Measuring the pulse of the Gulf of Alaska: oceanographic observations along Seward Line, 1997-2010

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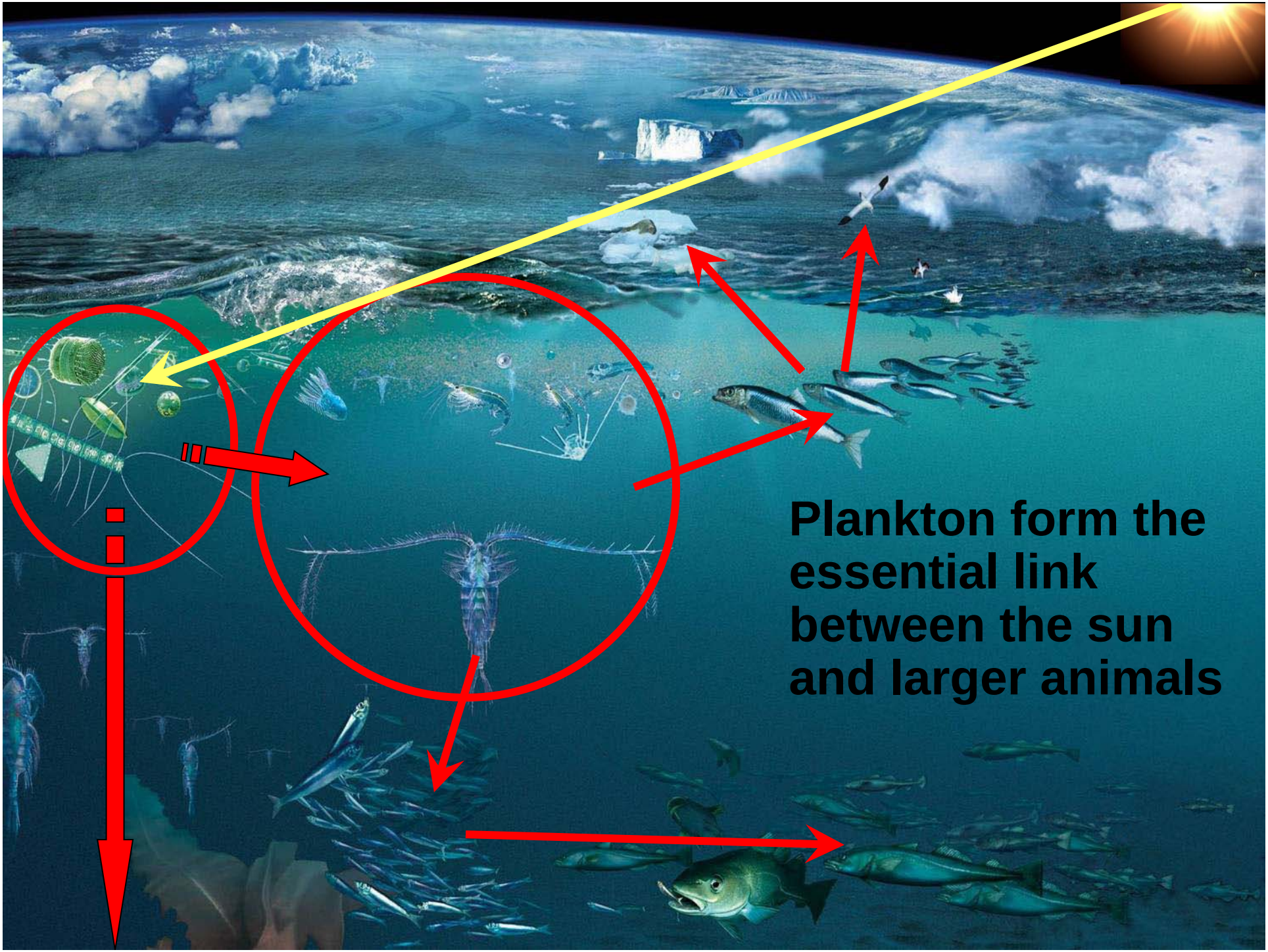
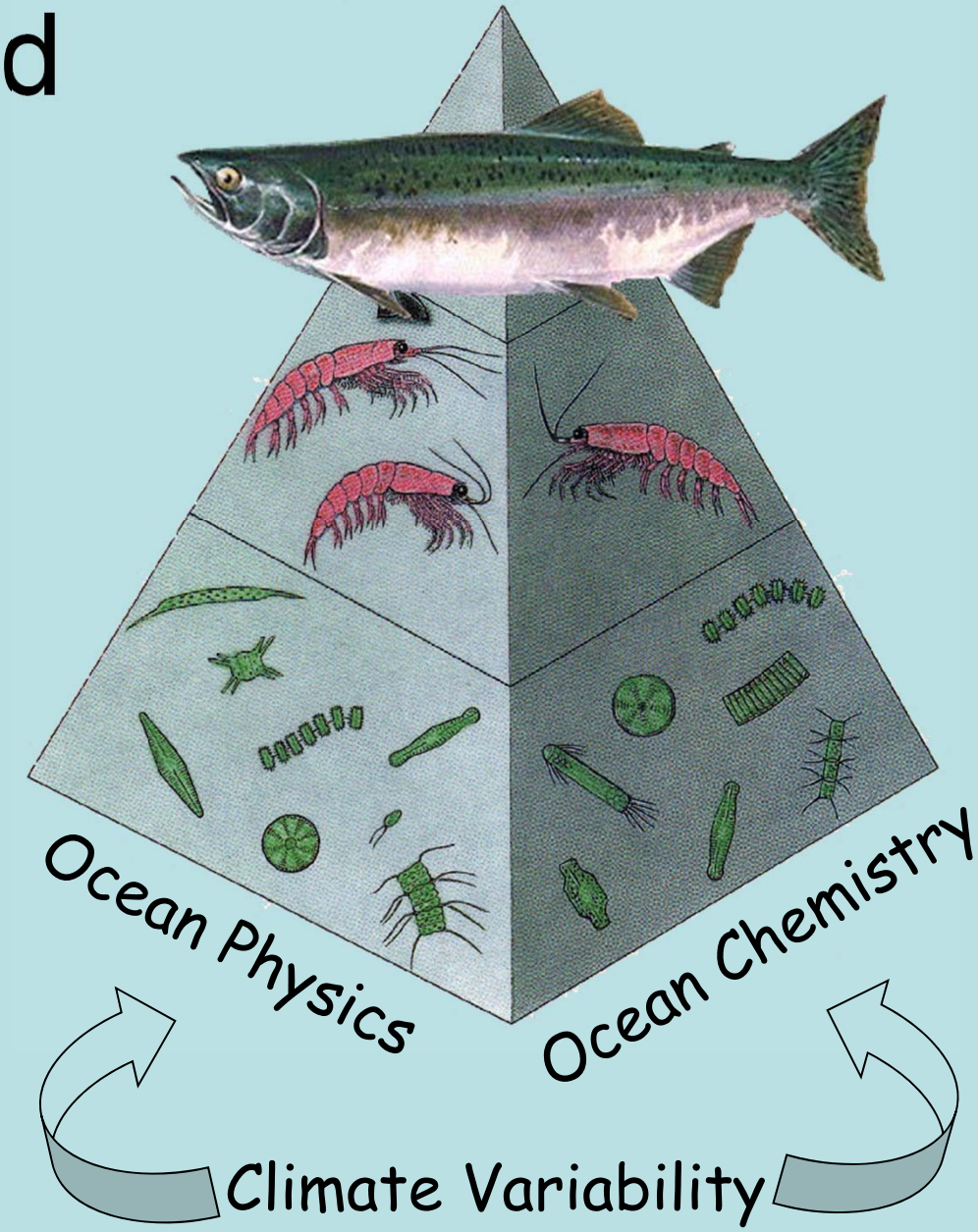
NSF NOAA AOOS Alaska Ocean Observing System


Plankton form the essential link between the sun and larger animals

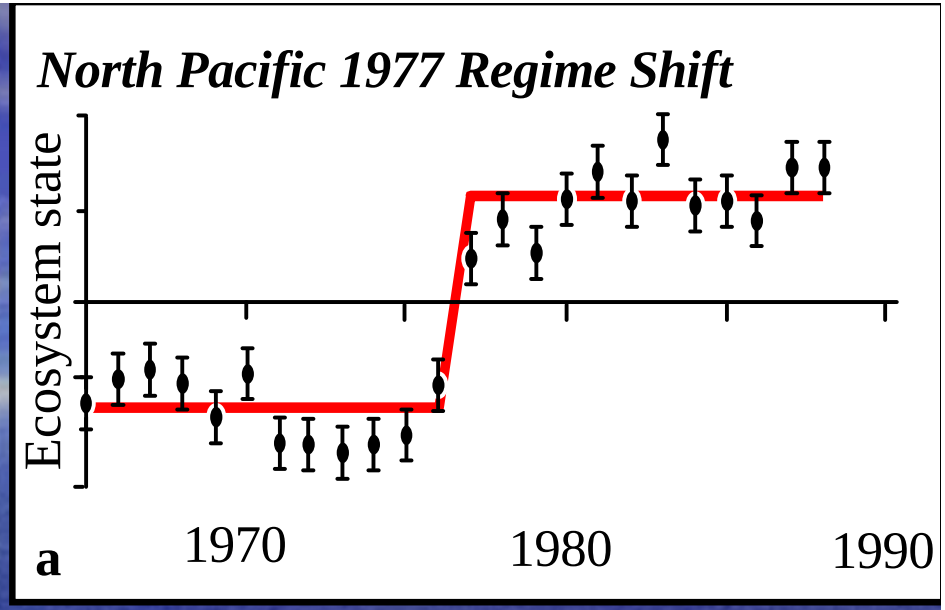

No Plankton
= no fish to
harvest

Food Pyramid

- Climate variability alters marine groups through changes in ocean physics and chemistry that cascade through the food web
- To understand AND predict a harvested species, we need routine observations of the complete food web
- Otherwise, there is no direct connection (fish don’t eat ‘climate’)



Climate: Why care?

