Consequences of dormancy timing and duration on the distribution of *C. finmarchicus* in a changing North Atlantic

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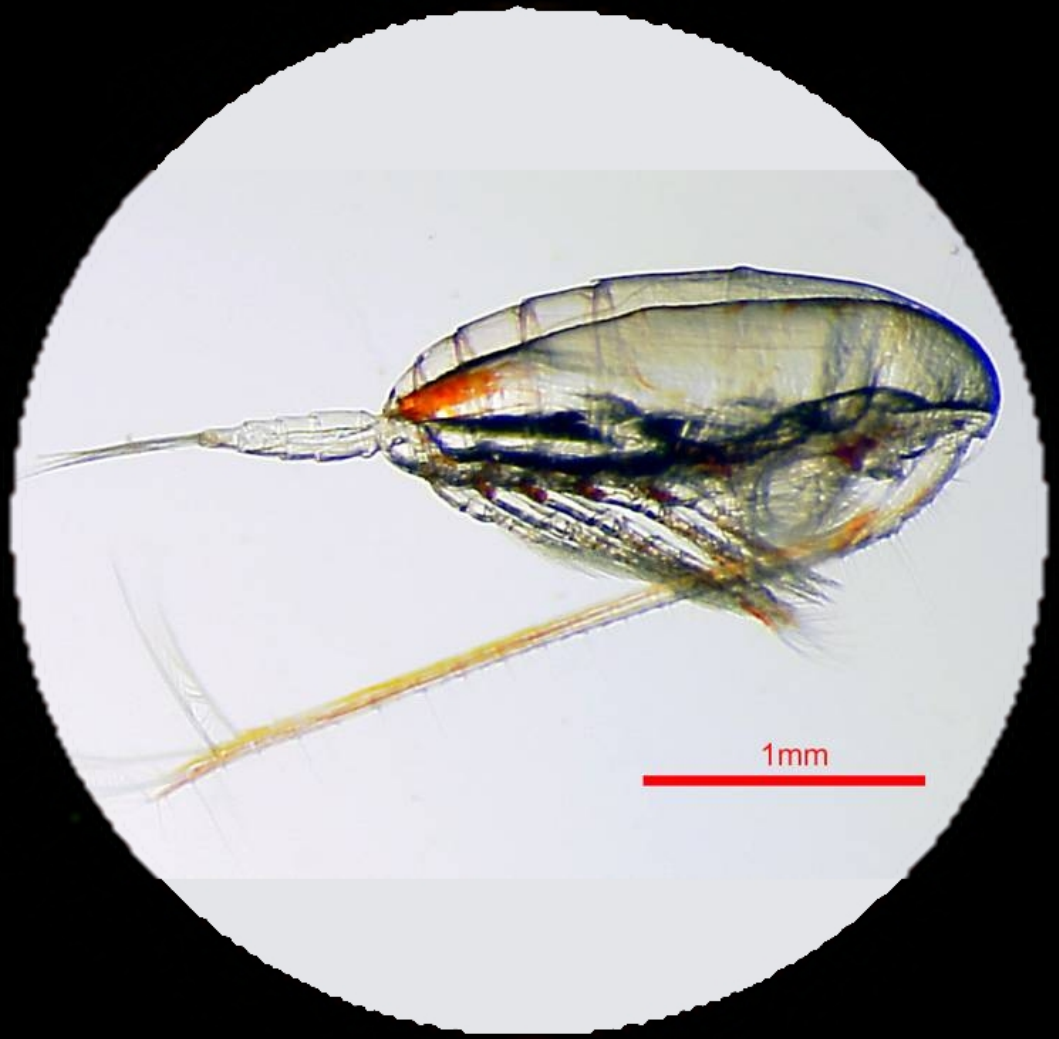
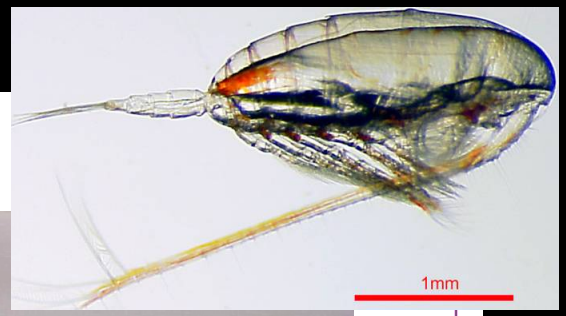


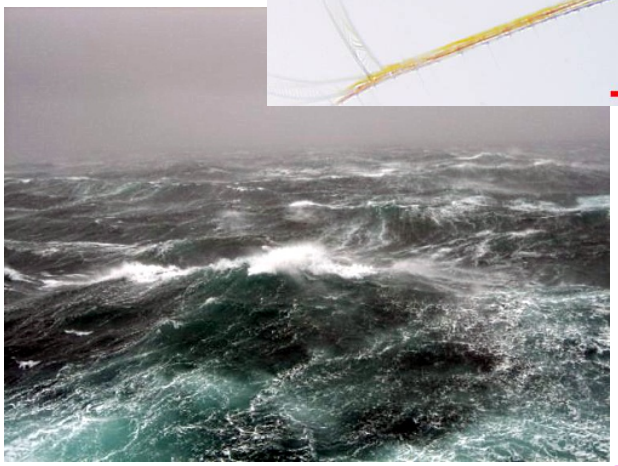
Outline

- Distribution and dormancy strategy in *C. finmarchicus*
- Individual-Based Modeling & Genetic Algorithm procedure
- Developing the model in the NW Atlantic
- Proof of concept: preliminary application to the NE Atlantic
- Implications for *C. finmarchicus* in changing ecosystems

