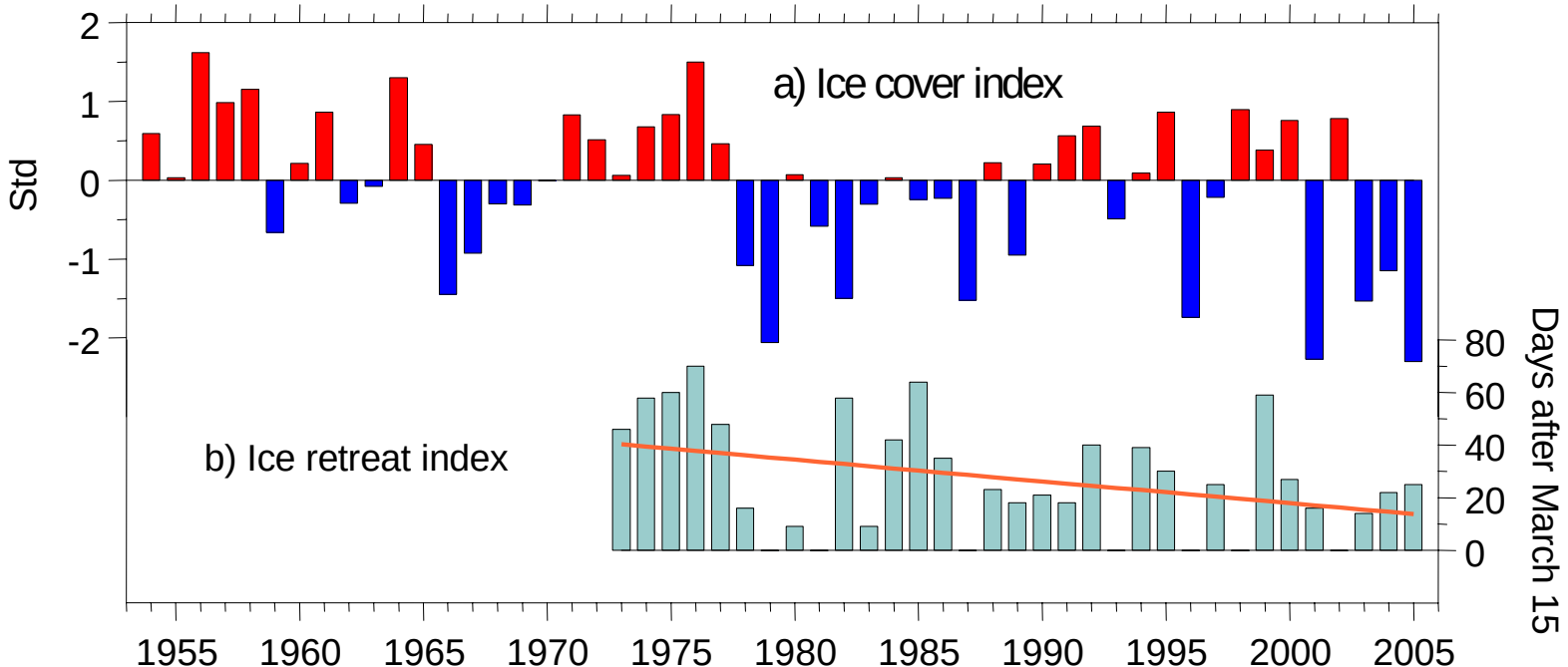


OCEAN -Bering Sea Temperature (Rodionov et al.)

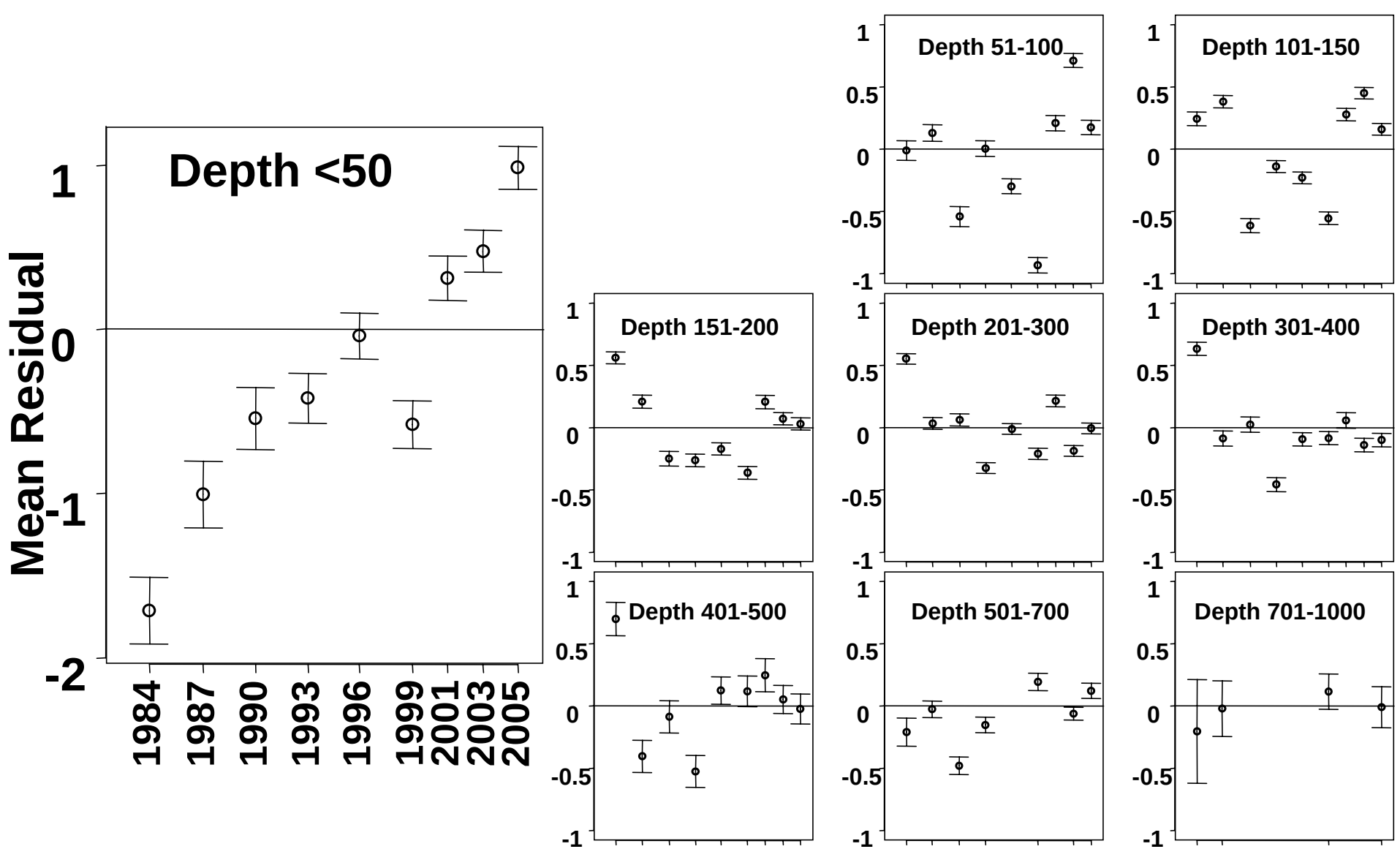


OCEAN -Bering Sea Ice (Rodionov et al.)



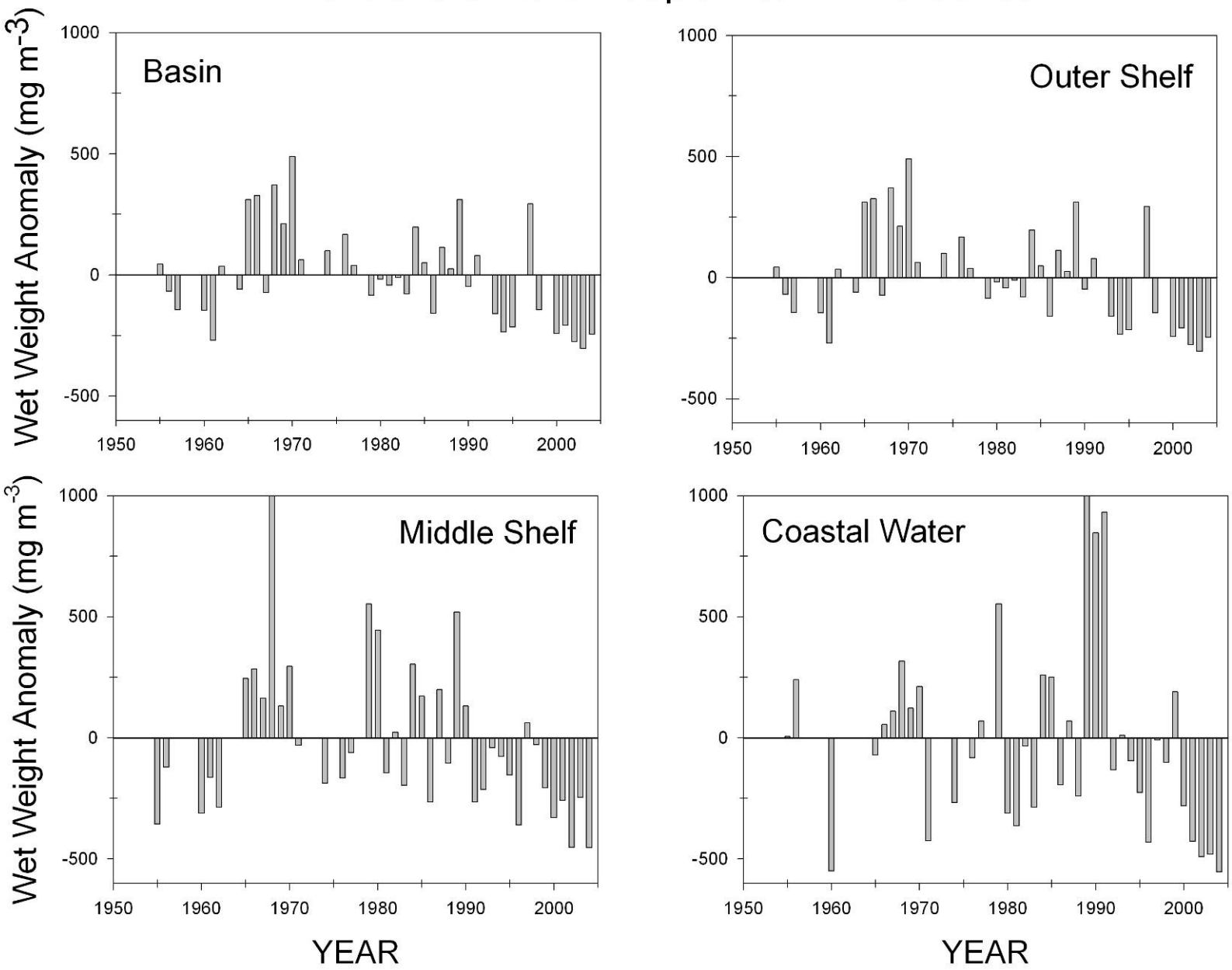


OCEAN - GOA Bottom Temperatures (Martin)



