

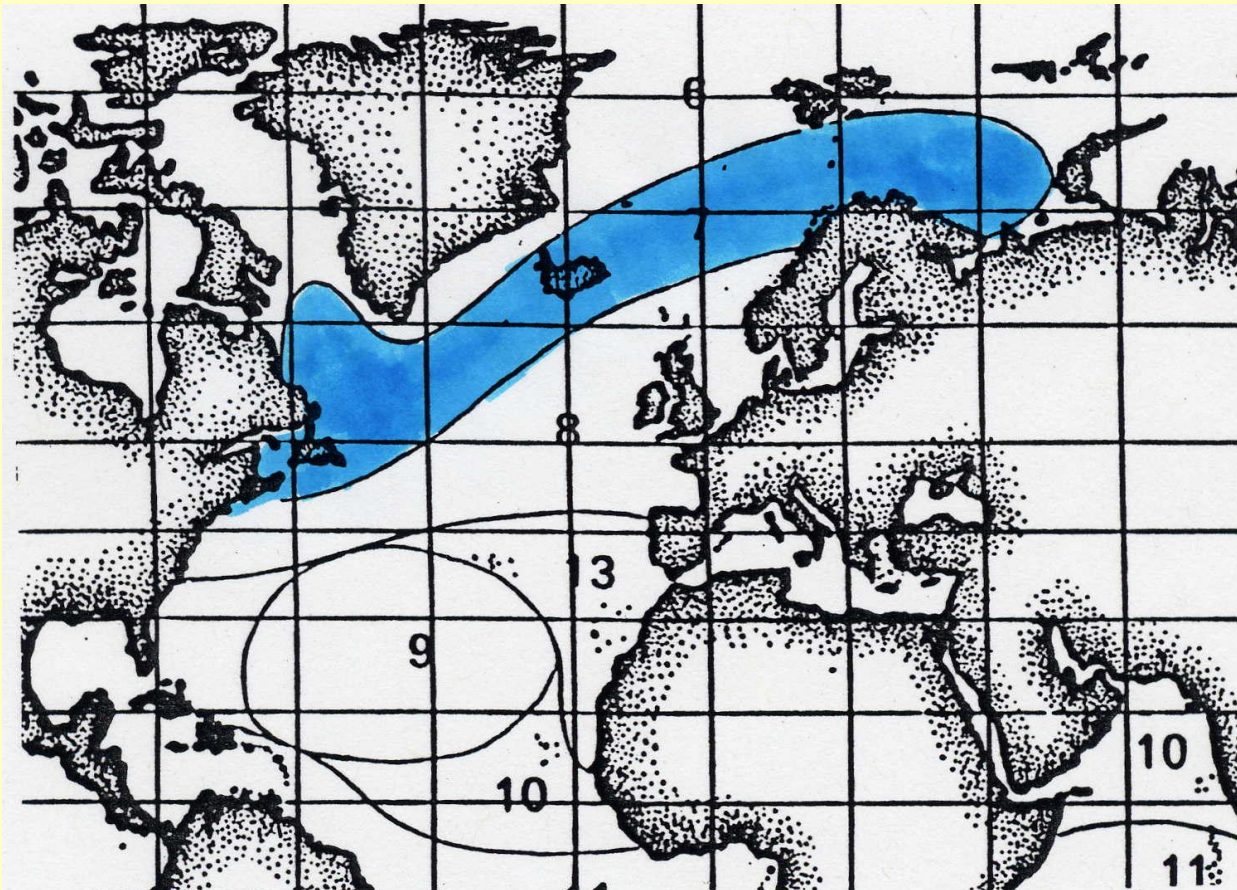
# Rargom Annual Science Meeting, 2010

Impacts of climate change on the subarctic copepod, *Calanus finmarchicus*, in the Gulf of Maine: is it in hot water?

Jeffrey Runge, Frédéric Maps, Andrew Pershing,  
Rebecca Jones, School of Mar. Sciences, Univ. of Maine  
Andrew Leising, Southwest Fish. Sci.Center, NOAA  
James Pierson, Univ. Maryland Center for Env. Studies  
David Kimmel, East Carolina University

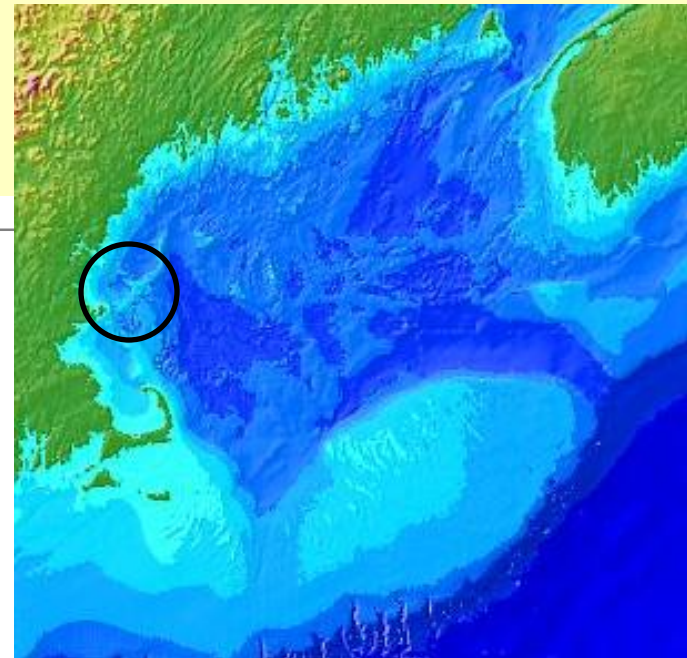
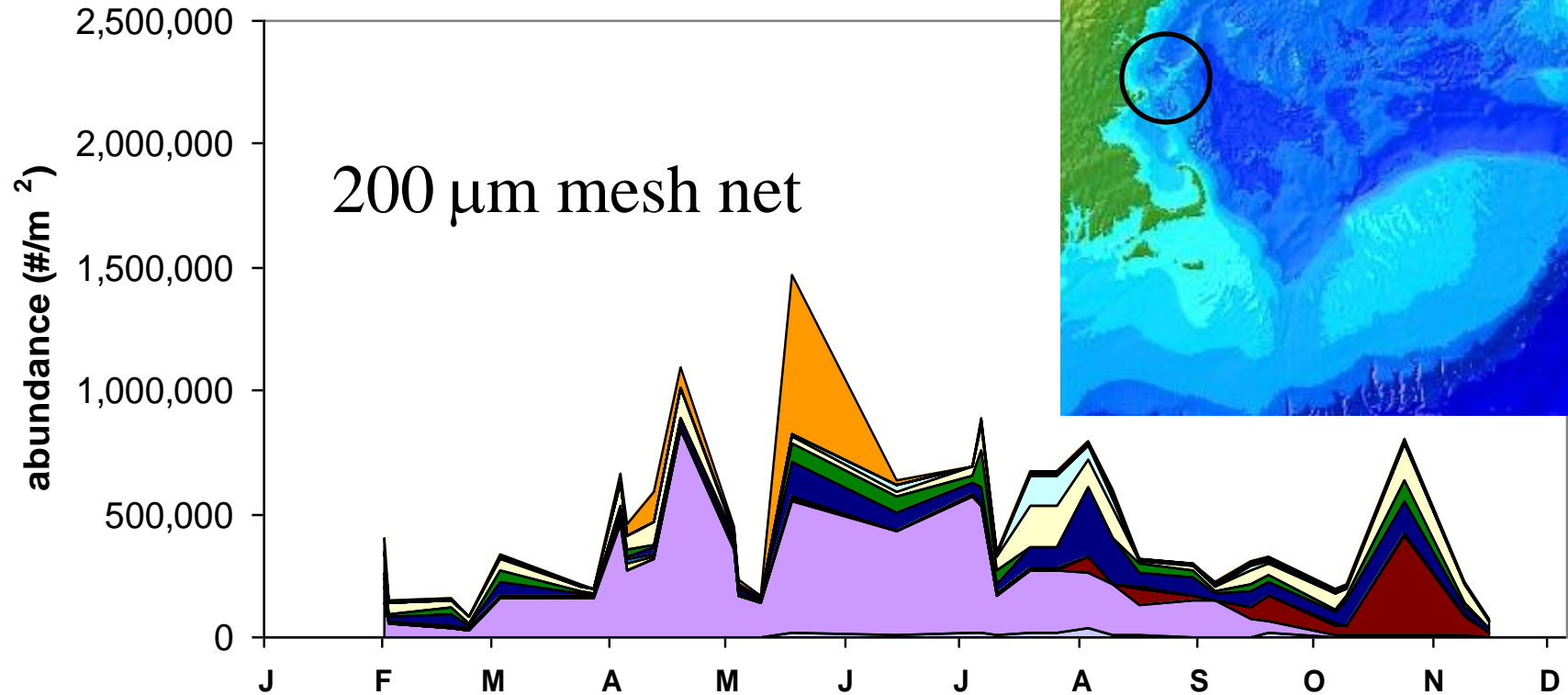


