Measuring the pulse of the Gulf of Alaska: oceanographic observations along Seward Line, 1997-2011

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UNIVERSITY OF ALASKA FAIRBANKS

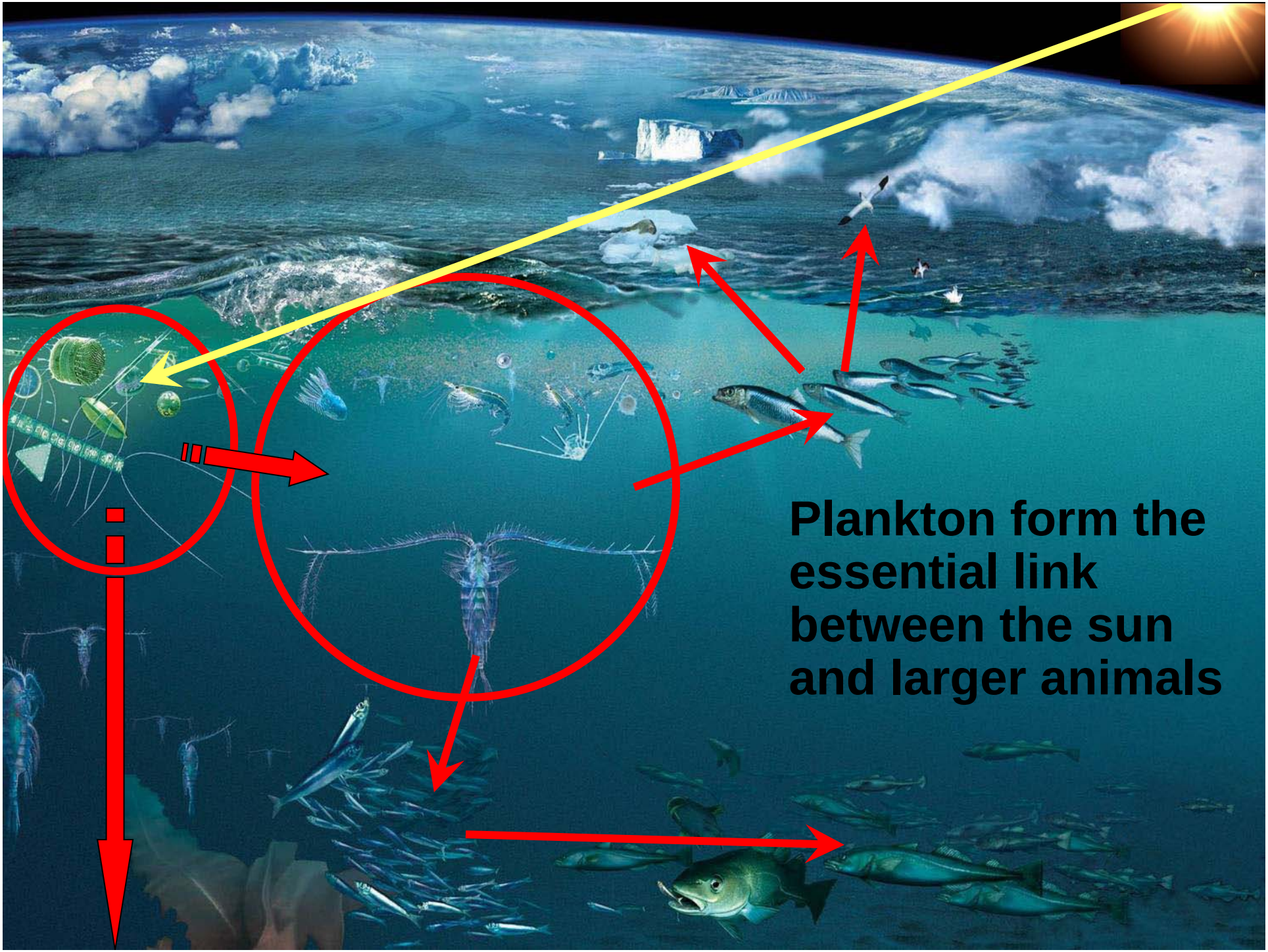
U.S. GLOBEC Northeast Pacific Program

NORTH PACIFIC RESEARCH BOARD

NSF NOAA AOOS Alaska Ocean Observing System

Science is about knowledge and understanding

Good science is story telling

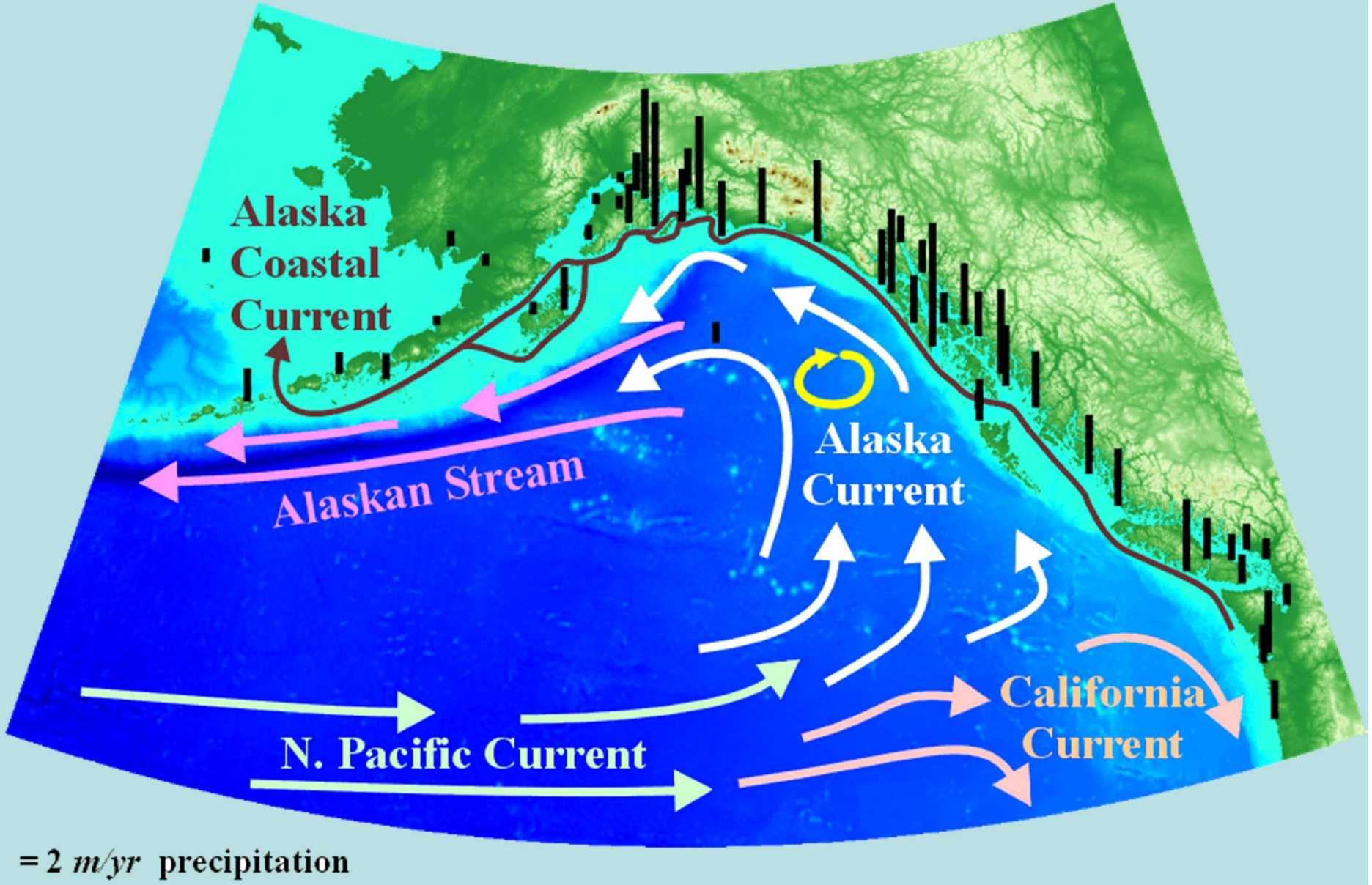

Plankton form the essential link between the sun and larger animals


No Plankton
= no fish to
harvest

Ocean biology

- The productivity of the ocean is fuelled by both light and nutrients (fertilizer)
- One of them will always be limiting
- Times and places when they are not are the hotspots in the ocean
- In higher latitudes, we shift seasonally between light and nutrient limitation
- Alaskan seas are the nation’s most productive (in tons and $$$$)