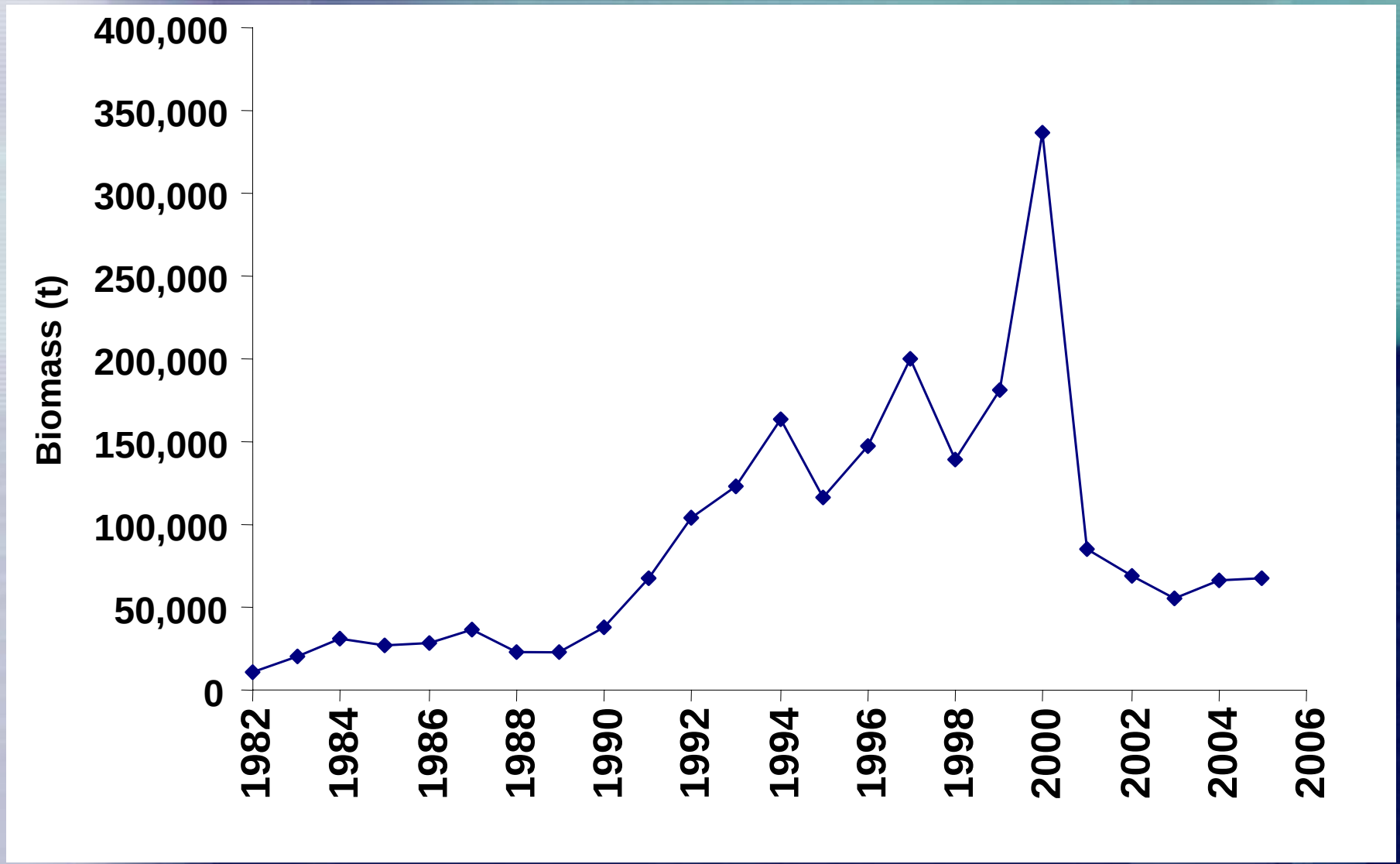
FORAGE -Bering Sea 1950-2004 (Napp and Shiga)

T/S *Oshoro Maru* Zooplankton Time Series

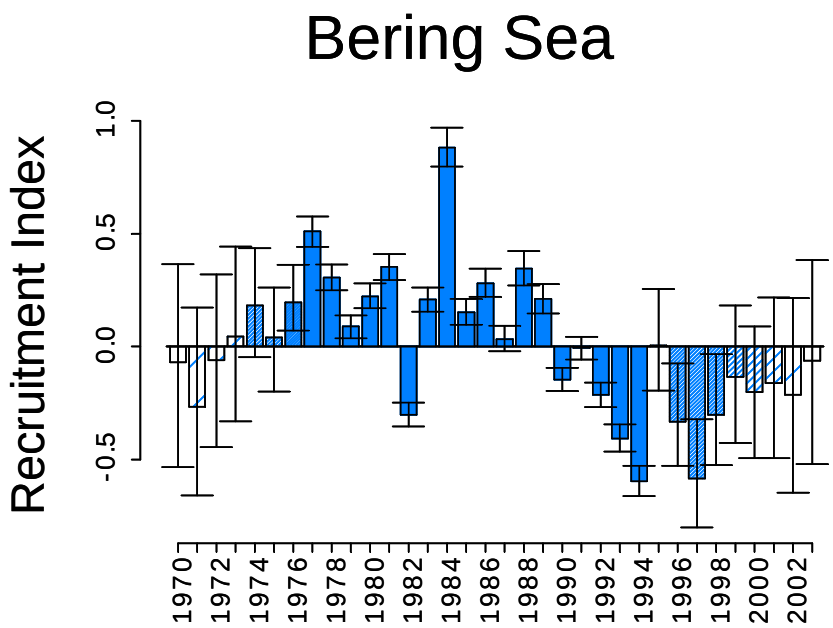


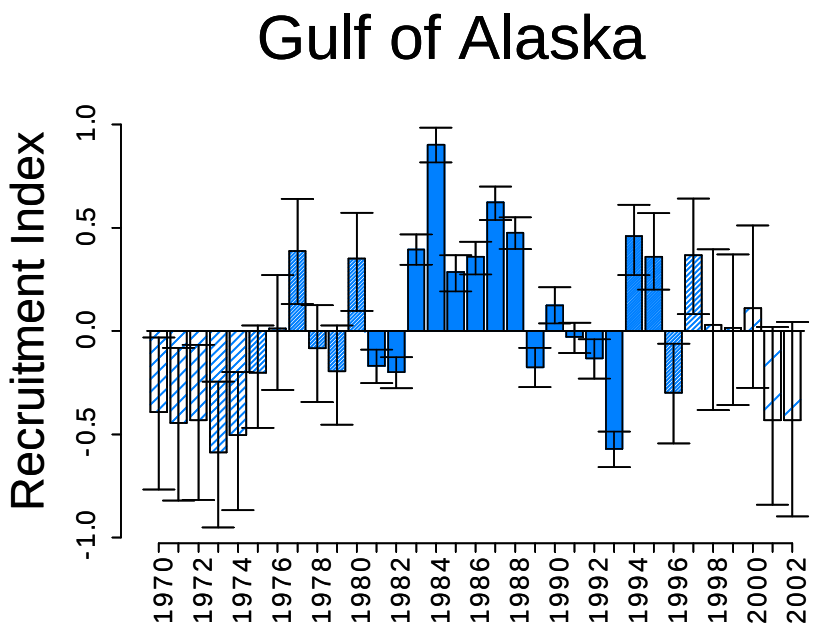
J. Napp & N. Shiga (unpublished)

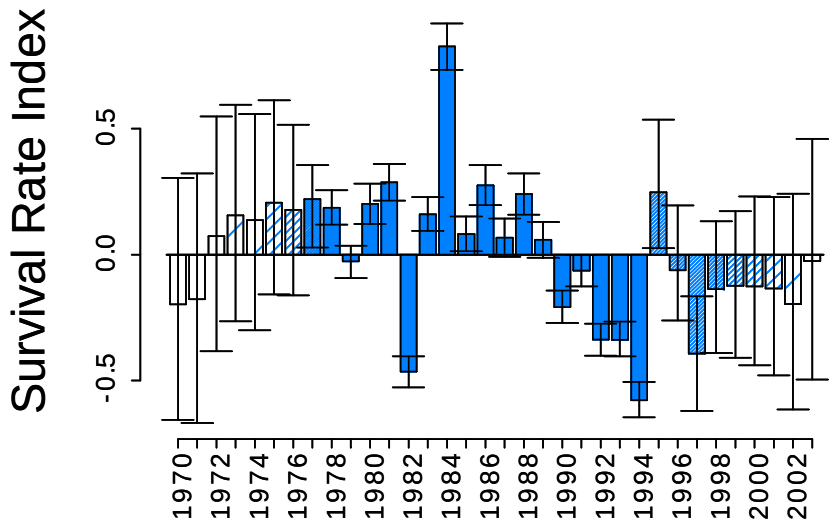
TOP PREDATORS -Bering Sea Jellyfish (Lauth)

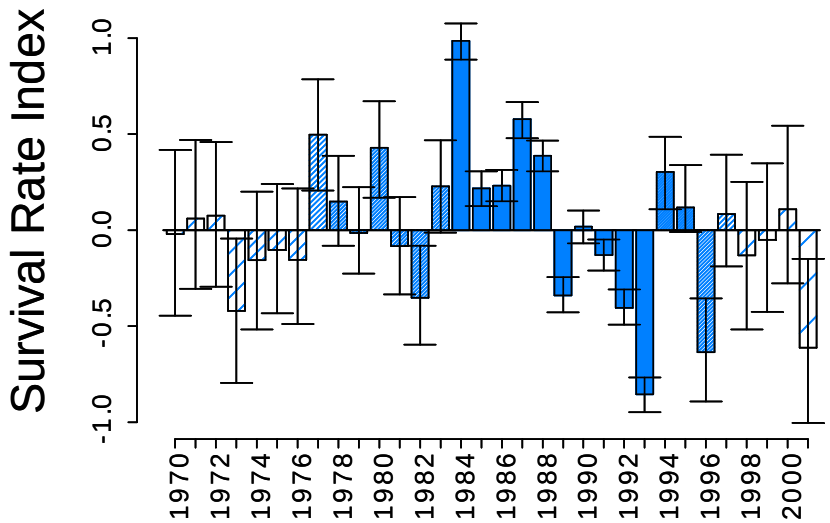


GROUNDFISH – Combined Std. Indices of Recruitment and Survival (Mueter)









