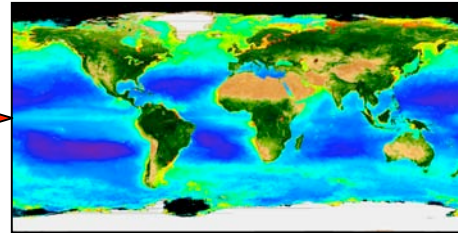
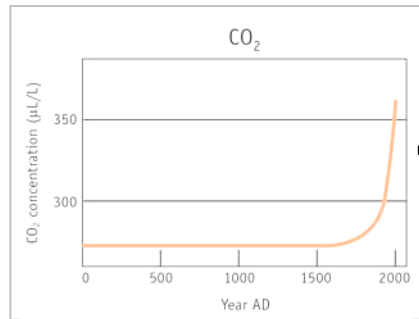


Oceans of Change: decadal basin scale monitoring using the Continuous Plankton Recorder Survey

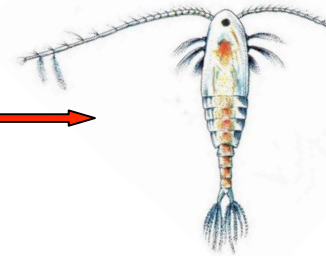
Peter Burkill & Chris Reid
Sir Alister Hardy Foundation for Ocean Science
Plymouth, UK

Plankton are important because...

- Climate



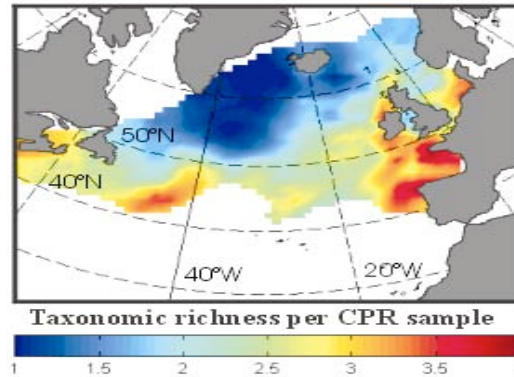
Phytoplankton - chl



Zooplankton

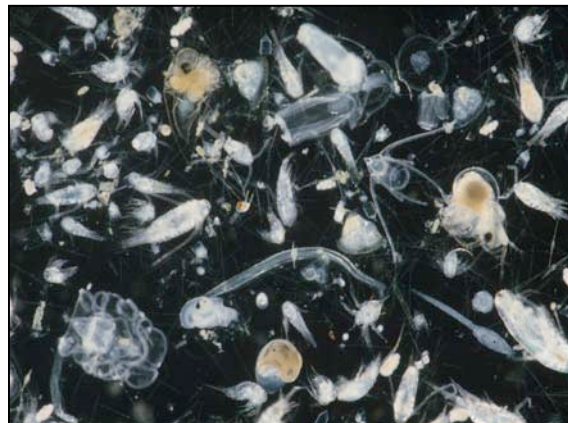
C sink

- Biodiversity



key taxa face "the acid test"