# The subarctic distribution of *Calanus finmarchicus*



Van der Spoel and Heyman (1983)

# Jeffreys Ledge copepod species composition, 2003

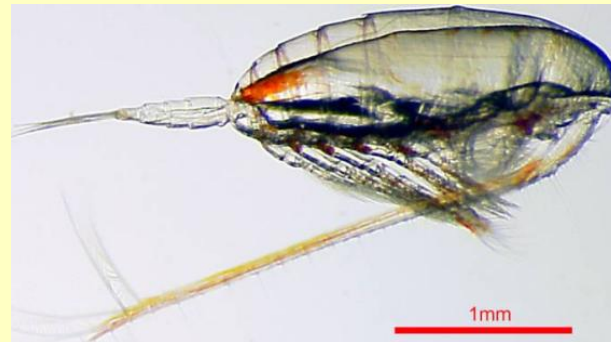


- |                        |                              |                      |
|------------------------|------------------------------|----------------------|
| □ Acartia spp.         | □ C. finmarchicus            | ■ Centropages spp.   |
| □ Metridia spp.        | ■ Parvocalanus crassirostris | ■ Oithona similis    |
| ■ Paracalanus parvus   | □ Pseudocalanus spp.         | □ Temora longicornus |
| ■ Eurytemora herdmanii | ■ Microcalanus pusillus      | ■ Other              |



(Runge and Jones, In Press)

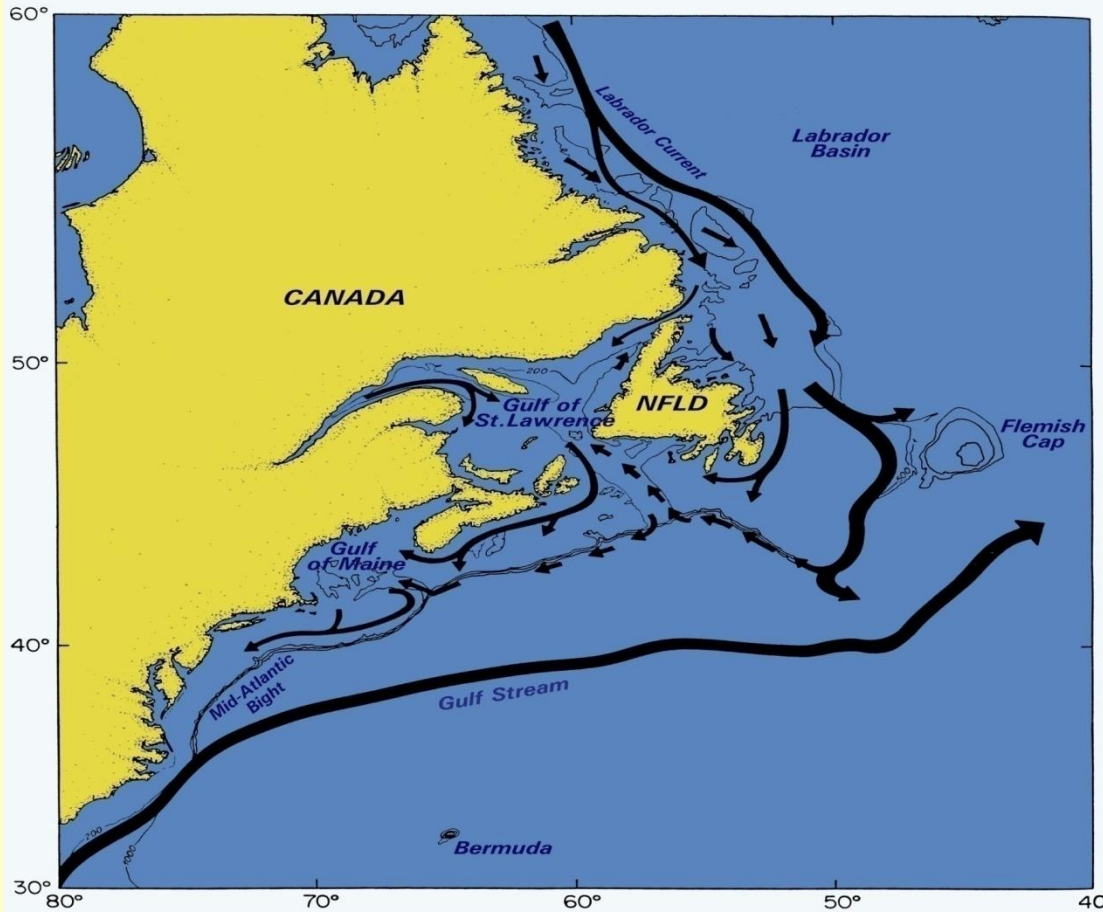
How will anticipated changes due to climate change influence the abundance of *Calanus finmarchicus* in the Gulf of Maine?



*C. finmarchicus* Stage CV

(And what would be the consequences for the structure of the coastal food web?)

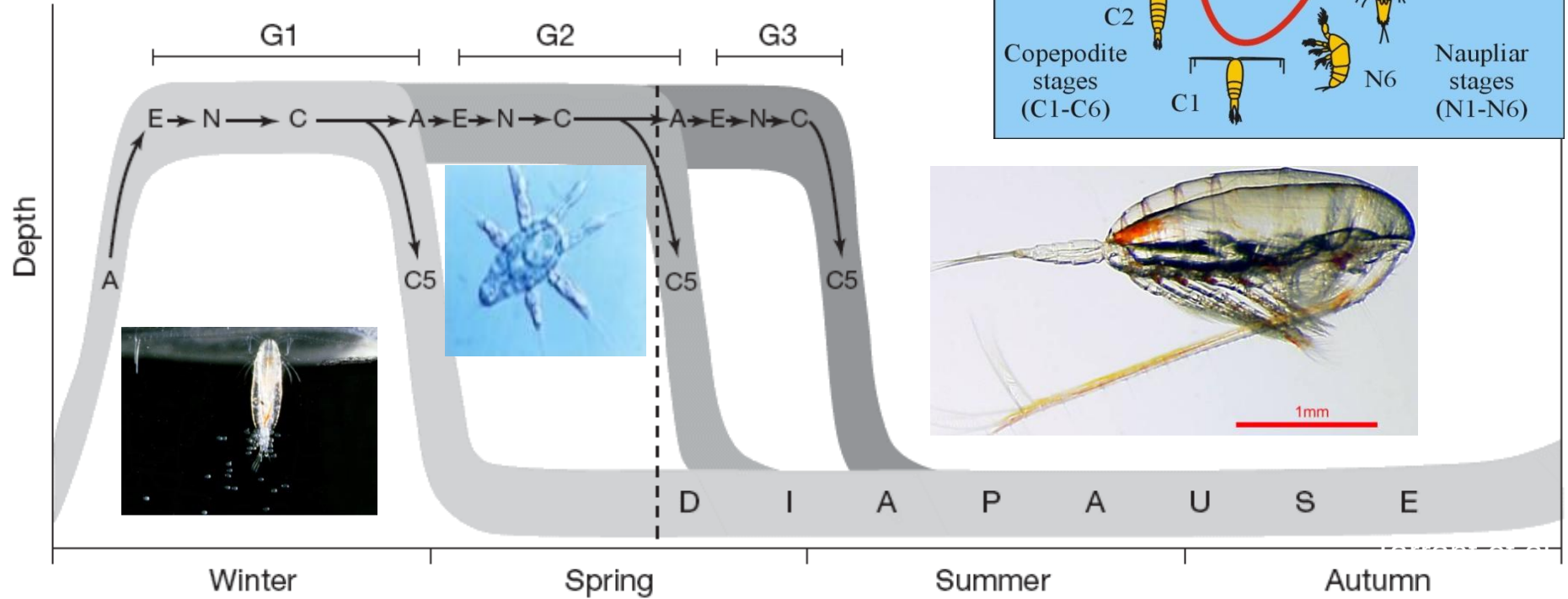
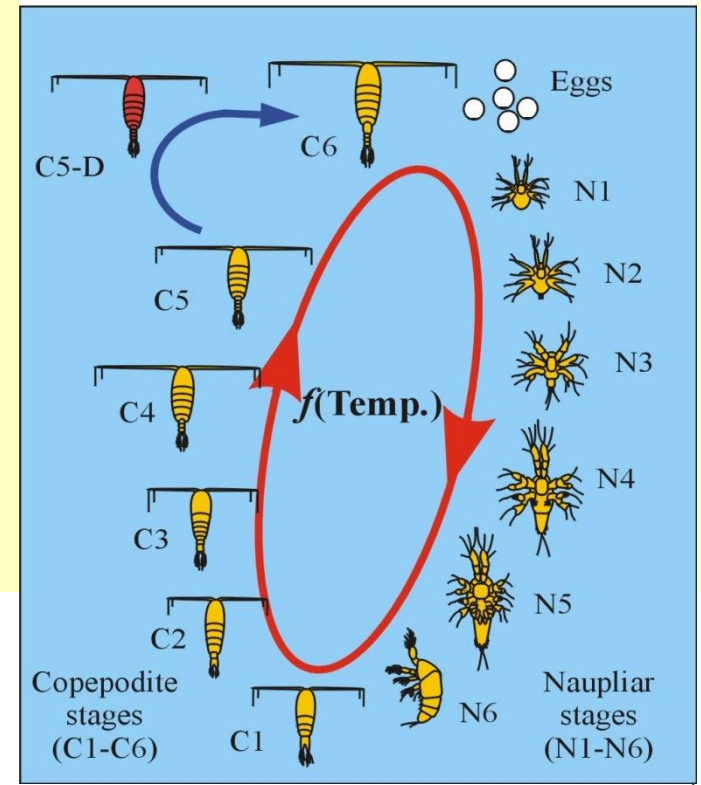
# Factors influencing the abundance of *Calanus finmarchicus* in the Gulf of Maine