GROUNDFISH

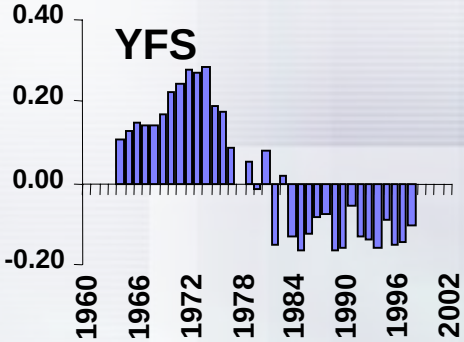
B.Sea

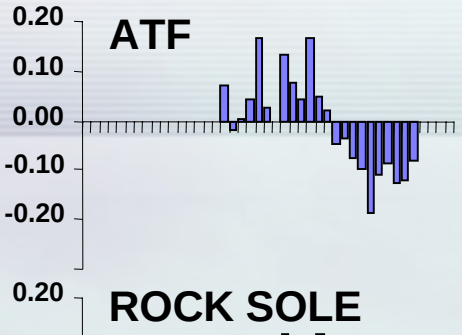
1976/77 shift

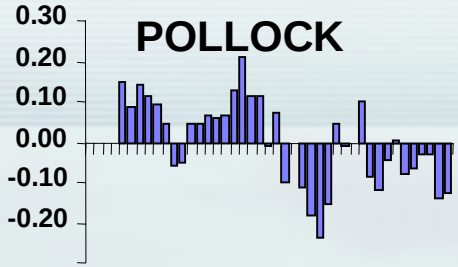
1988/89 shift

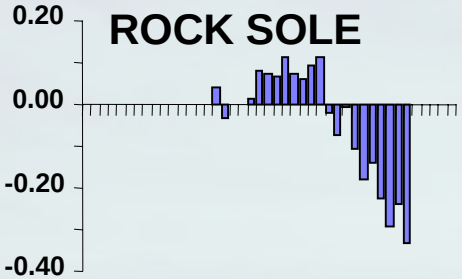
Other shift

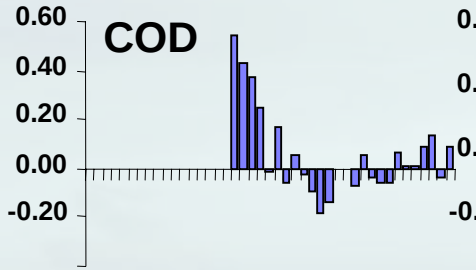
R/S Anomalies

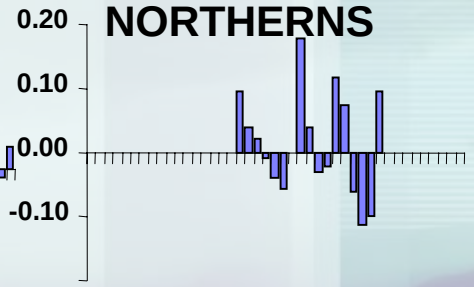


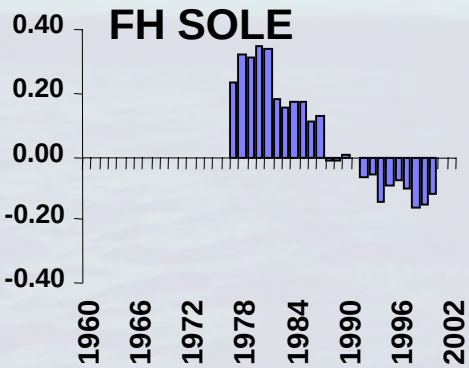


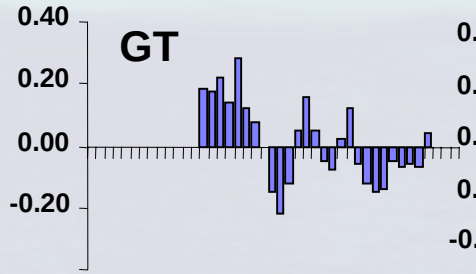


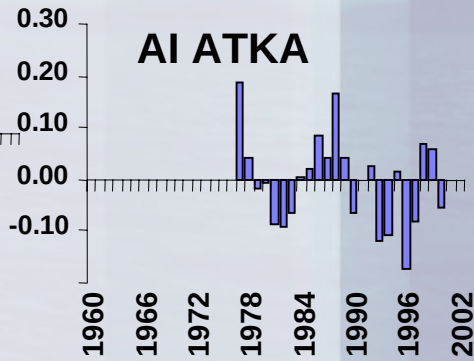


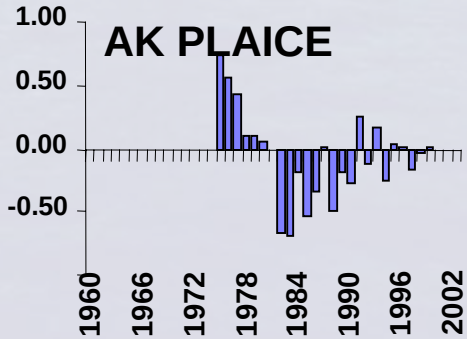