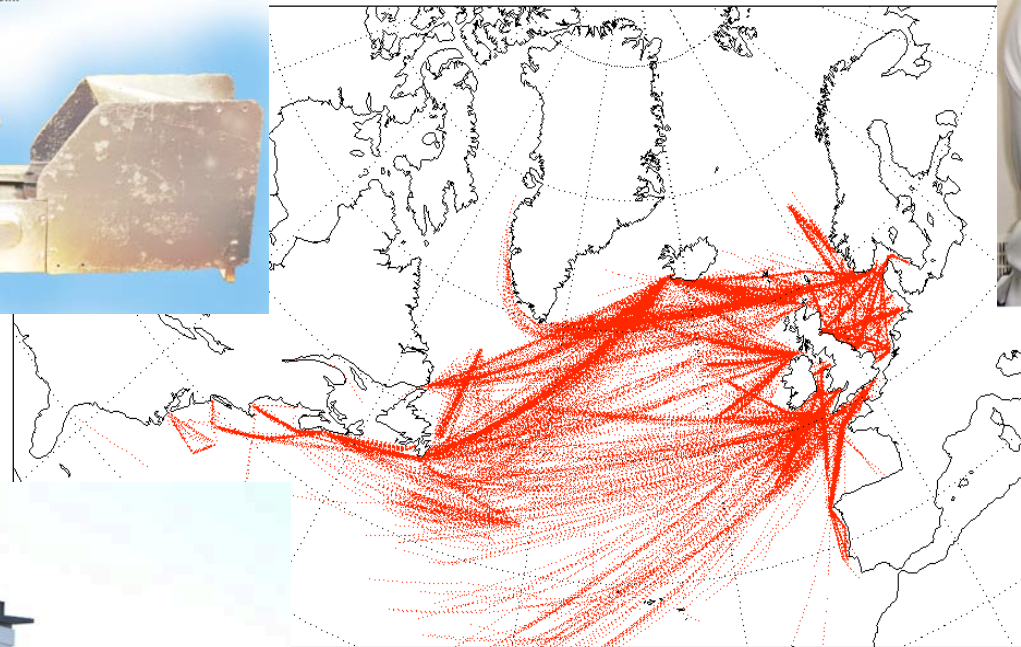
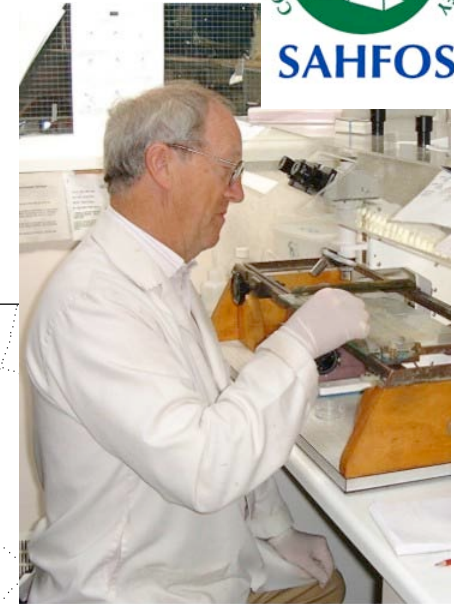
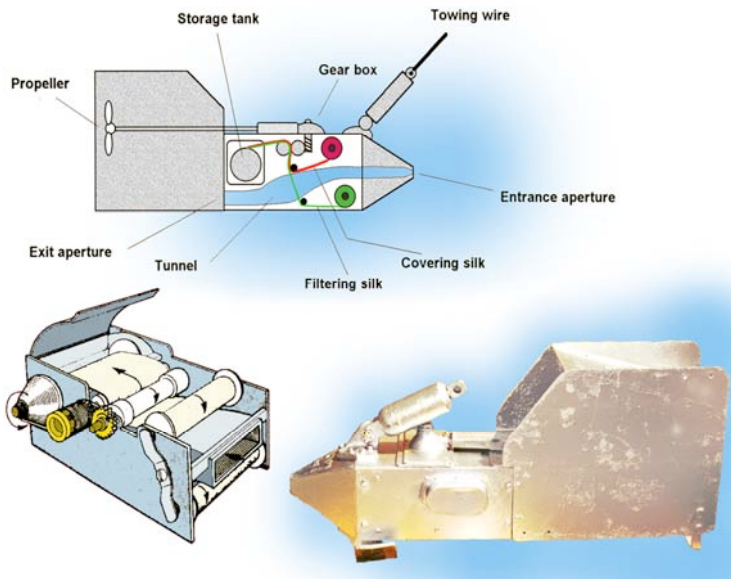
- Food Web



...they are "the ocean's pulse"



The CPR Survey started in 1931 and is....