Distribution and dormancy strategy in *C. f nmarchicus*

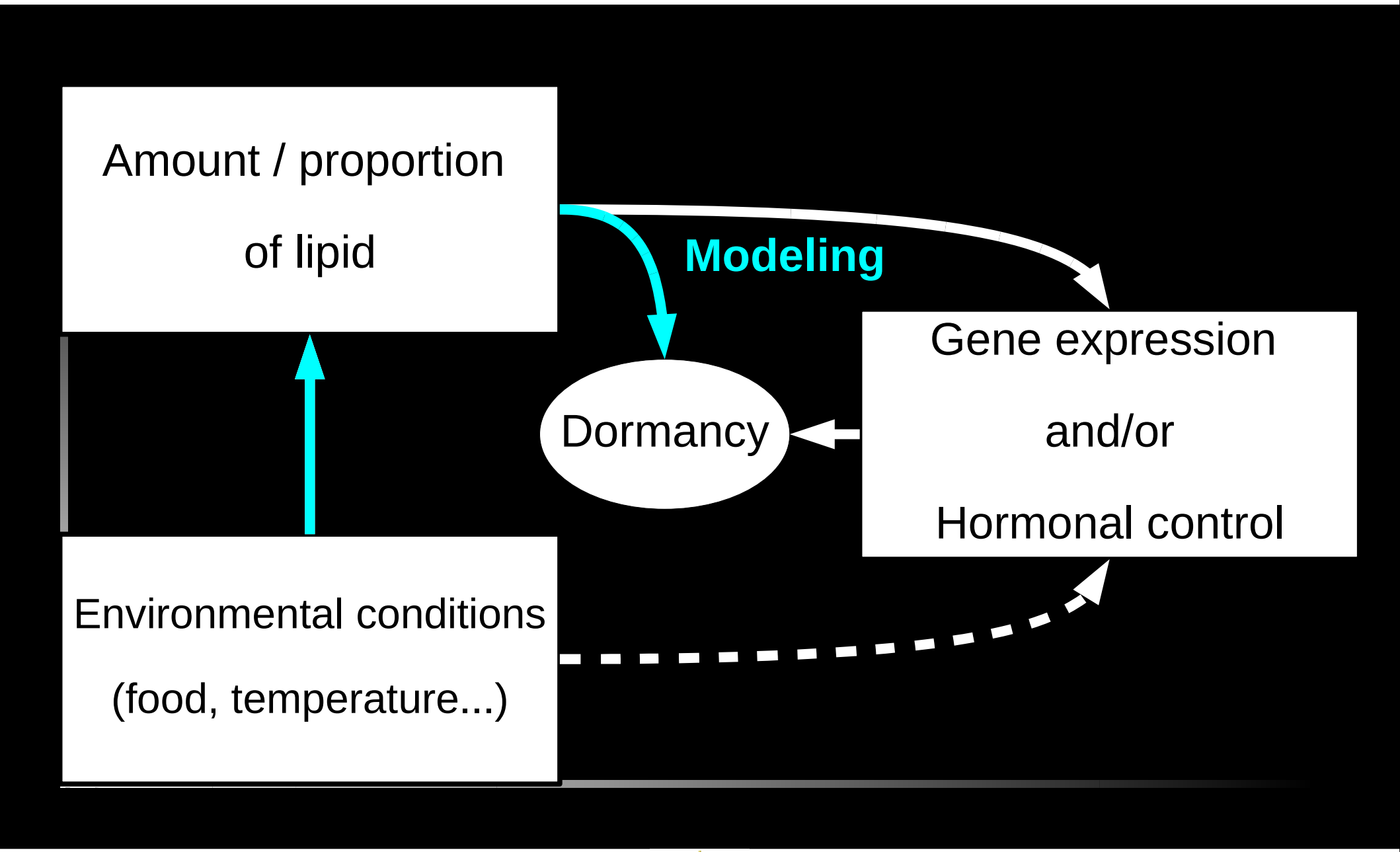
- Dormancy: allows species to thrive in seasonal environments
- Need to (1) synchronize entrance/exit to bad/good conditions
  (2) accumulate stores while growing



