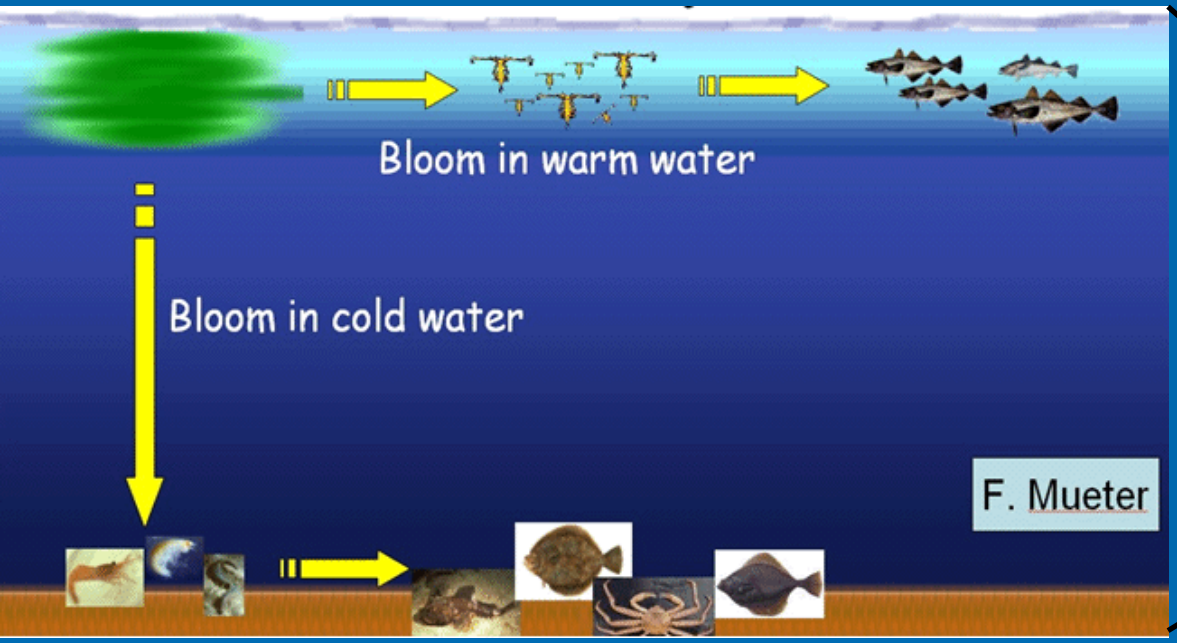
Where Do We Go From Here?

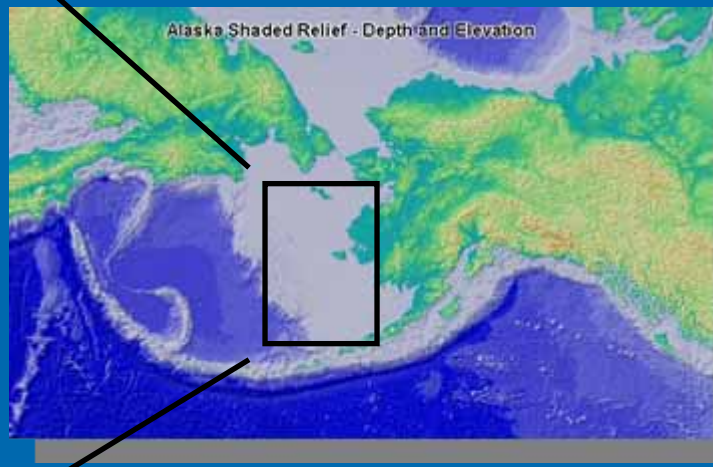
Climate Effect on Salmon Carrying Capacity

- Models predict warming sea temperatures in the Bering Sea (N. Bond).
- Climate warming not expected to effect carrying capacity for salmon in the western Bering Sea (O. Temnykh)
- More immature salmon migrate to Bering Sea during warmer spring/summer years (T. Nagasawa)
- On eastern Bering Sea shelf, the carrying capacity for salmon appears higher during warm years (need to test whether or not increased warming may decrease growth potential).