~500 taxa



CPR Database & Samples

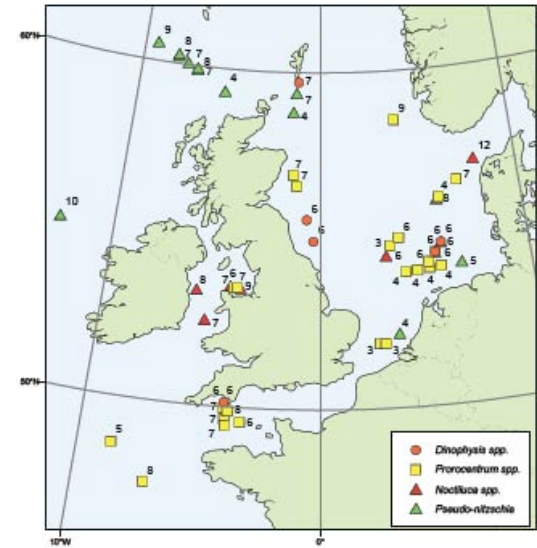
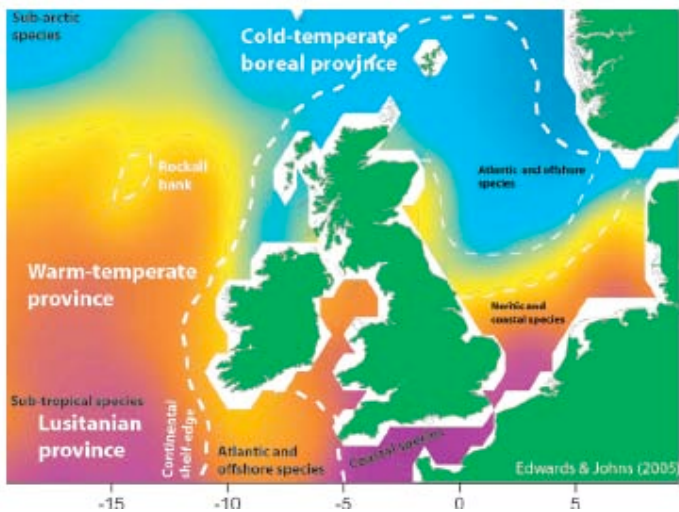
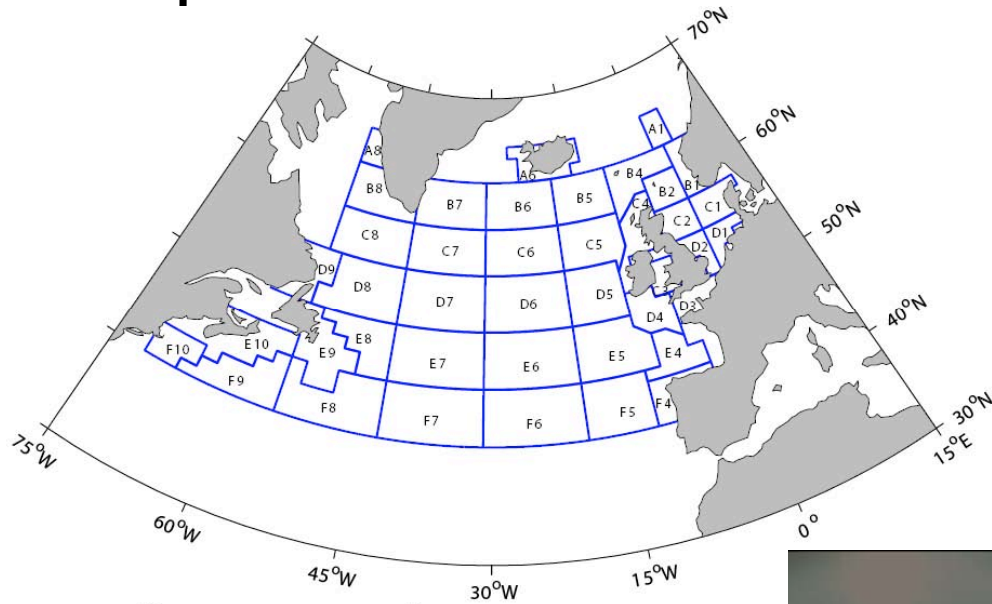


...the longest running marine plankton survey

CPR products...