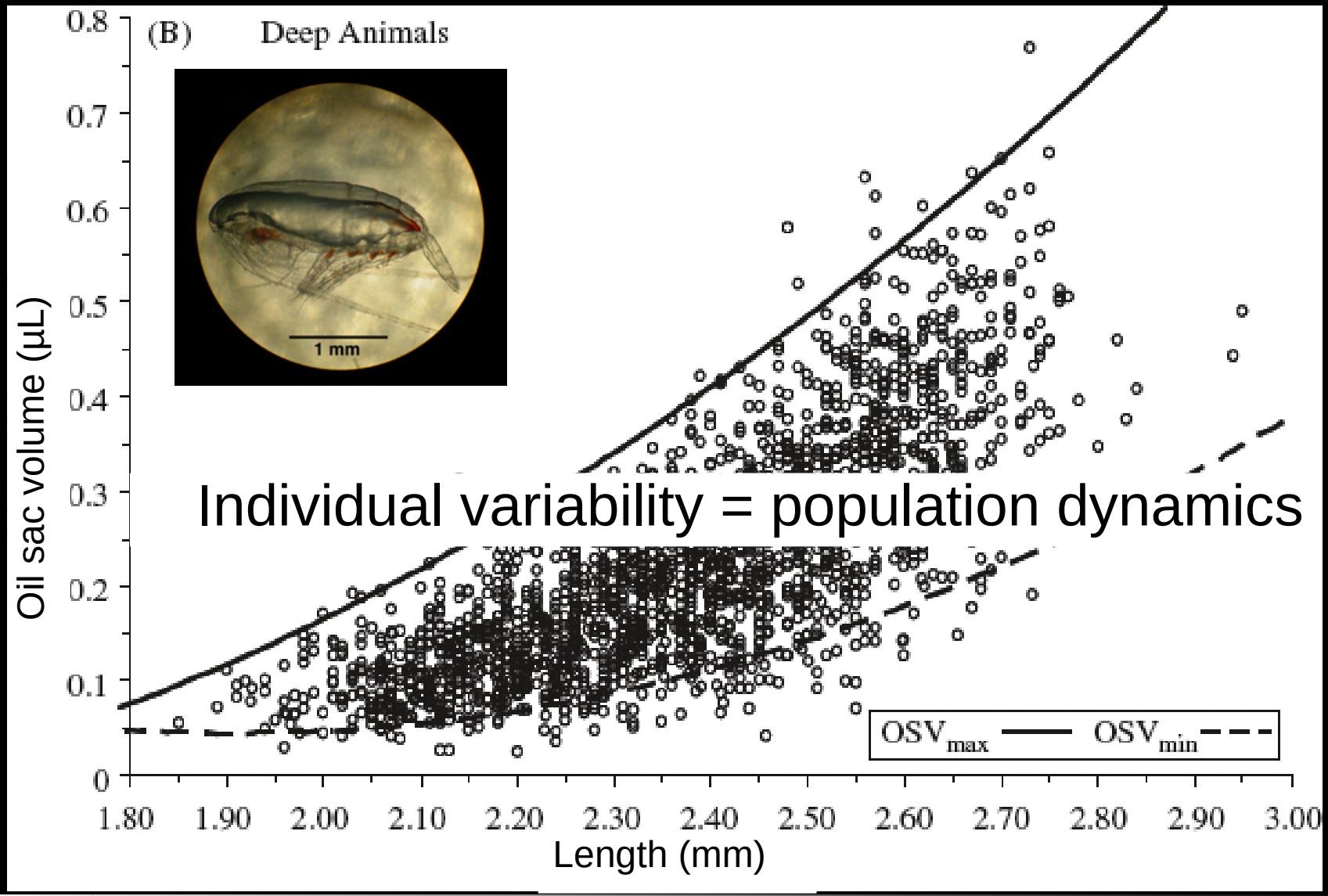


Tarrant et al. 2009

Distribution and dormancy strategy in *C. finmarchicus*

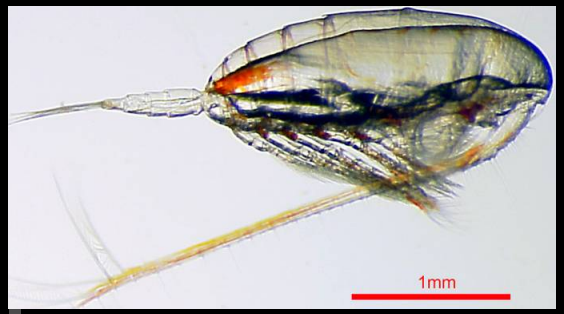


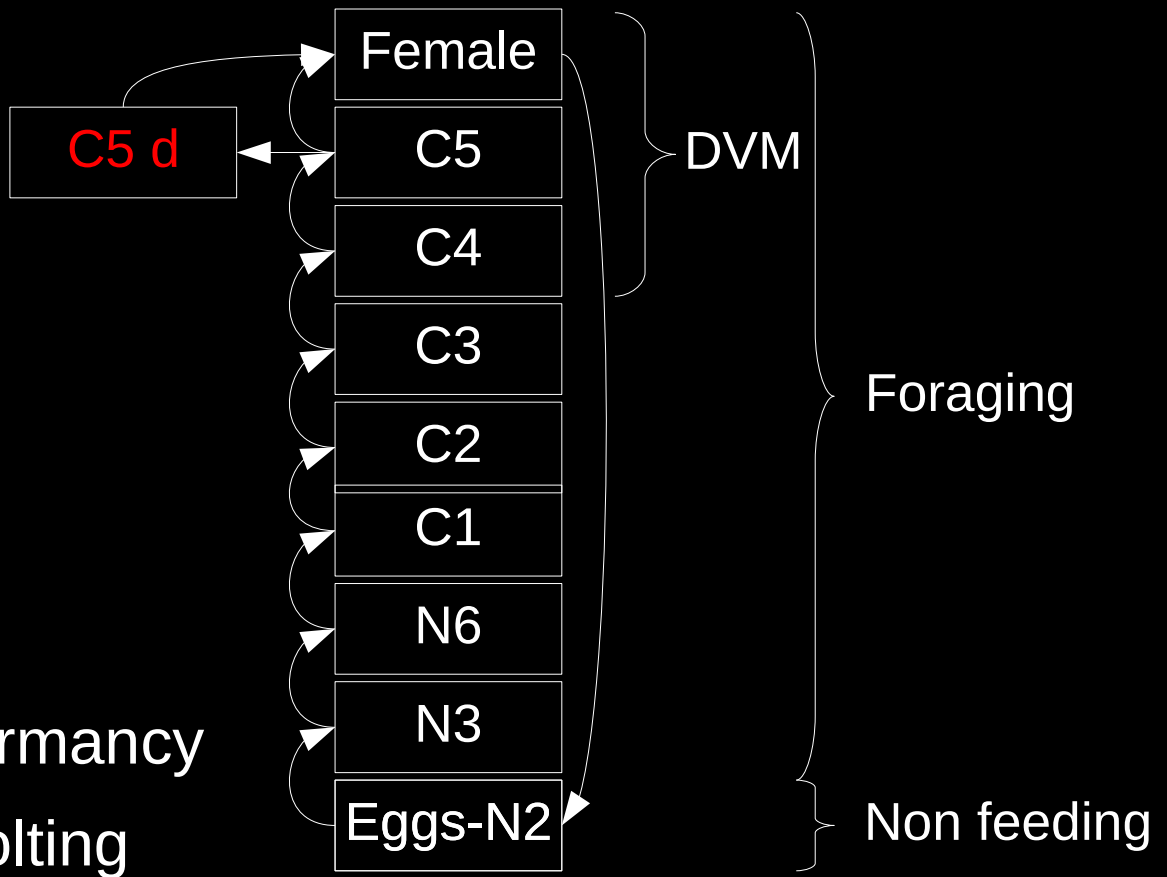
Individual-Based Modeling & Genetic Algorithm procedure



Saumweber & Durbin 2006

Individual-Based Modeling & Genetic Algorithm procedure





- Decision in late C4 / early C5
- Dormancy in C5
- Level of lipid:

  > threshold dormancy

  < threshold molting

Individual-Based Modeling & Genetic Algorithm procedure

- **"Firm" parameters:**

  Abundant / reliable literature

✔ Development, growth, egg production, DVM ...

✔ Optional dormancy in C5

✔ Use of lipids while dormant / molting

- **"Soft" parameters:**

  Educated guess --> range

✗ Relationship with food, mortality...

✗ Lipid stores build-up

✗ Thresholds for control of dormancy by lipids

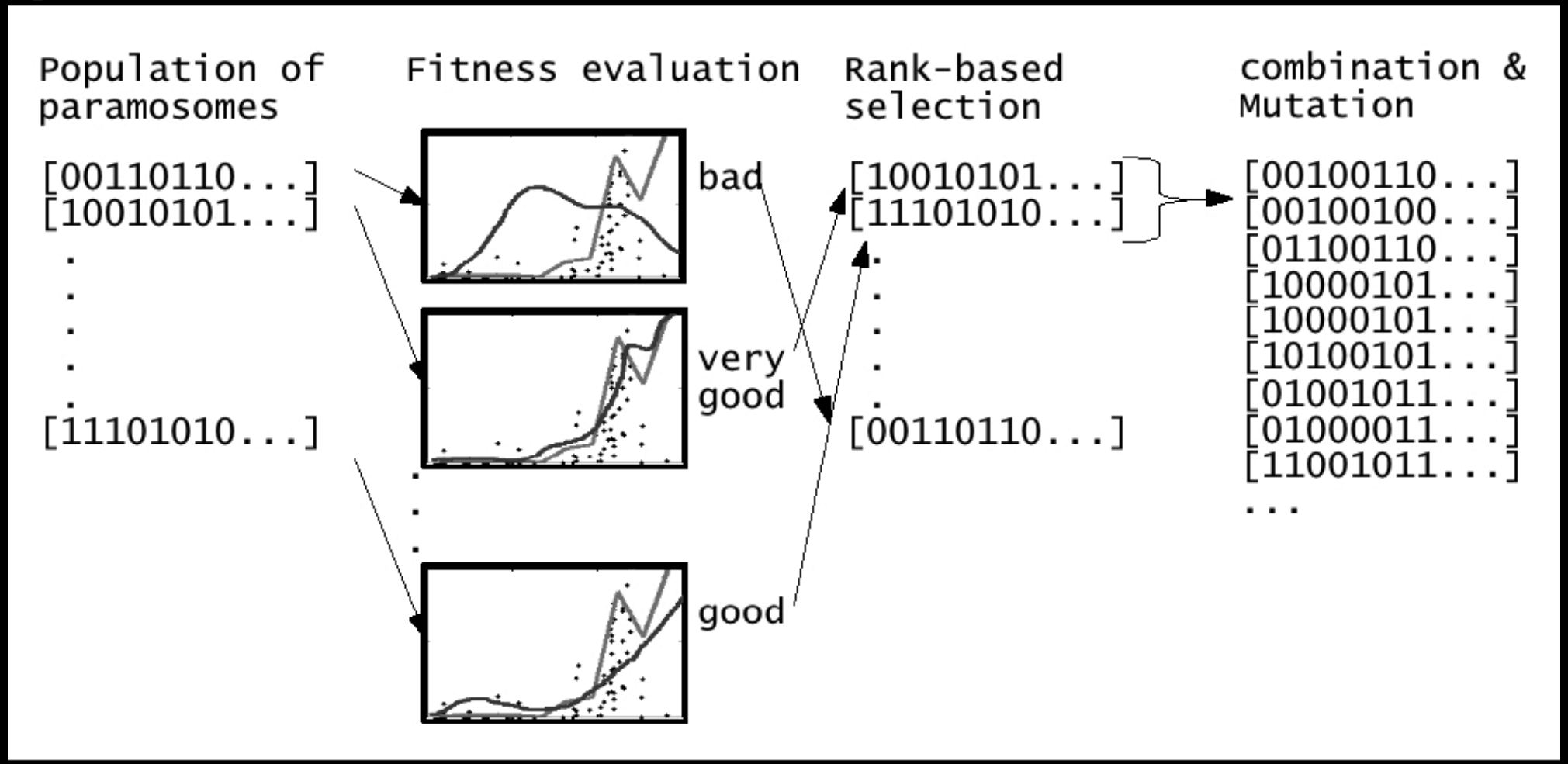
➔ **Genetic Algorithm** procedure objectively explores the parameters' space