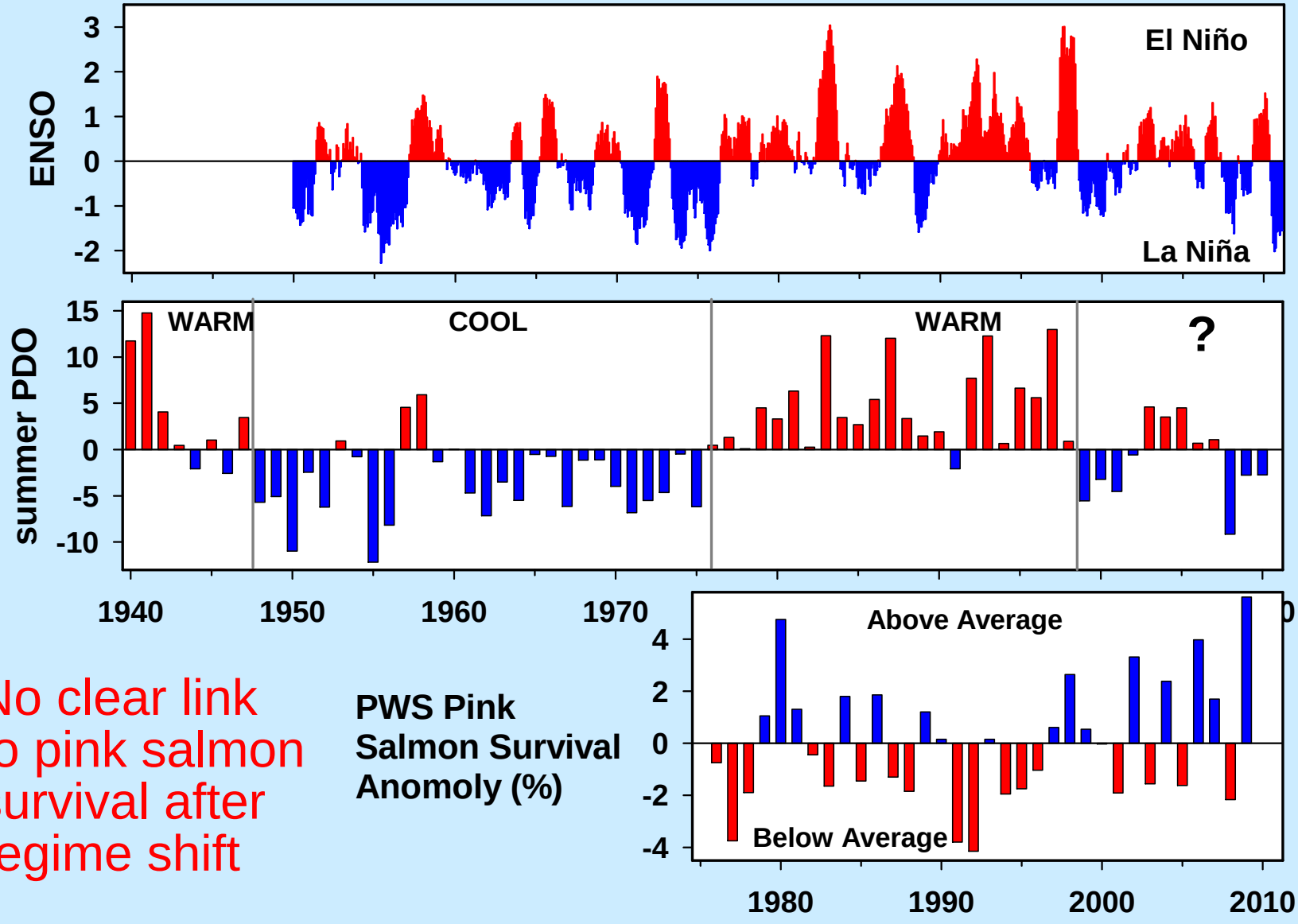


Late 1960's

Early 1980's

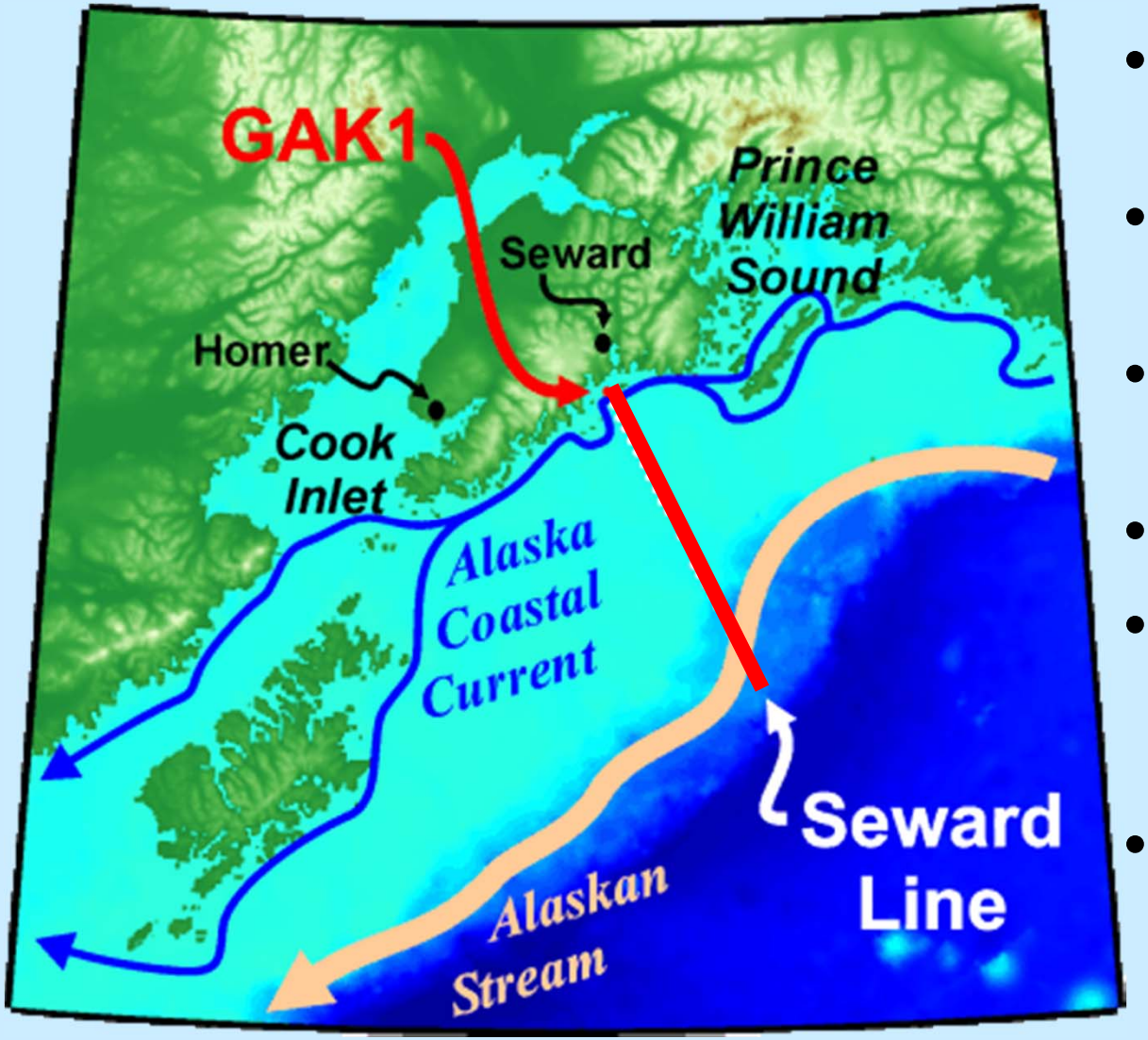
Changes catches in a small mesh bottom trawl in Pavlof Bay, Alaska, through the regime shift of the mid-1970s.

What drives productivity in GoA is complicated: seasonal, inter-annual & longer-term forcing