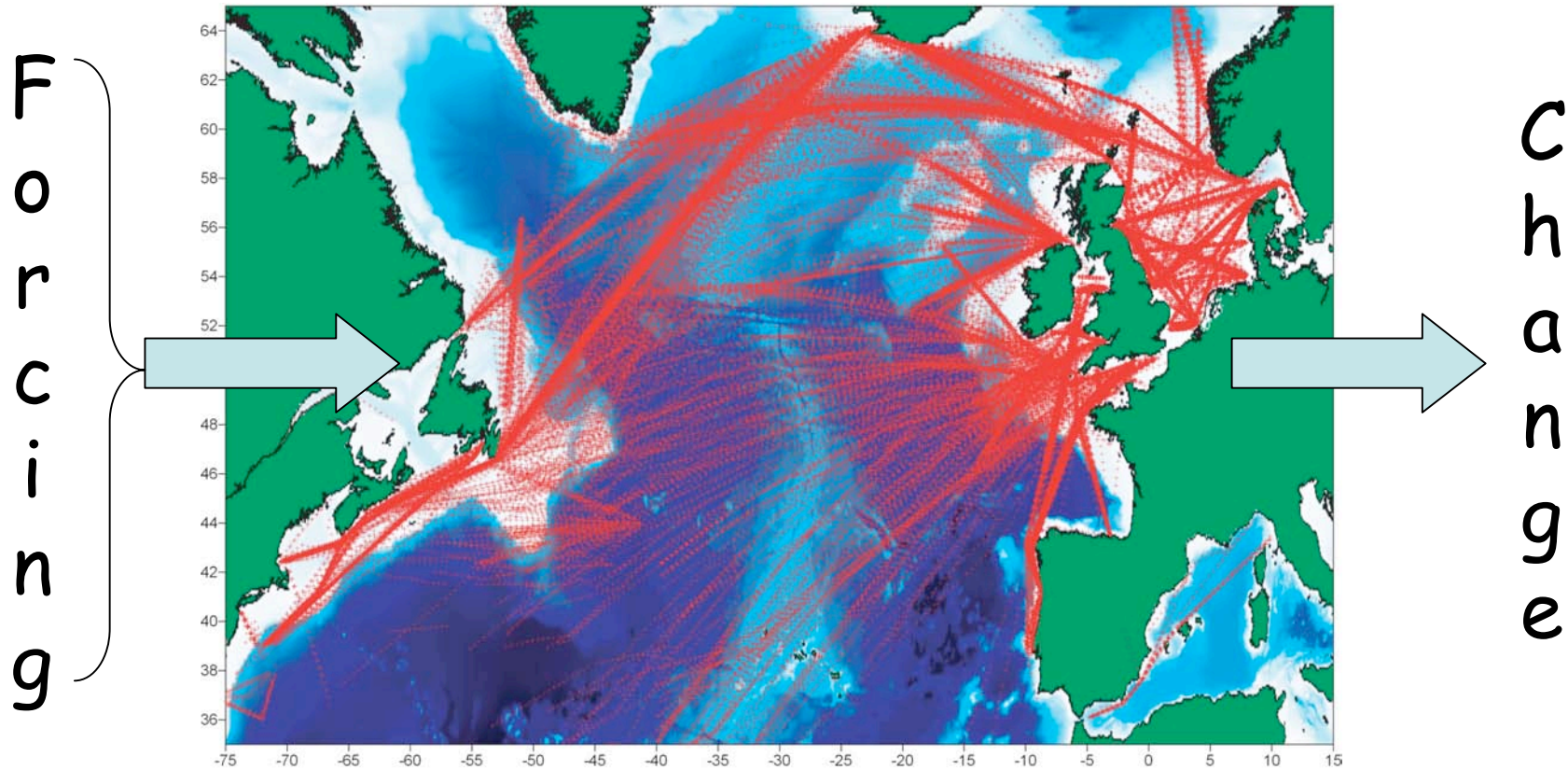
Database for ~500 taxa
 ~1 million samples
 ~5 million miles sampled
 with historical samples



Harmful algal blooms in 2007

...are available free to scientists

Why bother with "monitoring"?

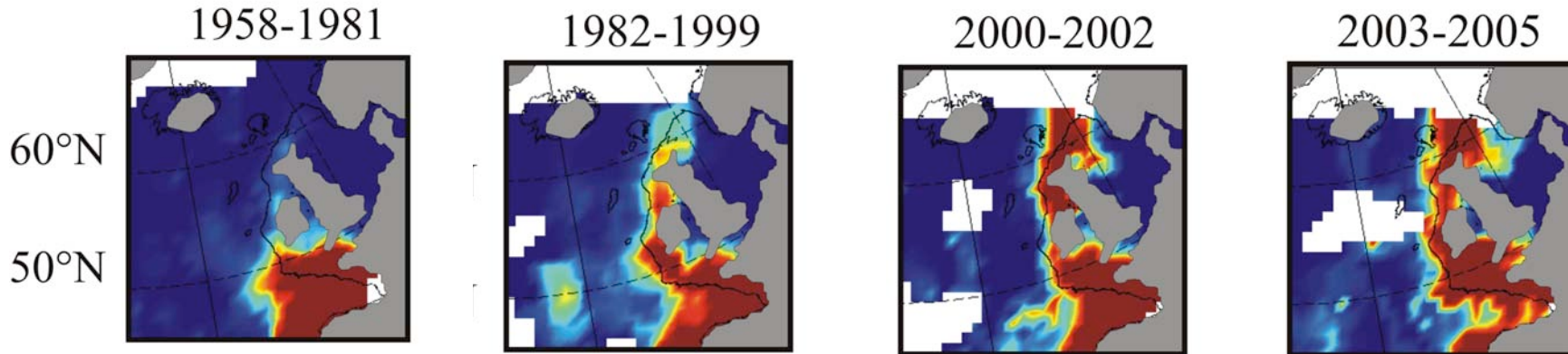


...because we need to understand the "rules of marine behaviour"