The Gulf of Alaska – a subarctic sea

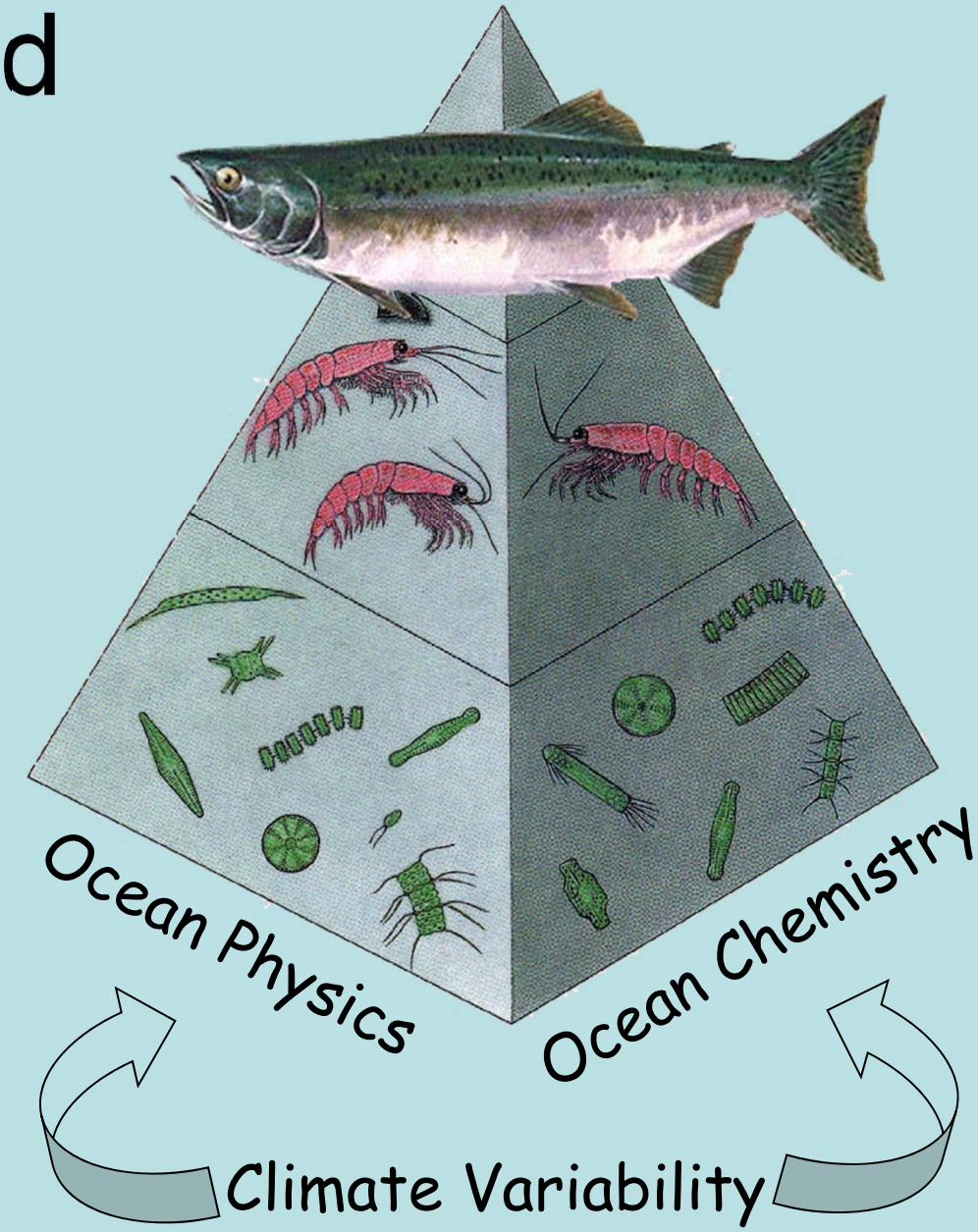


COASTAL GULF OF ALASKA SEWARD LINE

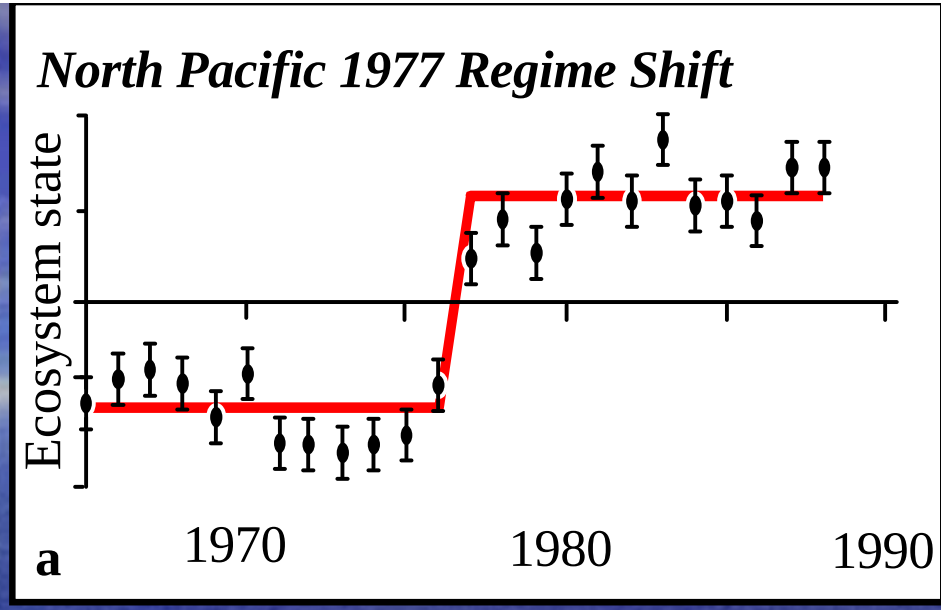
- Physical data over ~3 decades
- Biological data over 14 years
- Currently funded by a consortium: NPRB, AOOS, NOAA, EVOS & UAF
- Longest **&** most detailed time-series in the coastal GoA

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?