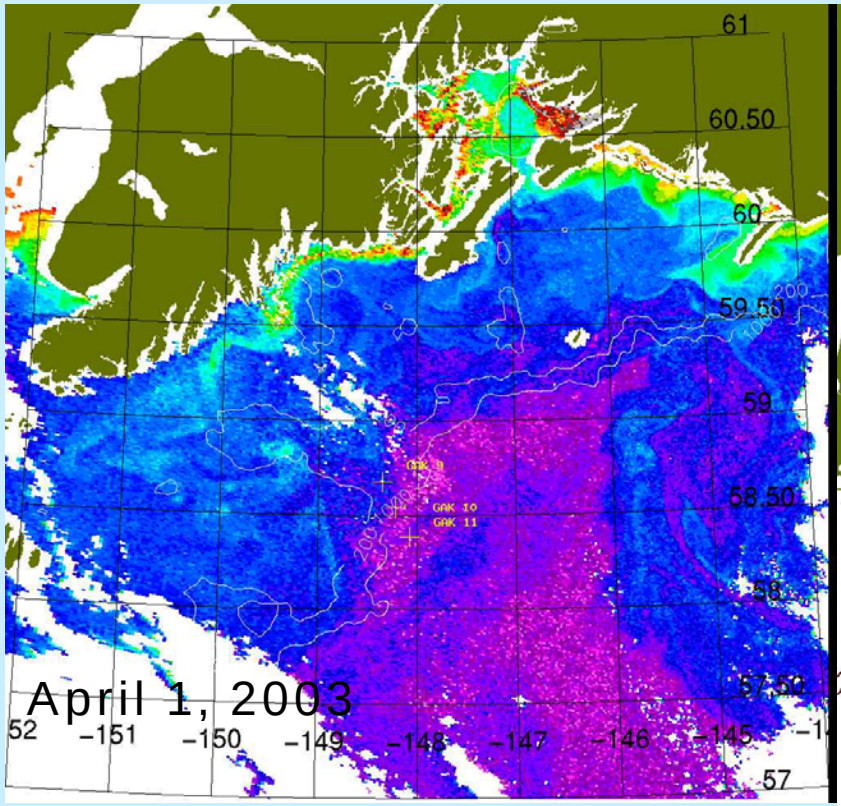


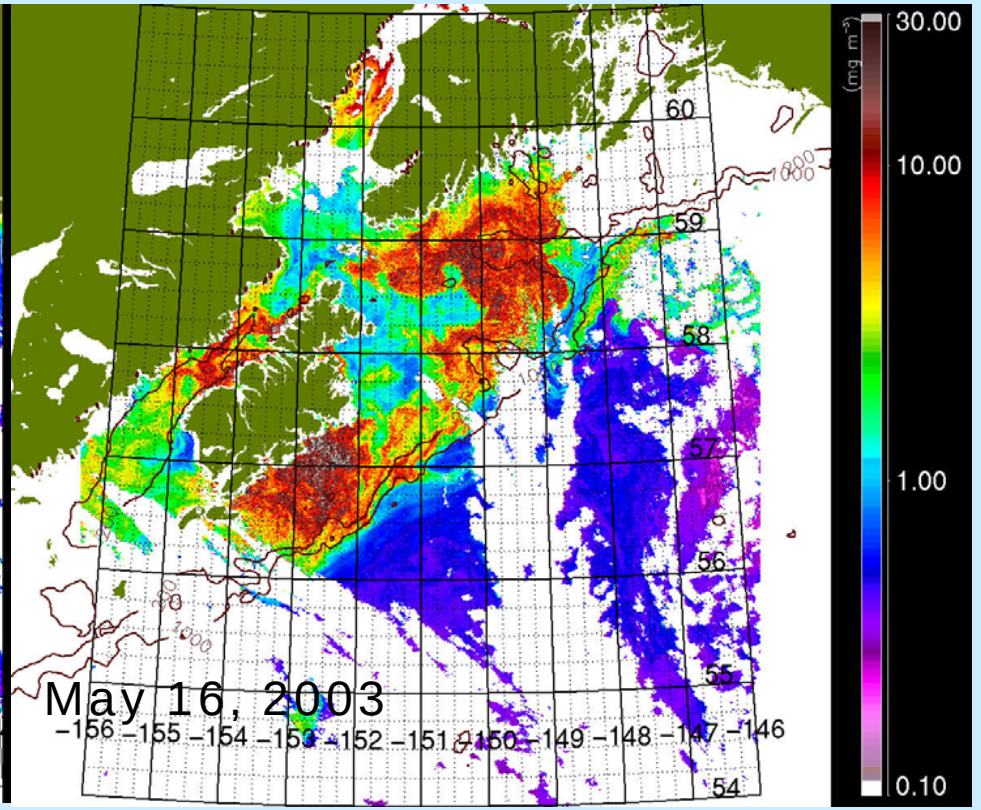
No clear link to pink salmon survival after regime shift

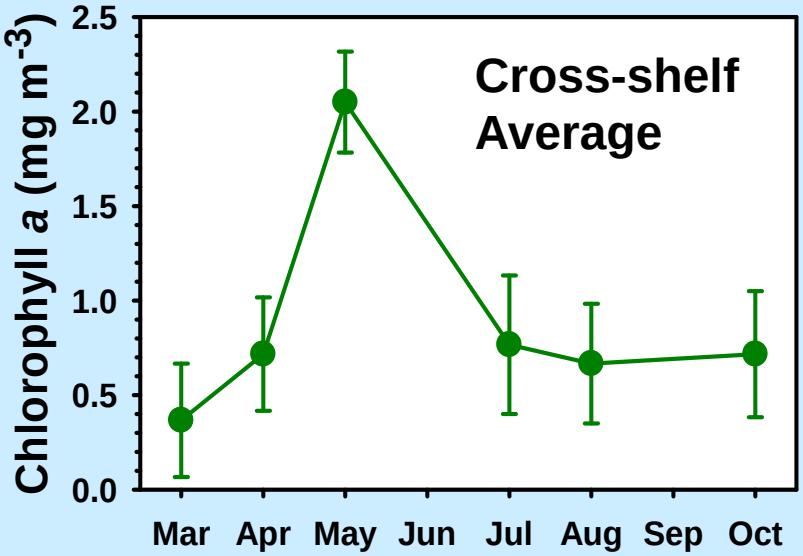
COASTAL GULF OF ALASKA SEWARD LINE



- Physical data over ~3 decades
- Biological data over 13 years
- GLOBEC 1997-2004
- NPRB 2005-2009
- Consortium: NPRB, AOOS & NOAA 2010-2013
- Longest **&** most detailed time-series in the coastal GoA