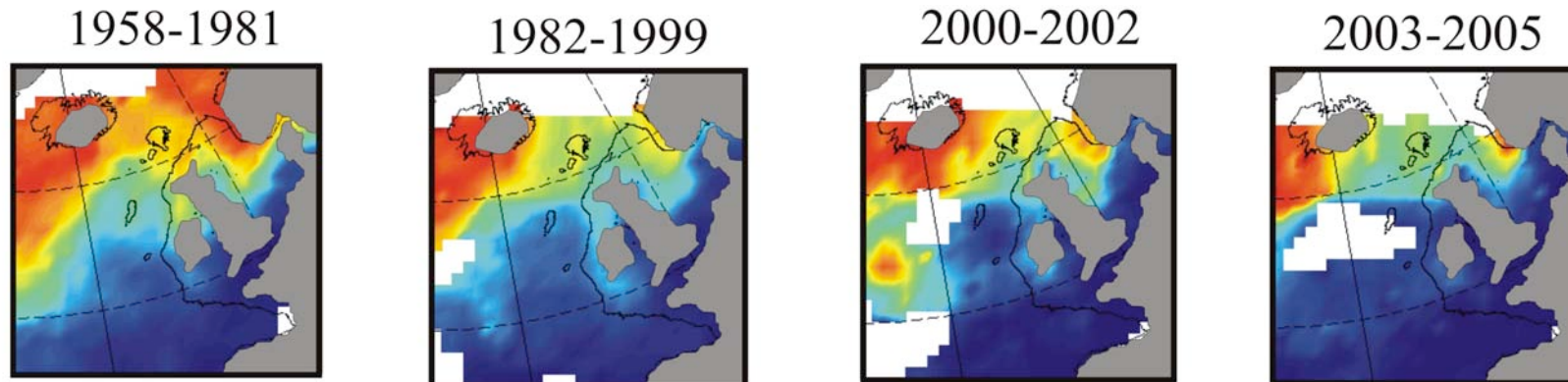
Atlantic plankton communities are changing.....



Warm Temperate species



Sub Arctic species



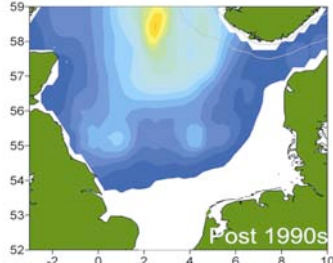
Updated from Beaugrand *et al* (2003) *Science* 296: 1692

....forming the biggest decadal migration on Earth

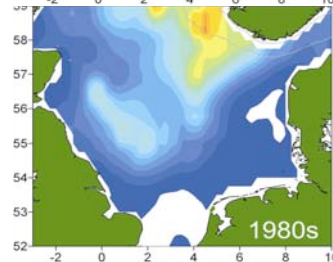
Gradual changes



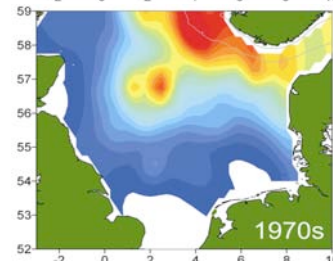
1990



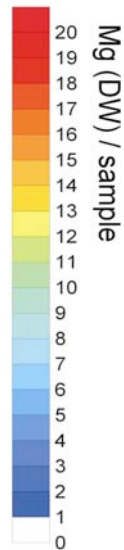
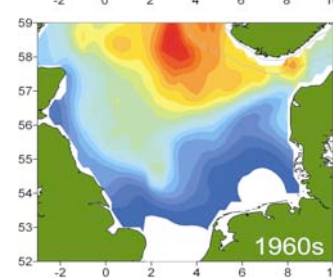
1980