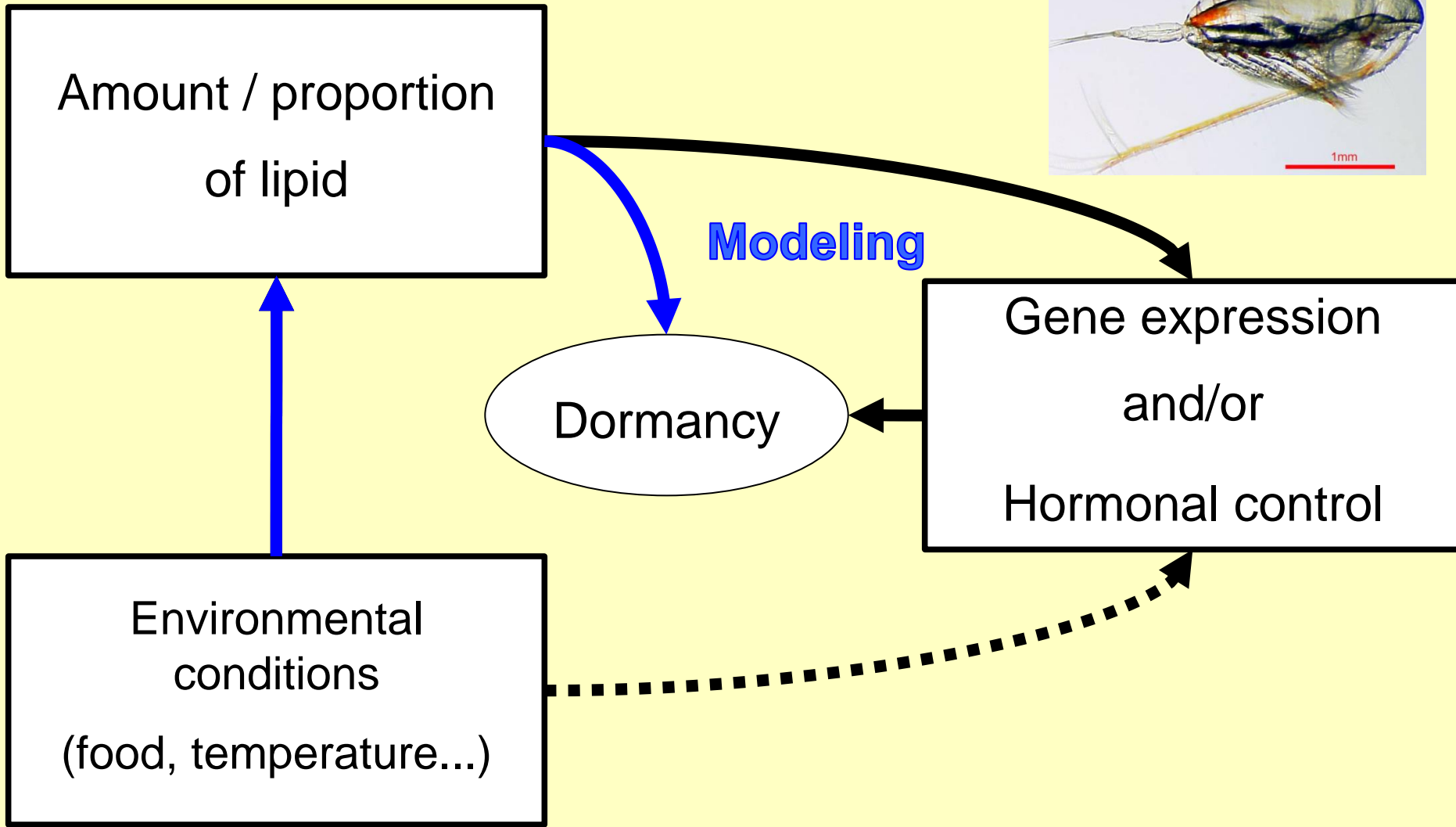
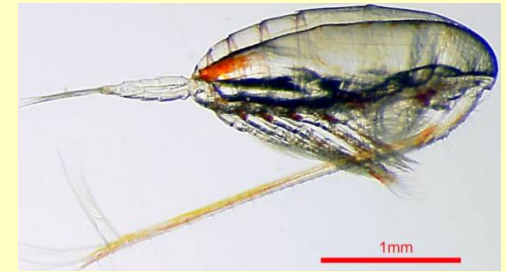
Chapman and Beardsley

- Transport of *Calanus* from the north
- Local production
  - model of *Calanus* life cycle
  - test climate change scenarios

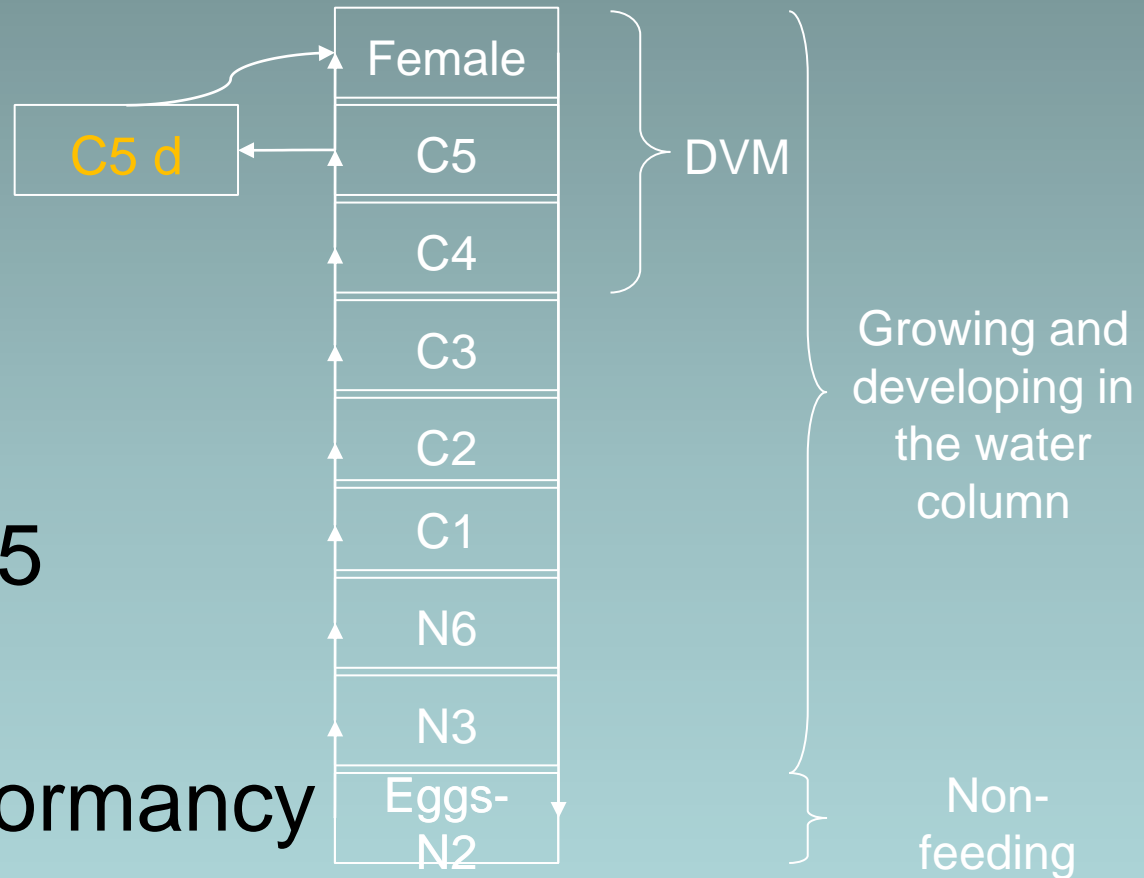
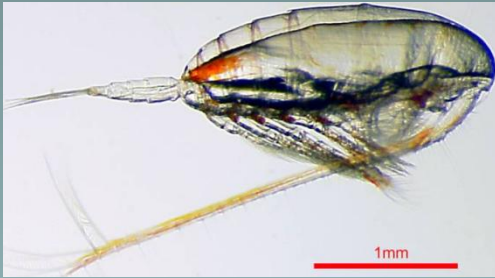
# *C. finmarchicus* life cycle