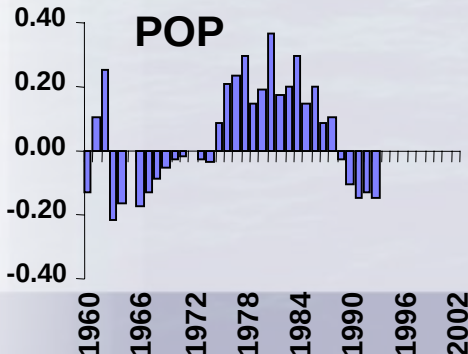




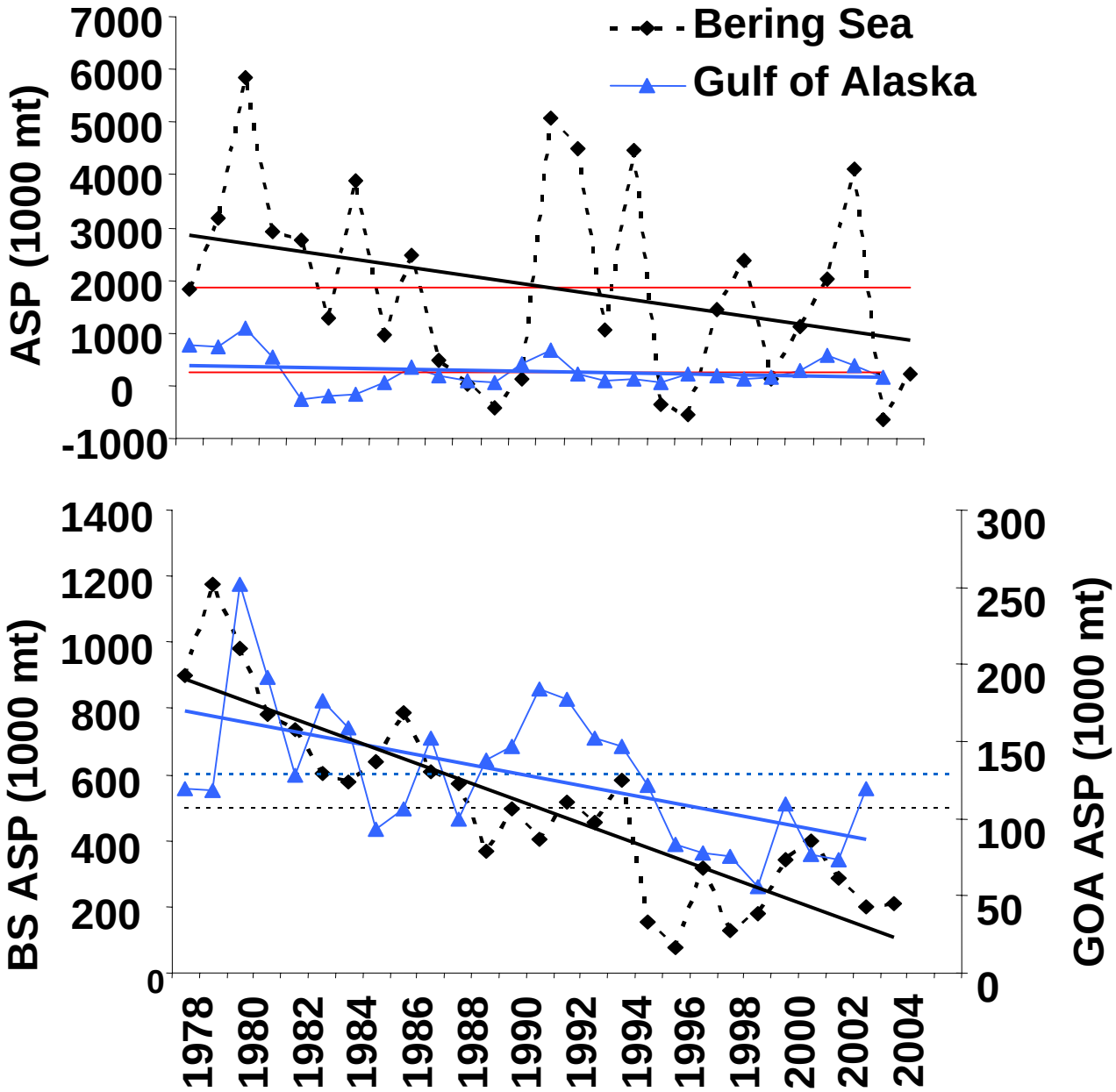


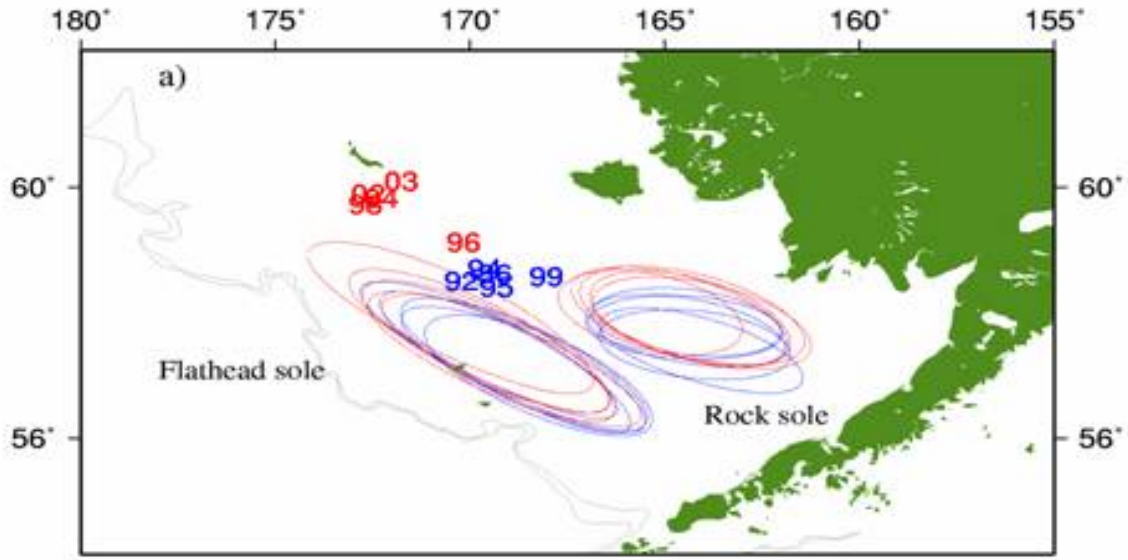




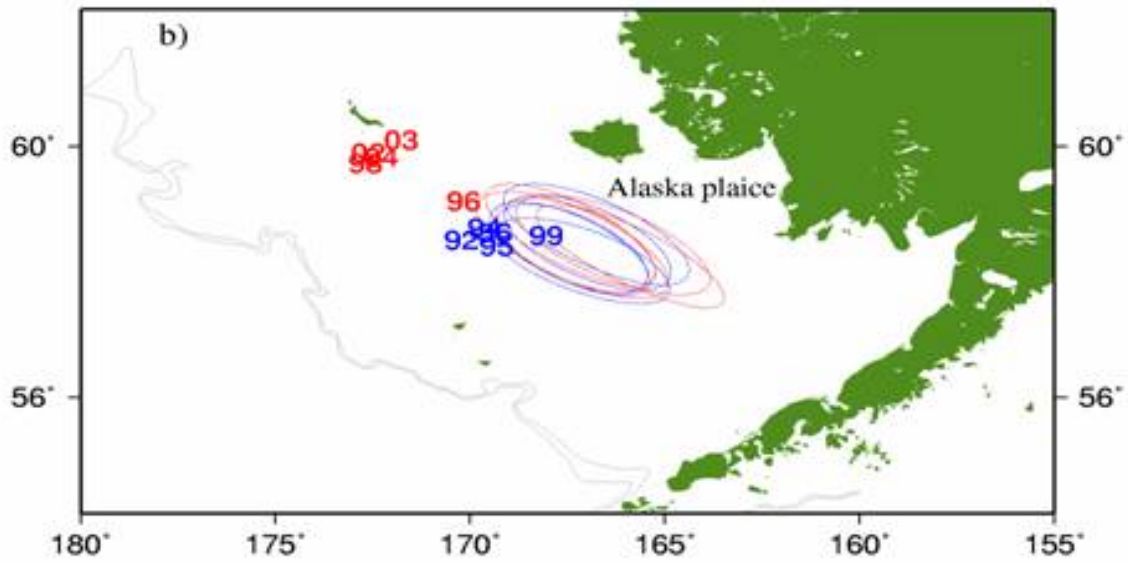


Annual Surplus Production (Mueter)

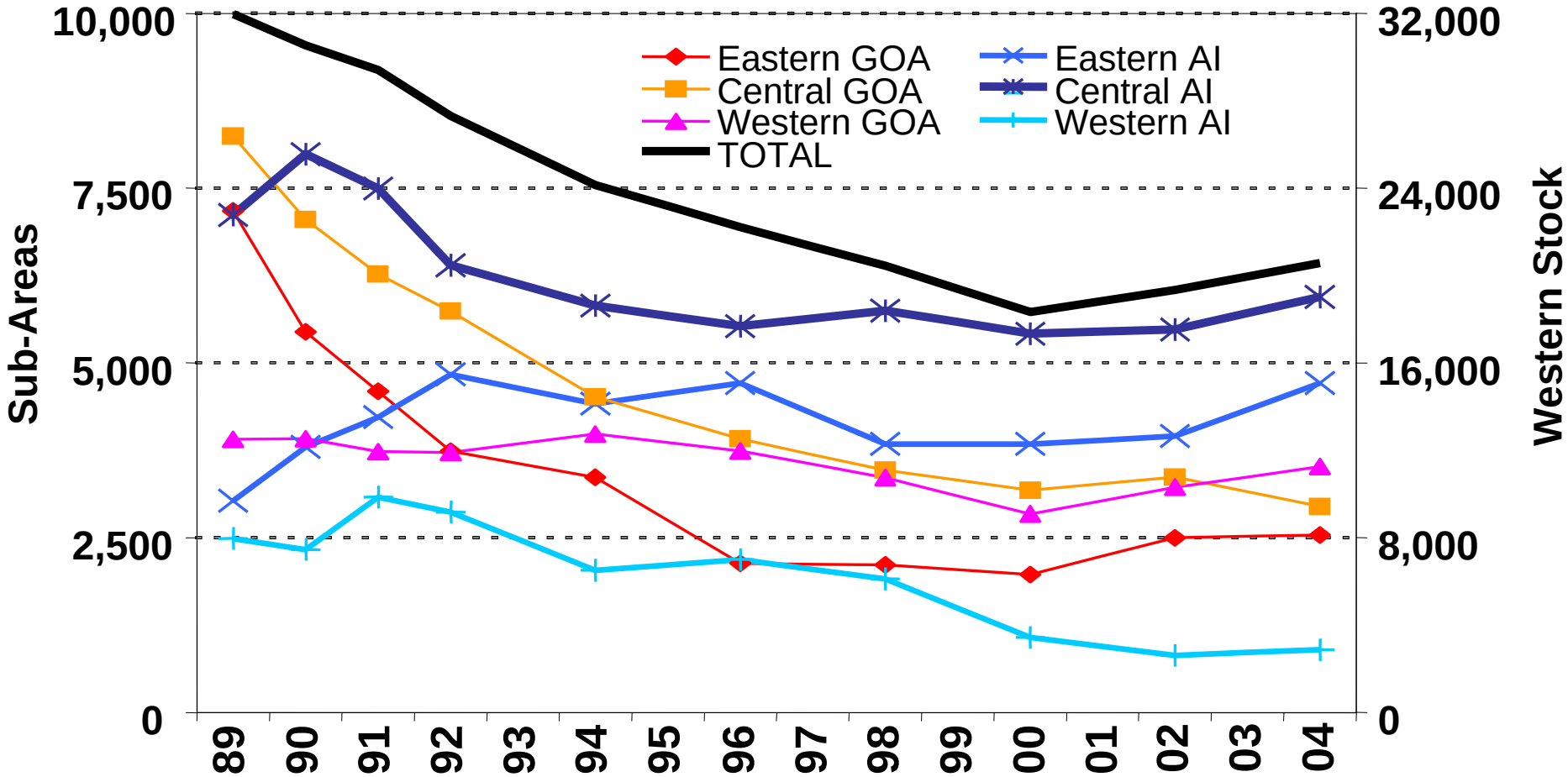




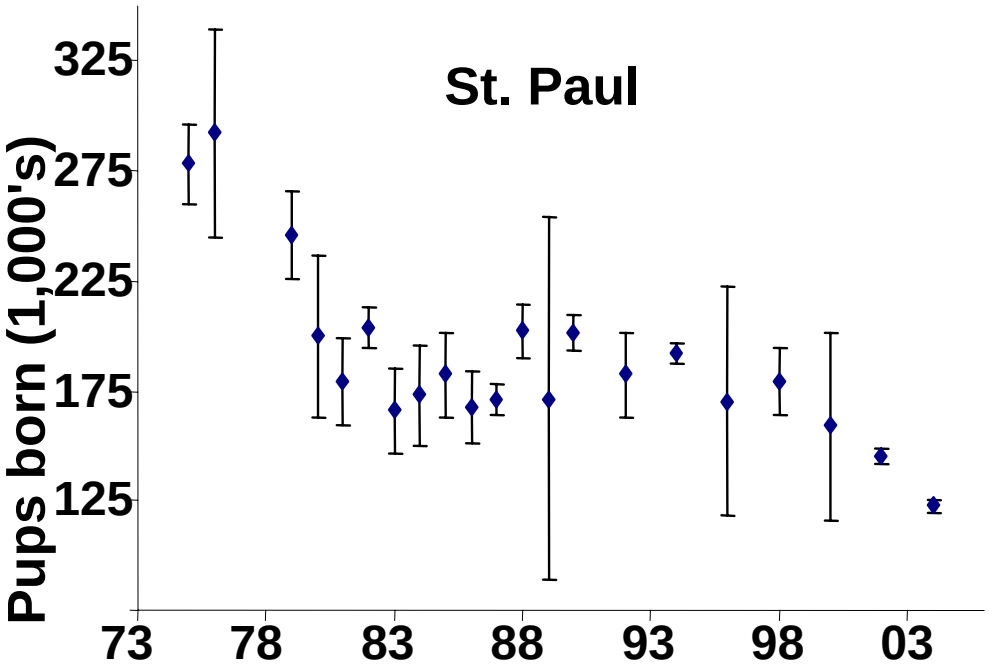
GROUNDFISH
Flatfish Distribution-(Spencer)

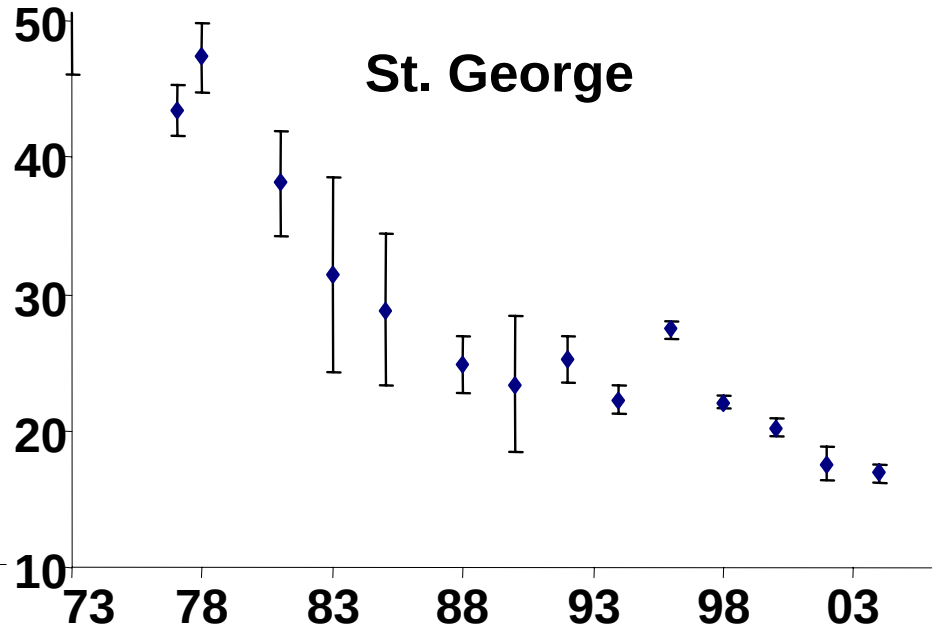


TOP PREDATORS-
Marine Mammals (Sinclair and Testa)
Steller Sea Lions – Non-pup counts