1970

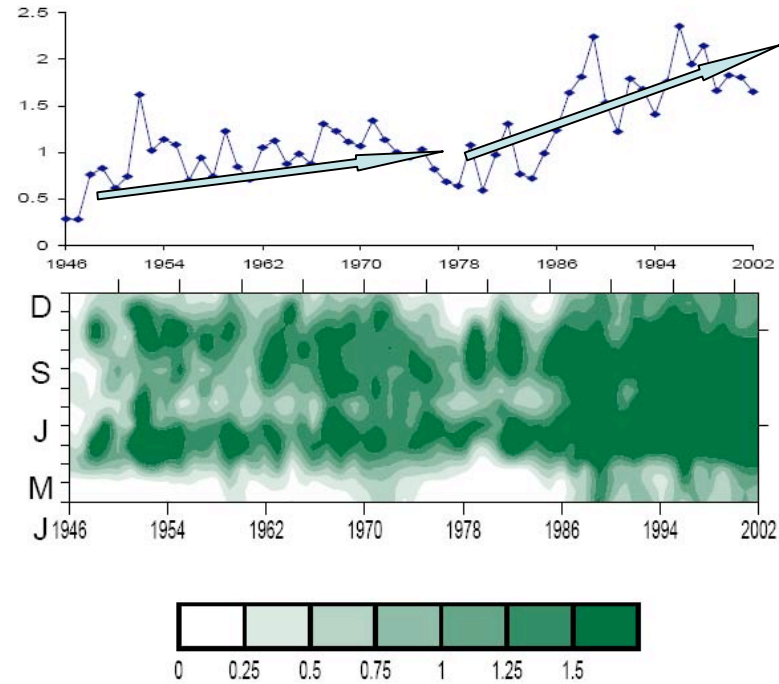


1960



Beaugrand *et al* (2003) *Nature* 391: 546

Abrupt changes

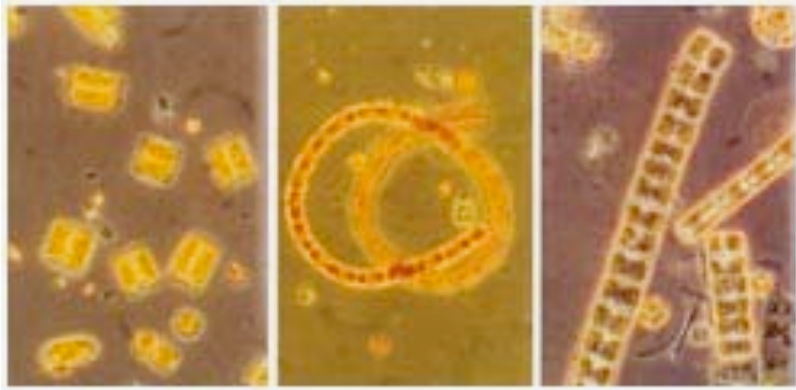


Phytoplankton chlorophyll (ug/L)

Update of Reid *et al* (1998) *Nature* 391: 546

....as regime shifts

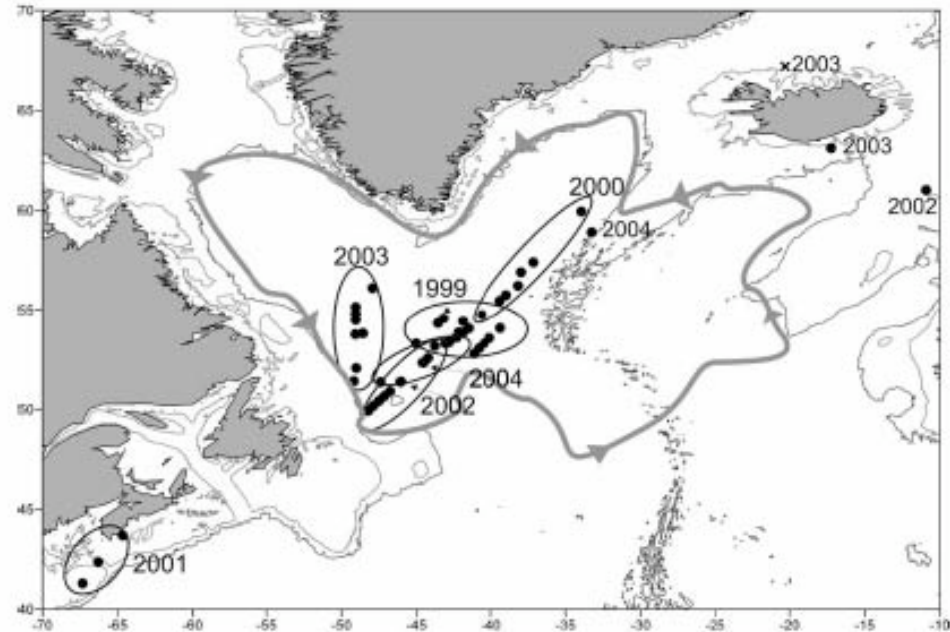
A different sort of shift - Trans Arctic Migration.....