1. Develop Hypotheses

Productivity of the Eastern Bering Sea Ecosystem

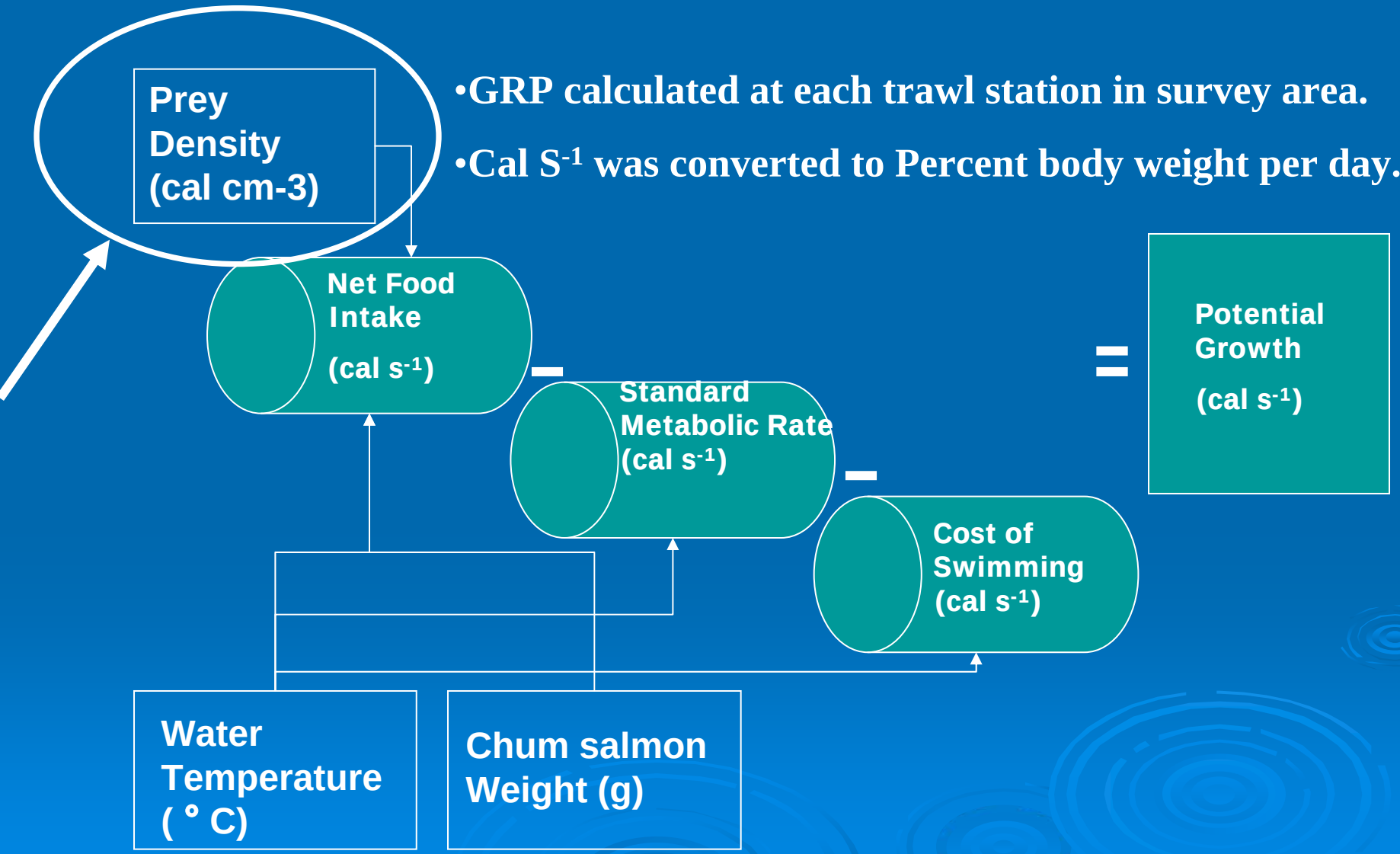




2. Develop Models

- To test the effect of climate change on salmon productivity.

Growth Rate Potential (GRP) Model



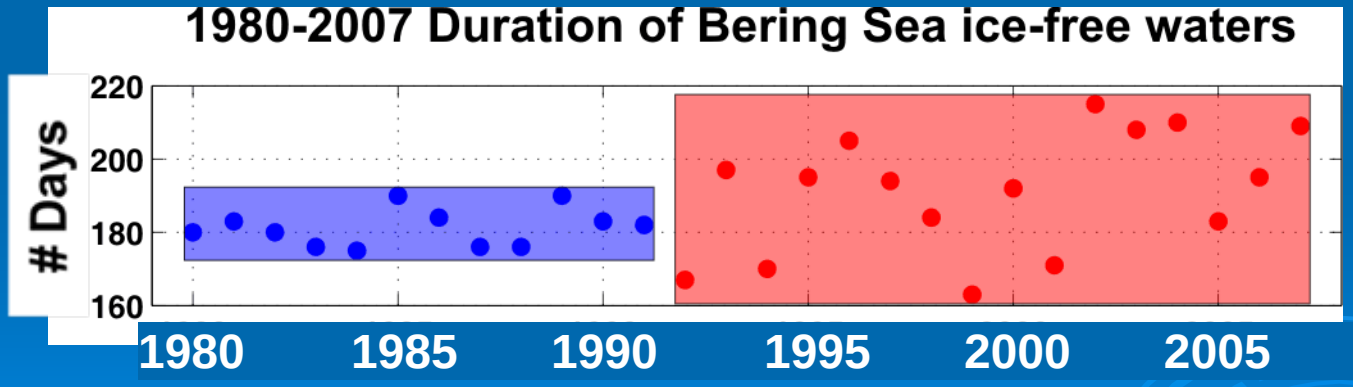
- GRP calculated at each trawl station in survey area.
- Cal S^{-1} was converted to Percent body weight per day.

Models

- With climate warming likely to see large variation in true state versus model results as models are built on data sets collected during prior climate states.

Motivation

- Quantification of the temperature and salinity fields.
  - More fully describe the physics that form a foundation for the chemical and biological portions of the ecosystem.
- Determine mechanisms responsible for the observed interannual variability.
  - River discharge, surface heat fluxes, ice melt, advection
- Are these processes stable? What are ramifications of changes to these mechanisms?

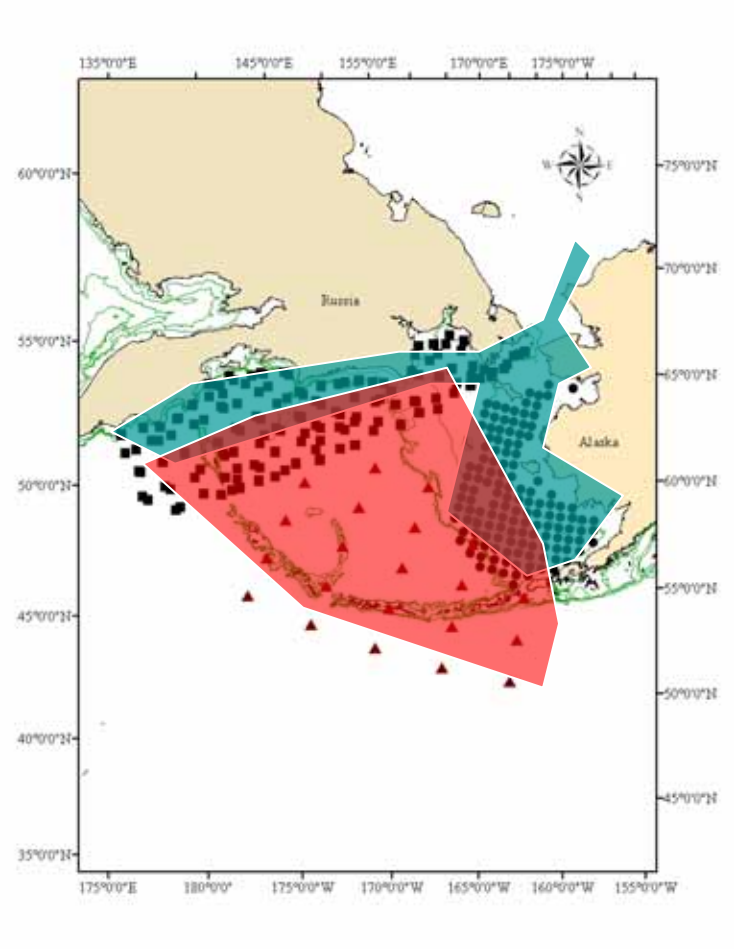


1980-2007 trend = 8 days/decade

Standard deviation greater by a factor of 3.24, p=0.08

Significant at the 99% level for the last 16 years

Life History Stage



Western Bering Sea – no climate effect on productivity

Eastern Bering Sea – shifts in shelf productivity dependent on extent of ice cover and spring and summer sea temperatures

Bering Sea Basin – sea temperature is positively related to number of immature salmon utilizing the Bering Sea during summer.