TOP PREDATORS-
Marine Mammals (Sinclair and Testa)
Northern fur seal pup counts



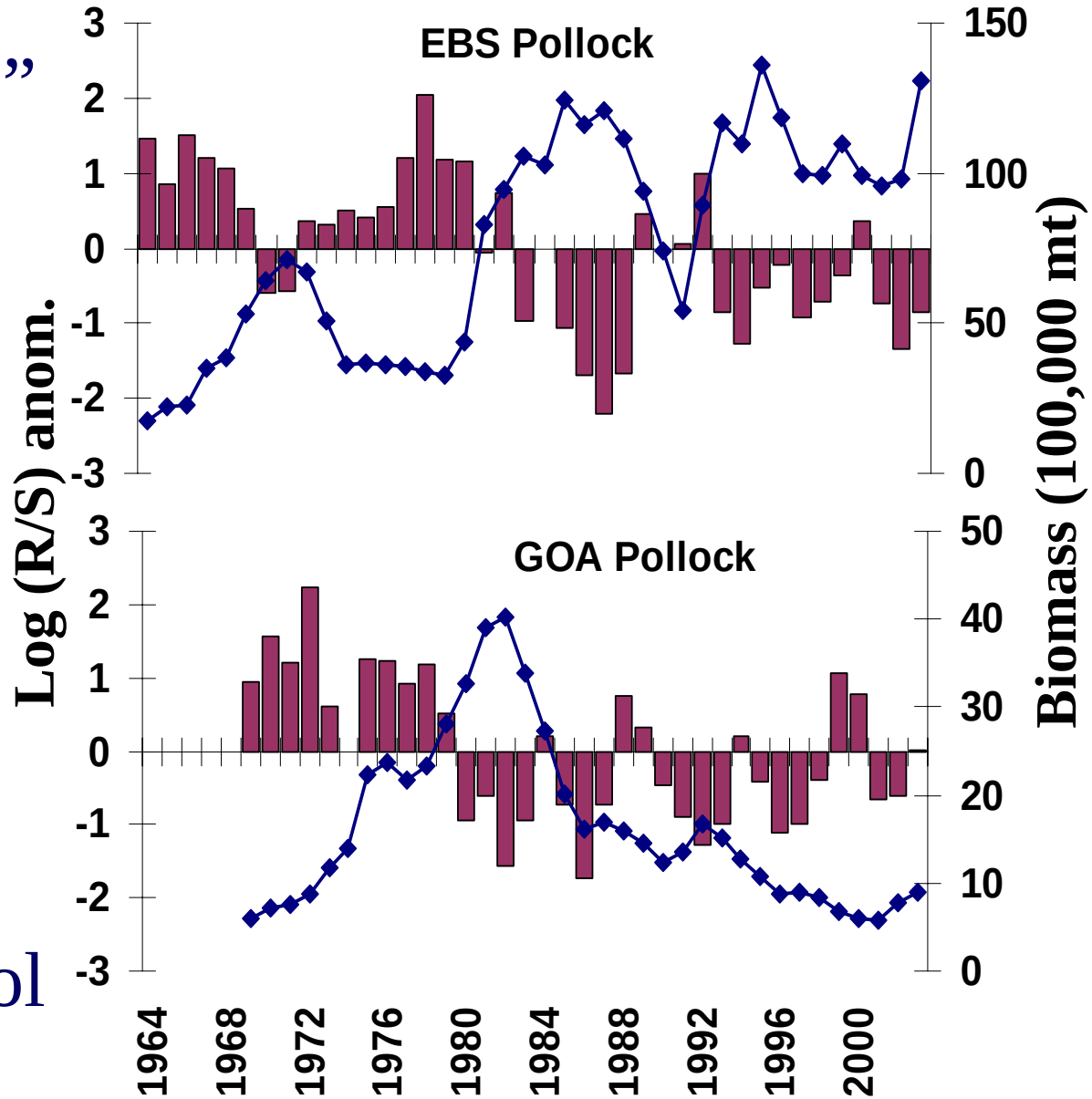


Summary

- BS continues to warm, less sea ice and earlier retreat
- GOA bottom temperatures increased in shallow areas
- BS summer zooplankton biomass: low 2000-2004
- BS jellyfish biomass: low 2000-2005
- Warming trend may affect flatfish distribution
- Climate change may affect groundfish productivity
- ASP in BS and GOA decreased from 1978-2004
- 2004 N. fur seal pups born continued to decline
- 2004 non-pup Steller sea lion counts increased in most areas

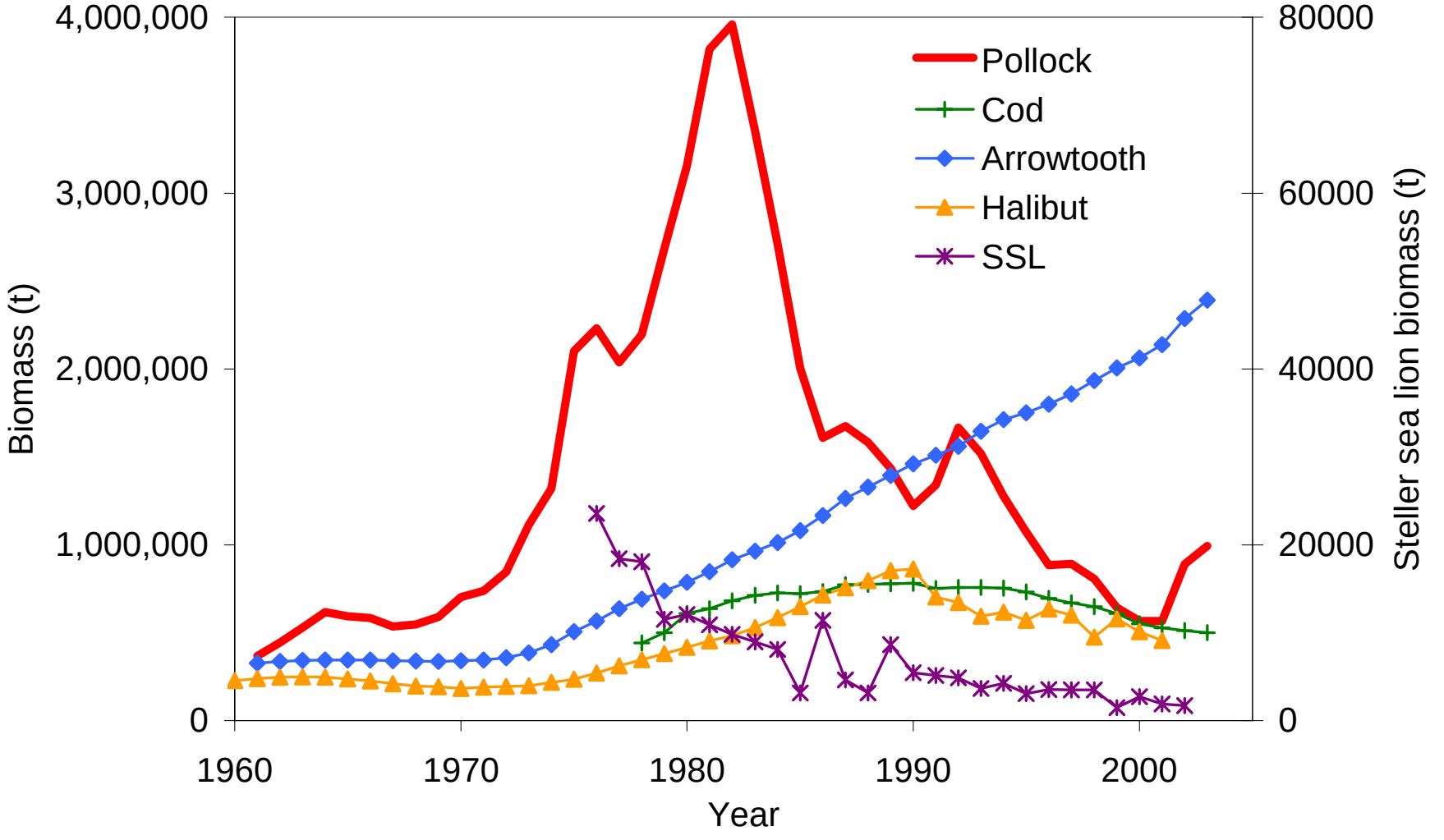
Pollock Recruitment

- Pollock "regimes" unpredictable: detection of mechanisms through food habits data?
- Shifting mechanisms
- Oscillating control hypothesis



Pollock energy shift in groundfish predators?

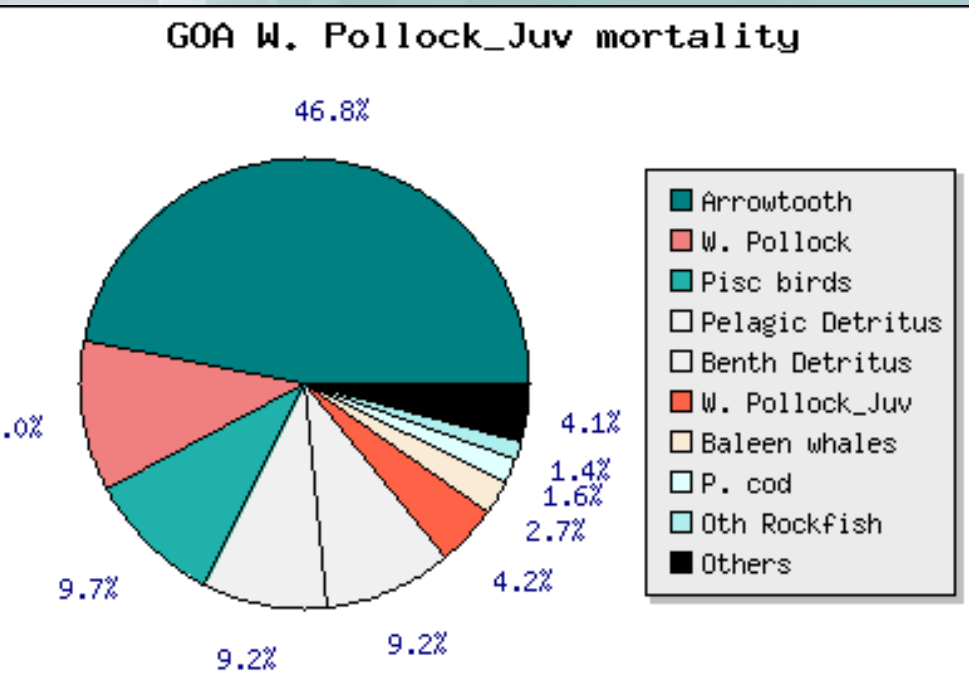
Gulf of Alaska Biomass trends

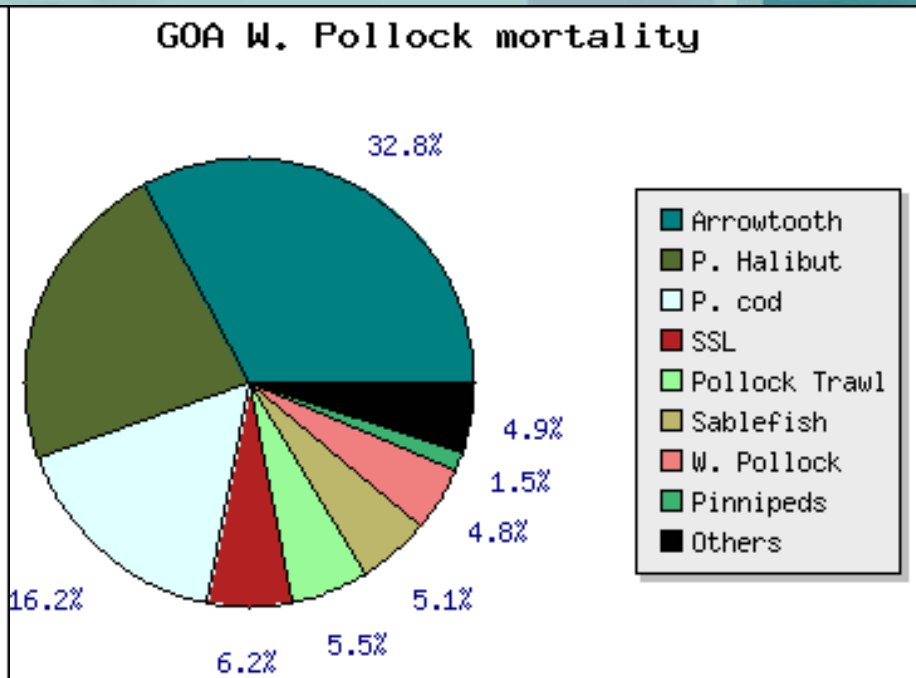


Mortality sources of pollock (1990-96 average)