Neodenticula seminae



←————→
20 μm



Distribution of *N. seminae* in CPR samples since it was first recorded in 1999

Reid *et al* 2007 *Global Change Biology*
& News Feature in *Nature* Nov 2007

...makes the first link for 800,000 years

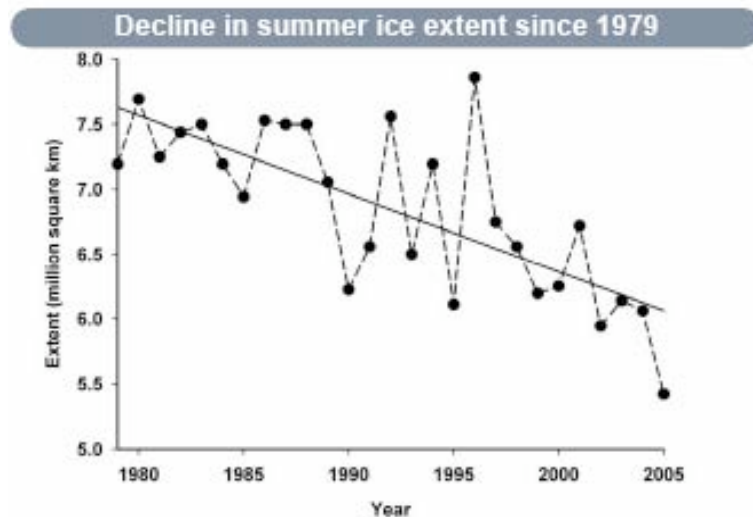
Forging new links between Pacific and Atlantic ..



Courtesy Bigelow Lab



Courtesy NASA



Blurring ocean boundaries

Is this a trickle before a flood?

Competition?

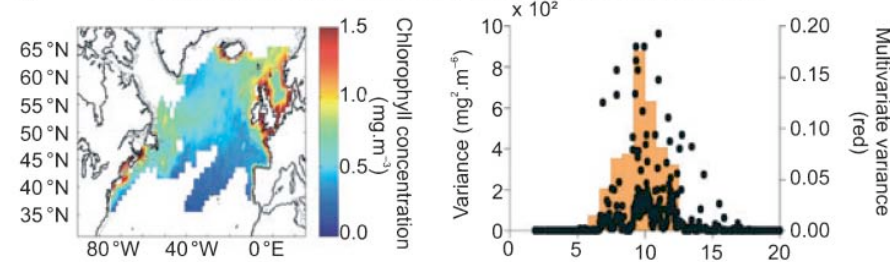
Biological Pump?

...with unknown consequences.

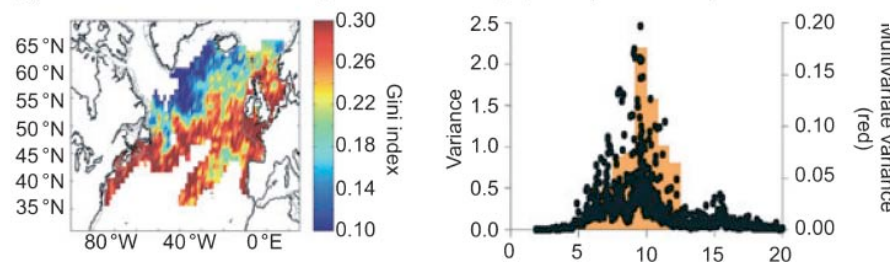
From present to future ..new observations



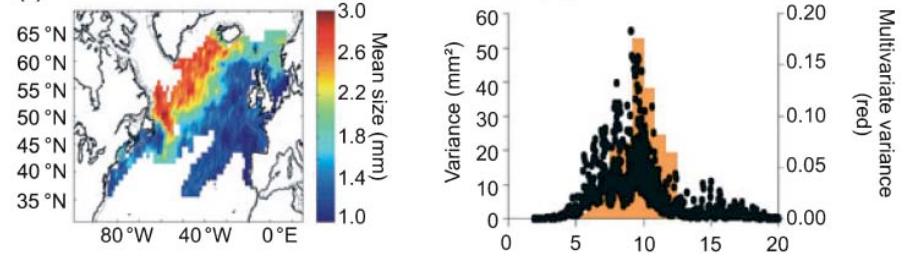
(a) Mean upper-layer chlorophyll concentration (SeaWiFS)



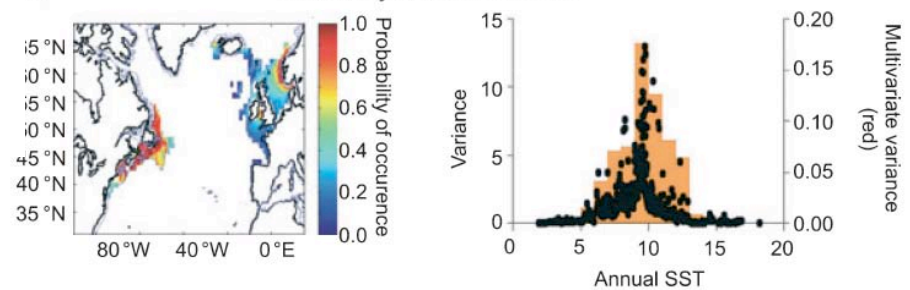
(b) Mean diversity of calanoid copepods (Gini index)