Individual-Based Modeling & Genetic Algorithm procedure

- Parameters' space = phenotypic response to environmental forcing within bounds (what is known & plausible)
- GA procedure IS NOT a genetic / evolution experiment
- GA is an approach by ensembles from which new relationships between parameters and variables can emerge

➔ Numerical experiment analogous to a laboratory experiment

Individual-Based Modeling & Genetic Algorithm procedure



Record & Pershing 2010

Individual-Based Modeling & Genetic Algorithm procedure

- "Paramosome" =

+ Relationship with food for nauplii, copepodids & female stages

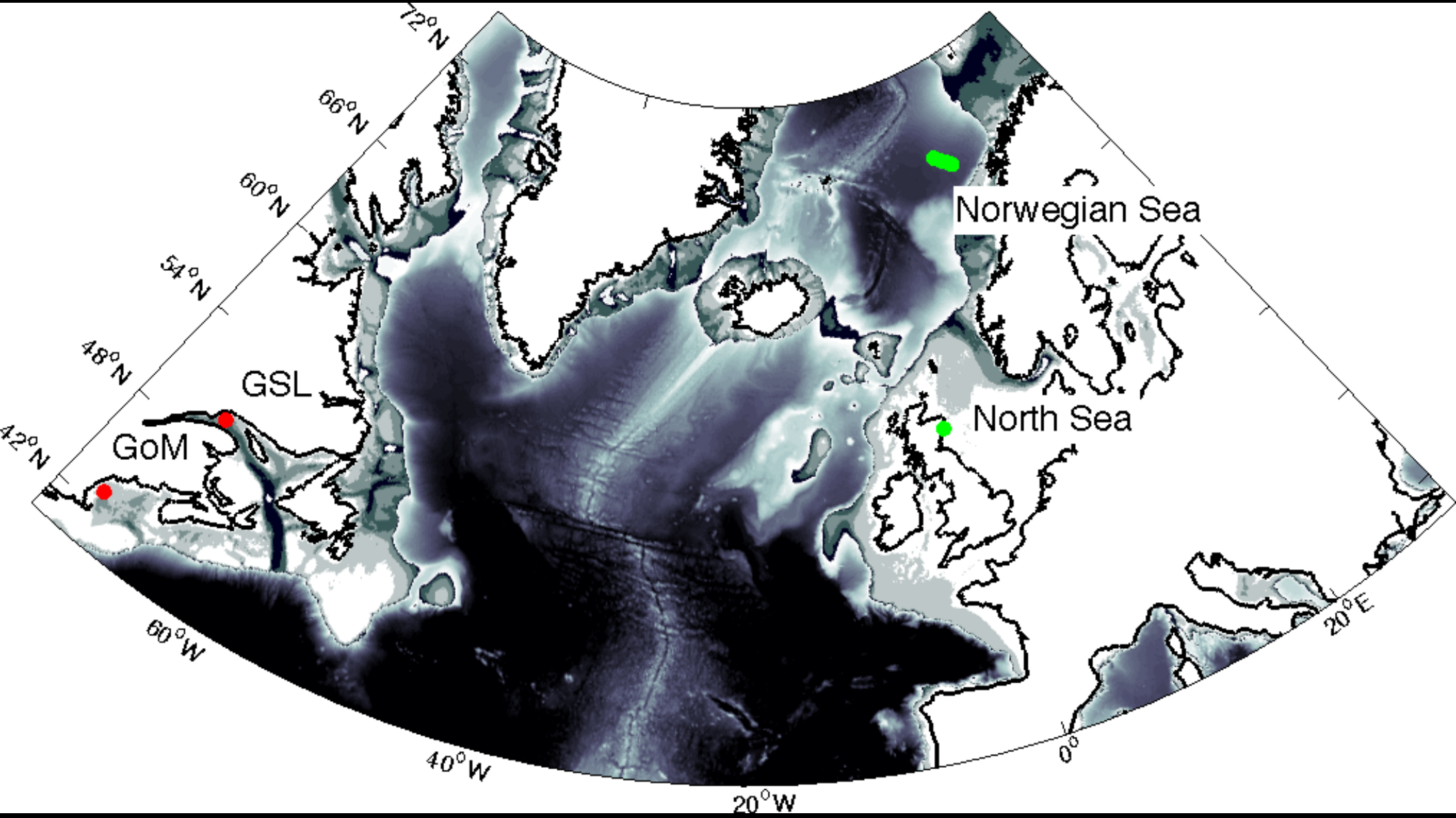
+ Scaling of mortality to temperature

+ *Allocation of growth to lipid stores in C4 & C5*

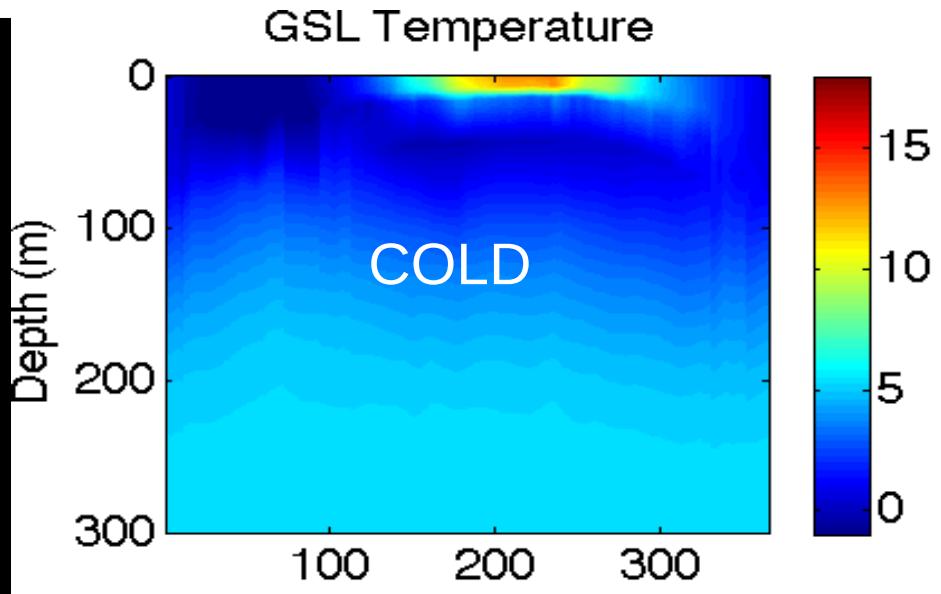
+ *Threshold of lipid proportion for induction of dormancy*