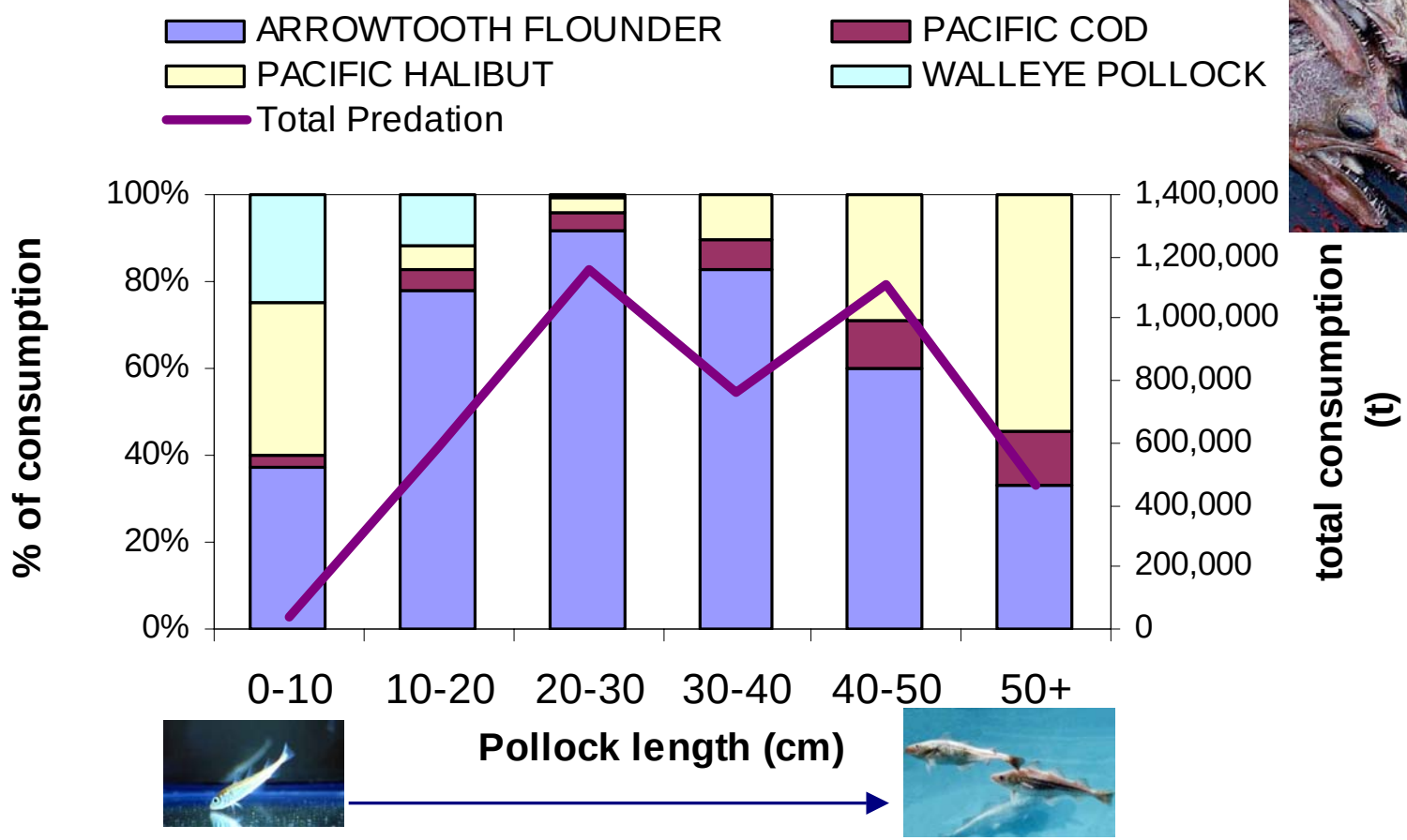
Juv. pollock

Adu. pollock

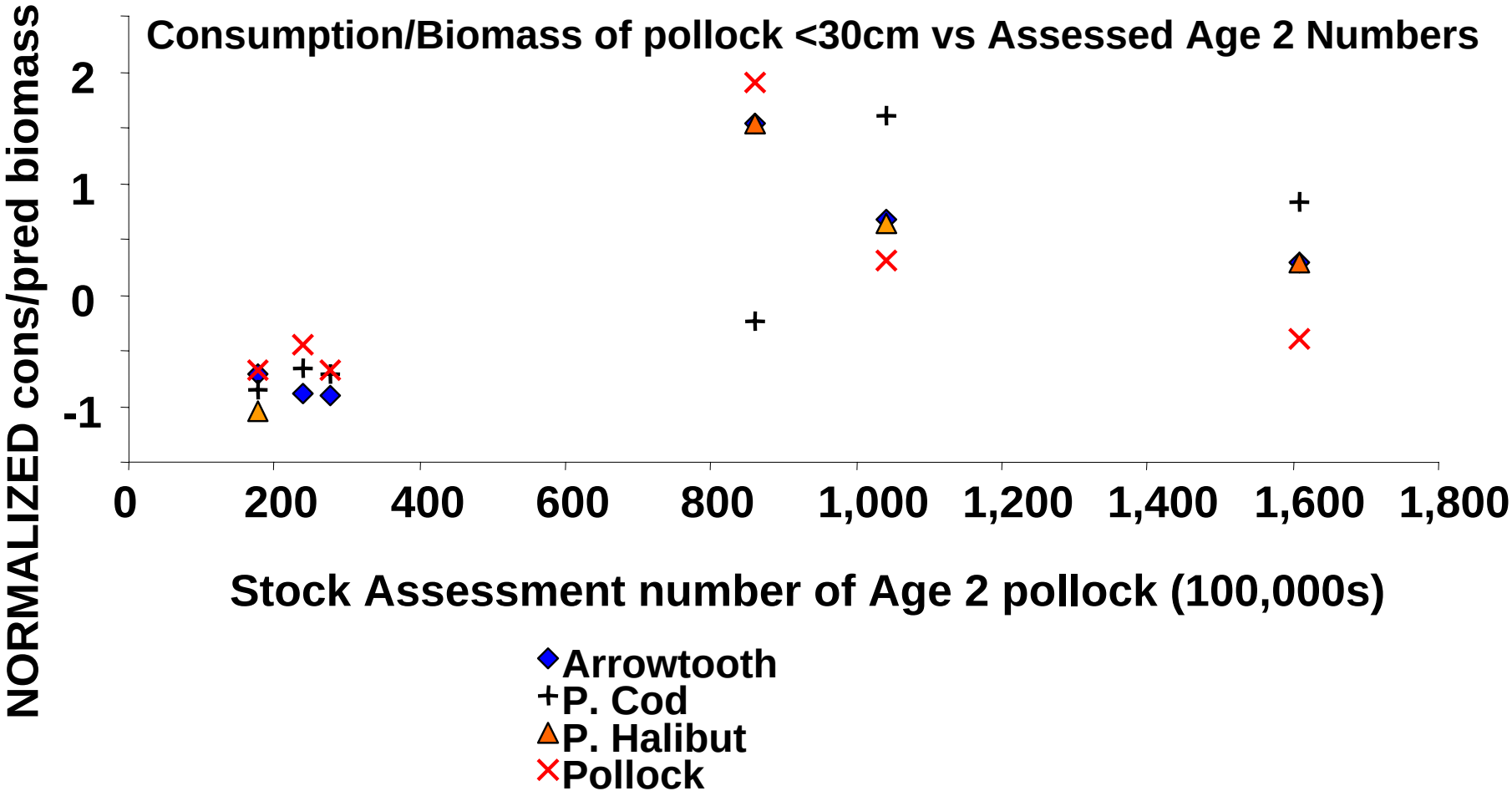




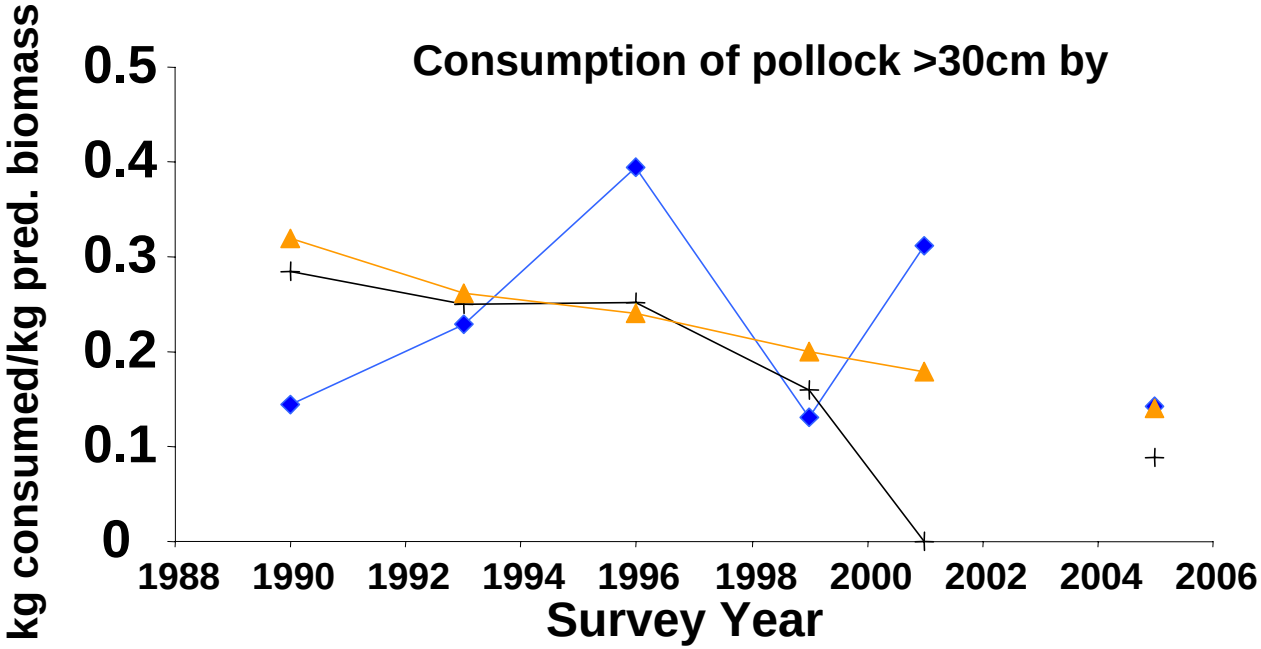
Gulf of Alaska pollock predators

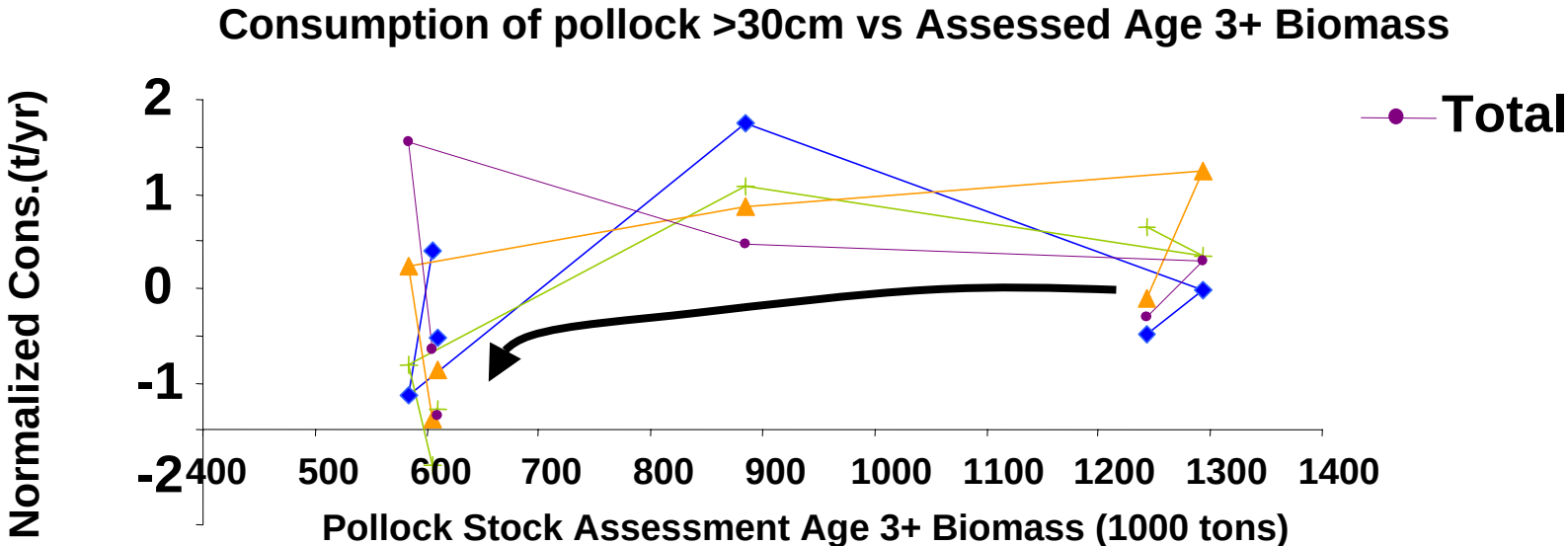


Functional response of predators to young pollock

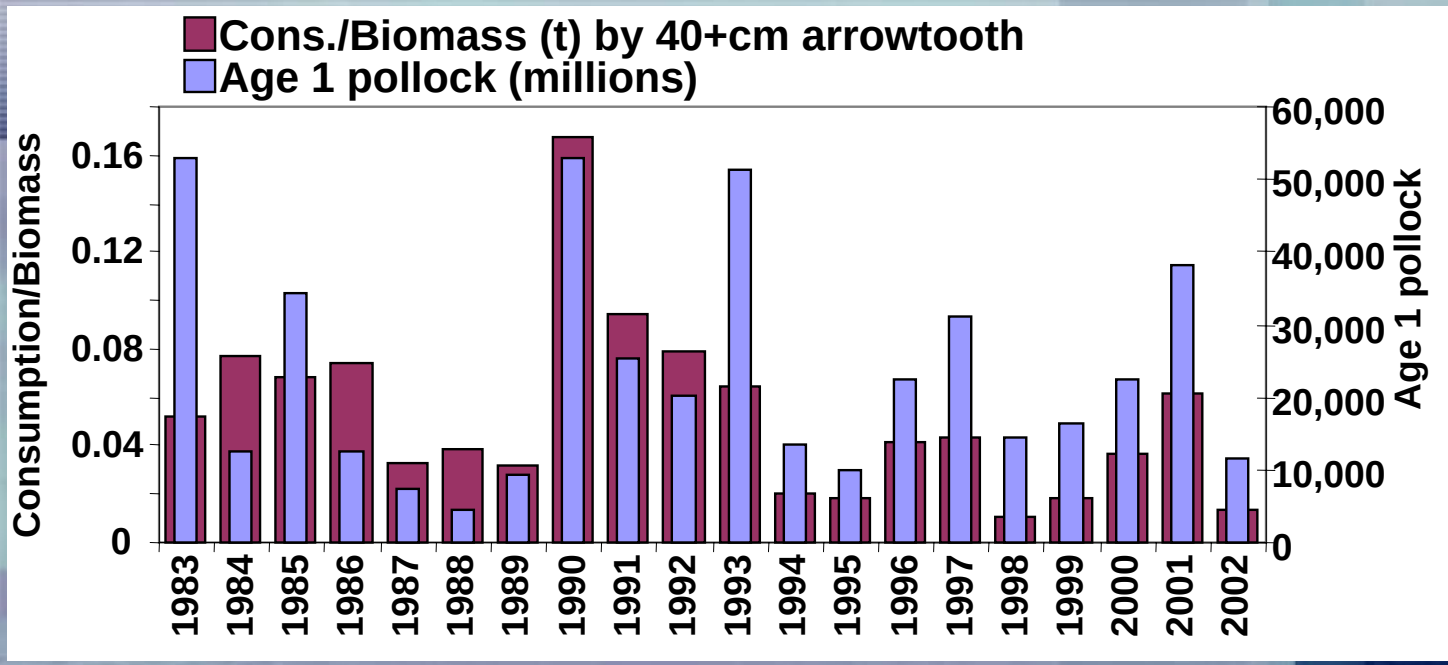