(c) Mean size of calanoid copepods



(d) Probability of cod occurrence



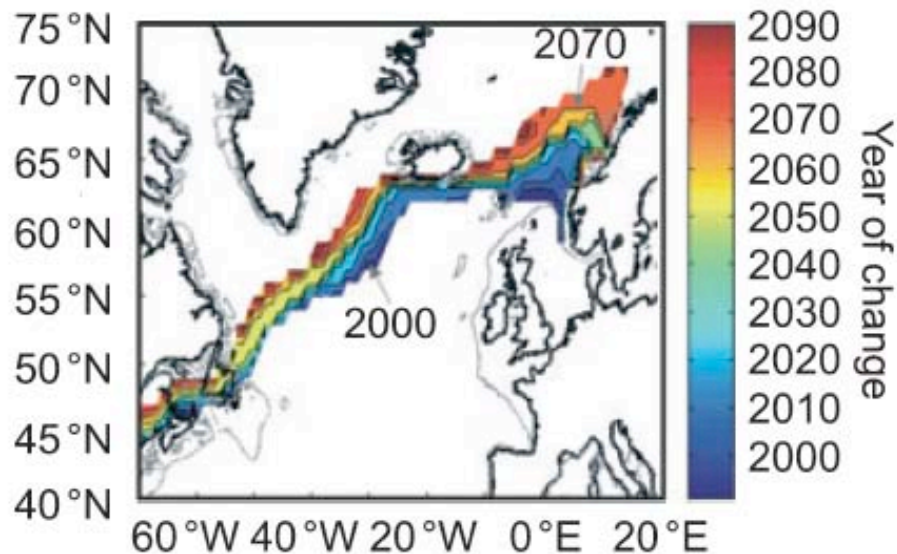
Beaugrand *et al* 2009 *Ecol Letters* 11: 1157

.....reveal a common tipping point at 10°C...

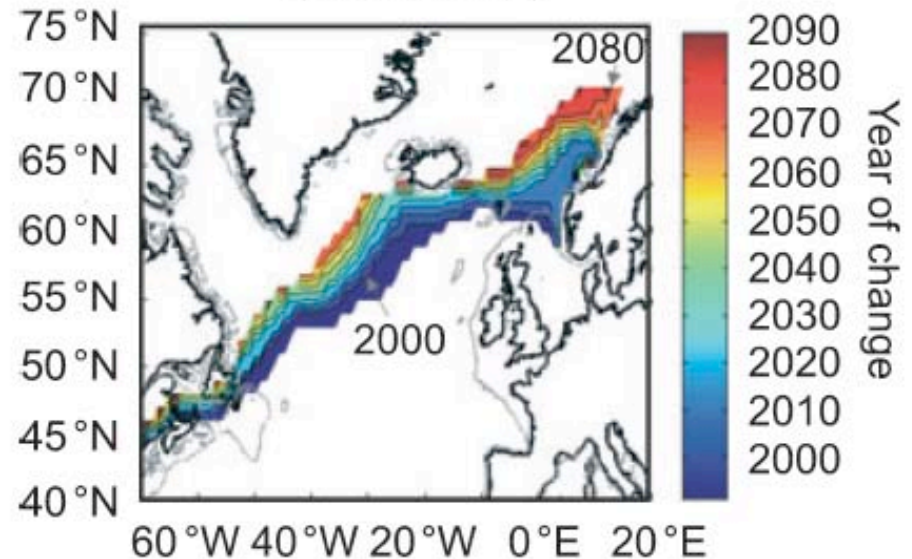
...that offers predictive capability.....



(a) Projected year of change
(scenario A2)



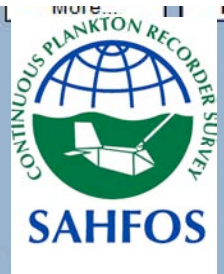
(b) Projected year of change
(scenario B2)



Beaugrand *et al* 2009 *Ecol Letters* 11: 1157

...for future marine ecosystems.

Future for the CPR Survey - "Going Global"





Summary



- Plankton in Atlantic is changing rapidly
- Atlantic invasion by Pacific diatom
- New tipping point for Atlantic pelagial
- Survey >1000 publications; multinational
- CPR Survey is now "Going Global"
- Data available for non-commercial use
- Survey products help "discern the rules"