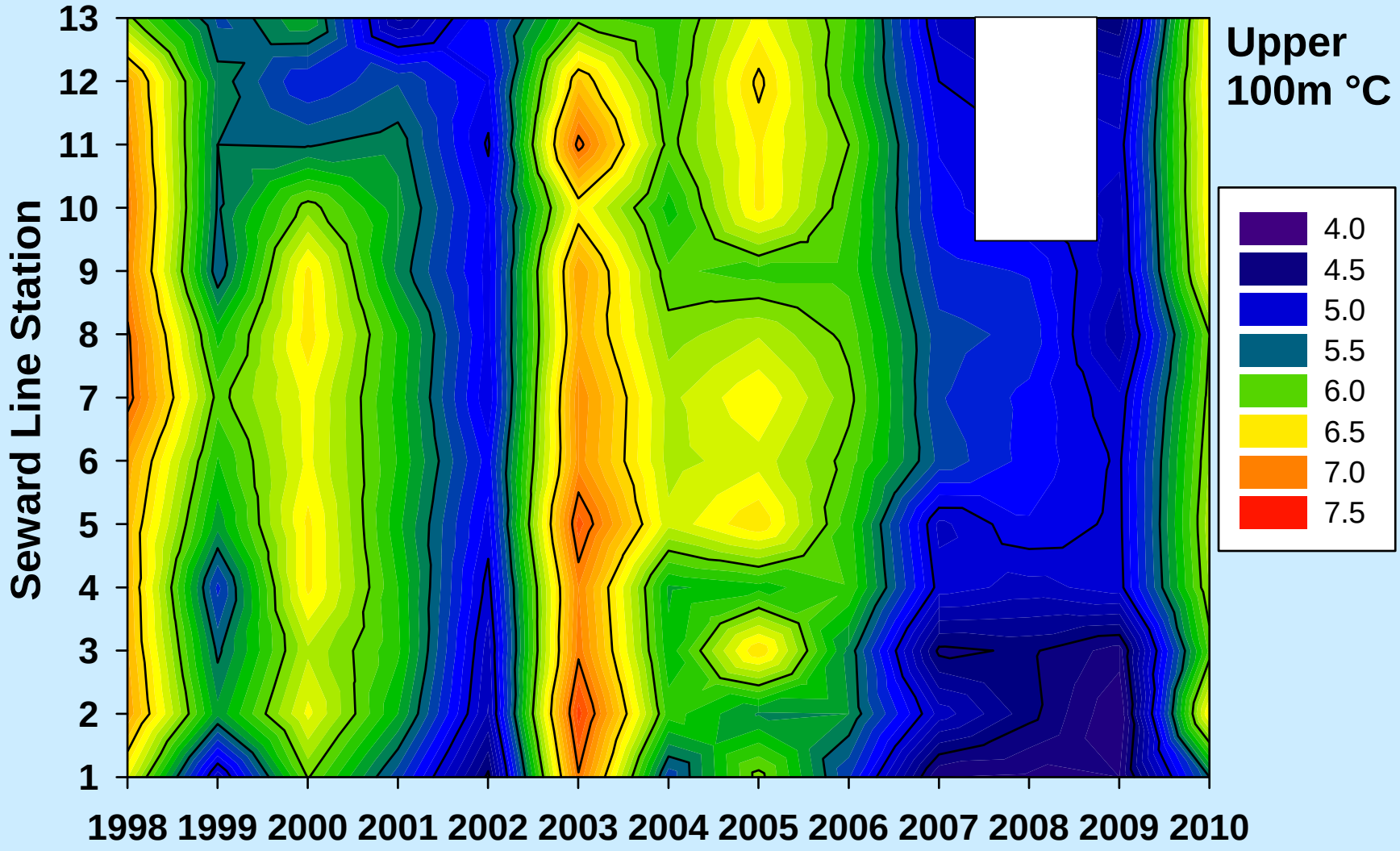




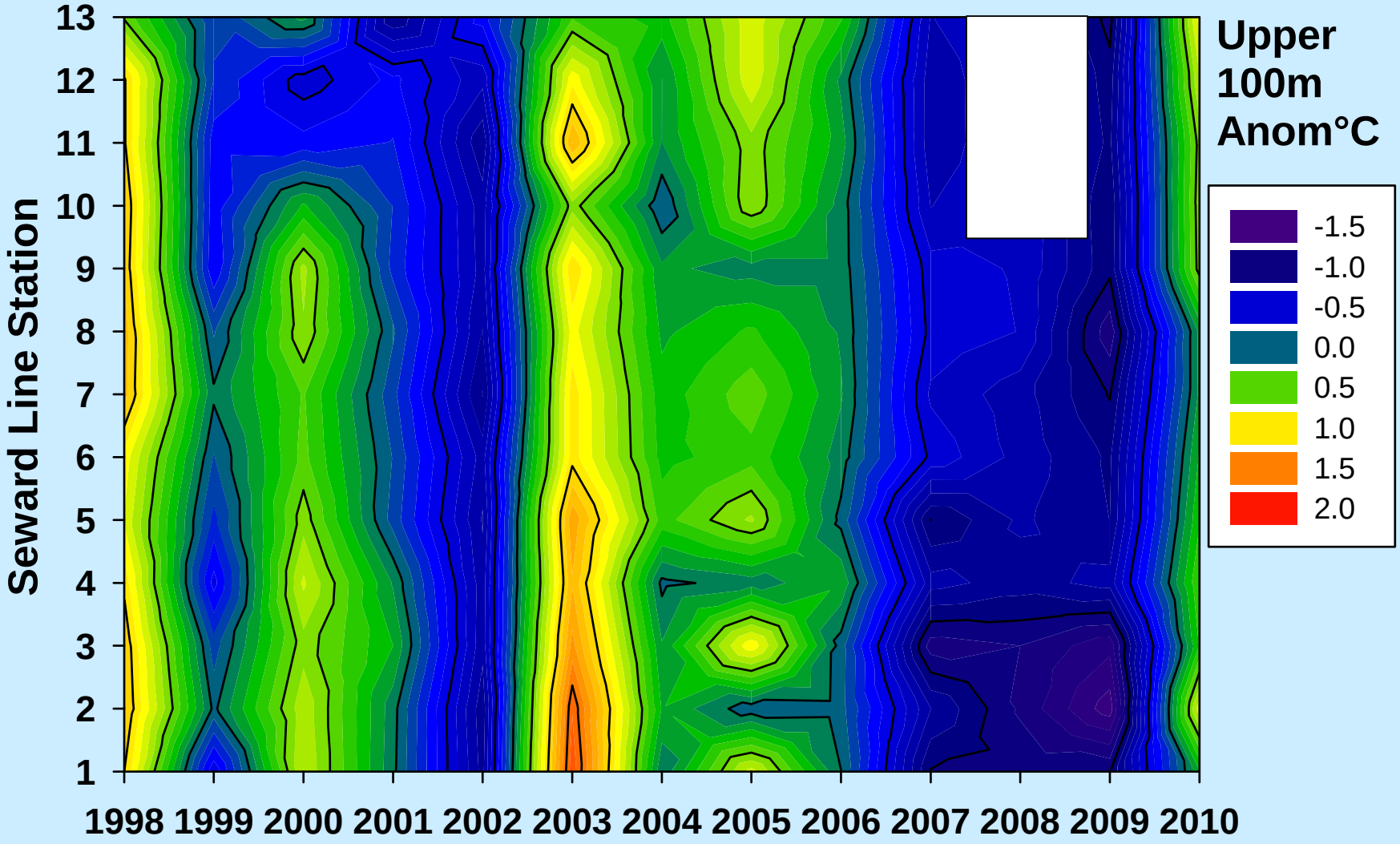


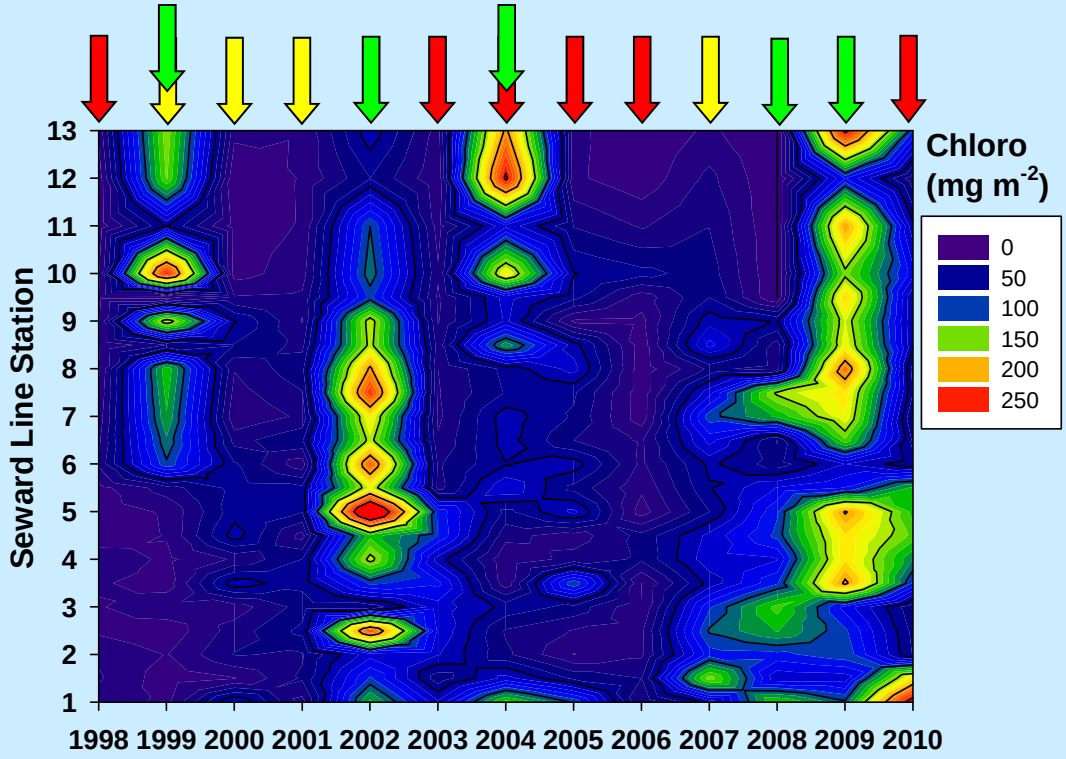
Primary production starts on the inner shelf earlier (0.5-1 month) than the mid- and outer shelf where it peaks in May

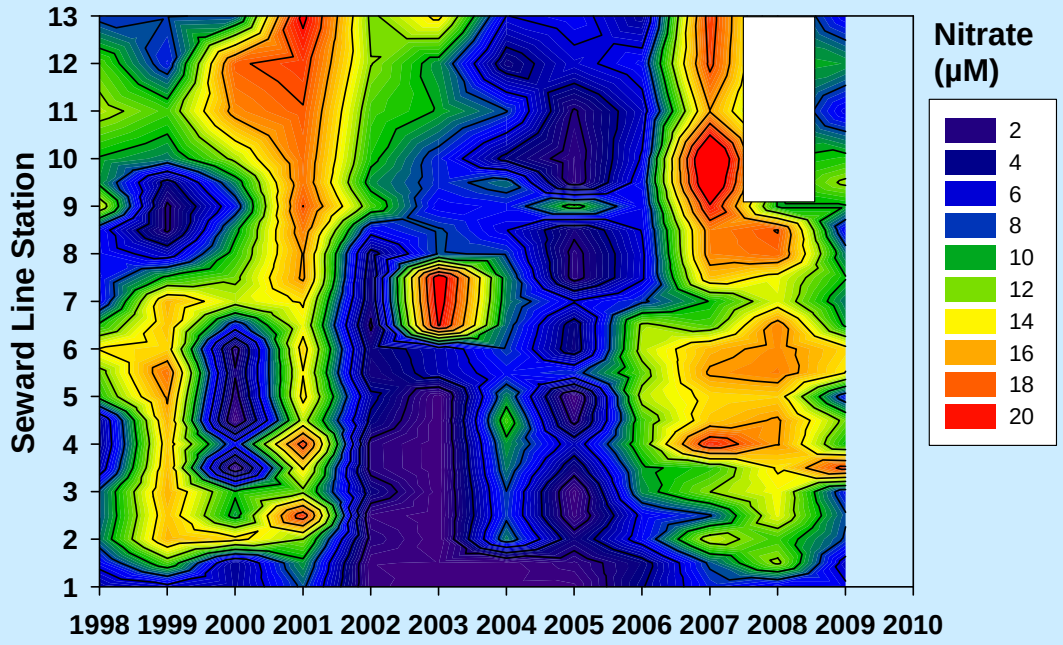
Driven by changes in the PDO, ENSO and winter weather, we have observed years of warm and cool springs – some recent Mays were similar to the early 1970s



Driven by changes in the PDO, ENSO and winter weather, we have observed years of warm and cool springs – some recent Mays were similar to the early 1970s … temperature anomalies emphasize these patterns