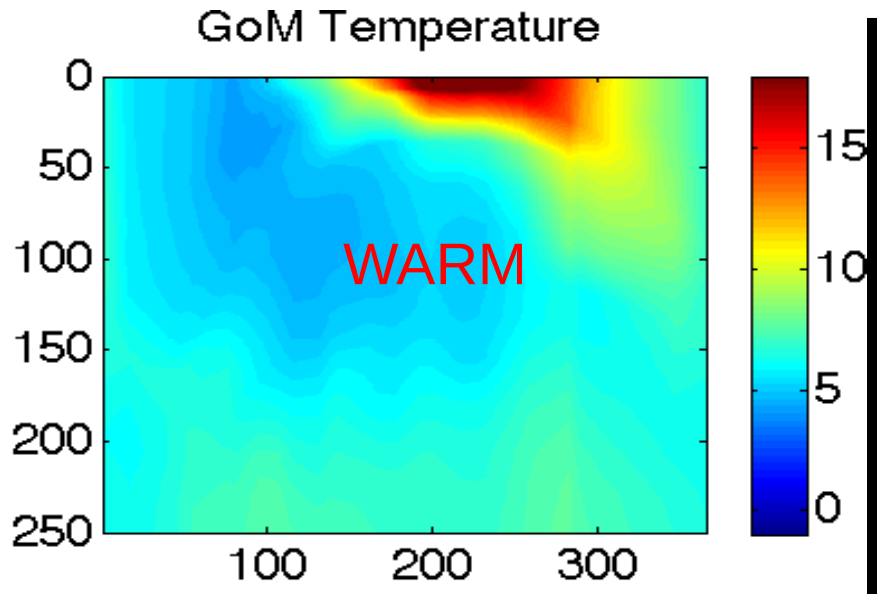
+ *Threshold of lipid proportion for termination of dormancy*

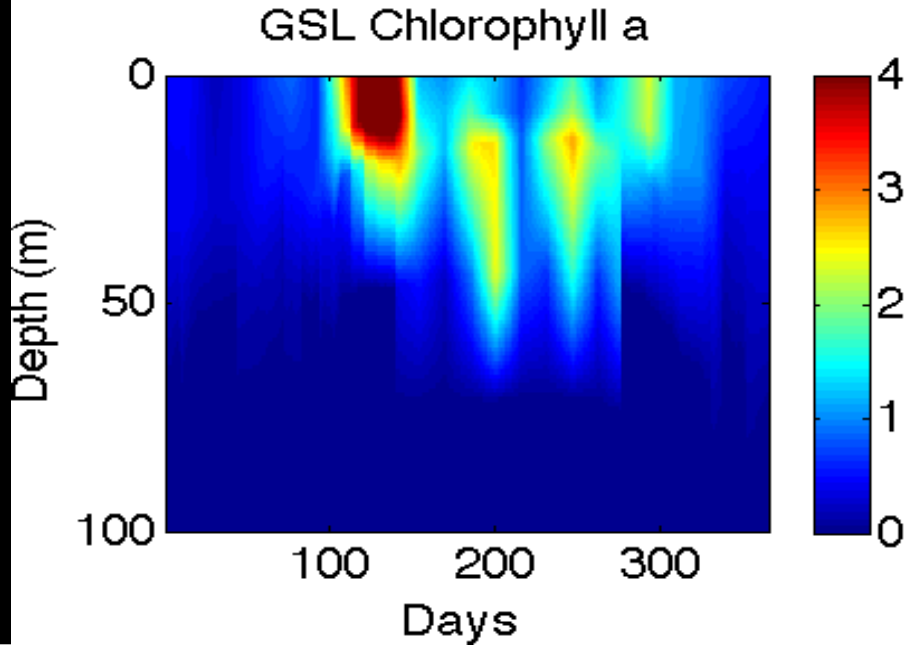
Developing the model in the North-West Atlantic