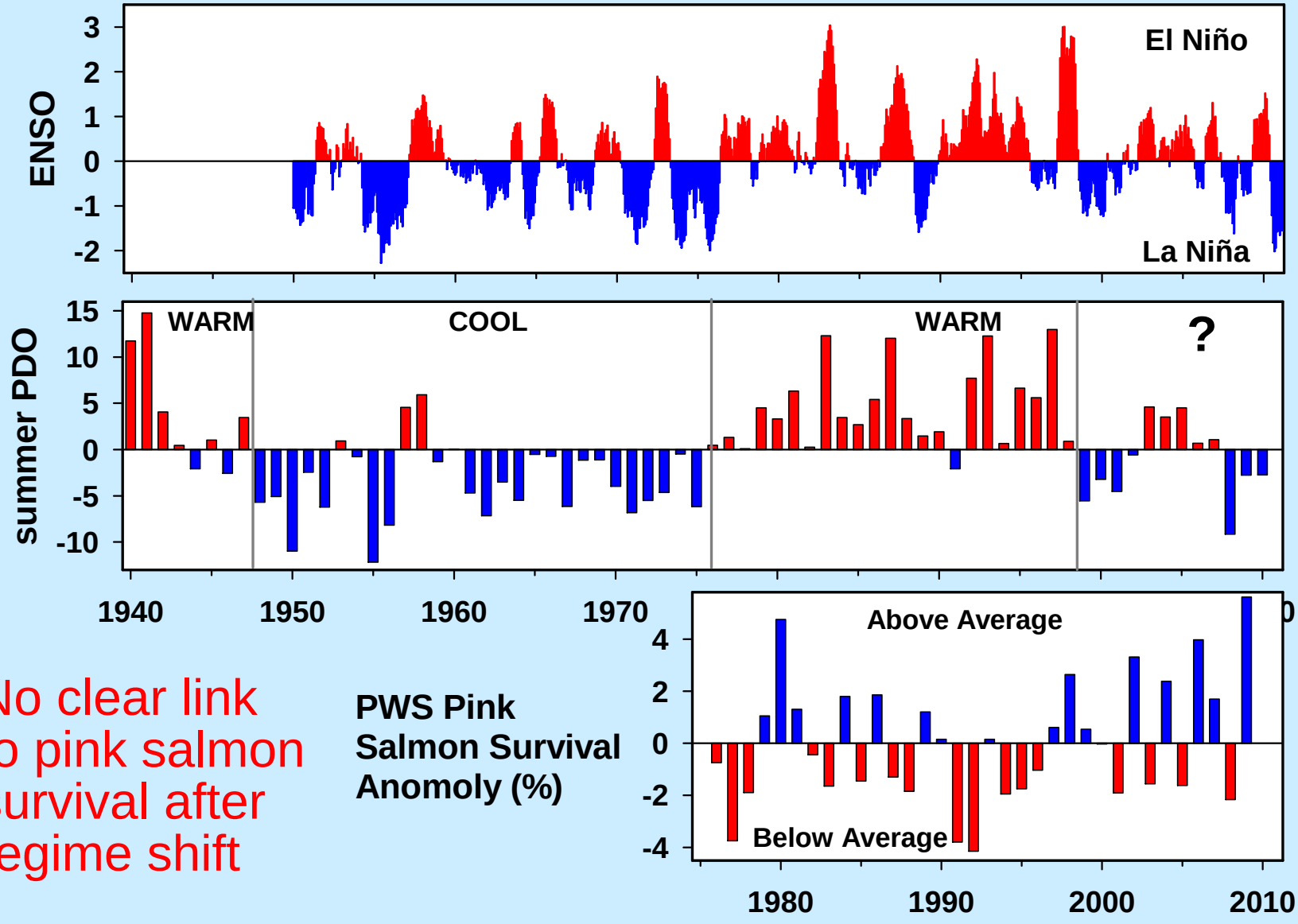


Late 1960's

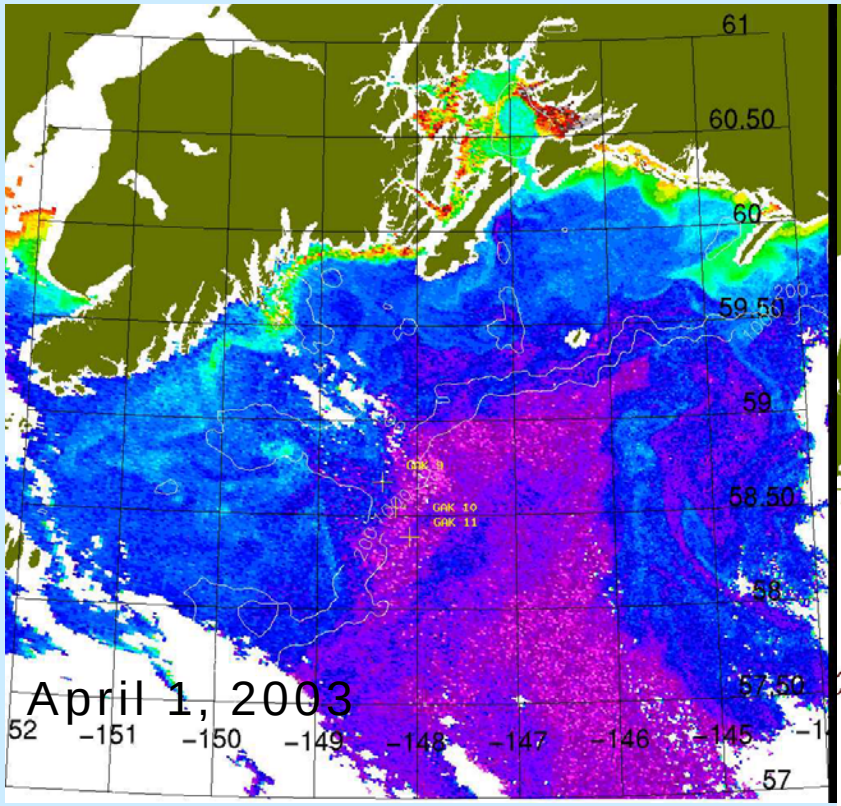
Early 1980's

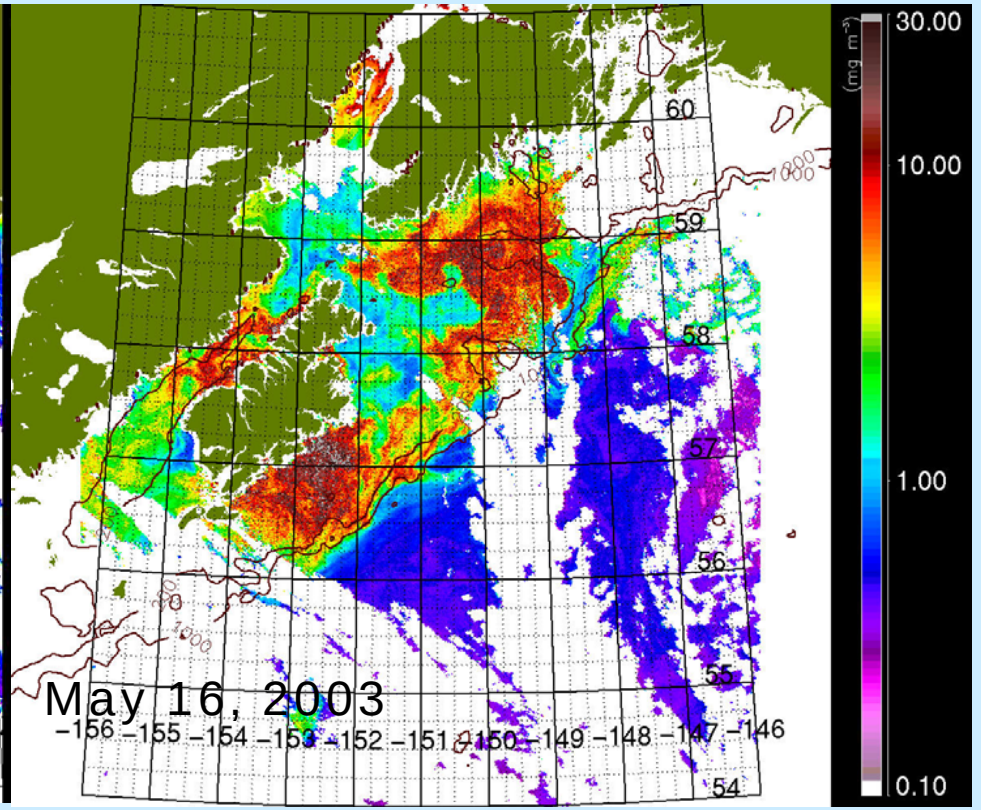
Changes catches in a small mesh bottom trawl in Pavlof Bay, Alaska, through the regime shift of the mid-1970s.

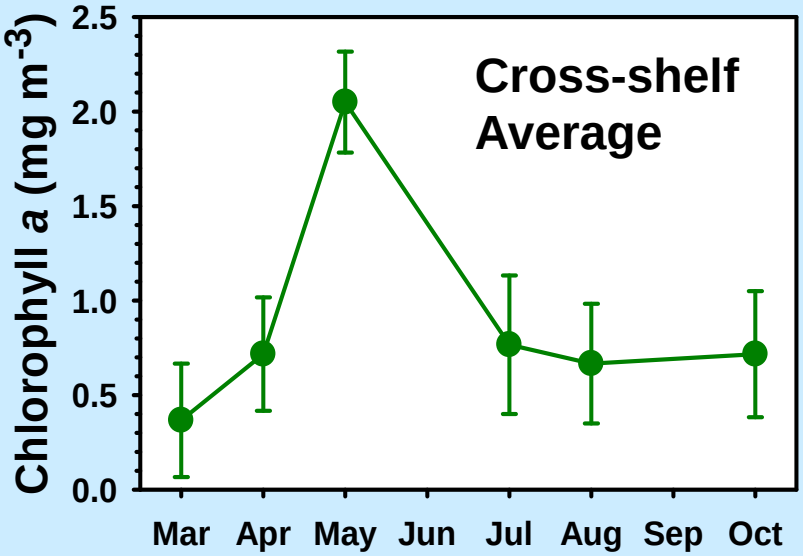
What drives productivity in GoA is complicated: seasonal, inter-annual & longer-term forcing