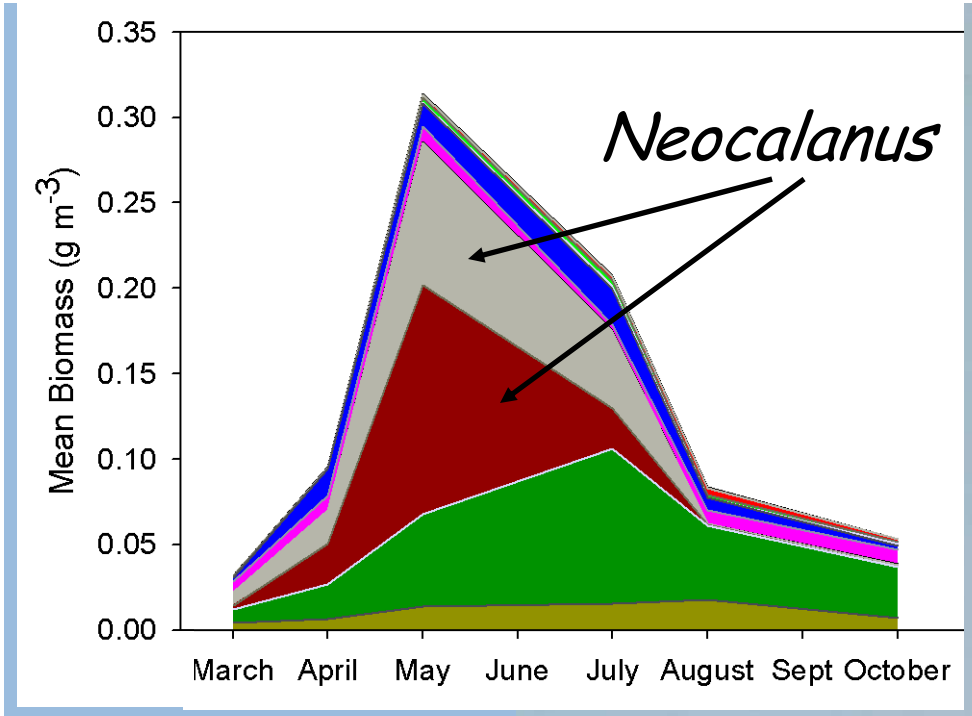




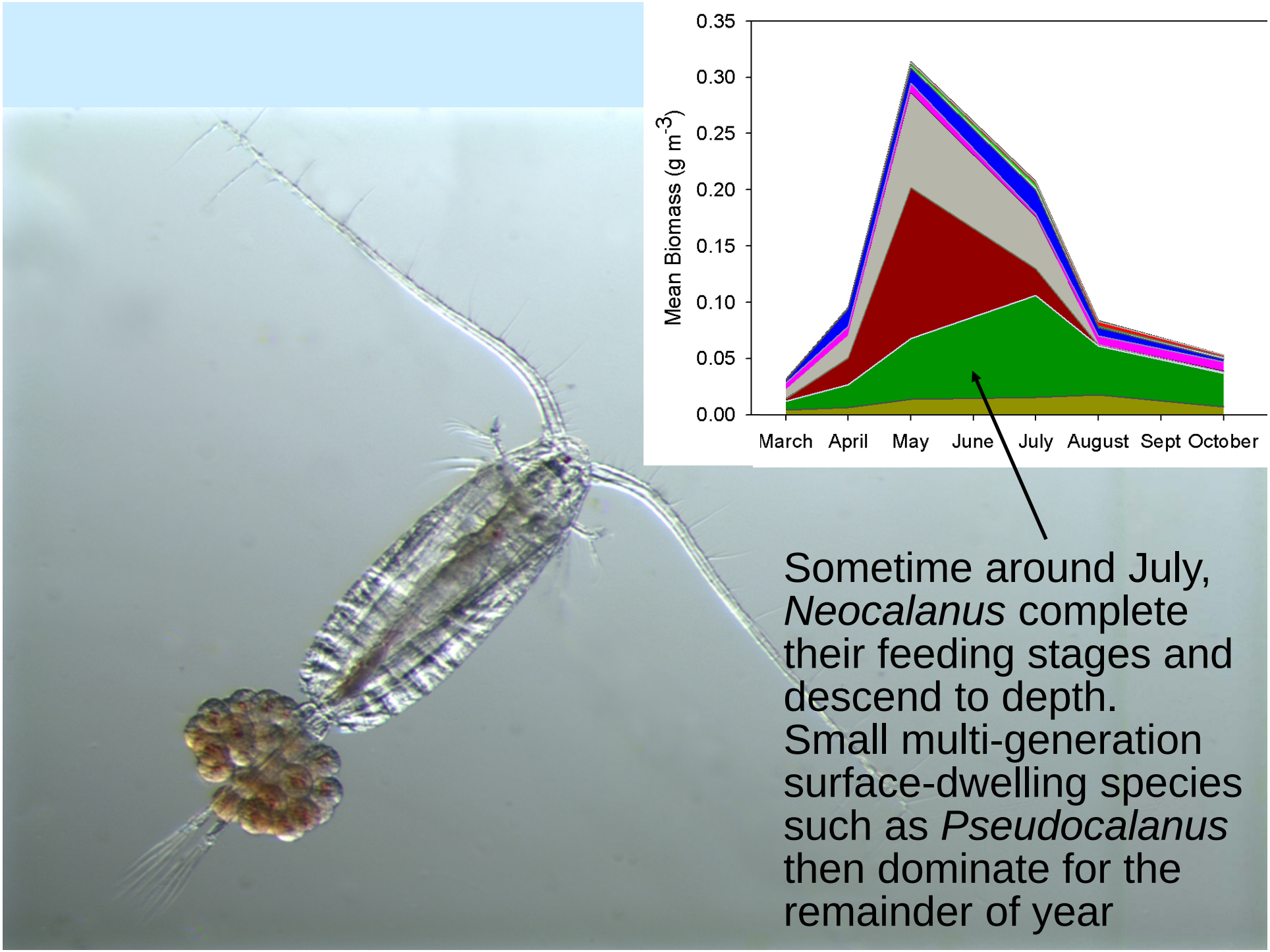


Spring Bloom

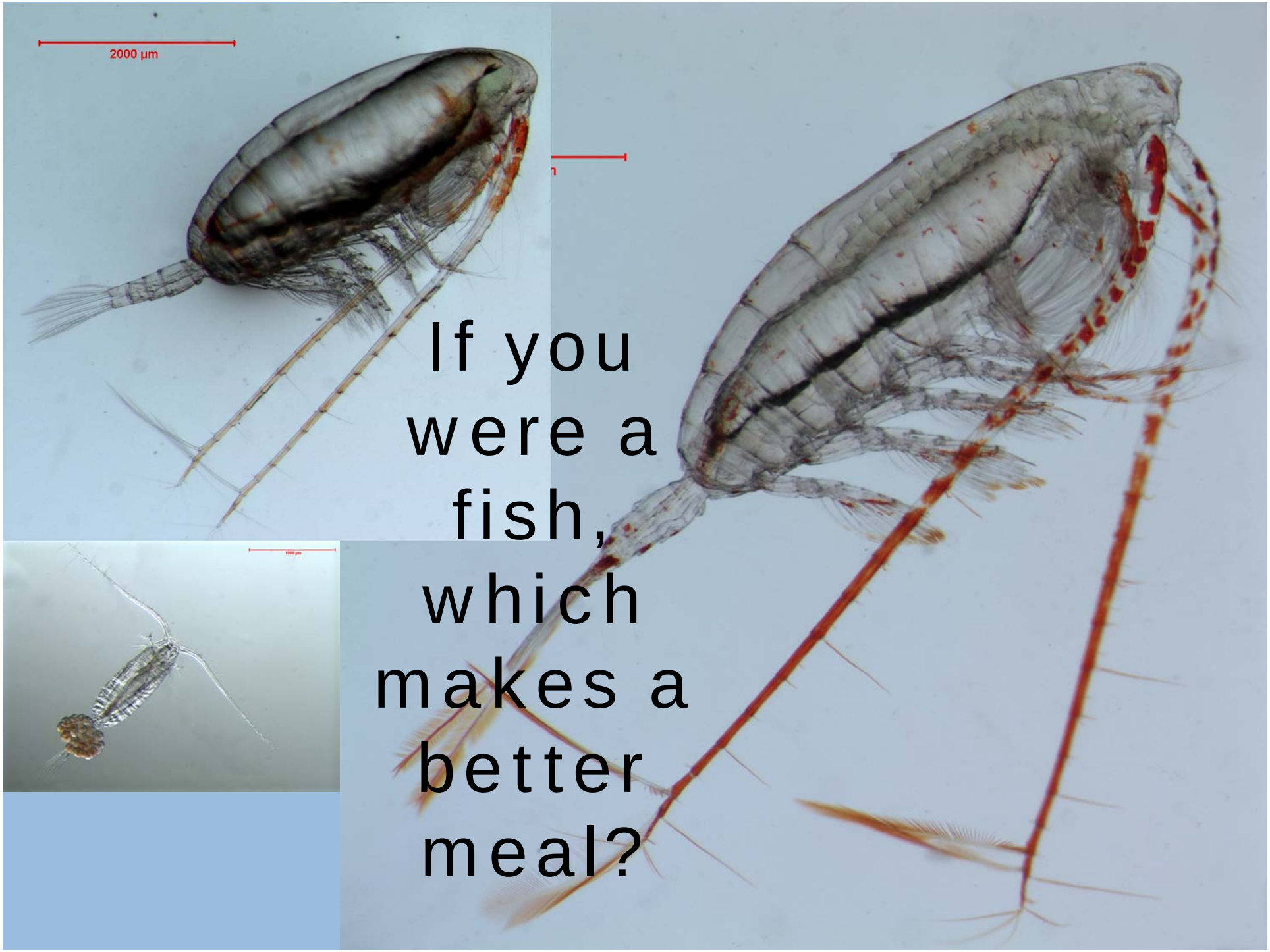
- Short-lived (1-2 weeks) so hard to hit when sampling
- Comparing to nutrients allows determination if we are sampling pre-bloom, post-bloom or the bloom
- 1998, 2003-2006 warm years had early blooms
- Blooms more typical timing (or late) in other years