# Controls on Calanus dormancy

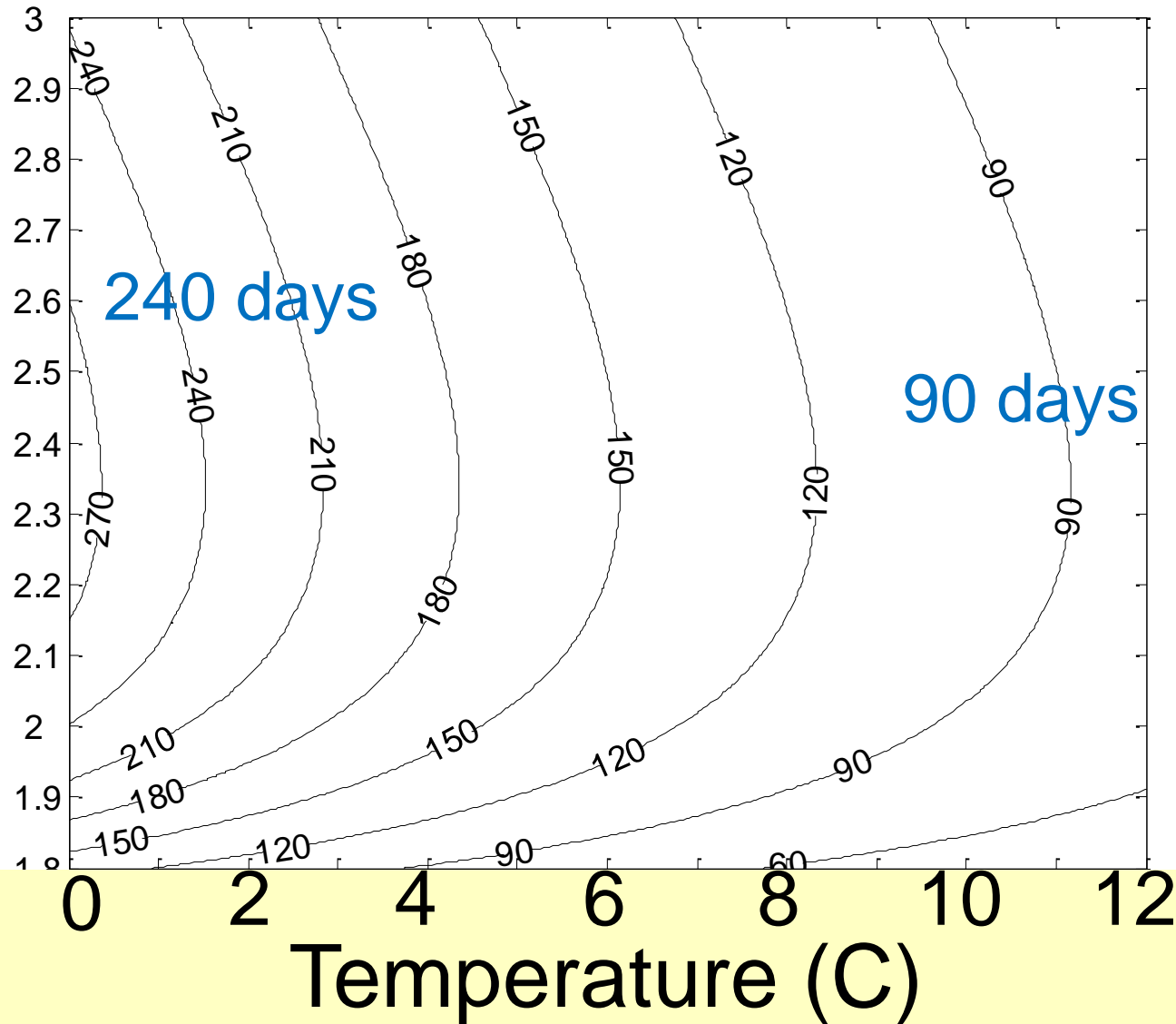


# Individual-Based Modeling with Genetic Algorithm procedure: western *C. finmarchicus*



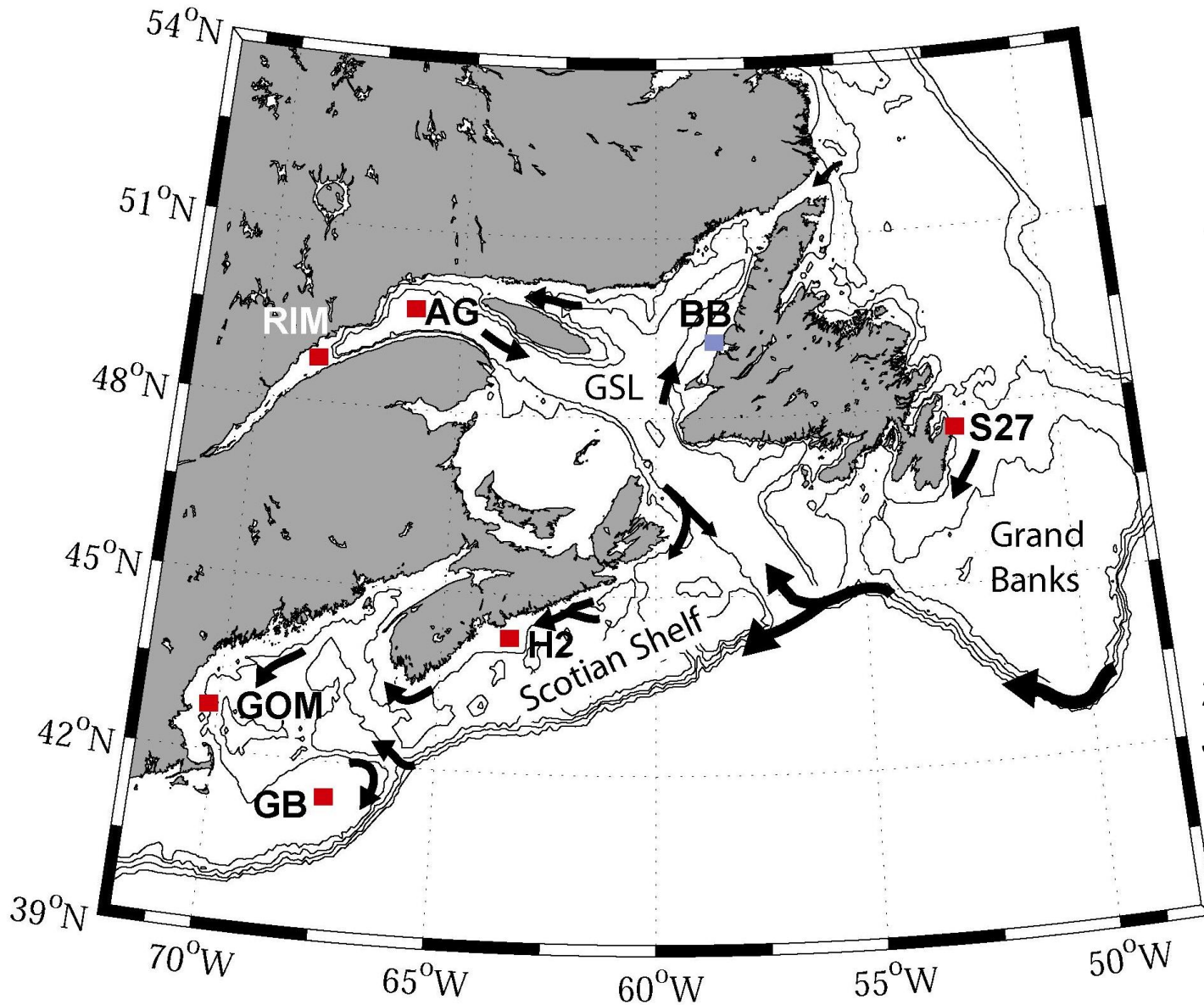
- Dormancy in C5
- Decision in late C4 / early C5
- Level of lipid:
  - > threshold → dormancy
  - < threshold → molting

# Maximum potential diapause duration (isoline in days) for *C. finmarchicus*



Saumweber  
and Durbin  
2006

# Data sources



## Data from:

DFO – AZMP:  
1999 – 2005  
(E.Head, P.Pepin)