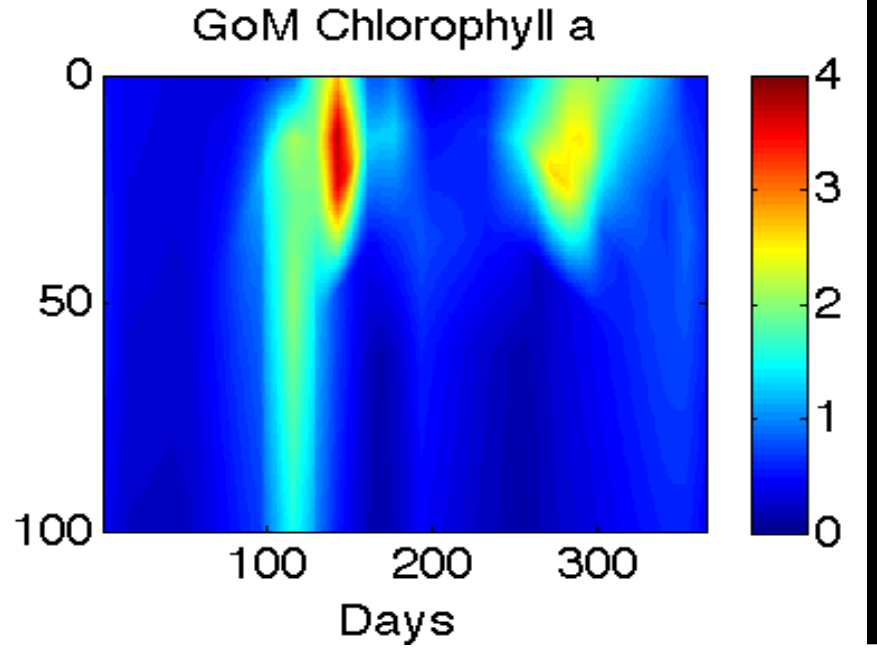


Developing the model in the North-West Atlantic









THE UNIVERSITY OF MAINE 1865

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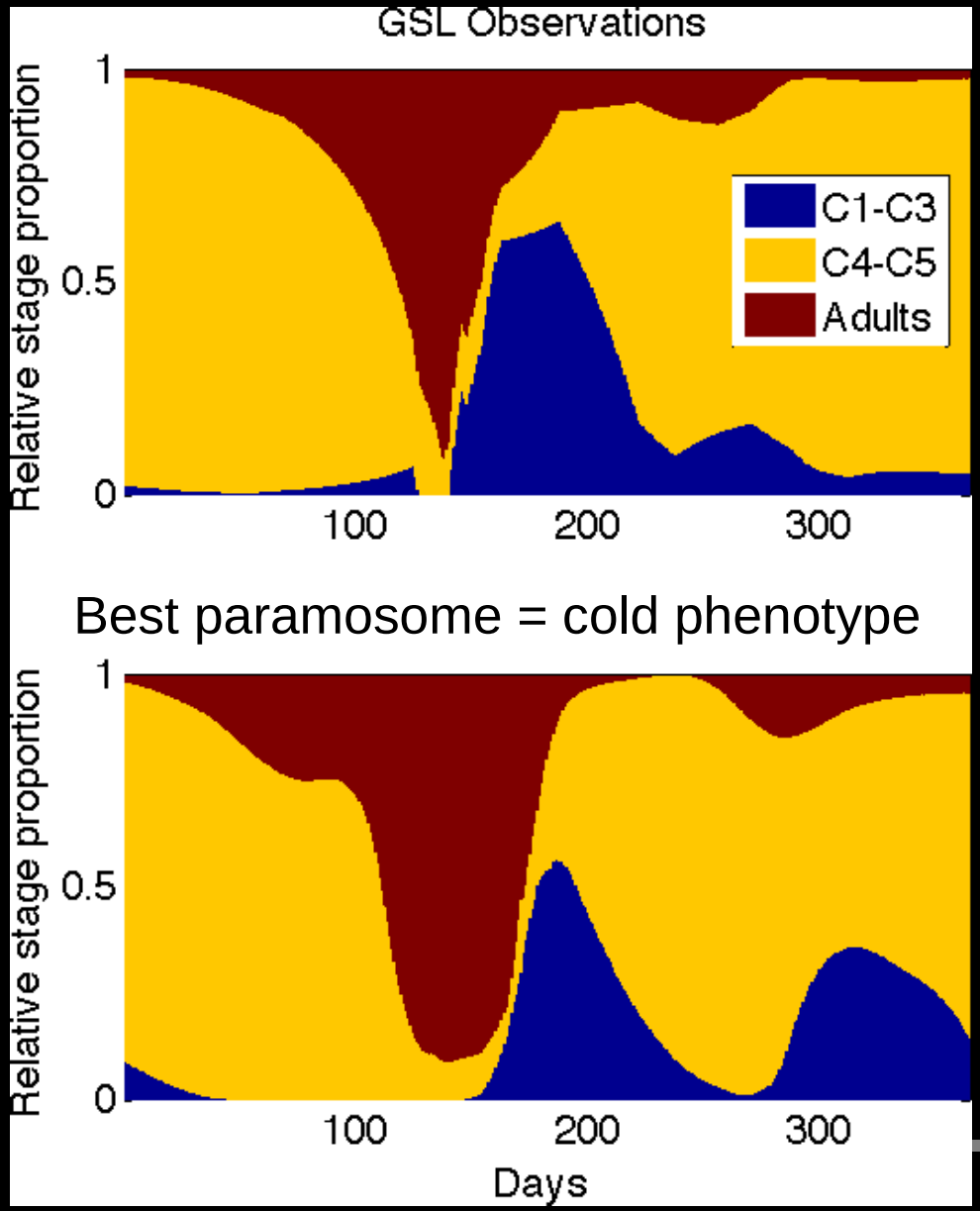
NSF