Okhotsk Sea – Important Juvenile rearing area for Asian salmon

Nutrient-Phytoplankton-Zooplankton Models

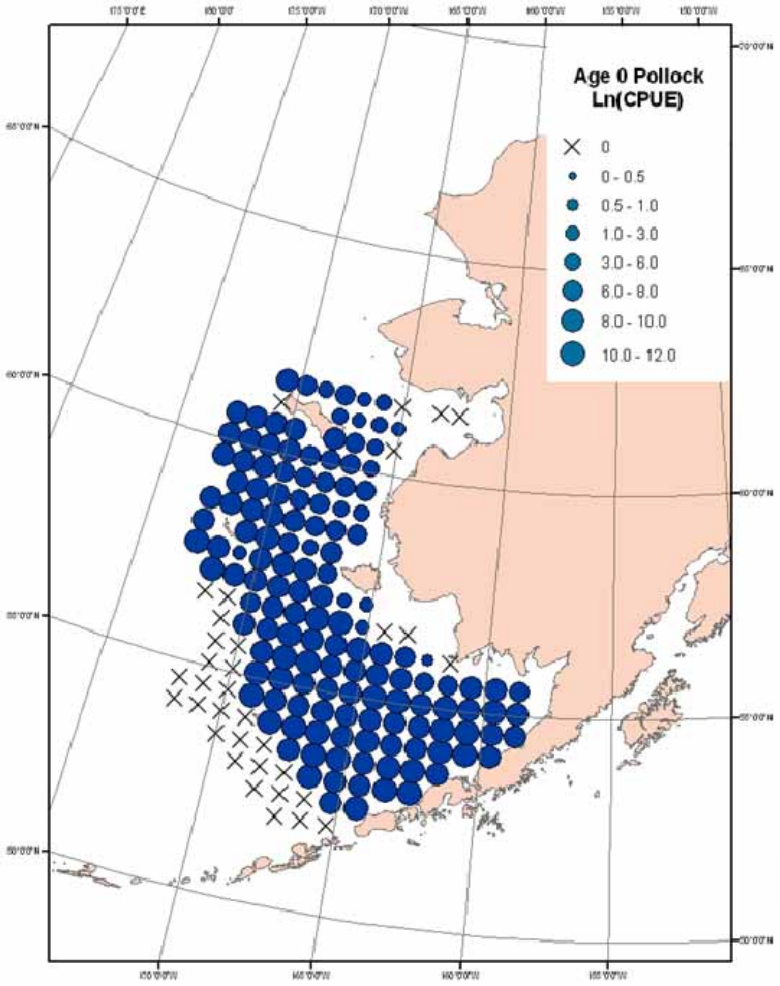
- NEMURO – Deep water productivity
- BSIERP/NPRB – Developing model for eastern Bering Sea shelf

3. Monitor the Ecosystem

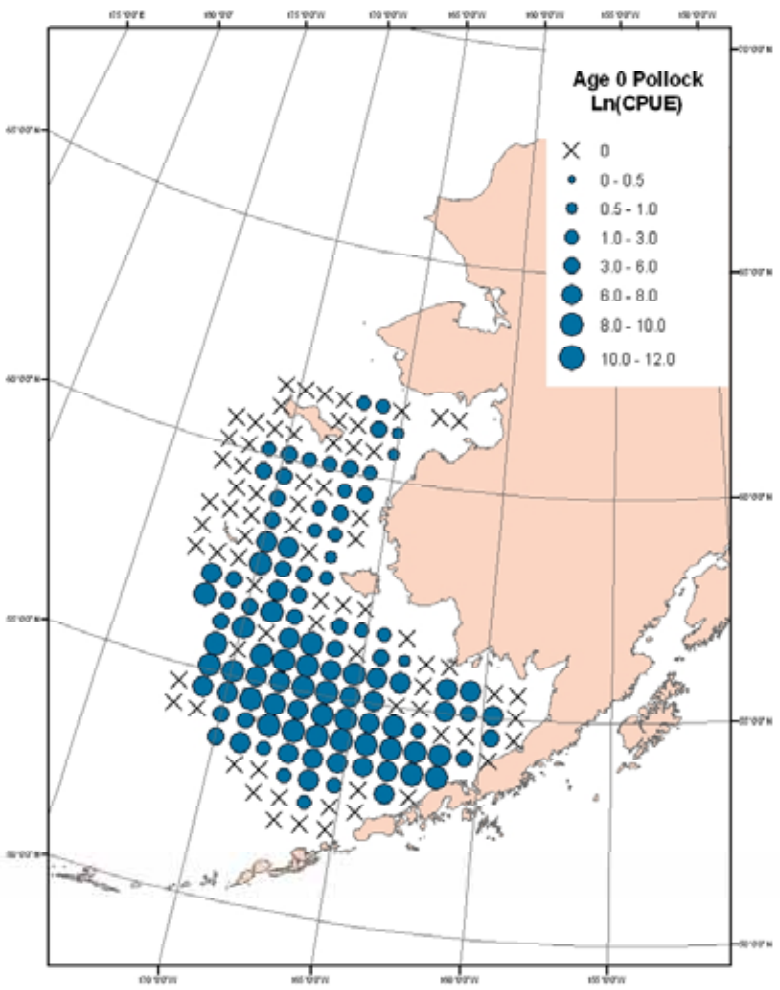
- But at what level?
- When?
- What life history?