No clear link to pink salmon survival after regime shift

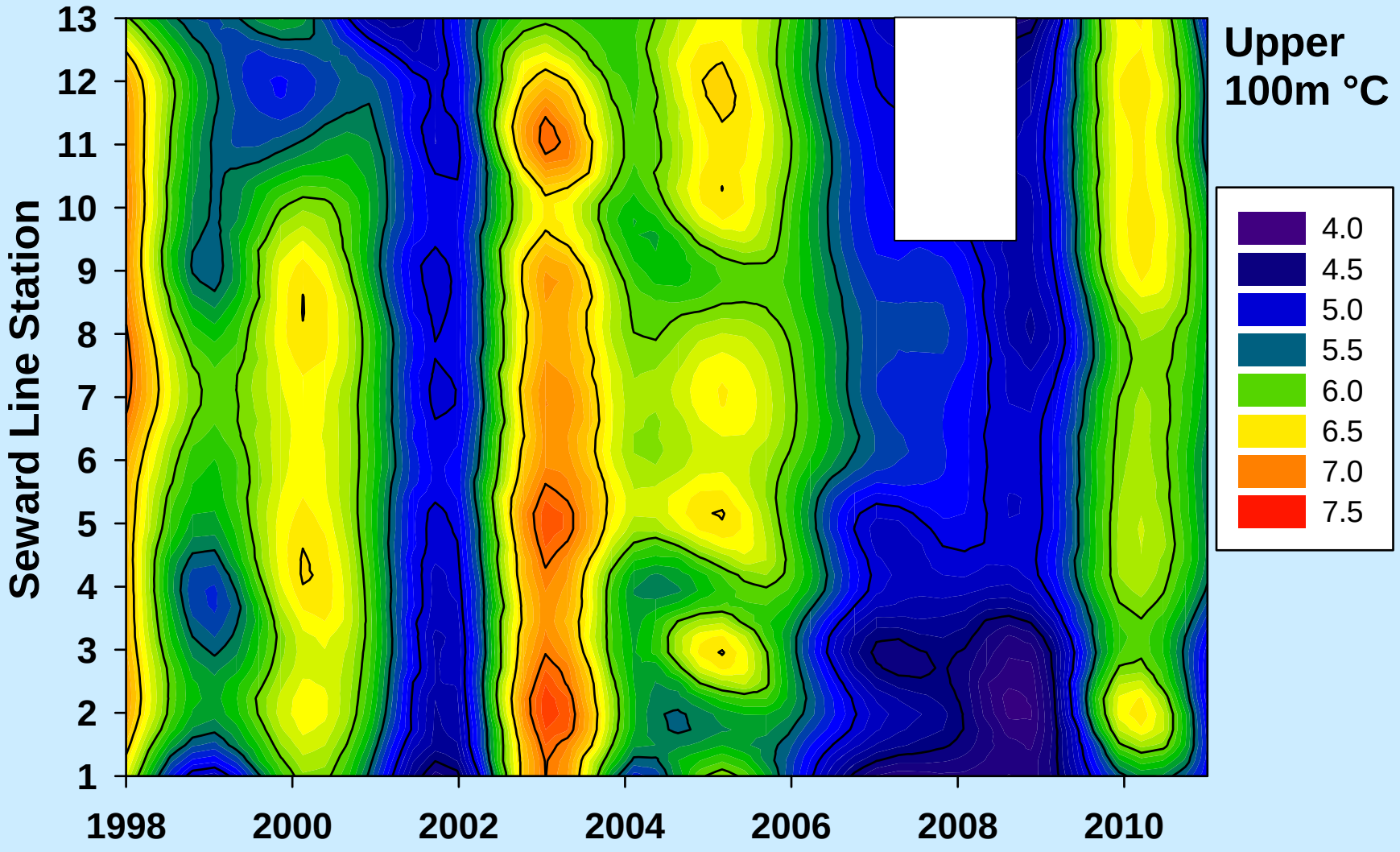




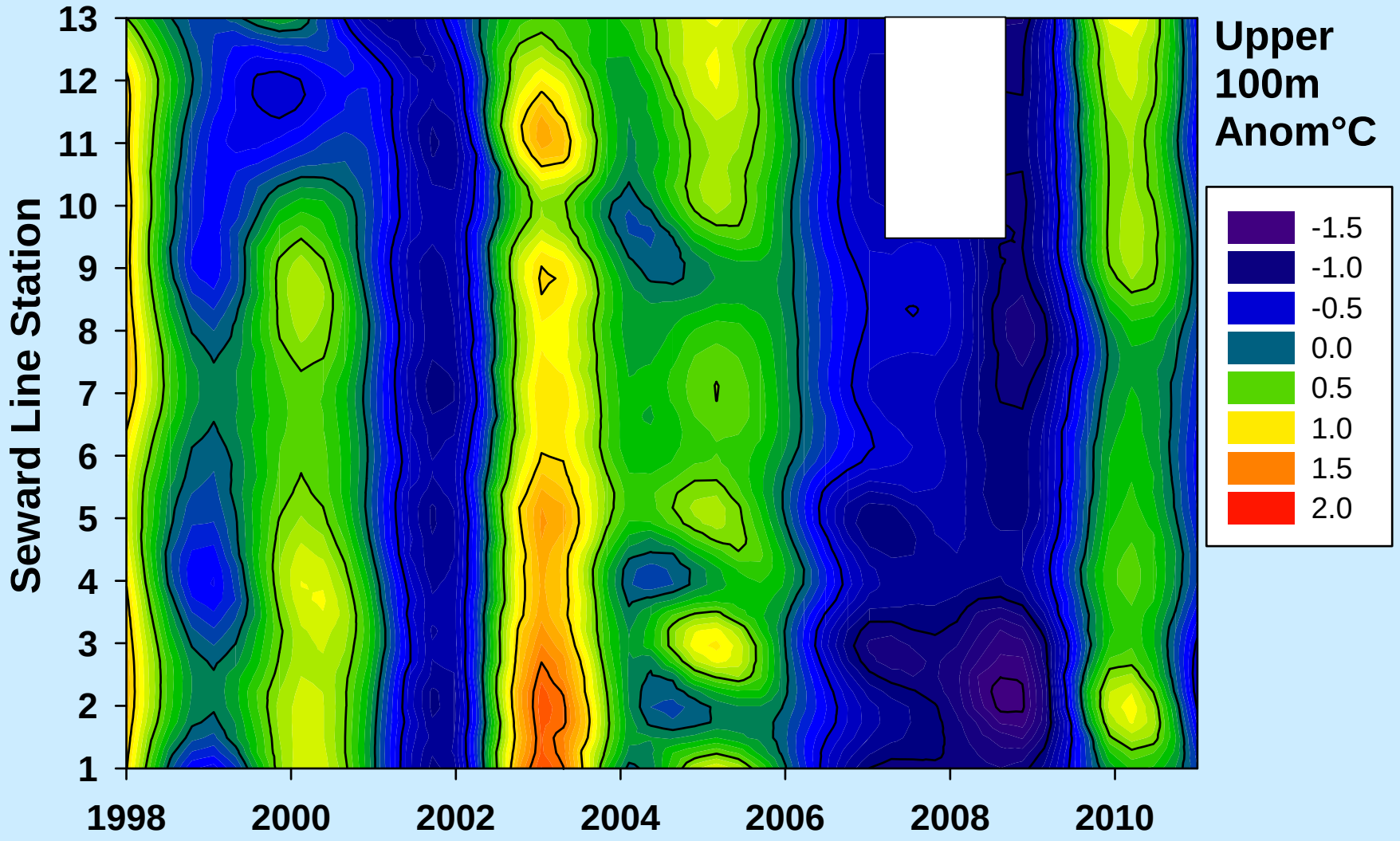


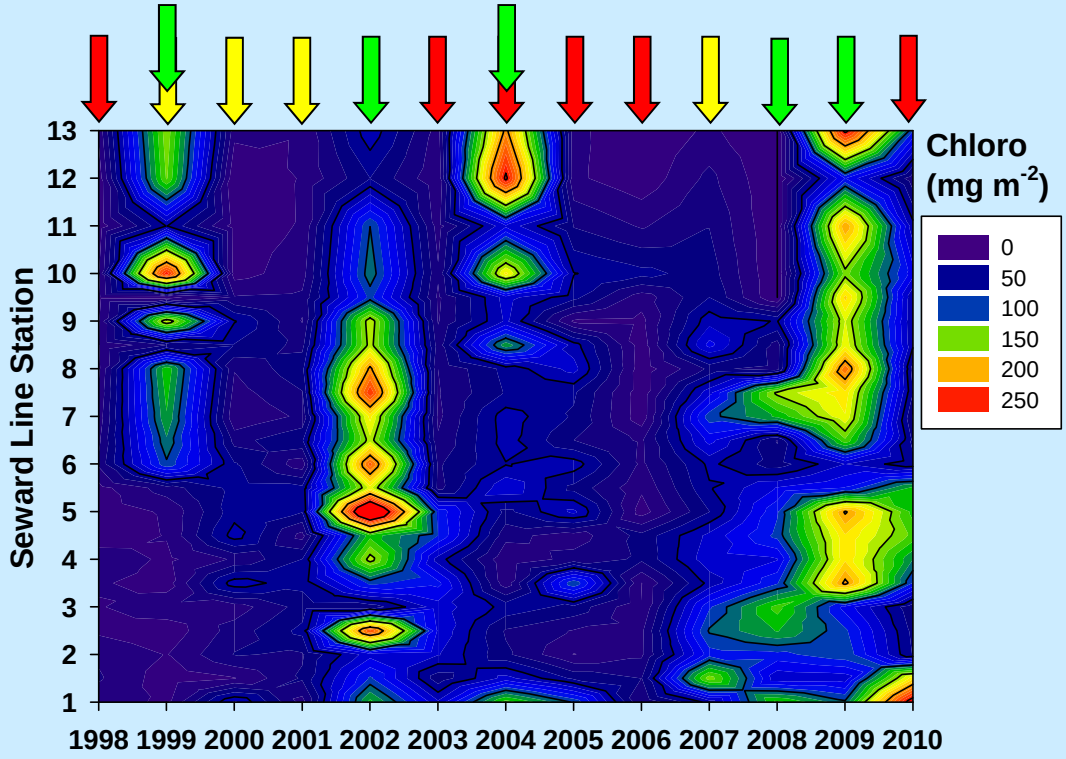
Primary production starts on the inner shelf earlier (0.5-1 month) than the mid- and outer shelf where it peaks in May

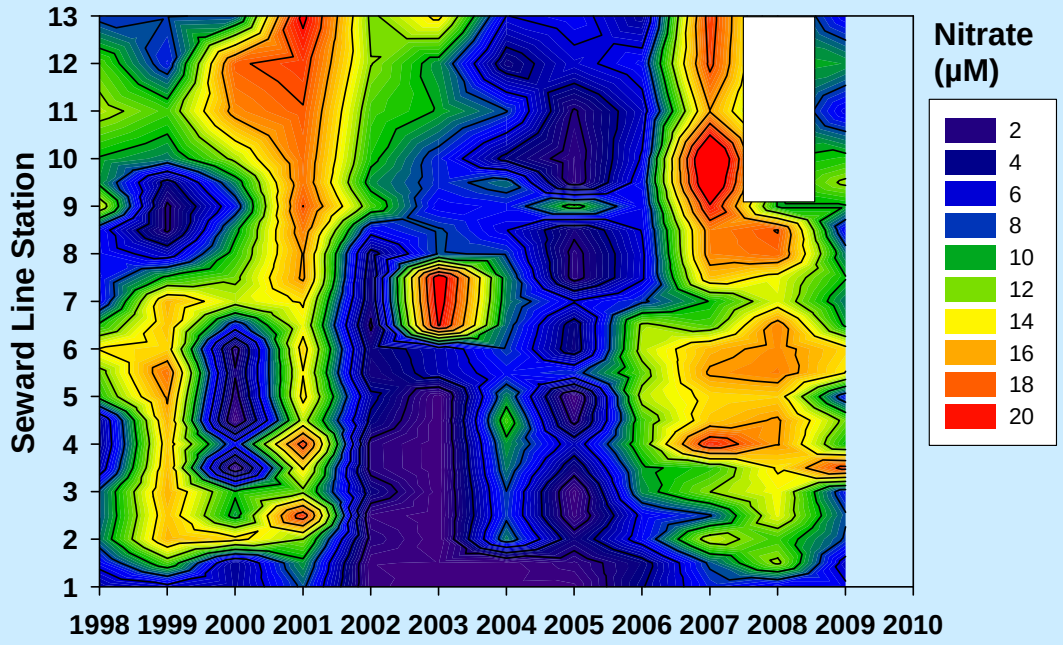
Driven by changes in the PDO, ENSO and winter weather, we have observed years of warm and cool springs – some recent Mays were similar to the early 1970s