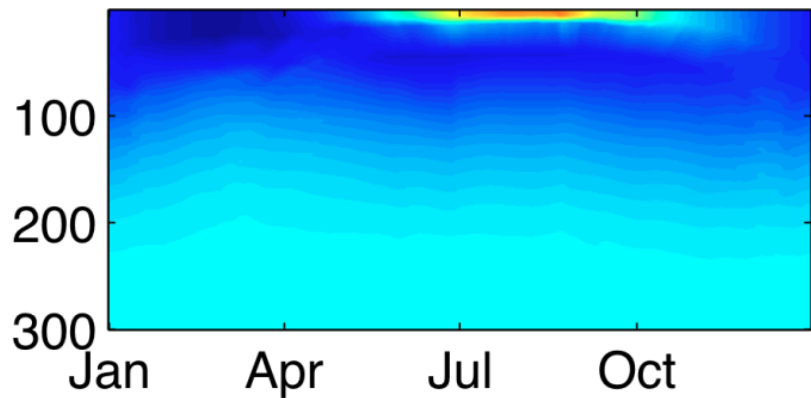
DFO – IML:1990 –  
1991 (S. Plourde,  
P. Joly)

US-GLOBEC:  
1995 – 1999 (E.  
Durbin, M. Casas)

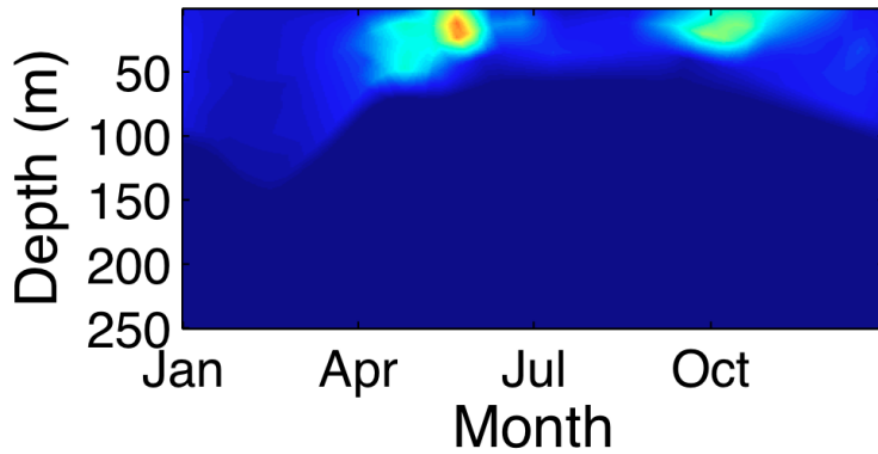
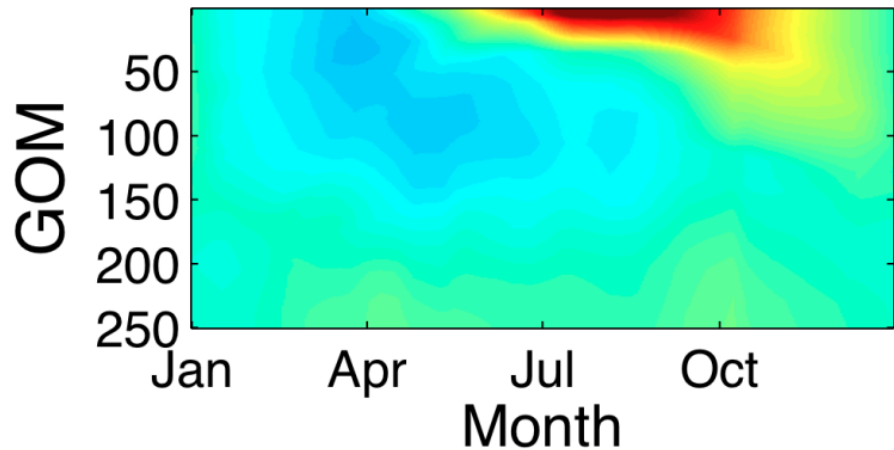
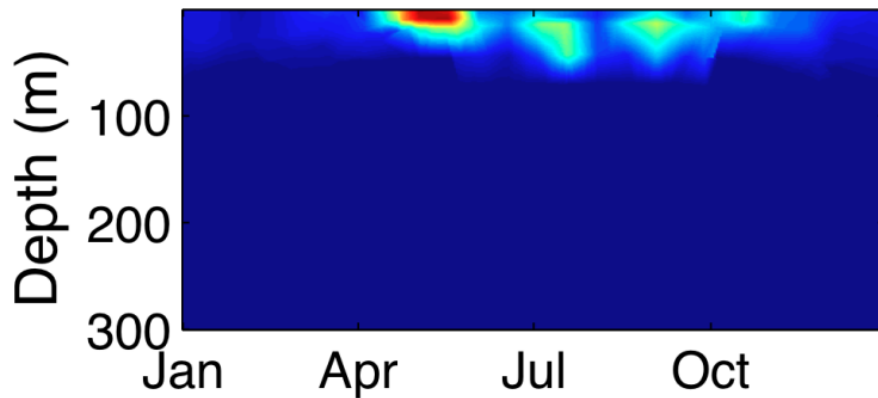
PULSE – NEC:  
2003 – 2005 (R.  
Jones)

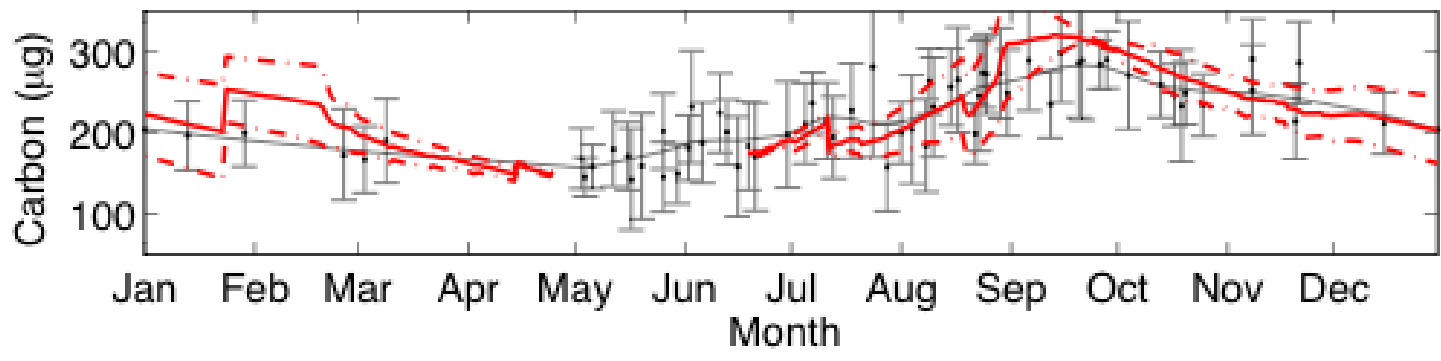
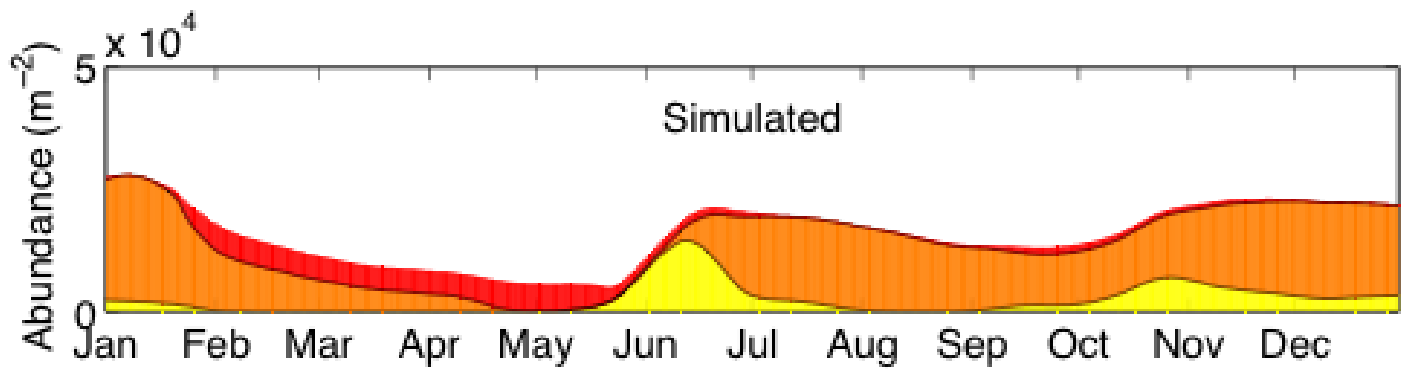
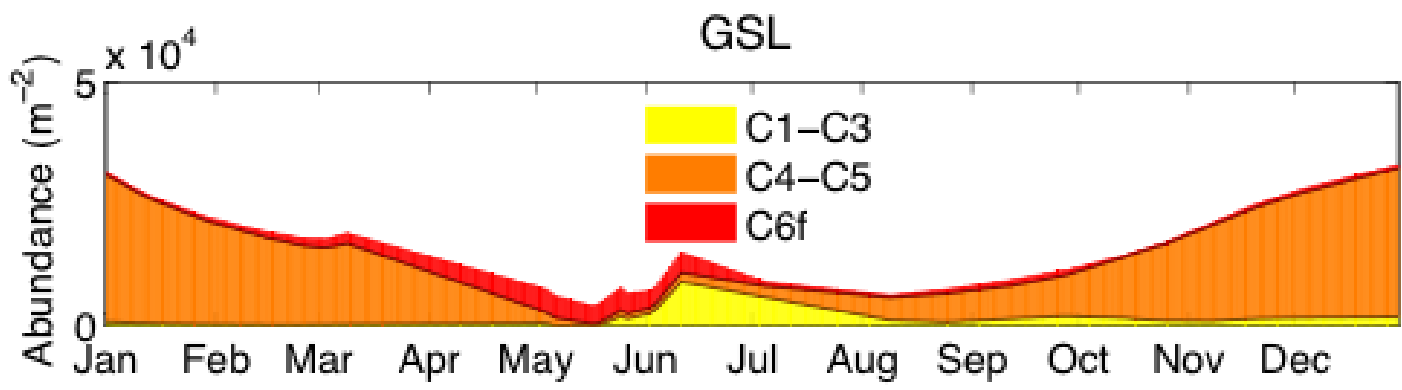