…redirection of adult pollock production from large predators

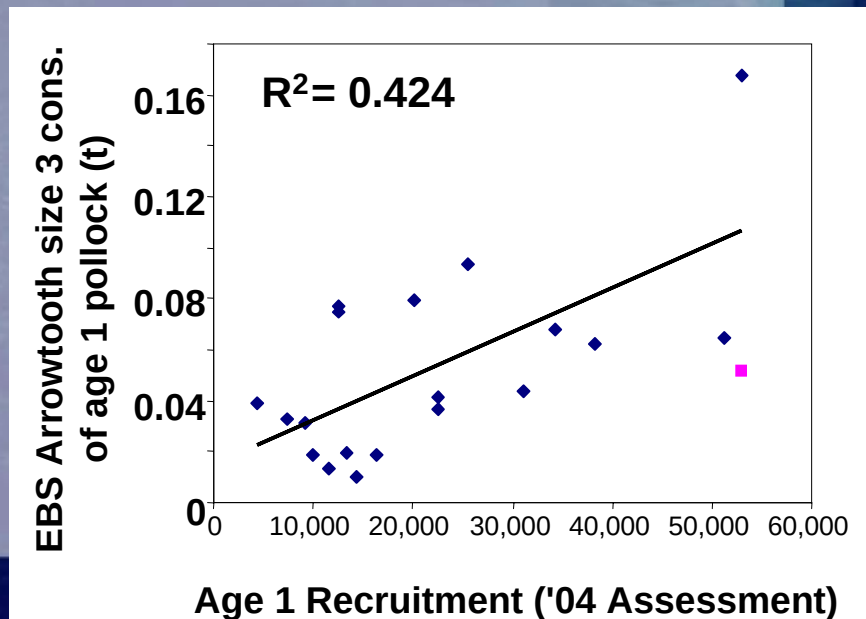




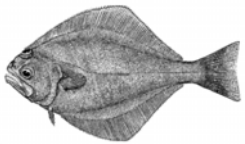
EBS pollock recruitment vs. consumption



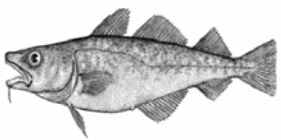
- **Two functional responses (pre- and post- 1992)?**
- **Shift of arrowtooth away from juvenile pollock consumption?**