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

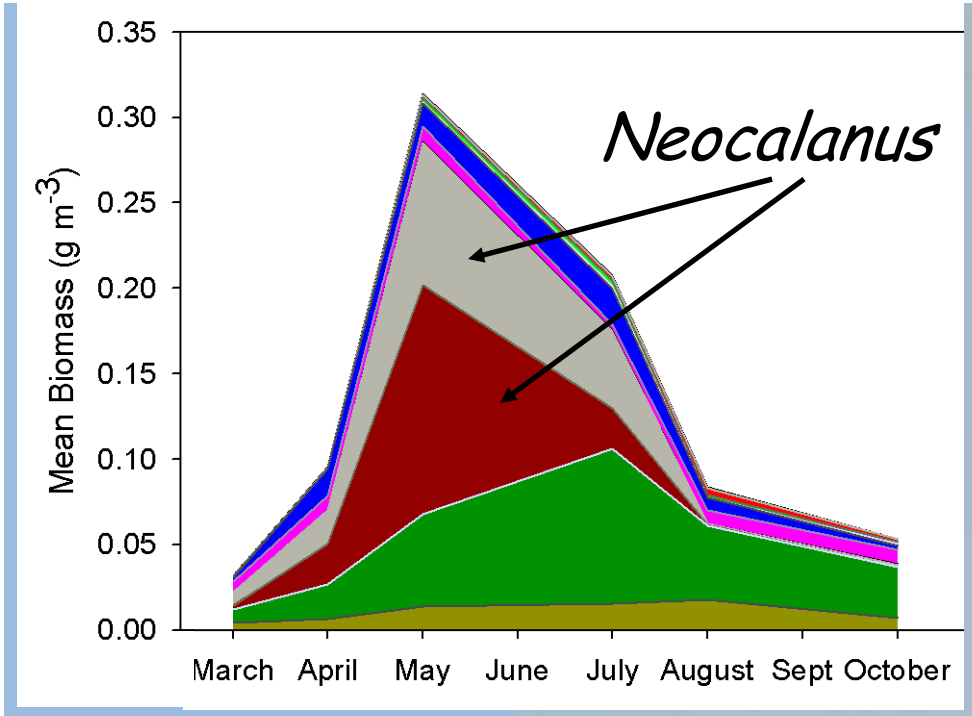




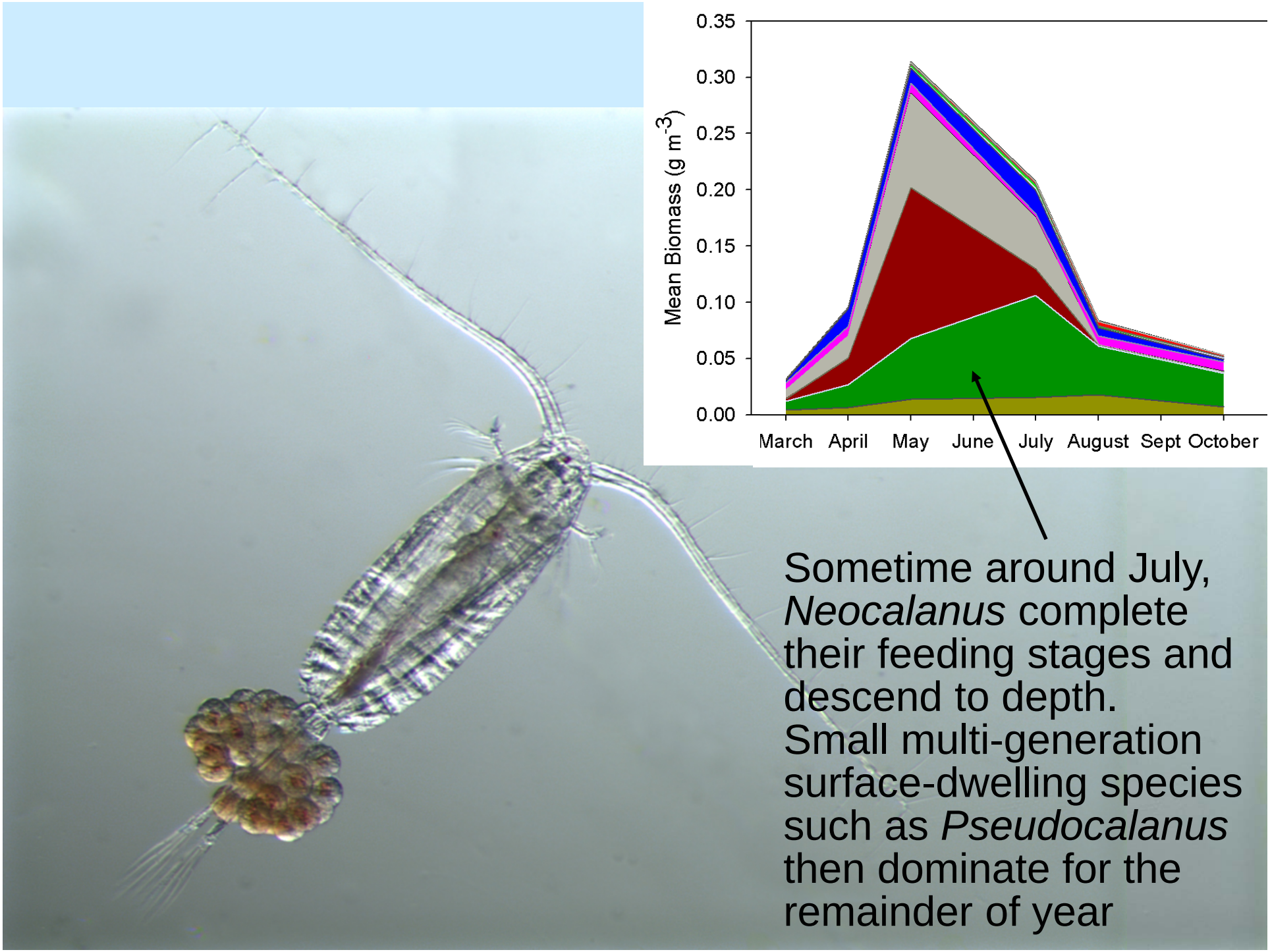


Spring Bloom

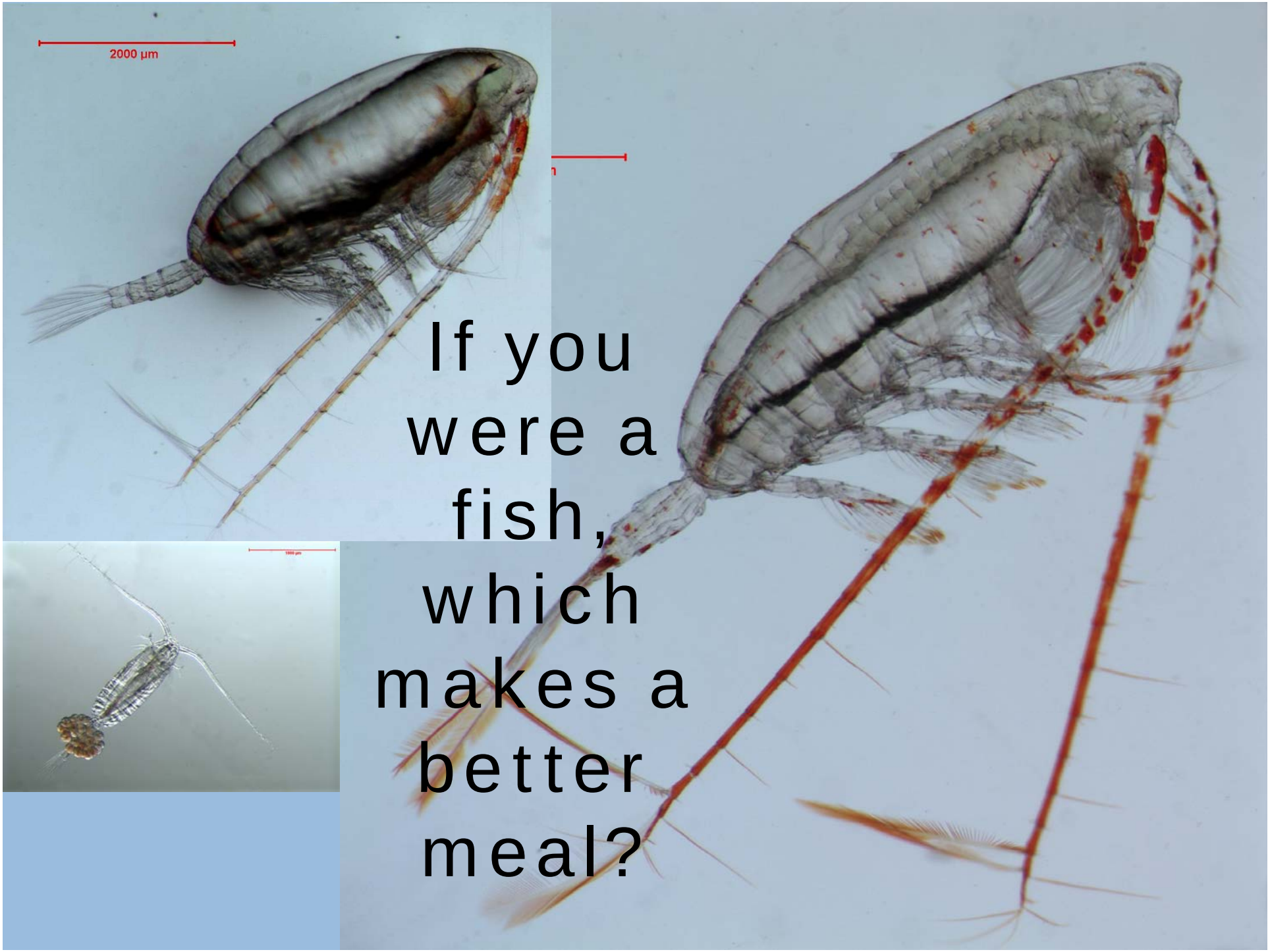
- Short-lived (1-2 weeks) so hard to hit when sampling
- Comparing to nutrients allows determination if we are sampling pre-bloom, post-bloom or the bloom
- 1998, 2003-2006 warm years had early blooms
- Blooms more typical timing (or late) in other years



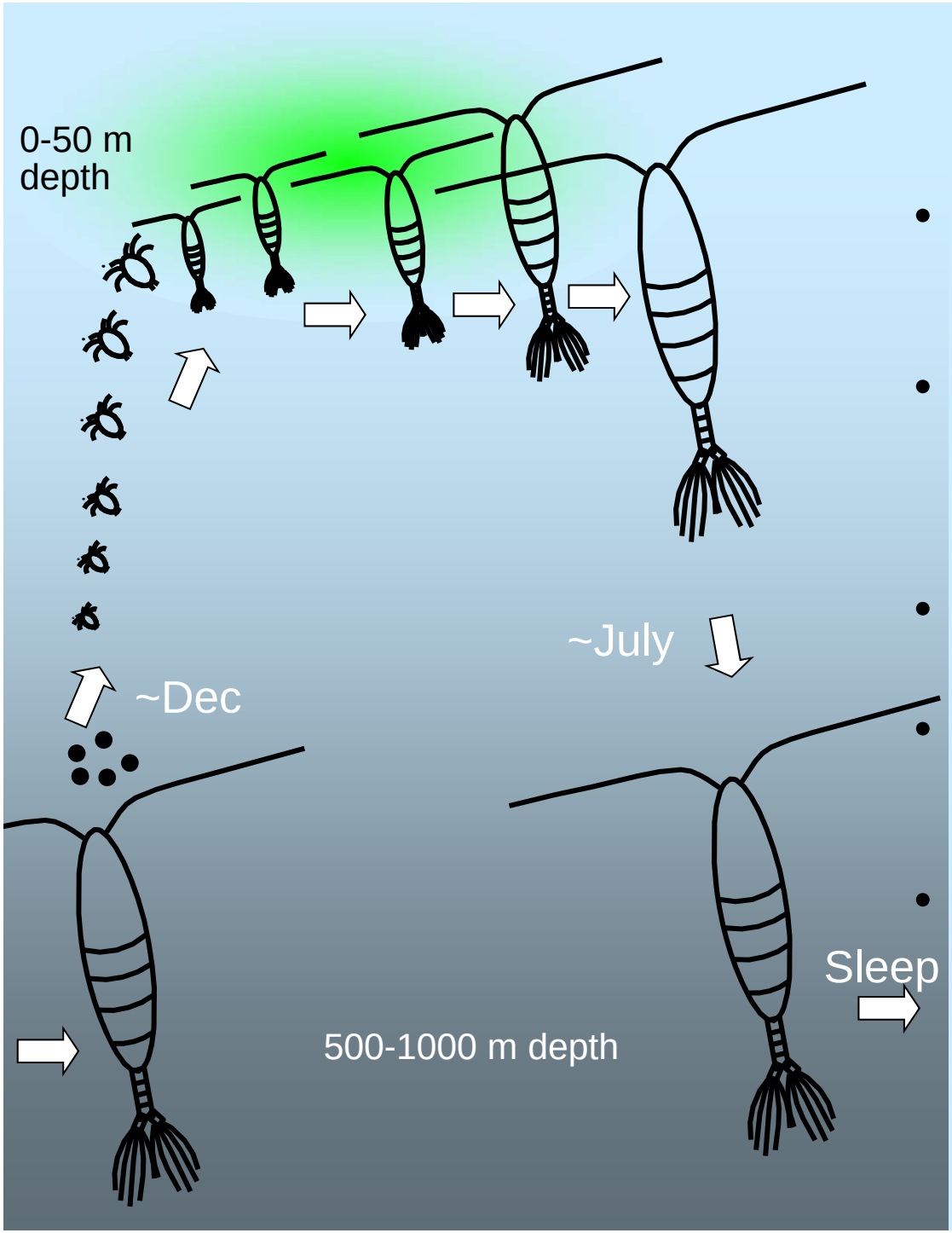
The success of the zooplankton that dominate the spring is related to their unique adaptations to the production cycles of the Gulf