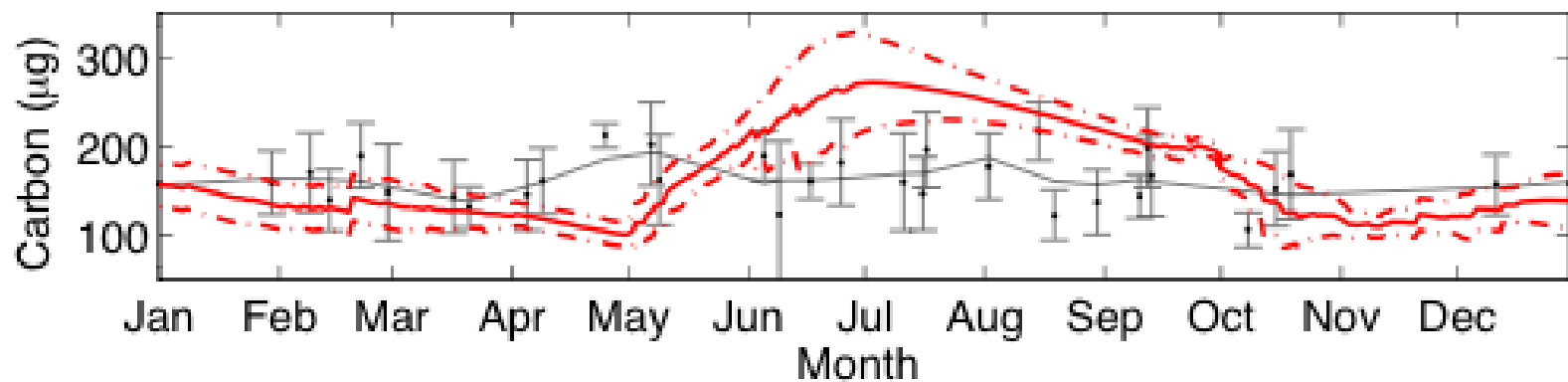
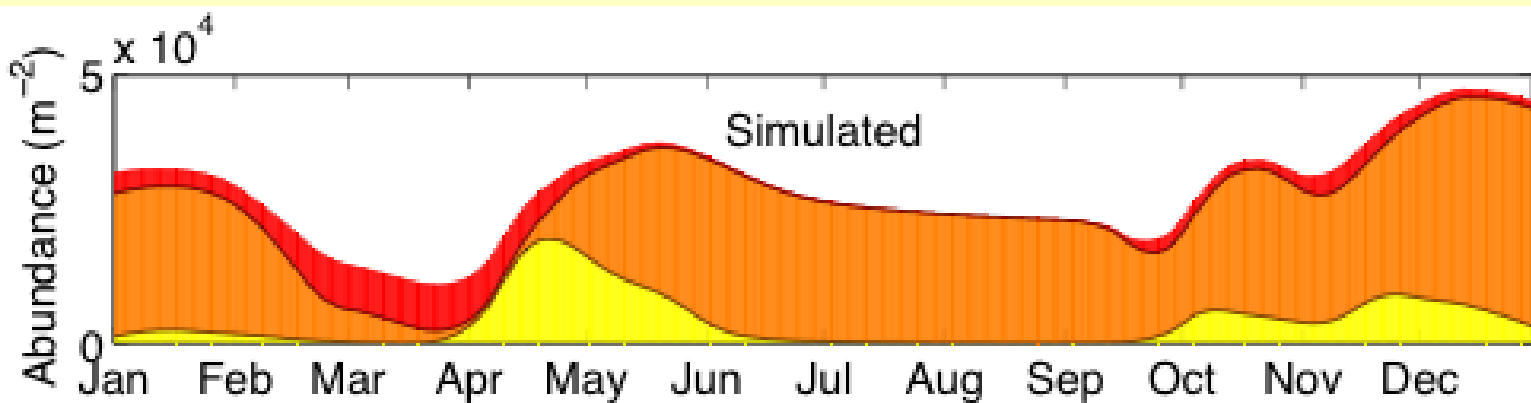
Temperature ( $^{\circ}\text{C}$ )

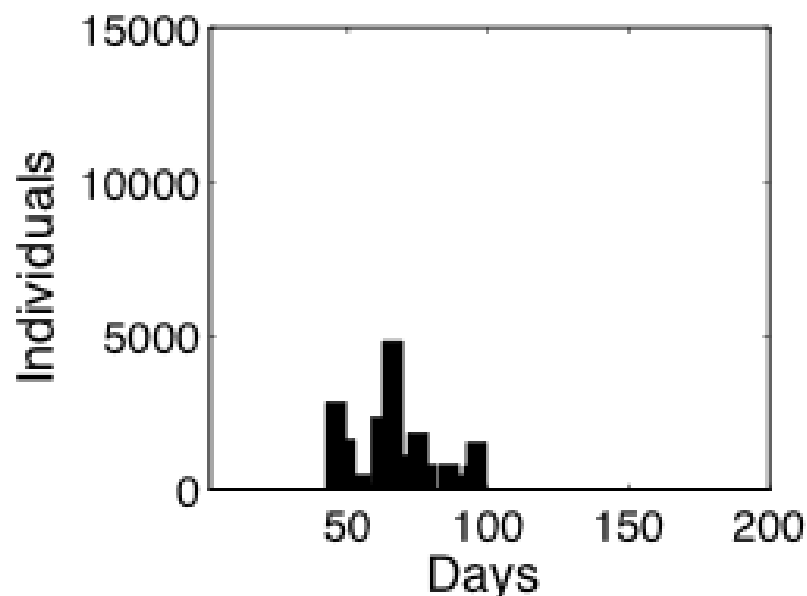
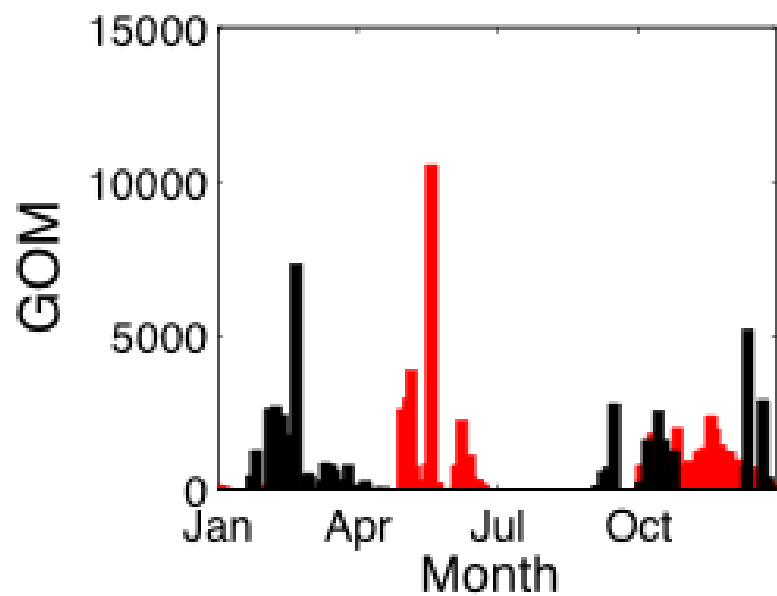
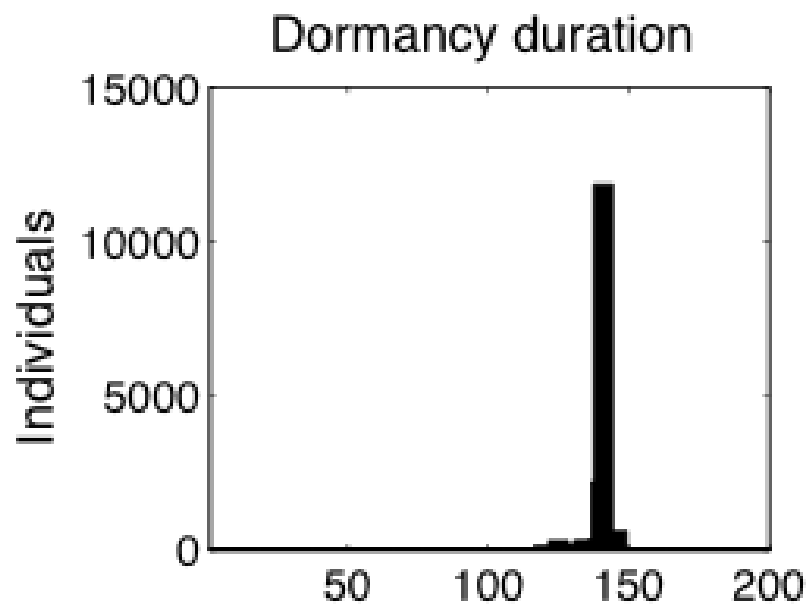
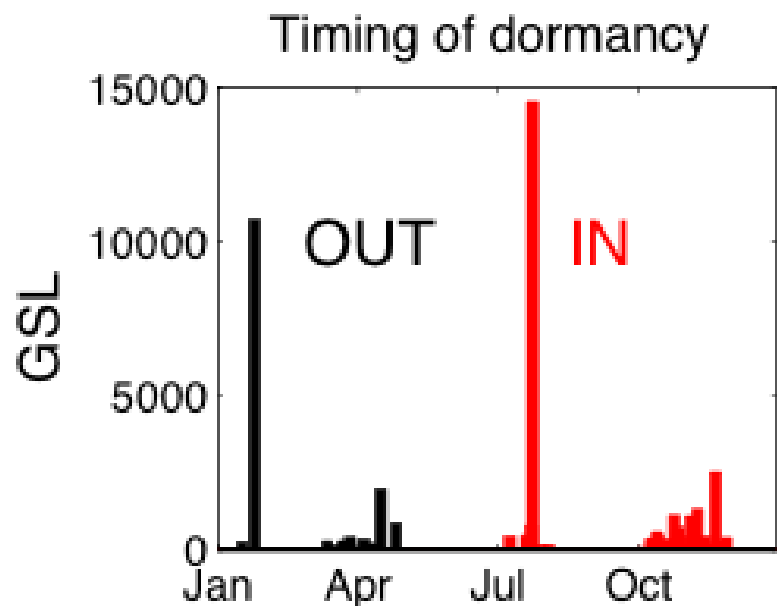