Age-0 Pollock Distribution

WARM

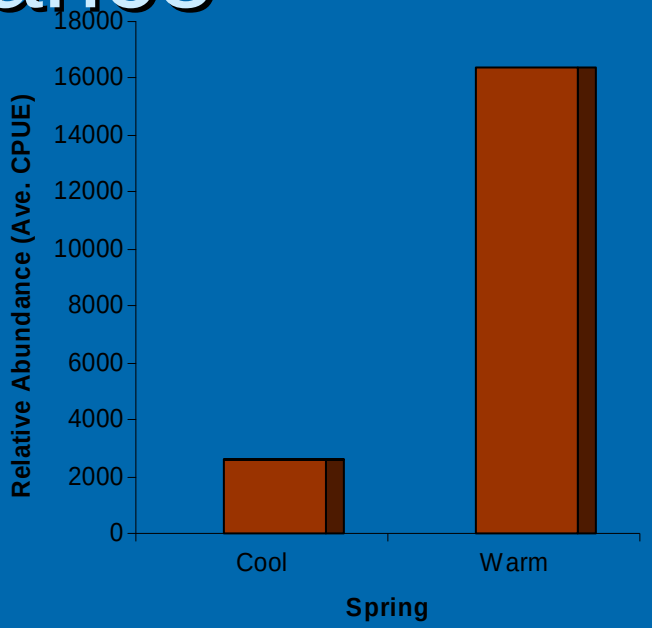


COOL

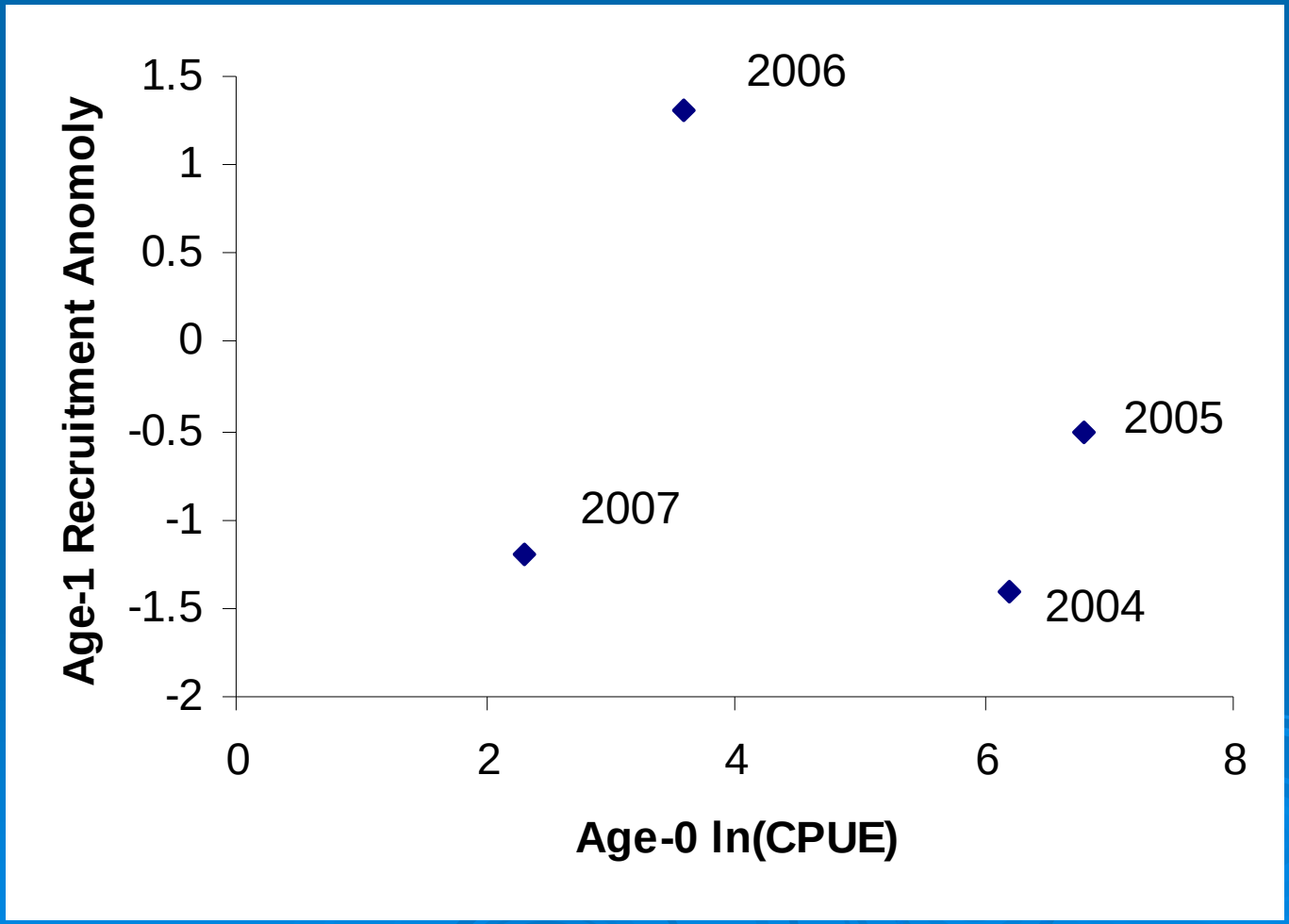


Age 0 Pollock Abundance

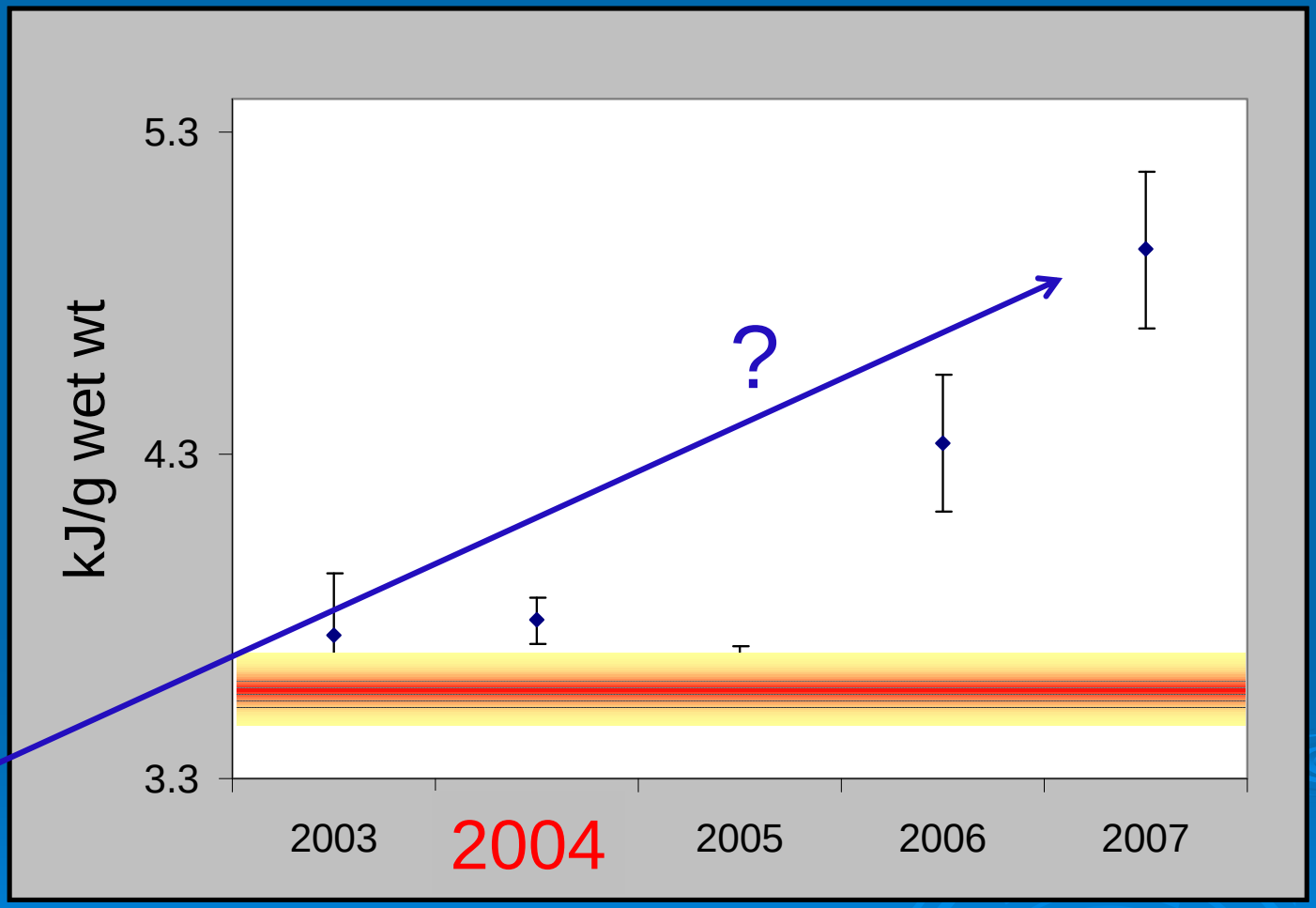
WARM



COOL


Age-1 Recruitment Anomoly
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
2
4
6
8