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

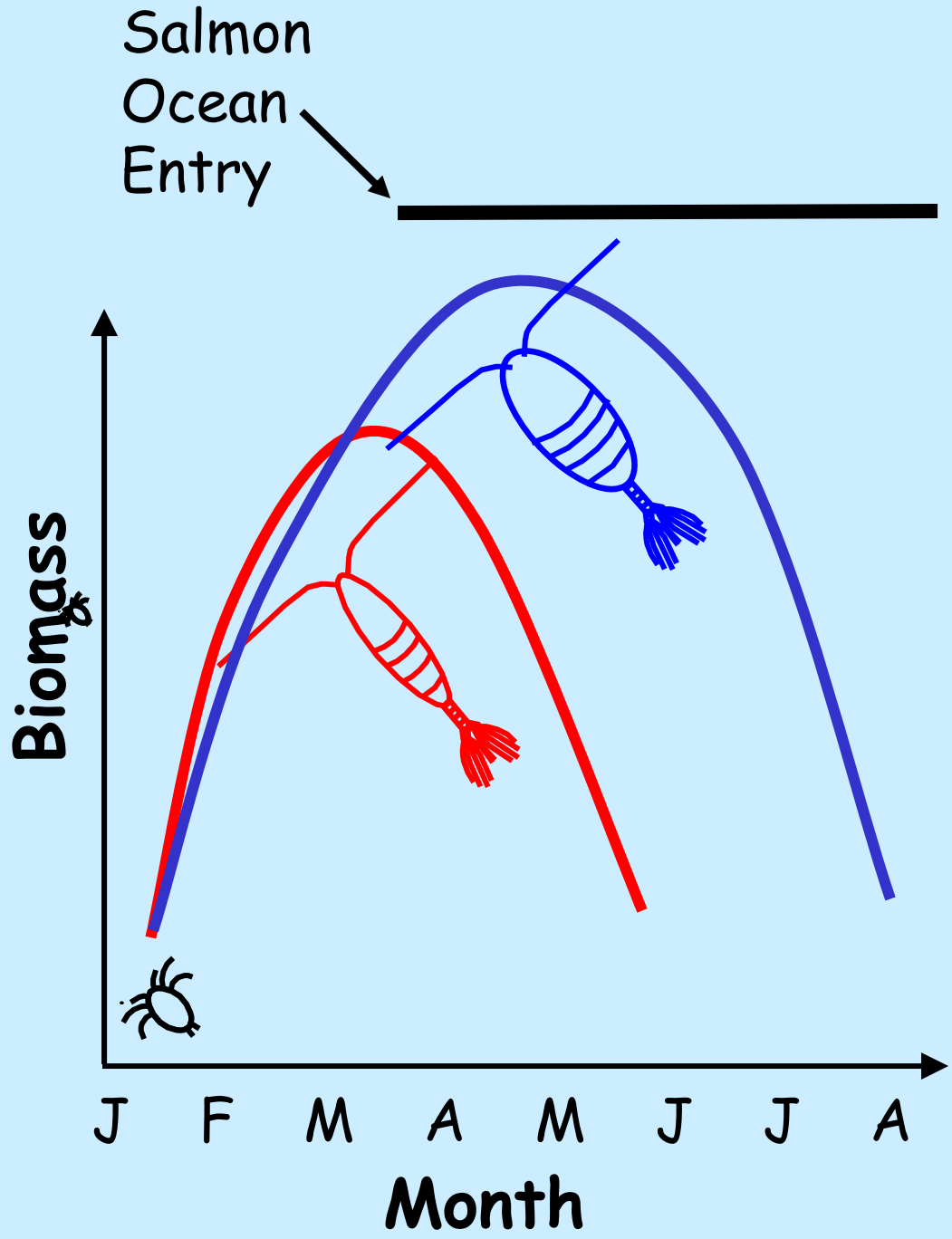


If you were a fish, which makes a better meal?



Neocalanus

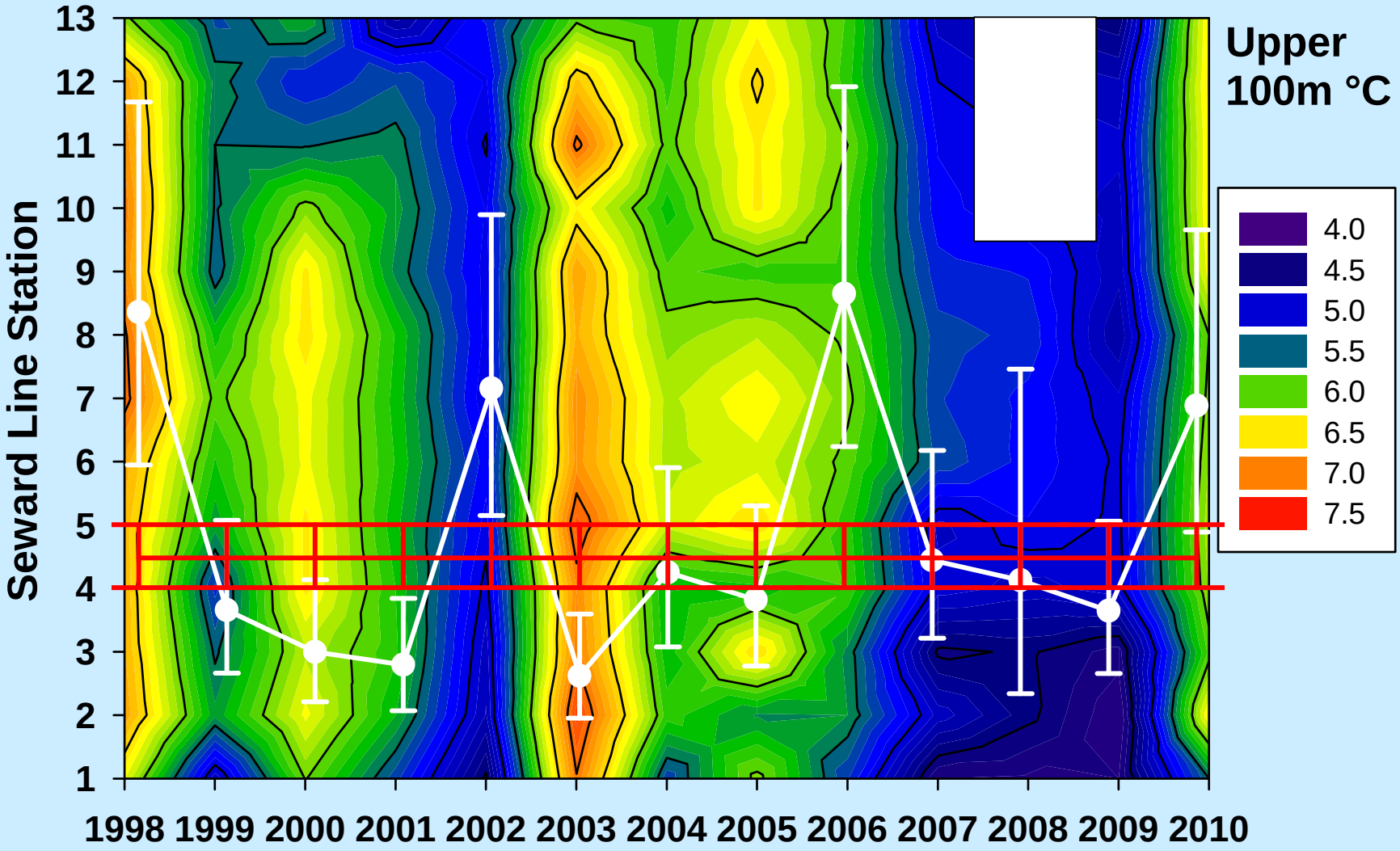
- Spawns Dec-Feb deep in the ocean (queued by day length)
- Young begin development, while ascending to surface in “anticipation” of spring bloom
- If they are too early, they starve prior to the bloom
- If they are too late they miss the “window” for best growth and survival
- Length of time feeding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