Chlorophyll a ( $\mu\text{g.L}^{-1}$ )

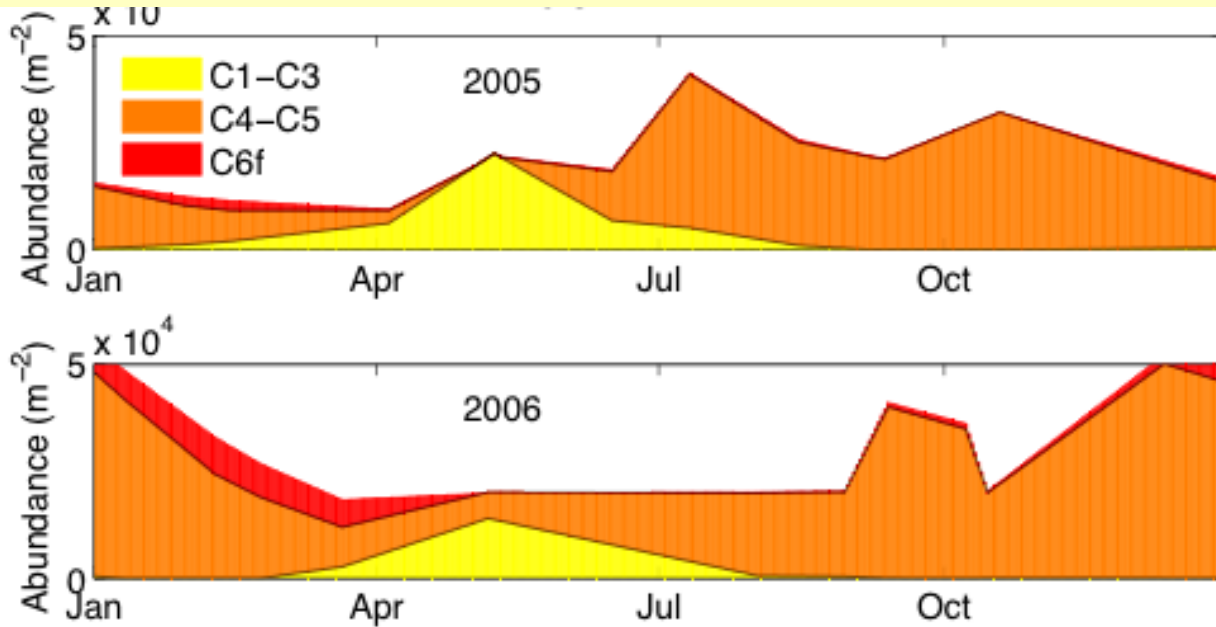




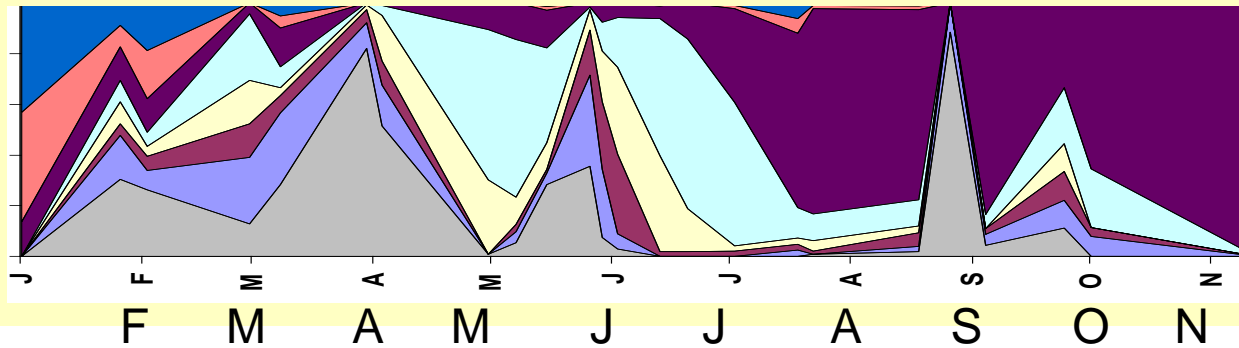




# Is there a fall generation in the Gulf of Maine?



Wilkinson Basin:  
sparse data from  
seasonal time  
series



Jeffreys  
Ledge (2007)

NI-NVI CI CII CIII CIV CV Male Female

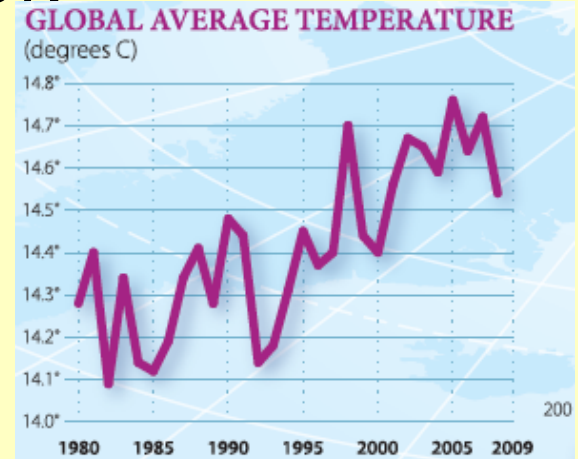
# Climate change scenarios: Impacts on *C. finmarchicus* populations in the GoM