Age-0 ln(CPUE)
2006
2005
2007
2004

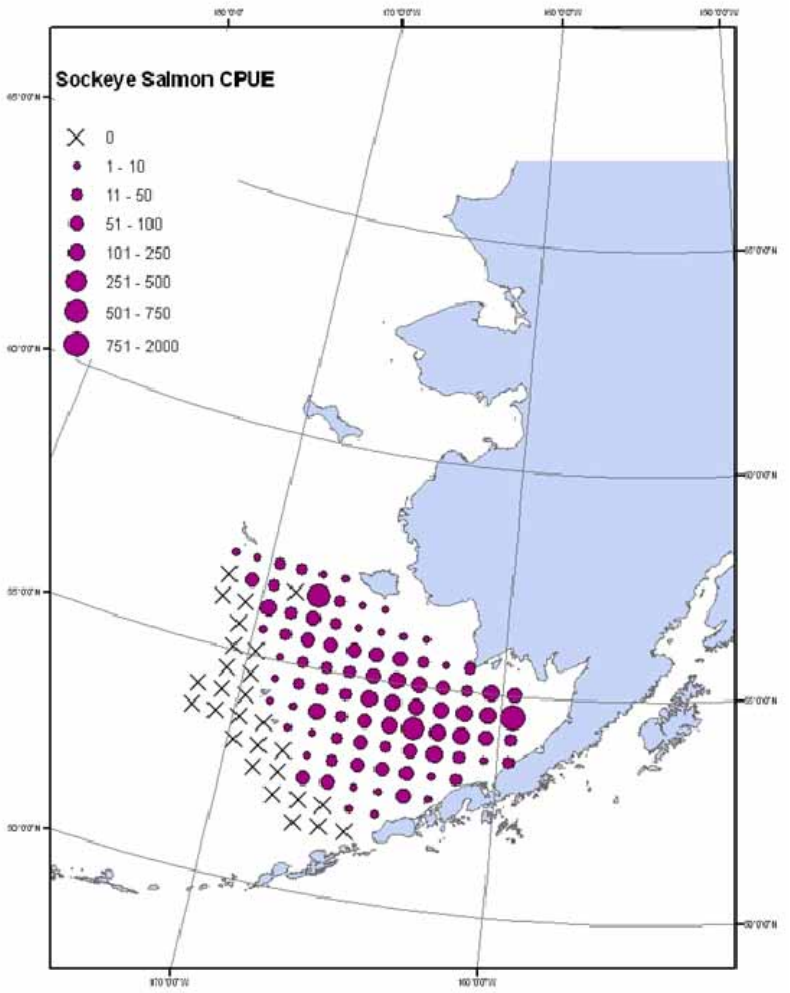
BASIS data:
Condition of age-0 walleye pollock
(energy density in September)



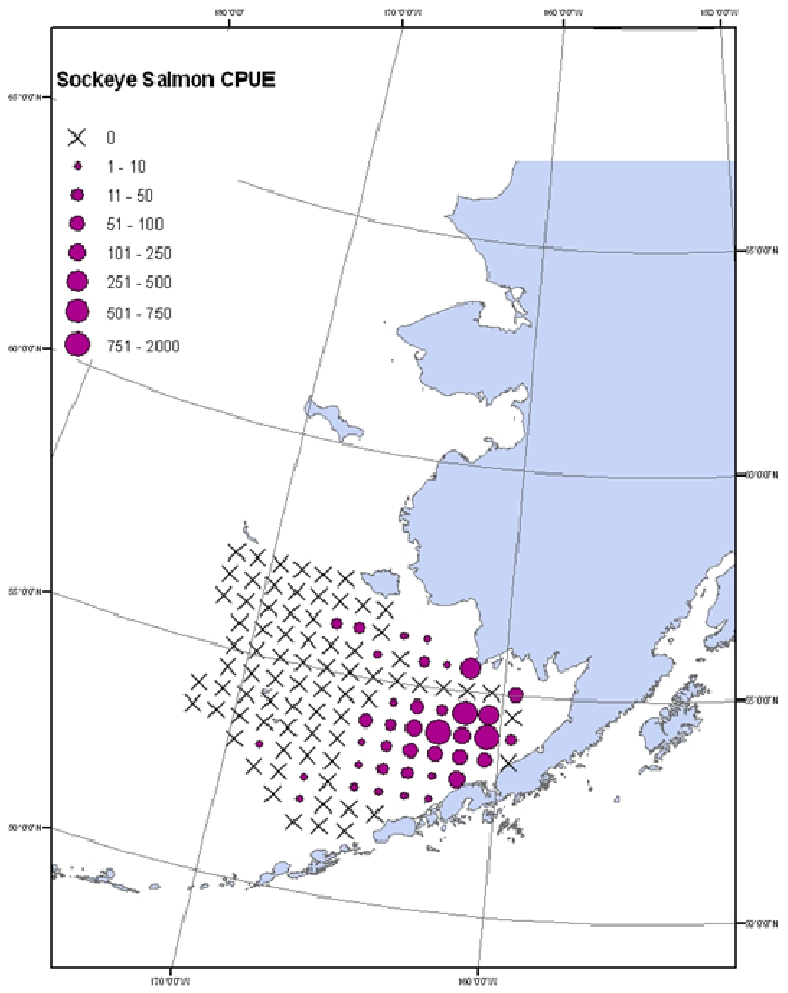
Diamonds with error bars are data from Bering Sea (Fall) and orange bar is data from SE Alaska (Spring)