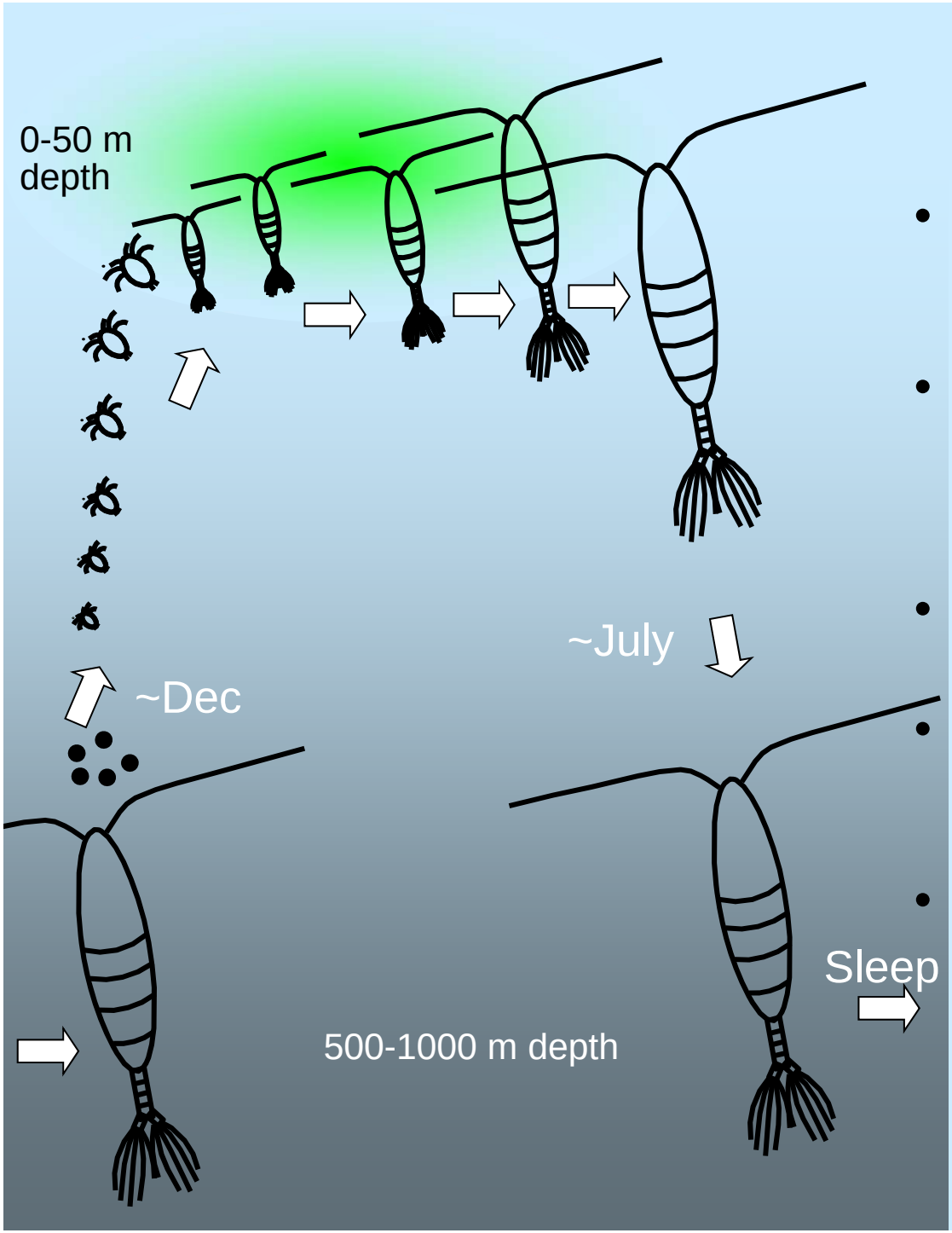
The success of the zooplankton that dominate the spring is related to their unique adaptations to the production cycles of the Gulf



Sometime around July, *Neocalanus* complete their feeding stages and descend to depth. Small multi-generation surface-dwelling species such as *Pseudocalanus* then dominate for the remainder of year

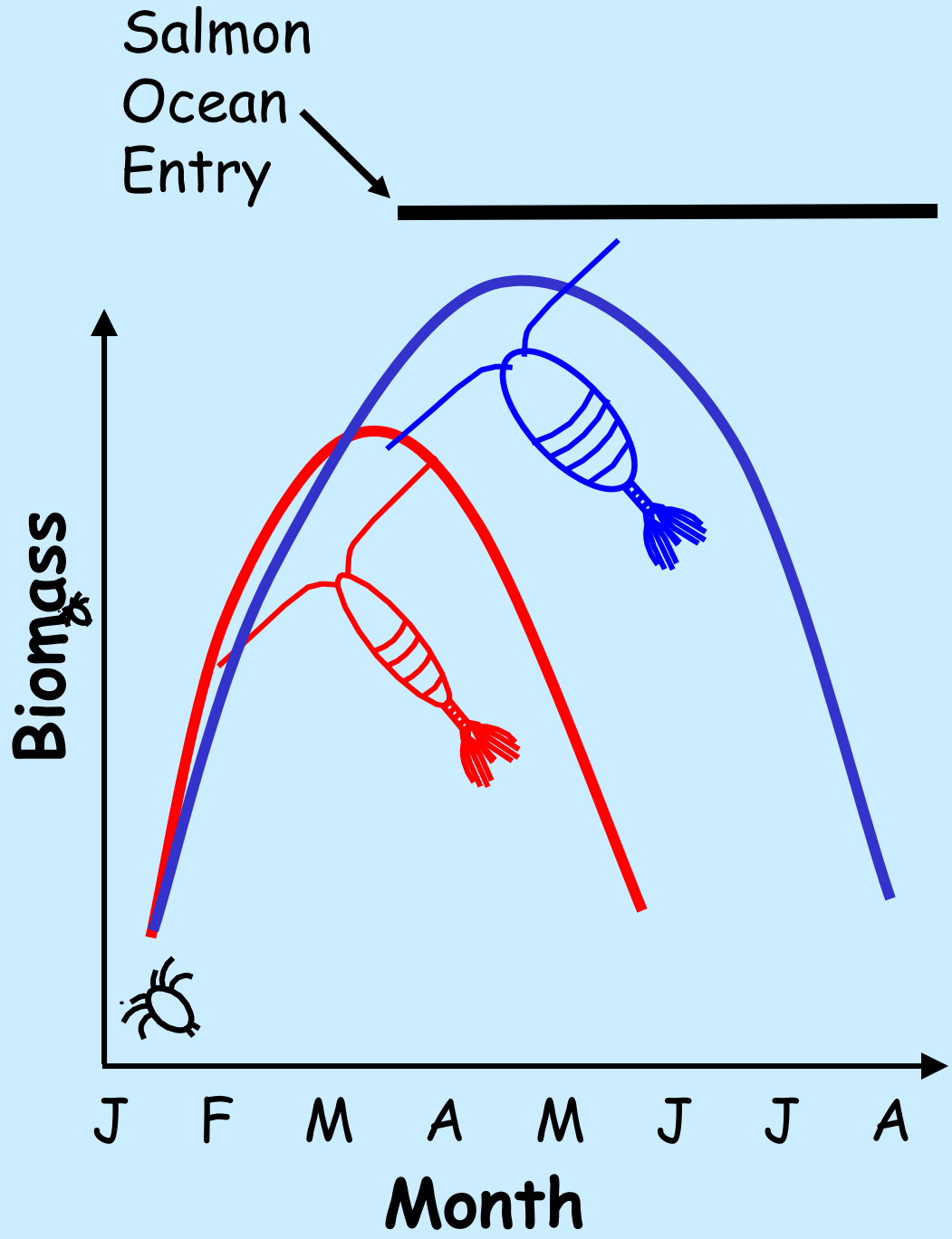


If you were a fish, which makes a better meal?