The impact on GoM *Cfin* abundance of: IGBP website

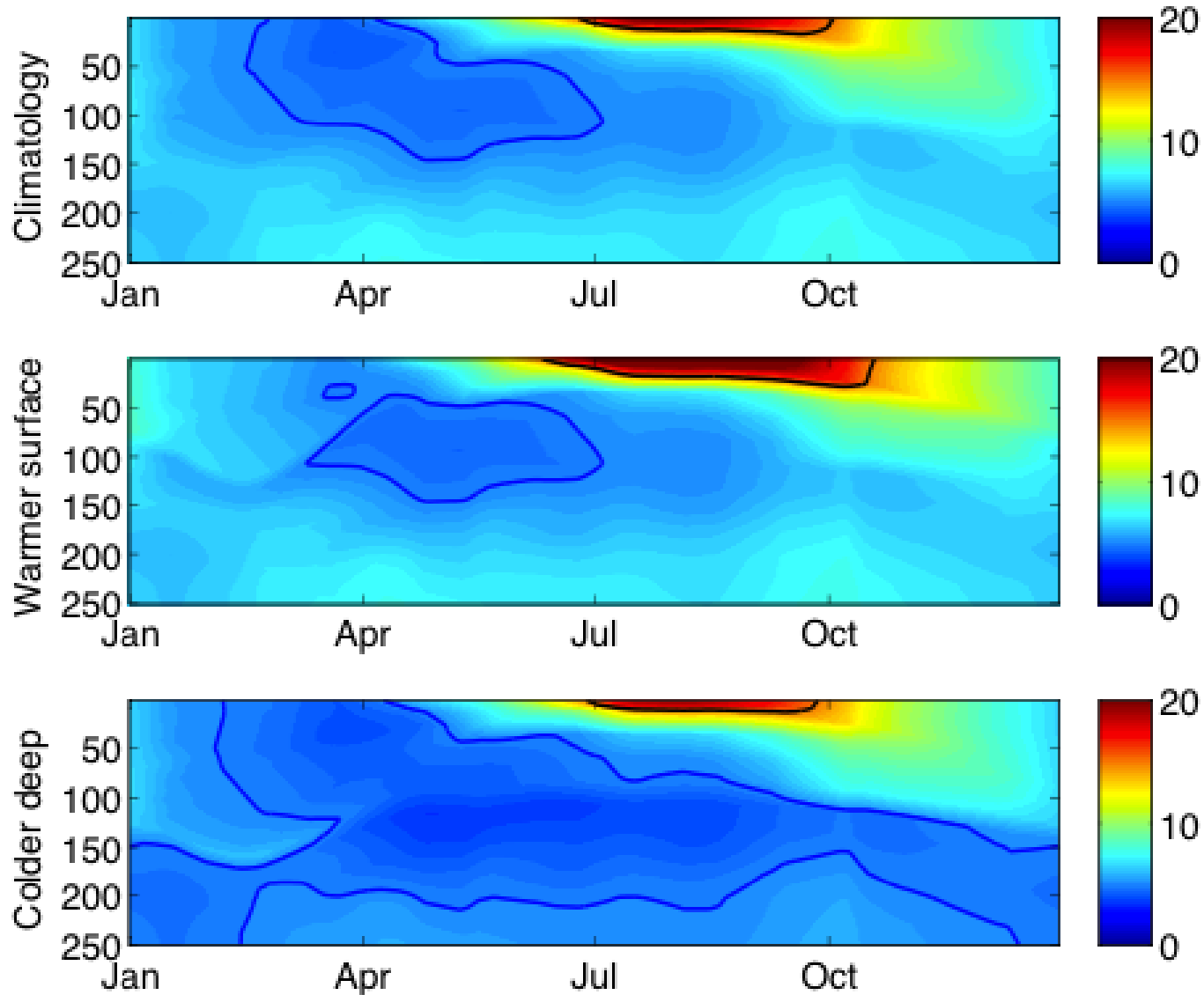
1. Accelerated/failed development of fall generation due to surface warming in summer and fall, where surface temperatures in the GoM may already be at the upper thermal limit

2. Colder ambient dormancy temperature due to arctic ice melt (- 2 C)

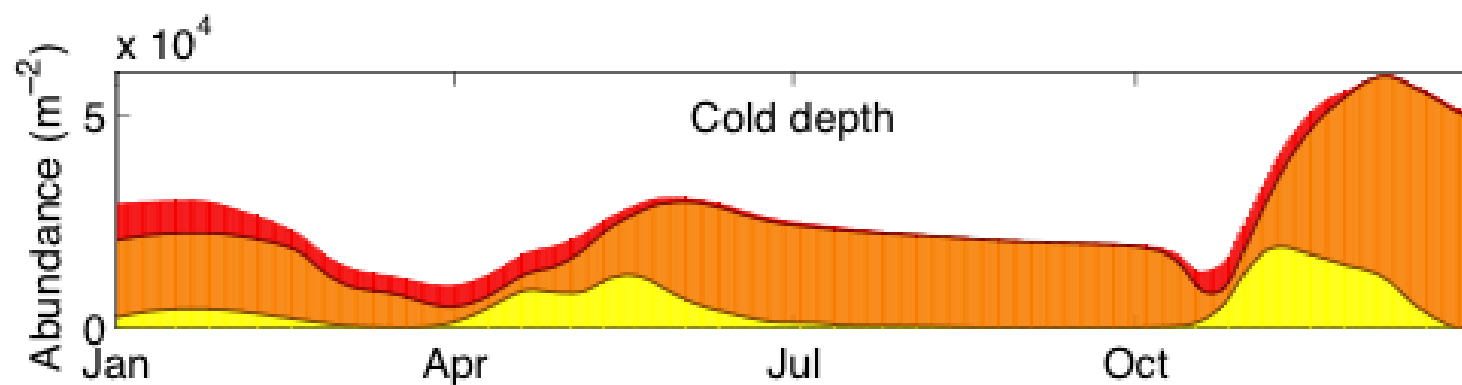
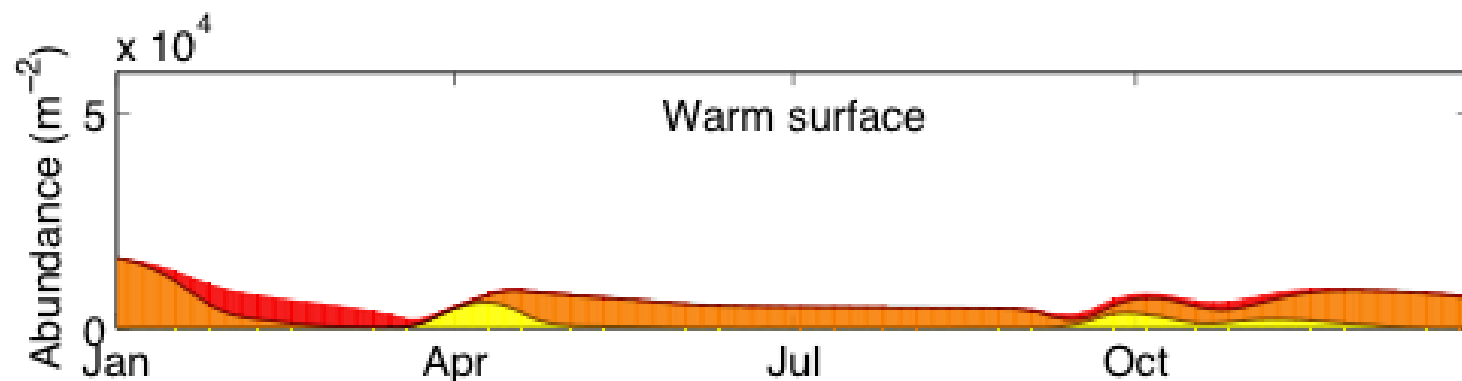
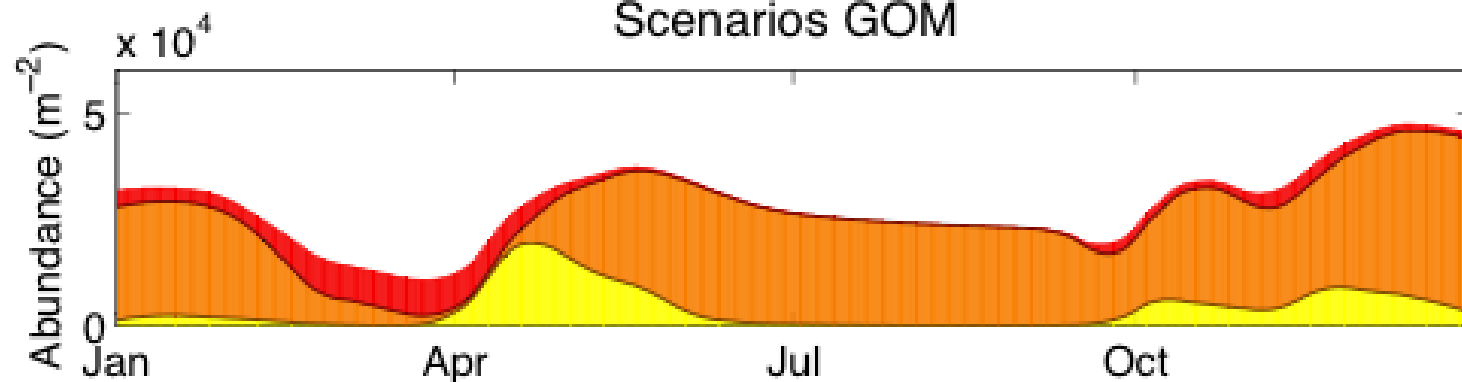
(3. Interactions between changes in timing of entry and exit with changes to the seasonal primary production cycles)



### GOM / WB-7 Temperature (°C)



# Scenarios GOM



# Conclusions (to date)

- High abundance of *Calanus finmarchicus* in the Gulf of Maine is supported by production of a fall generation contributing to the overwintering stock
- Reasonable climate change scenarios may result in substantial reductions in the local contribution to the overwintering stock
- Need to couple life cycle model to physical circulation models to assess relative roles of transport and local production
- Need to establish long term time series observations of zooplankton abundance and diversity in the coastal Gulf of Maine