Juvenile Bristol Bay Sockeye Salmon

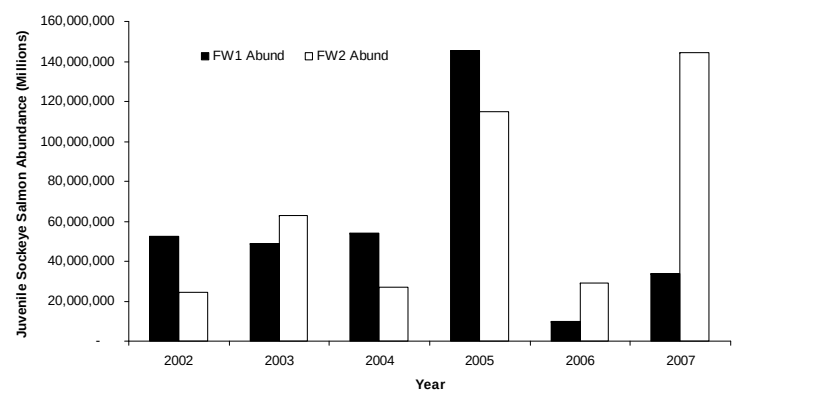
WARM

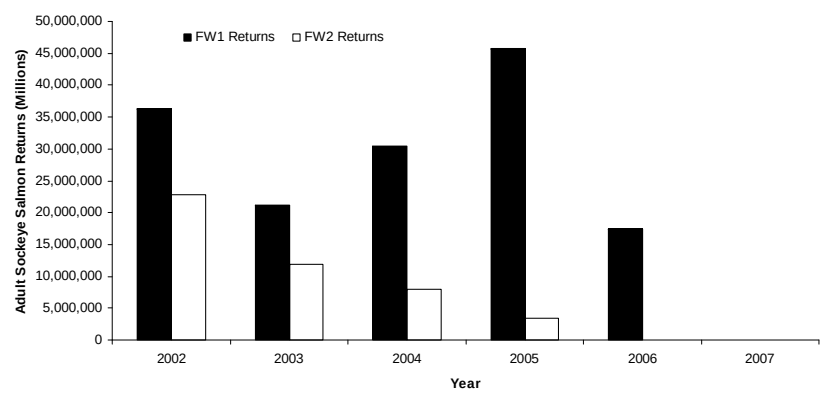


COOL



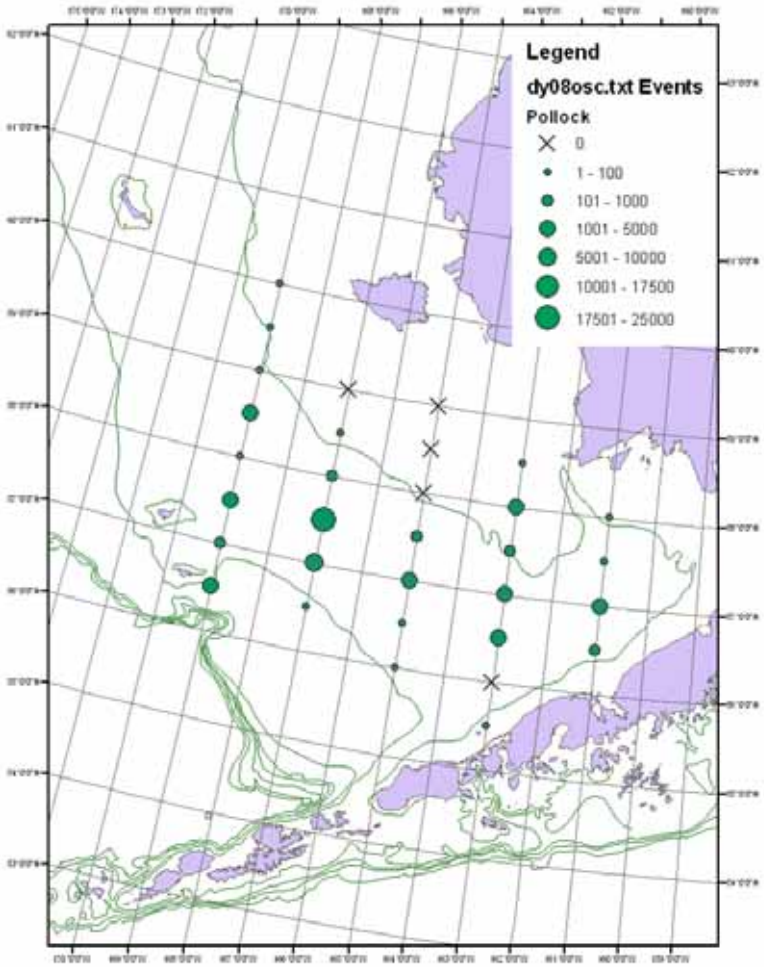
Juvenile Bristol Bay Sockeye Salmon Abundance