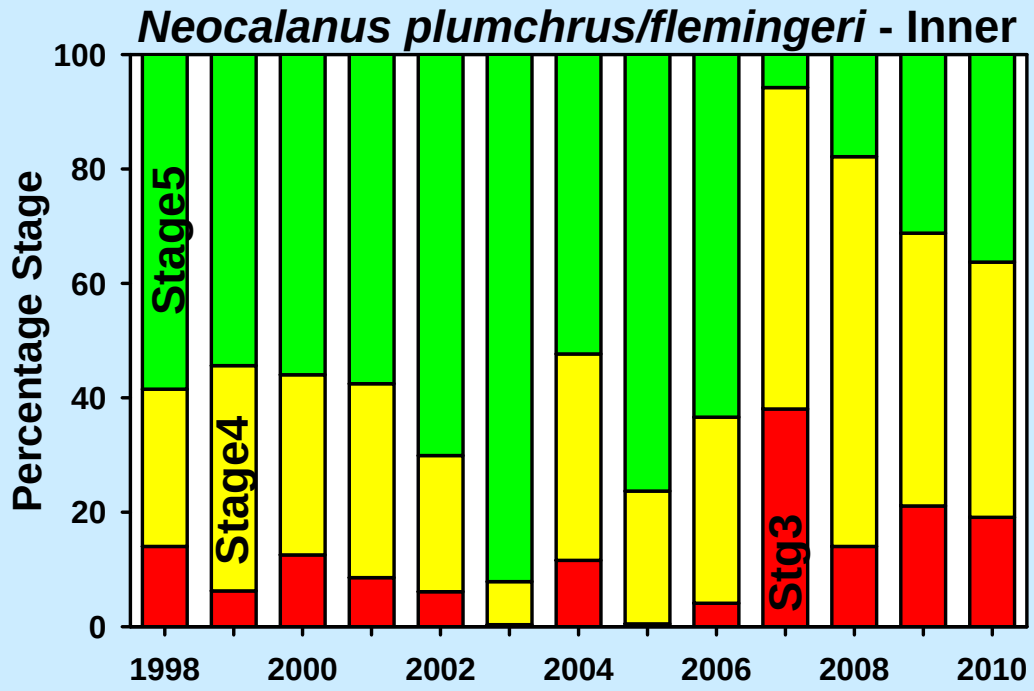
Neocalanus

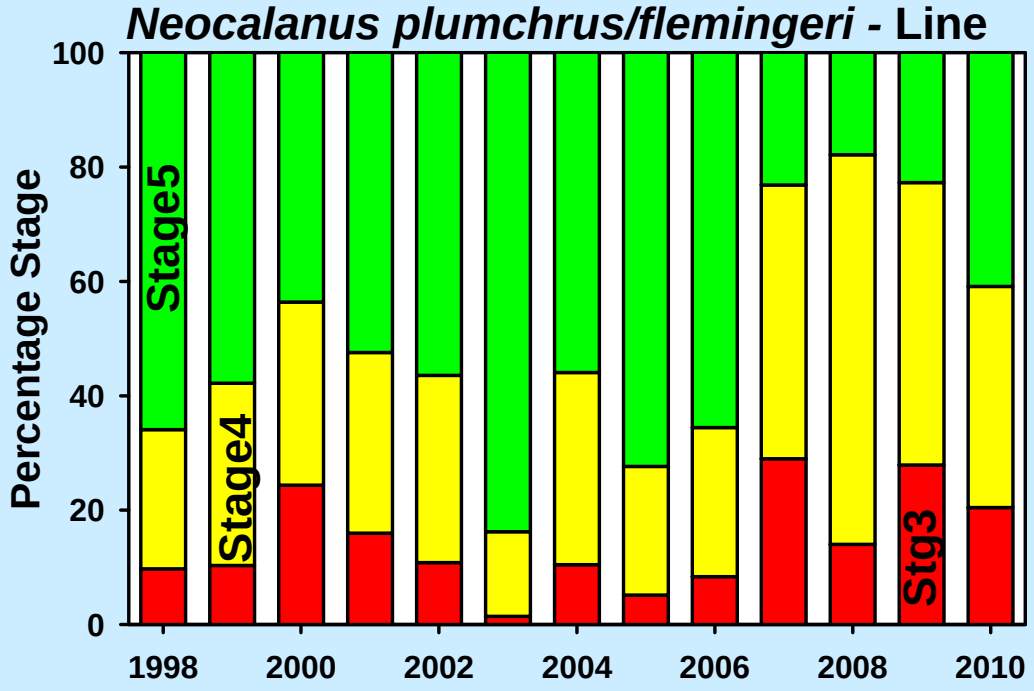
- Spawns Dec-Feb deep in the ocean (queued by day length)
- Young begin development, while ascending to surface in “anticipation” of spring bloom
- If they are too early, they starve prior to the bloom
- If they are too late they miss the “window” for best growth and survival
- Length of time feeding at surface until descent is determined largely by food concentration, and temperature



Initial Paradigm

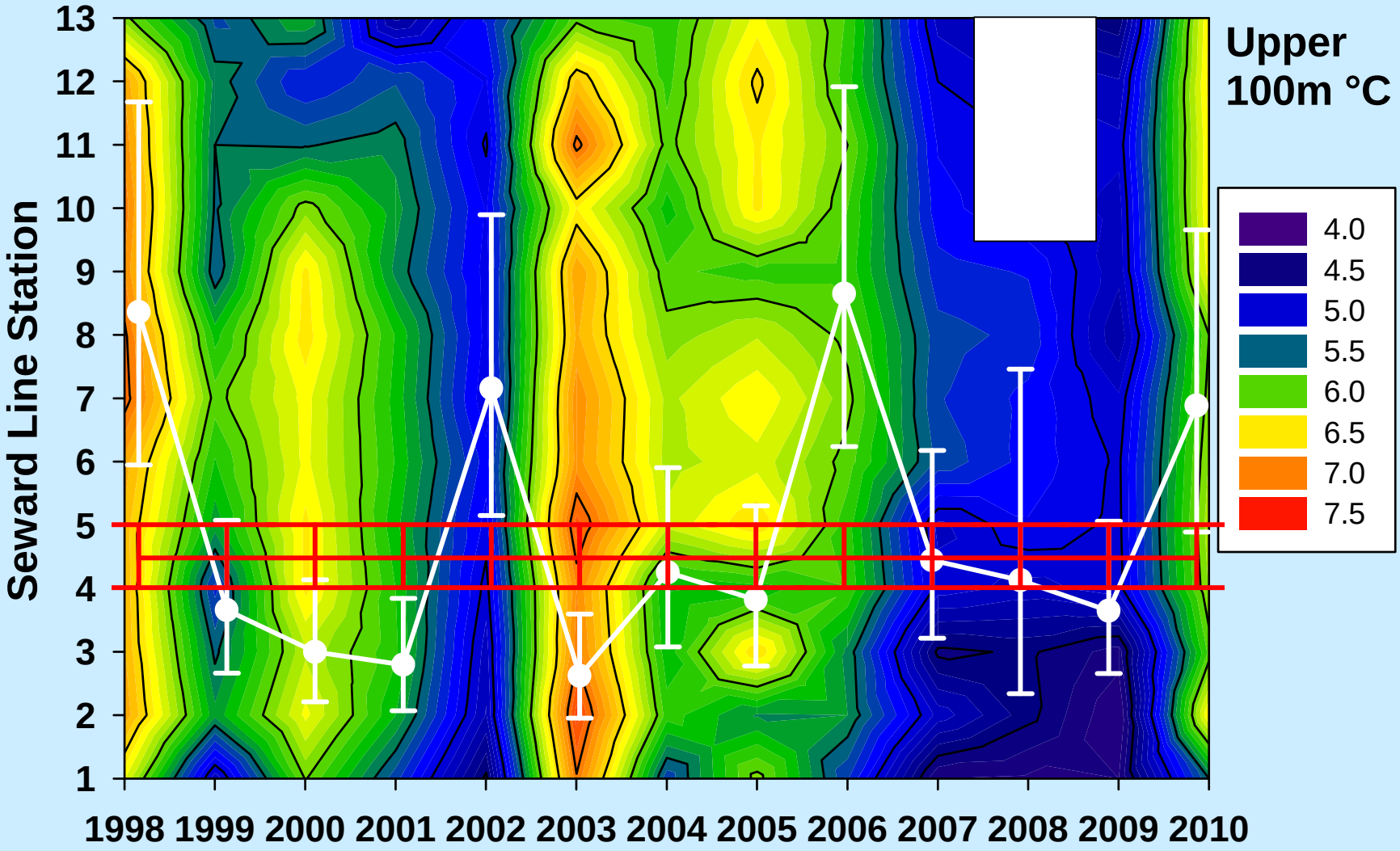
- In a warm year, the spring bloom is earlier (and often smaller) – *Neocalanus* growth phase is completed earlier….
- In a cold year, the bloom is later, larger and longer – *Neocalanus* success is greater, growth is completed later….
- Cold years have better & longer overlap of *Neocalanus* with juvenile pinks

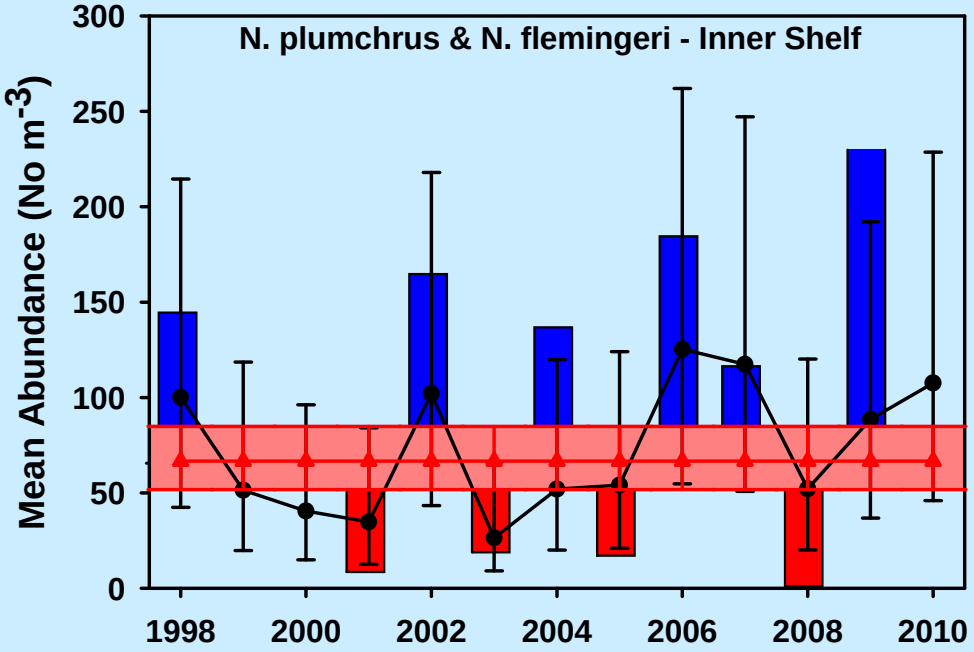




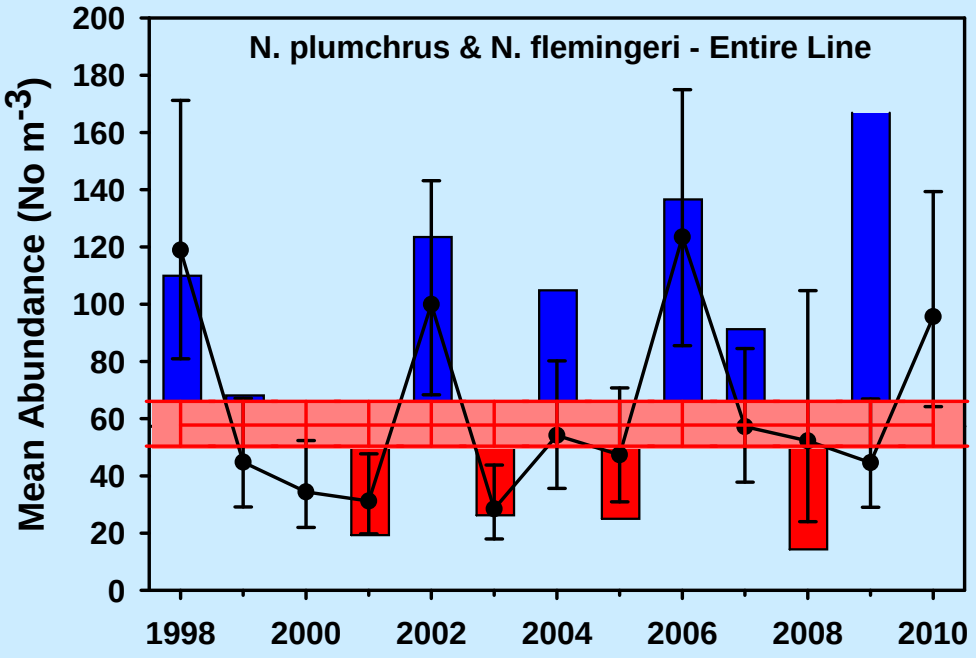
- *Neocalanus* have 6 life-stages, more late stages indicate faster growth and an earlier descent (at stage-5)
- Warm year 2003 (and 2005) show faster development
- Cold years, 2007-2009, have **strikingly** slow development compared to all other years
- **2007-9 were weeks behind normal!**
- BUT is hot or cold better for population?