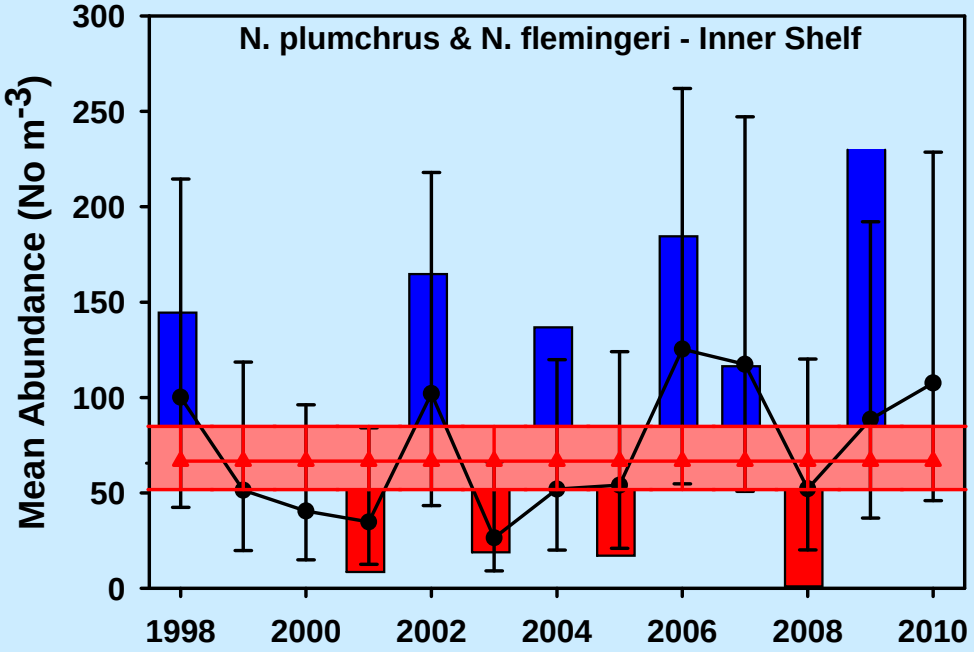


Initial Paradigm

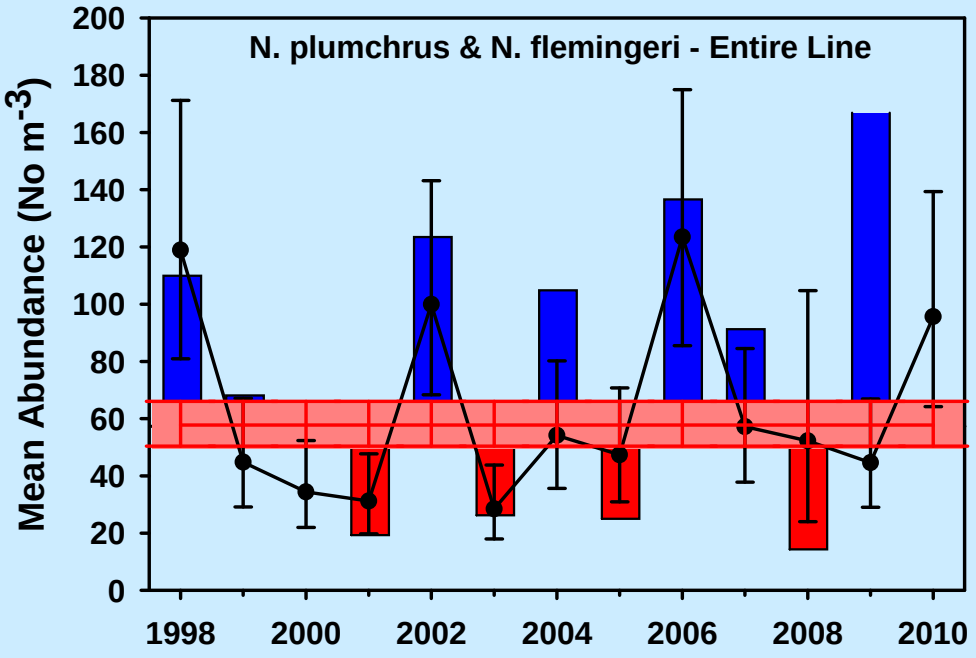
- In a warm year, the spring bloom is earlier (and often smaller) – *Neocalanus* growth phase is completed earlier….
- In a cold year, the bloom is later, larger and longer – *Neocalanus* success is greater, growth is completed later….
- Cold years have better & longer overlap of *Neocalanus* with juvenile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

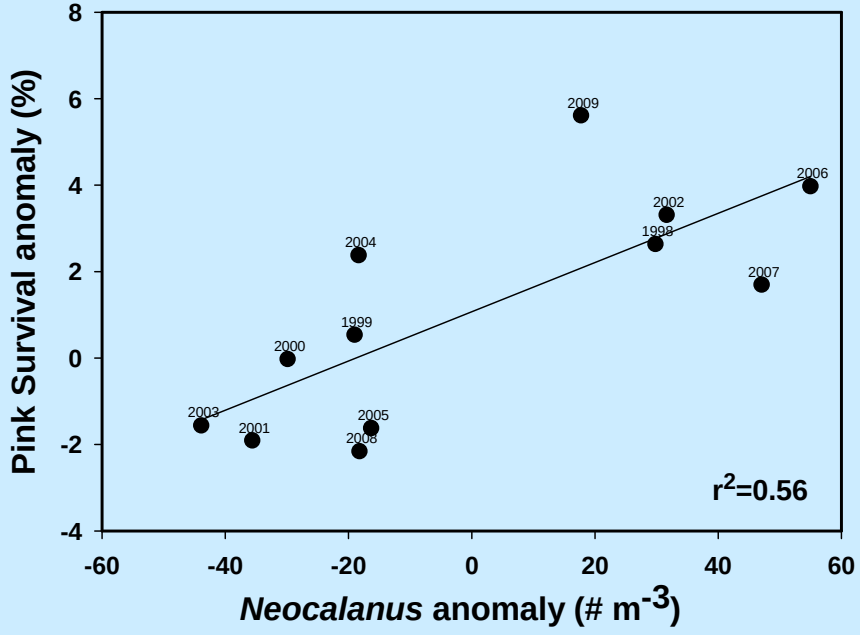
Although temperature drives rates of *Neocalanus* development, it does not seem coupled to their overall success on the shelf, suggesting other mechanisms must be important





- 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

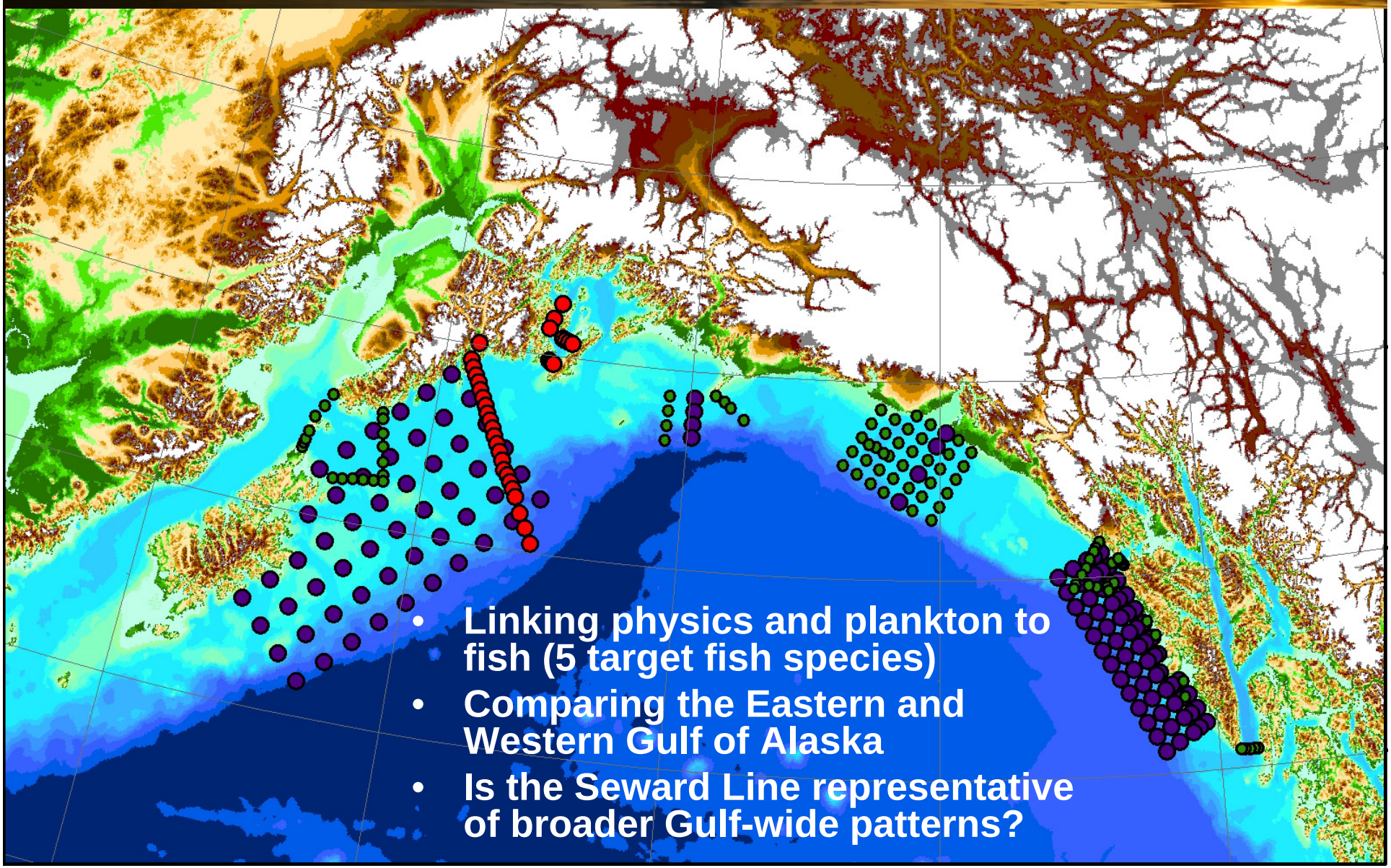




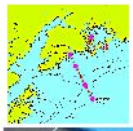
Thoughts

- *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 program)
  - Other factors also affect Pink survival beside *Neocalanus*, but a very strong *Neocalanus* years appear 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
- What about other fish species?

North Pacific Research Board
Gulf of Alaska Project

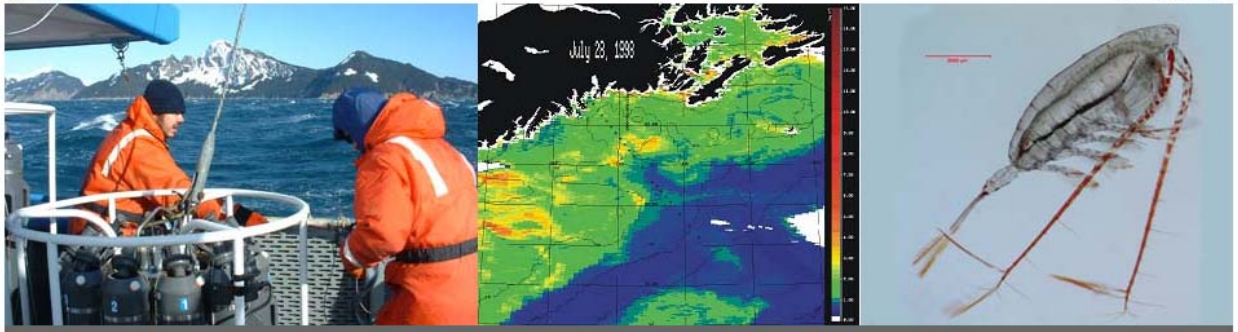


- **Linking physics and plankton to fish (5 target fish species)**
- **Comparing the Eastern and Western Gulf of Alaska**
- **Is the Seward Line representative of broader Gulf-wide patterns?**



SEWARD LINE

CENSUS OF MARINE LIFE



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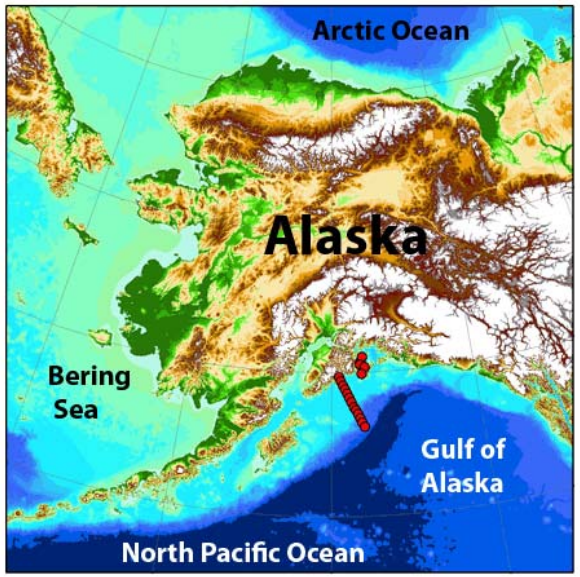
Gaining an understanding of the coastal Gulf of Alaska ecosystem through long-term observations



The Seward Line is a long-term observation program (LTOP) undertaken from 1998-2004 by the Northeast Pacific GLOBEC program, and continued from 2005-2009 by the North Pacific Research Board.