Shifting predator size compositions



Arrowtooth



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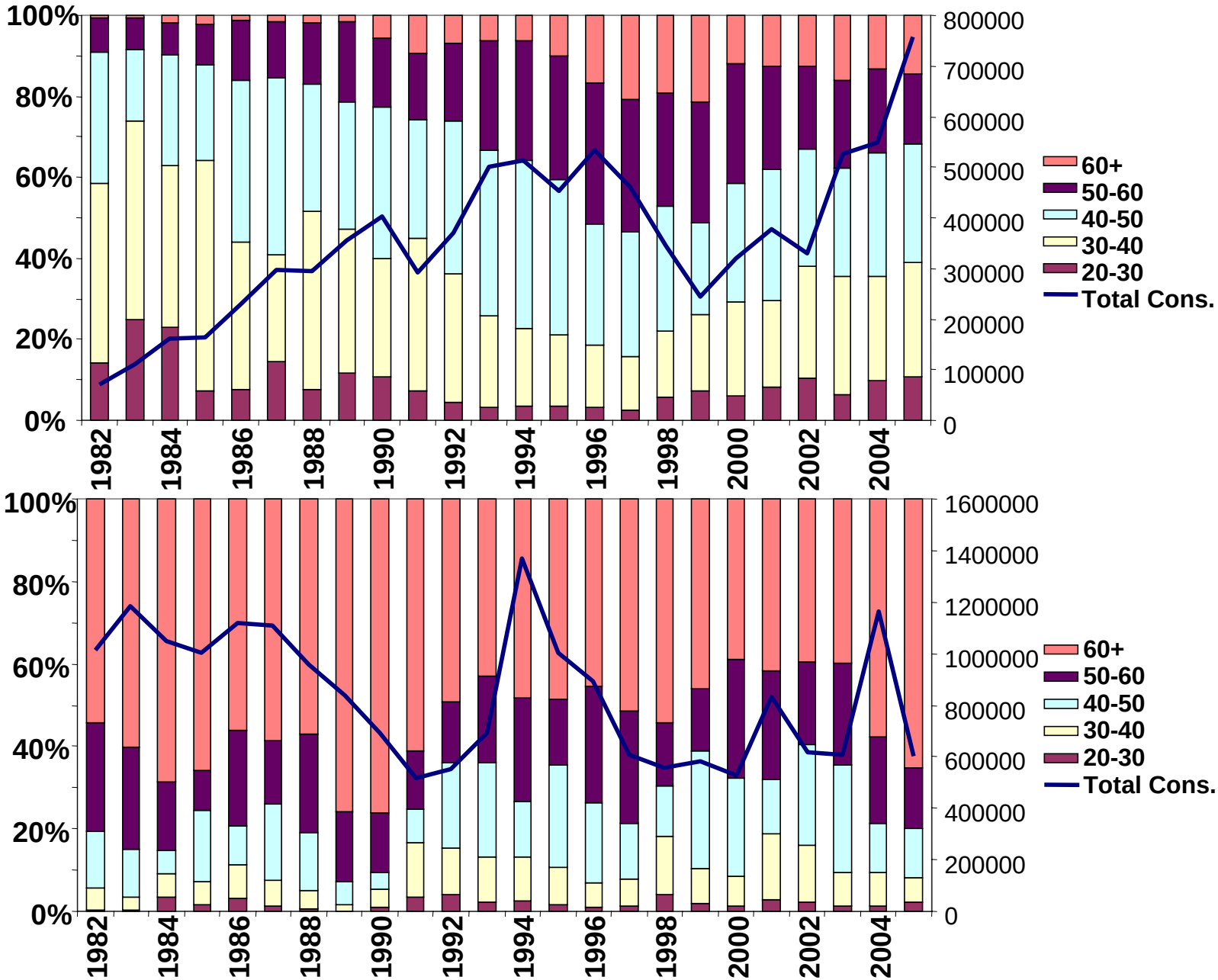
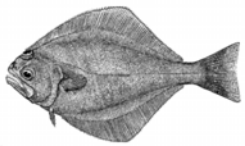
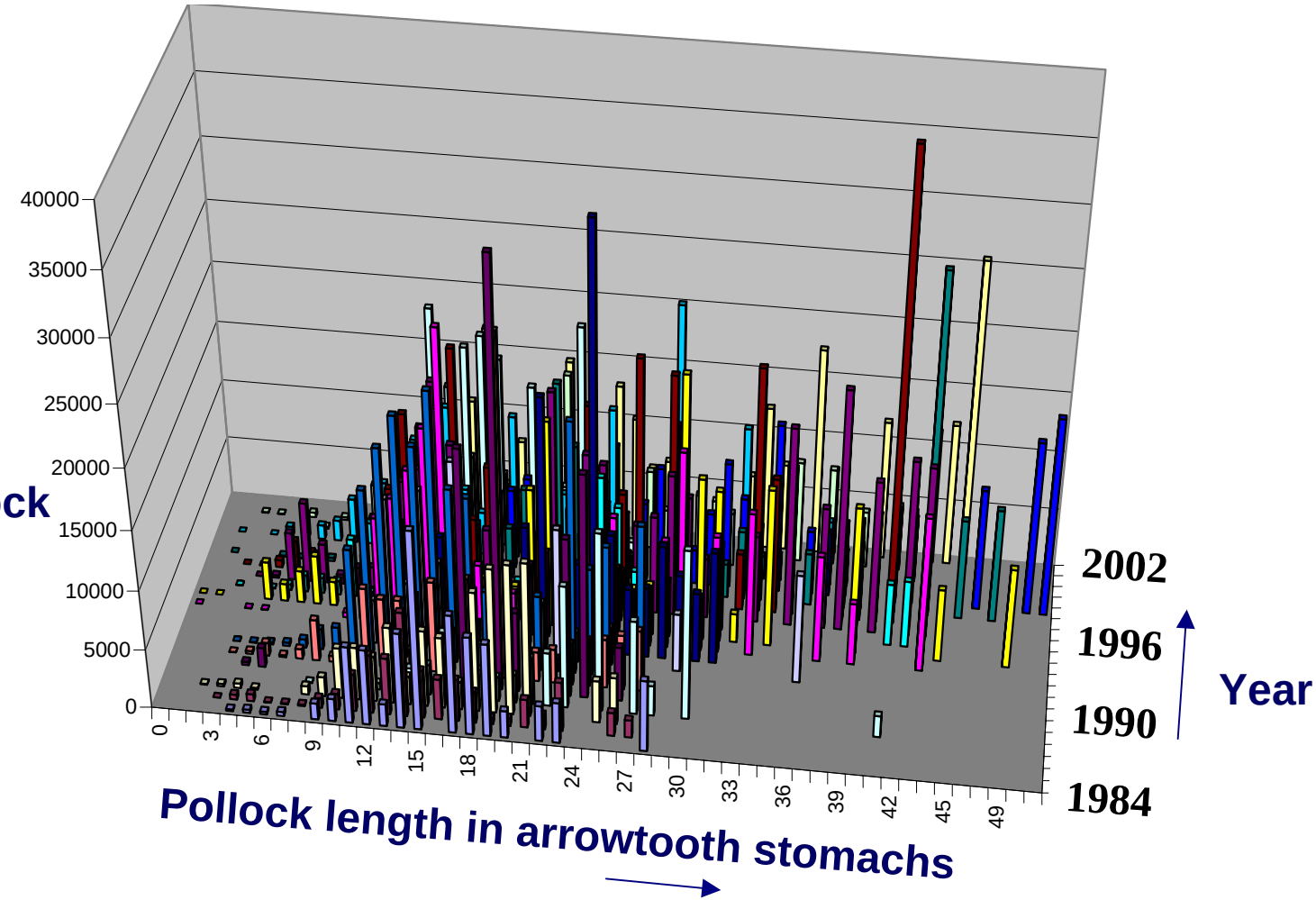
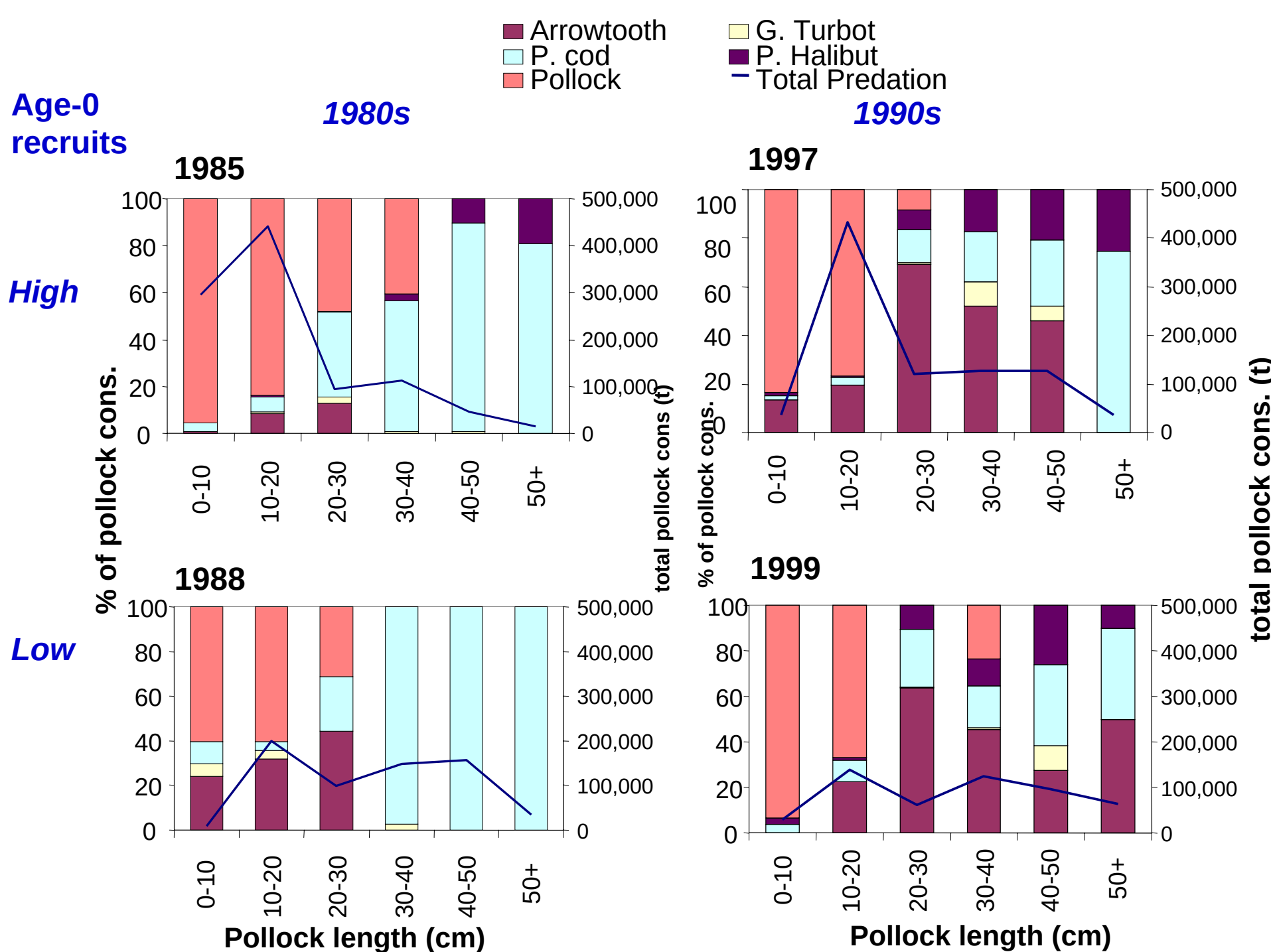


Changing arrowtooth population selectivity over time






Arrowtooth
P. cod
Pollock
G. Turbot
P. Halibut
Total Predation
Age-0 recruits
1980s
1990s
High
Low
1985
1997
1988
1999
% of pollock cons.
total pollock cons (t)
0-10
10-20
20-30
30-40
40-50
50+
Pollock length (cm)

Conclusions

- GOA pollock recruitment appears to be bottom-up controlled; top-down control appears to have increased on age 3+ in recent years
- Final BS pollock production a product of oscillating control through cannibalism (<20cm fish) and long term lags in predator shifts for mid-sized prey (20-40 cm).
- With all these lags, pollock recruitment may look like a lot of noise and still be driven by regimes!

Acknowledgements

- All Ecosystem Considerations contributors especially: N. Bond, R. Lauth, A. Macklin, M. Martin, F. Mueter, J. Napp, J. Overland, S. Rodionov, S. Salo, N. Shiga, B. Sinclair, P. Spencer, P. Stabeno, W. Testa
- FATE –Fisheries and the Environment
- AFSC –diet analysis laboratory
- PICES