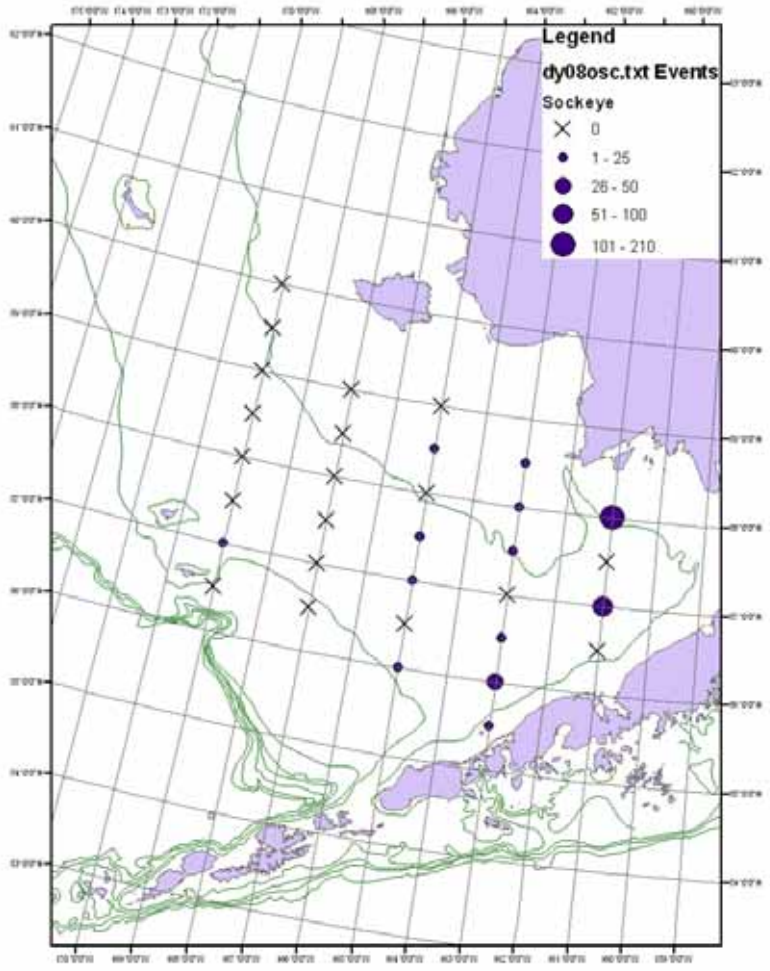


BASIS/BSIERP 2008

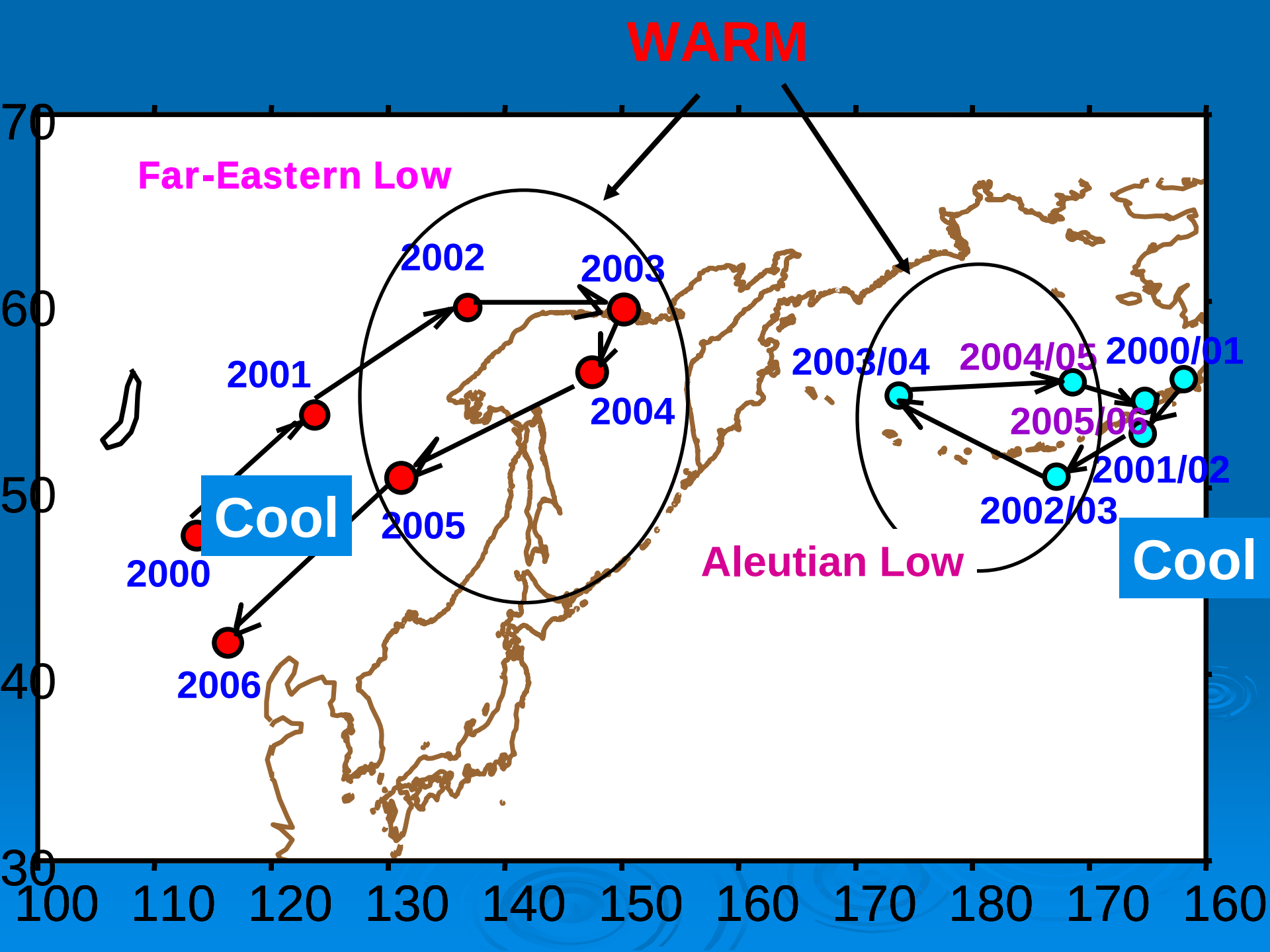
Age-0 Pollock



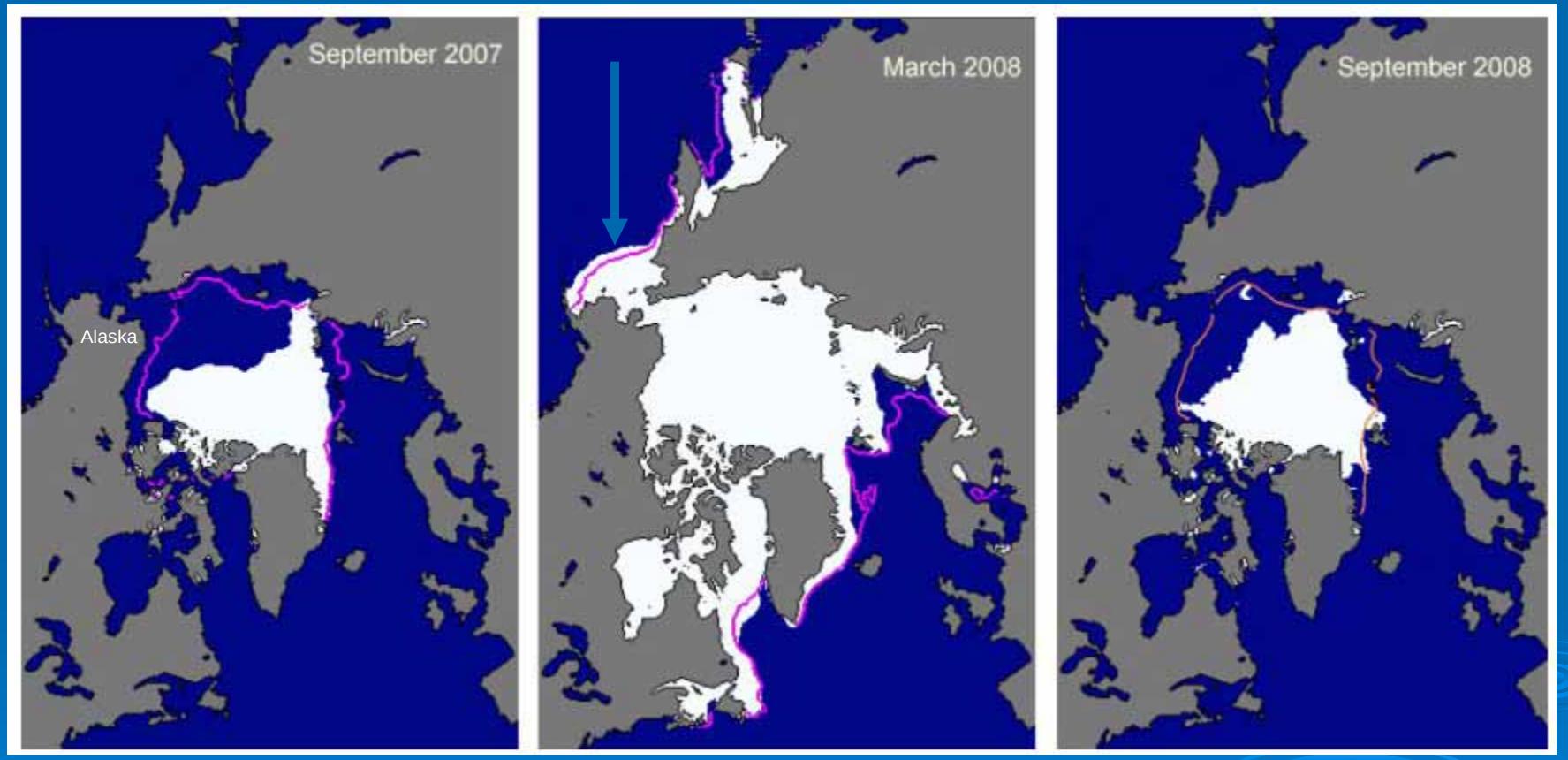
Juvenile Sockeye



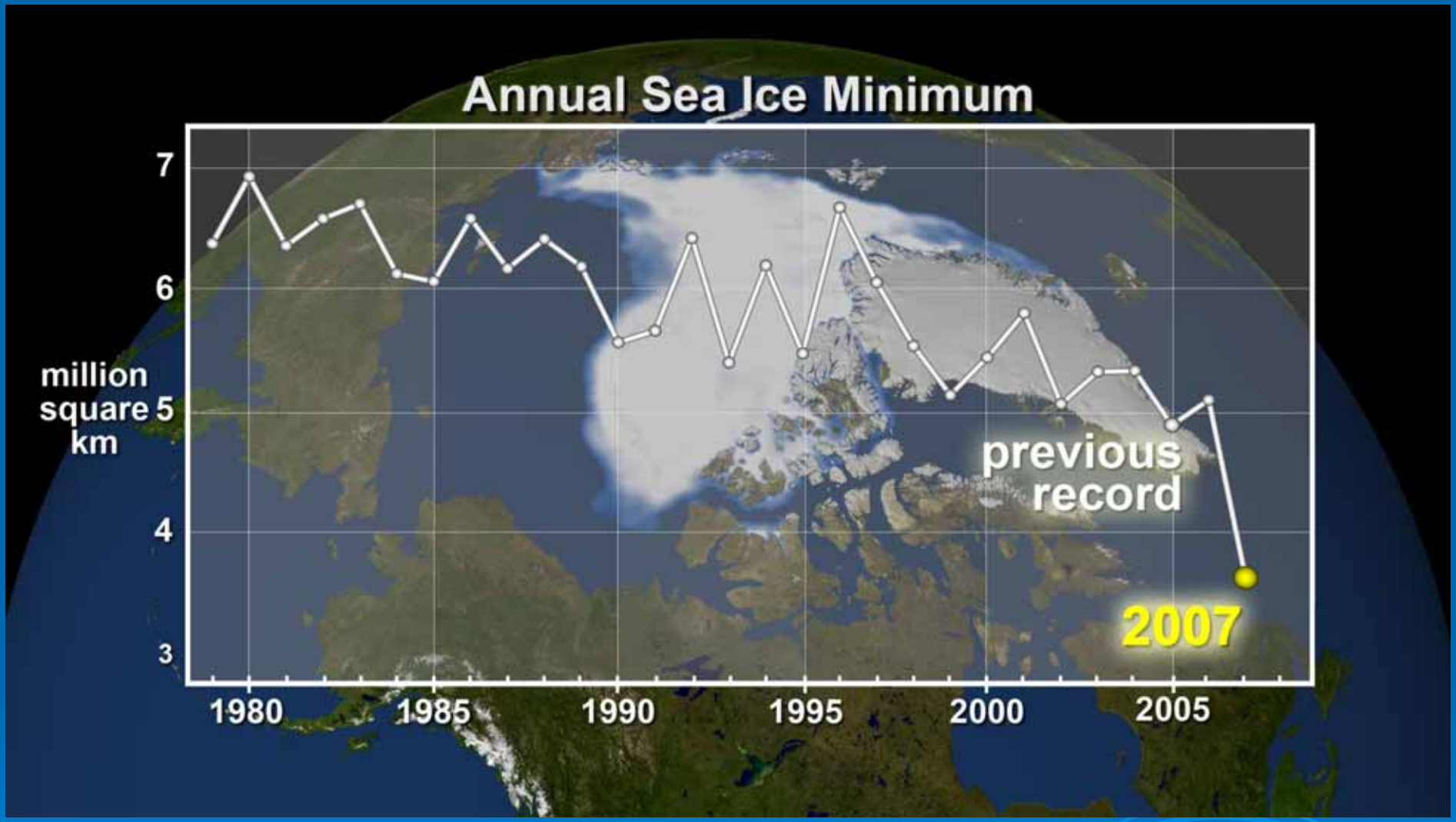
Suggestions?


WARM
Far-Eastern Low
2002
2003
2001
2004
2005
2000
2006
Cool
2003/04
2004/05
2000/01
2005/06
2001/02
2002/03
Aleutian Low
Cool
70
60
50
40
30
100
110
120
130
140
150
160
170
180
170
160

SEA ICE EXTENT



Sea ice extent in (left) September 2007, (center) March 2008 and (right) September 2008, illustrating the respective winter maximum and summer minimum extents. The magenta line indicates the median maximum and minimum extent of the ice cover, for the period 1979–2000. The September 2007 minimum extent marked a record minimum for the period 1979–2008. [Figures from the National Snow and Ice Data Center Sea Ice Index: nsidc.org/data/ seaice_index.]



NASA, September 2007

http://www.nasa.gov/vision/earth/environment/arctic_minimum.html