Dormancy and biogeography of *C. finmarchicus*

Maps F., PRS meeting, 22nd March 2010

Developing the model in the North-West Atlantic



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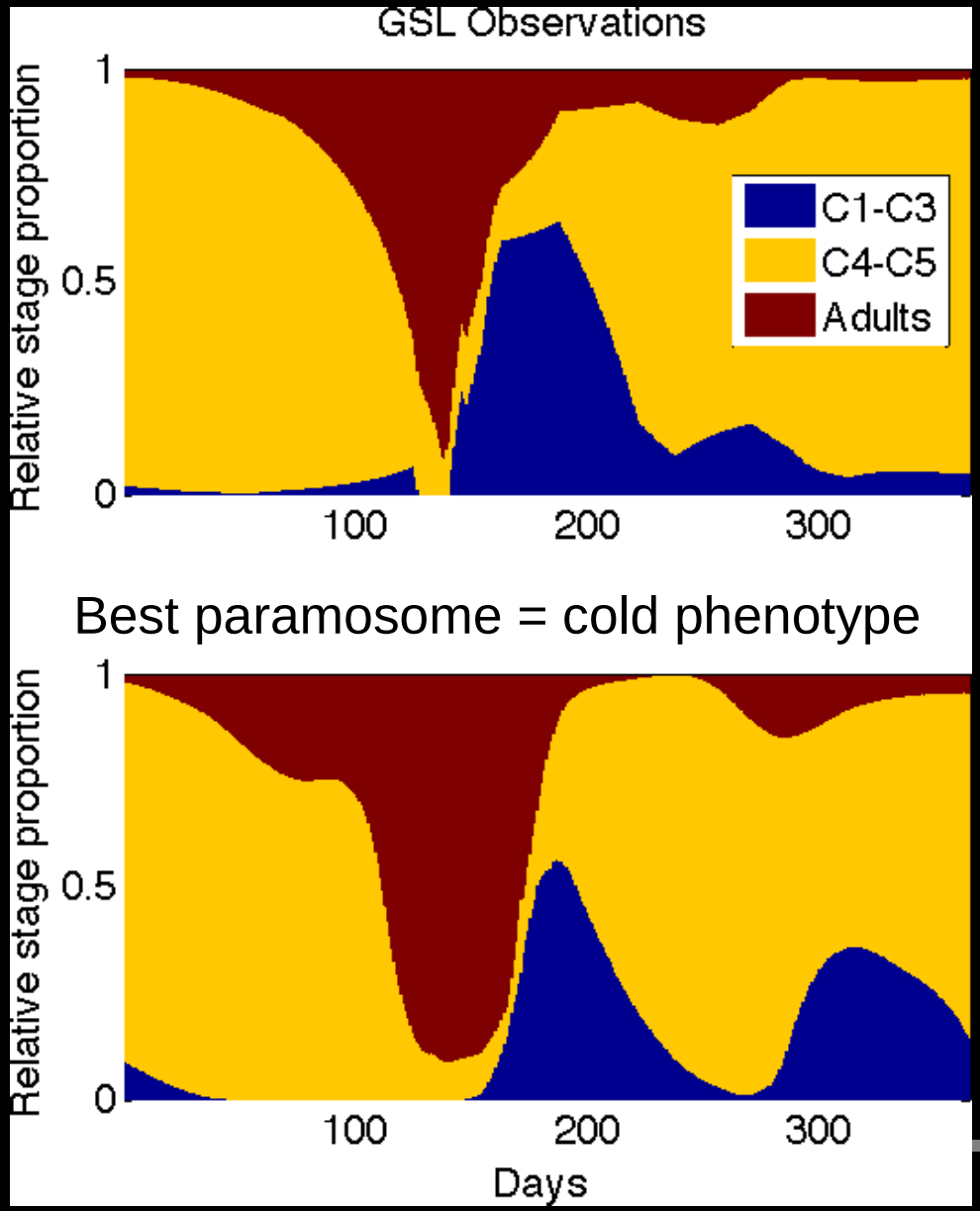
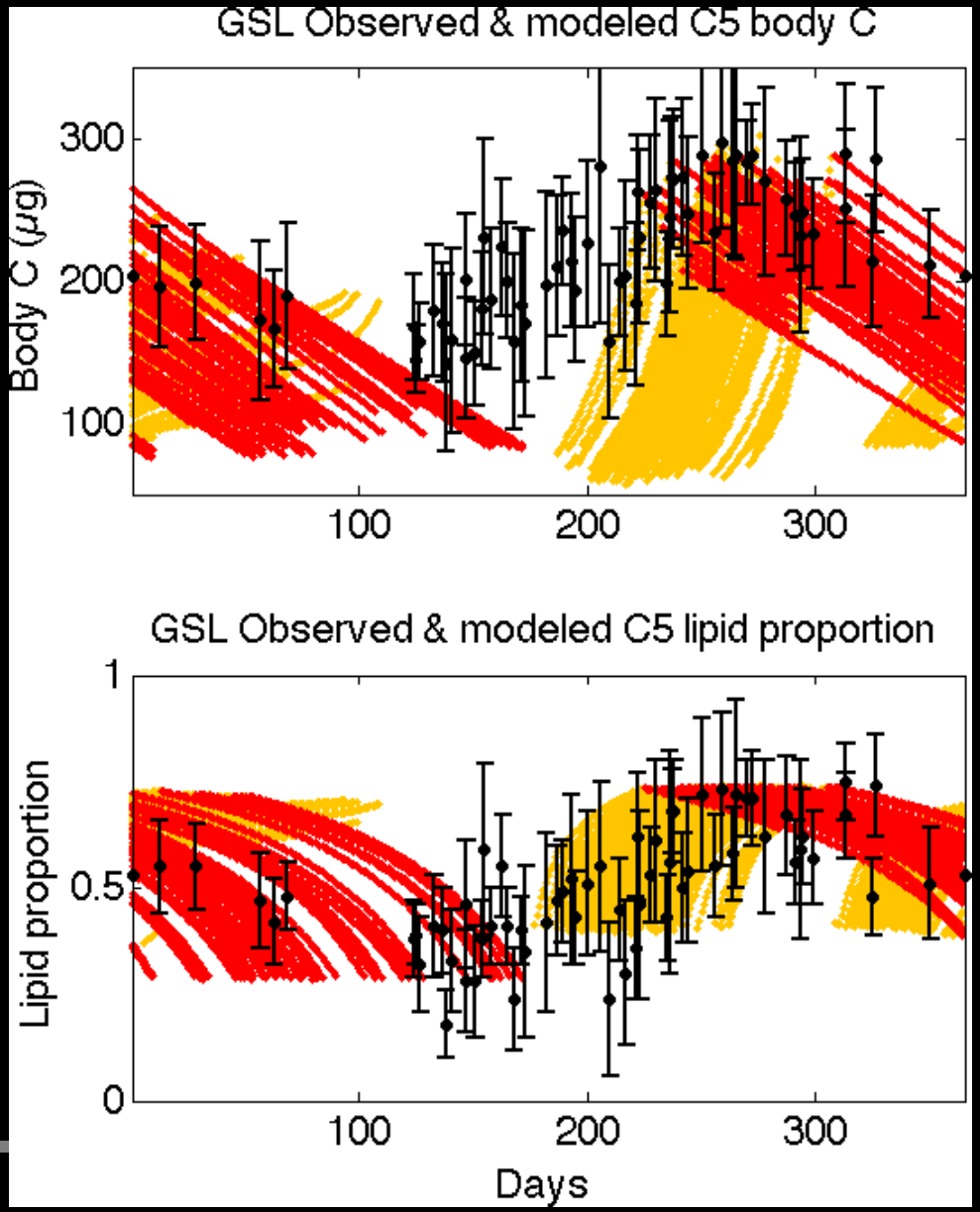
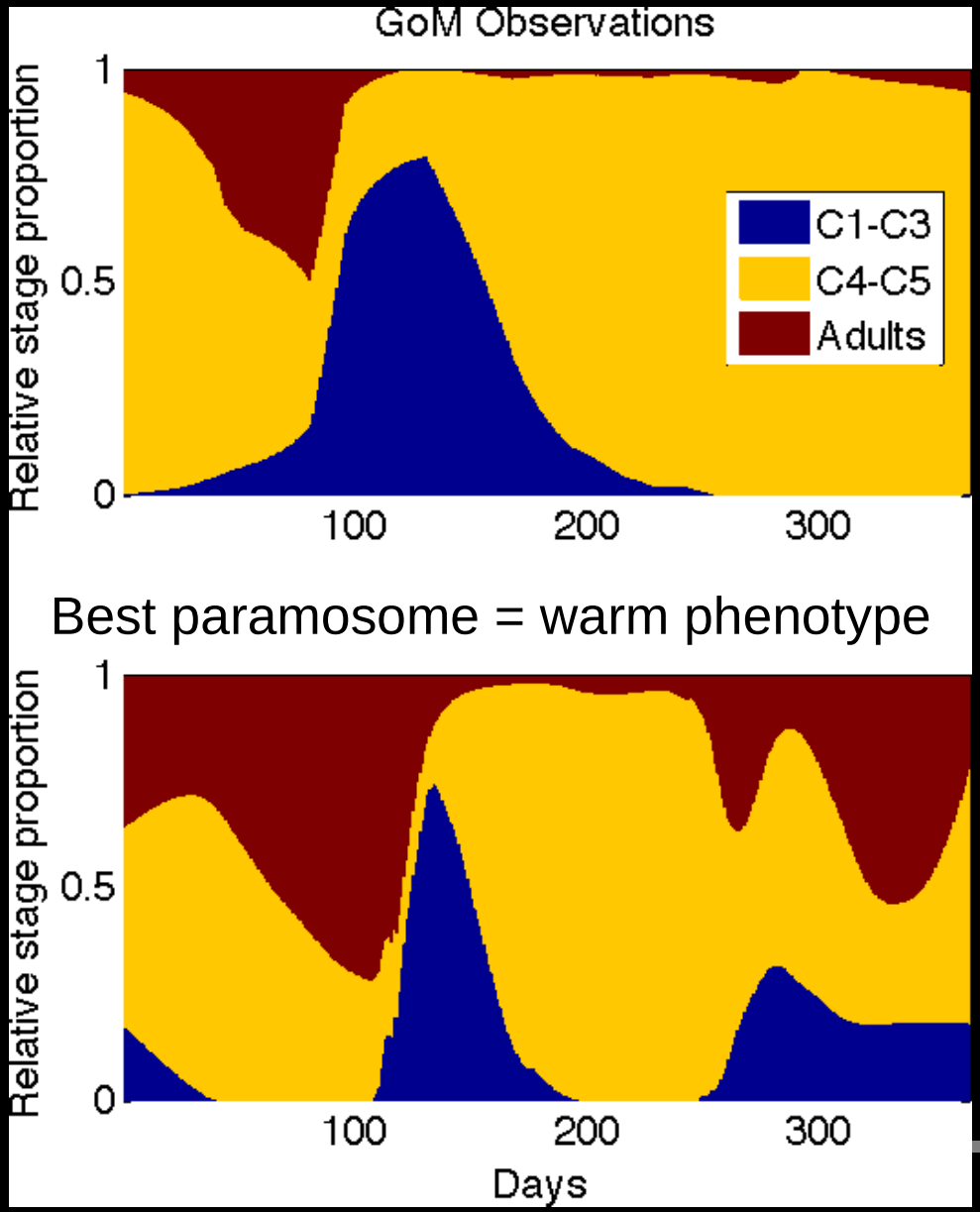