The purpose of this research is to develop an understanding of the response of this marine ecosystem to climate variability.

Toward this end, the Seward Line cruises on the Gulf of Alaska shelf determine the physical and chemical oceanographic structure, the primary production and the distribution and abundance of zooplankton. We then xamine the seasonal and inter-annual variations in these measurements. At present, cruises are conducted each spring (May) and late summer (early September).

Summer 2008 status

- Water temperatures: **NORMAL**
- Phytoplankton: **NORMAL**
- Zooplankton abundance: **NORMAL**
- Southern Zooplankton Species: **PRESENT**

Spring 2009 status

- Spring melt/run-off: **DELAYED**
- Water temperatures: **BELOW NORMAL**
- Spring phytoplankton bloom: **IN PROGRESS** (DELAYED)
- Spring zooplankton growth: **SLOW**
- Spring zooplankton number: **AVERAGE**

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U.S. GLOBEC

CMarZ

Site design: Russ Hopcroft & Seth Danielson. Images on this website can be used for educational purposes with reference to the site

Seward Line

Website

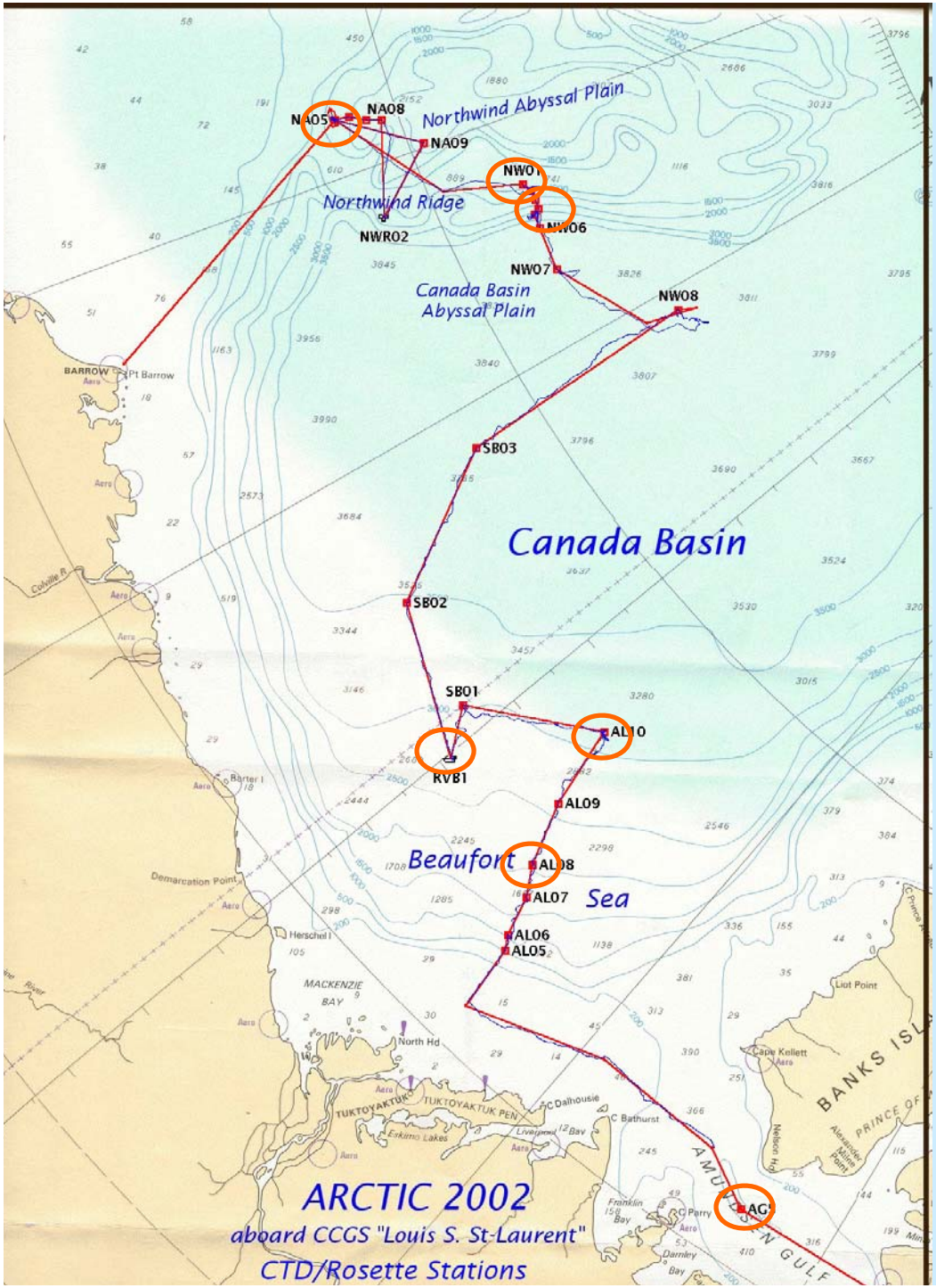
Contains:

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


2000 µm
5000 µm

It ain’t as easy as it looks: *stories from the field*

- The best made plans…
  - frequently don’t work
- Chance favors the prepared mind….
  - but improvising is also a great plan B
- If you aren’t prepared to break or lose it…
  - It shouldn’t go to sea
- Never give up…
  - You’ll always figure out what you **should** have done later
- Know when to run away
  - the ocean can be unforgiving – accept the limits of your people and equipment

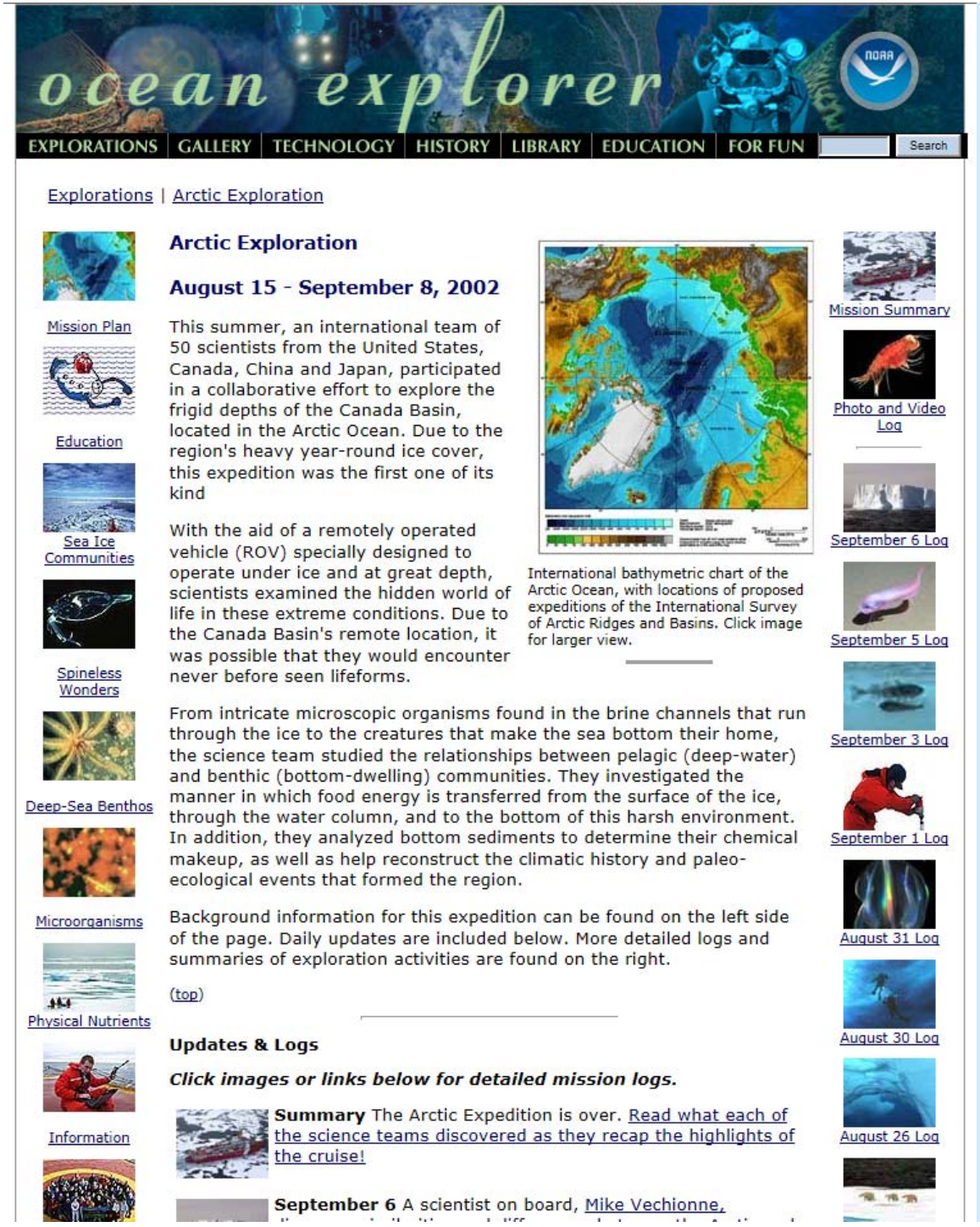


Hidden Ocean 2002

- 30 days!
- 22 CTD stations
- 10 shallow plankton nets
- 9 under-ice Scuba stations
- 10 box cores
- 7 ROV dives (only 3 pelagic)

ROV *Global Explorer*

- 2700 m (9000 ft) capable
- “portable”
- 80 kg (200 lb) science payload
- New vehicle: “shake-down” pains (i.e. most things didn’t work)



Failure?

- We showed what could be done
- Web portal was incredibly successful
- Lead to a second cruise (where things worked)
- It introduced us to the power of images (and NGM contacts)
- It lead to ArcOD, a project within CoML
- Special issue (7 papers published)

2005 vs 2002

- In 2005 everything worked!...
- Fuller digital inventory of arctic zooplankton
- Higher quality images
- Increased sampling of larger and deeper species
- Many pubs!