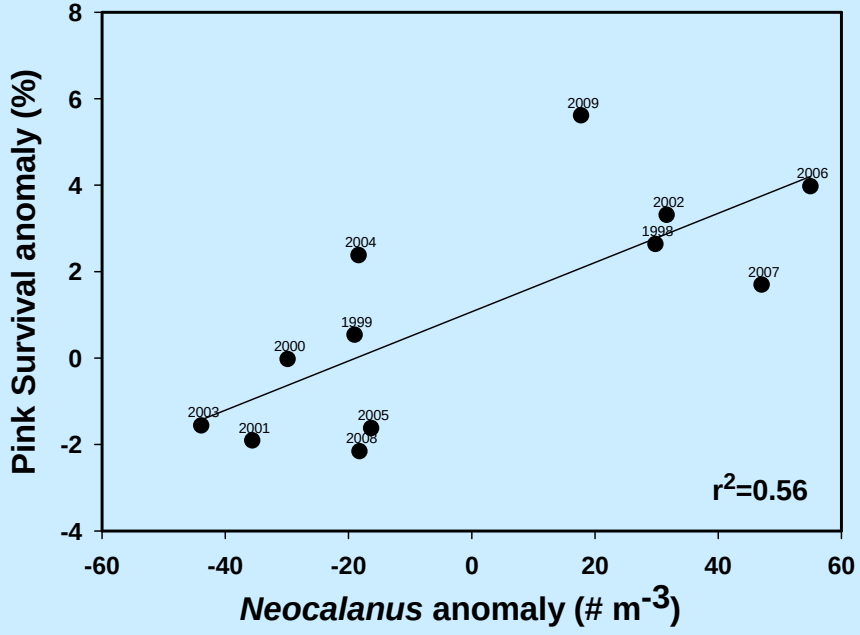
Although temperature drives rates of *Neocalanus* development, it does not seem coupled to their overall success on the shelf, suggesting other mechanisms must be important





- So what's the link to fisheries?
- Every year with high *Neocalanus* had good survival of Pink salmon. Low *Neocalanus* often yielded low Pink survival





Thoughts

- *Neocalanus* populations are correlated with Pink salmon survival BUT
  - Simple predictions of warm years => bad for *Neocalanus* => bad for salmon are **too simplistic**
  - Other mechanisms (e.g. timing and magnitude of spring bloom, cross-shelf exchange) must also be important for *Neocalanus* and should be explored (i.e. the Gulf of Alaska IERP)
  - Other factors also affect Pink survival beside *Neocalanus*, but a very strong *Neocalanus* years appears to their benefit
- At present, establishing the population size of *Neocalanus* requires an annual monitoring program like the Seward Line to index zooplankton productivity and the resources available to higher predators like Pink Salmon
- *Neocalanus* populations estimates for 2010 favor strong return of Pinks in 2010
- What about other fish species?

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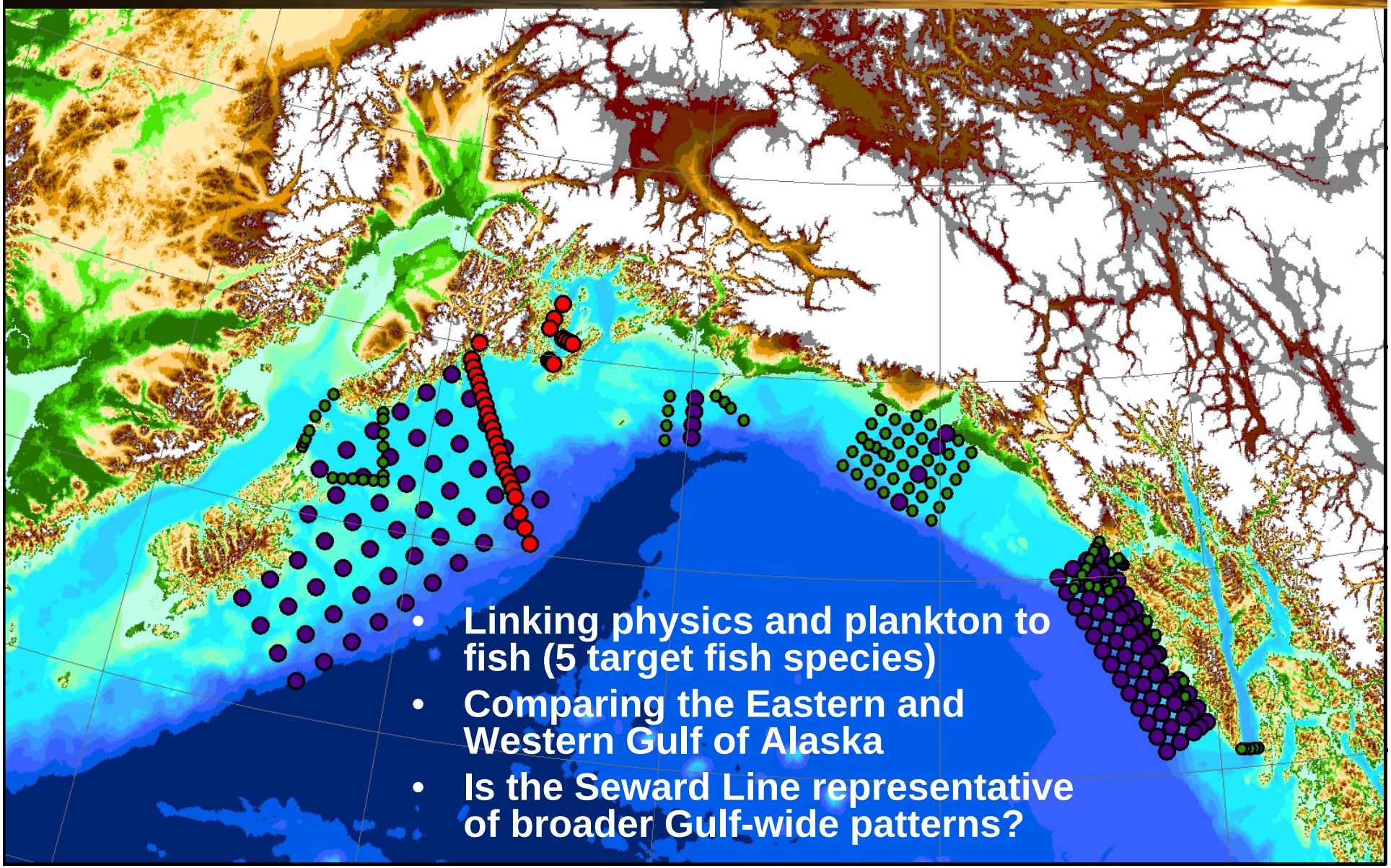
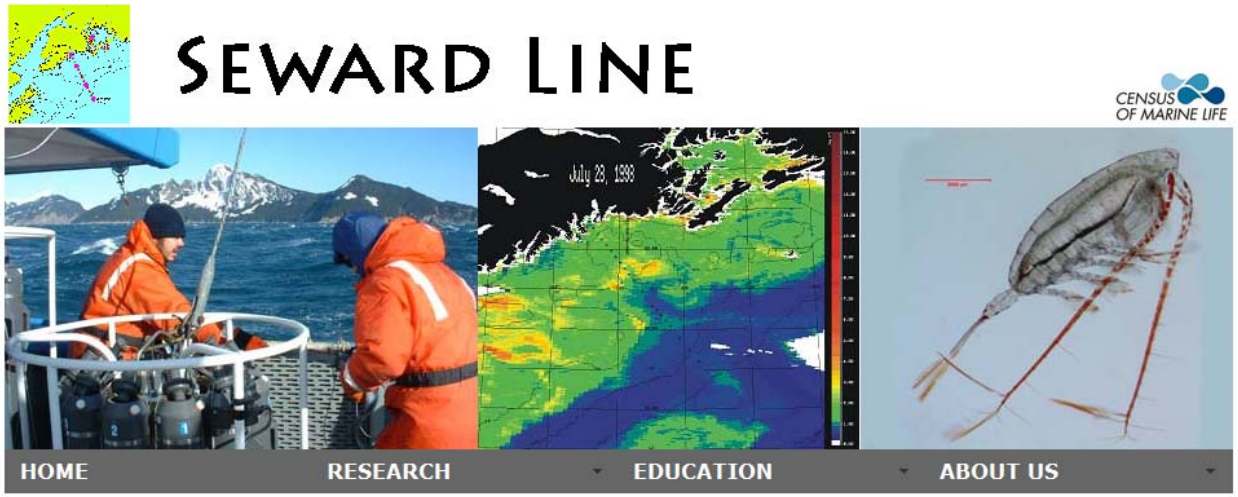


- **Linking physics and plankton to fish (5 target fish species)**
- **Comparing the Eastern and Western Gulf of Alaska**
- **Is the Seward Line representative of broader Gulf-wide patterns?**


2000 µm
5000 µm



Seward Line Website

Contains:

- time-series results
- individual cruises
- information on key species
- content still growing