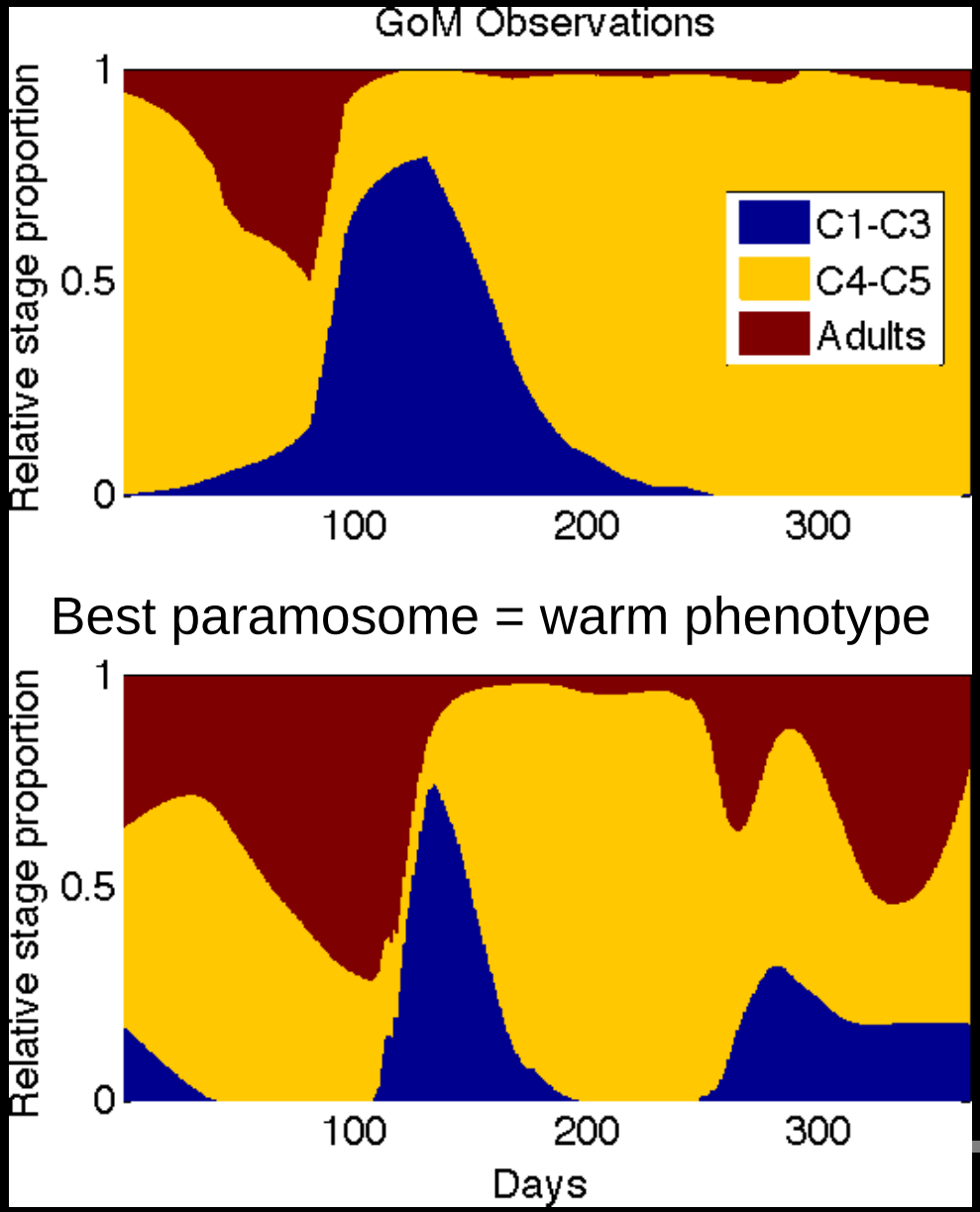
Best paramosome = cold phenotype



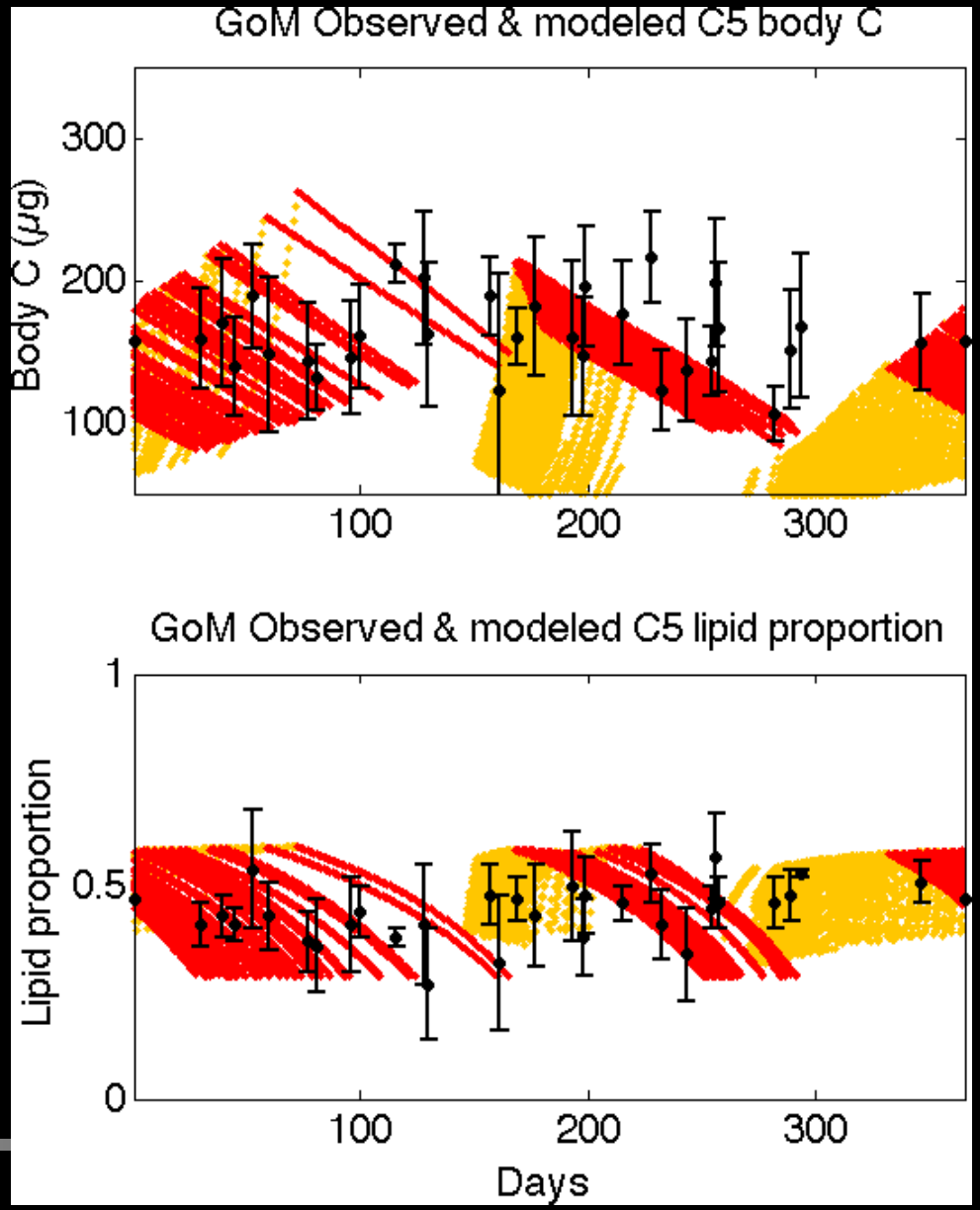
Developing the model in the North-West Atlantic



Developing the model in the North-West Atlantic

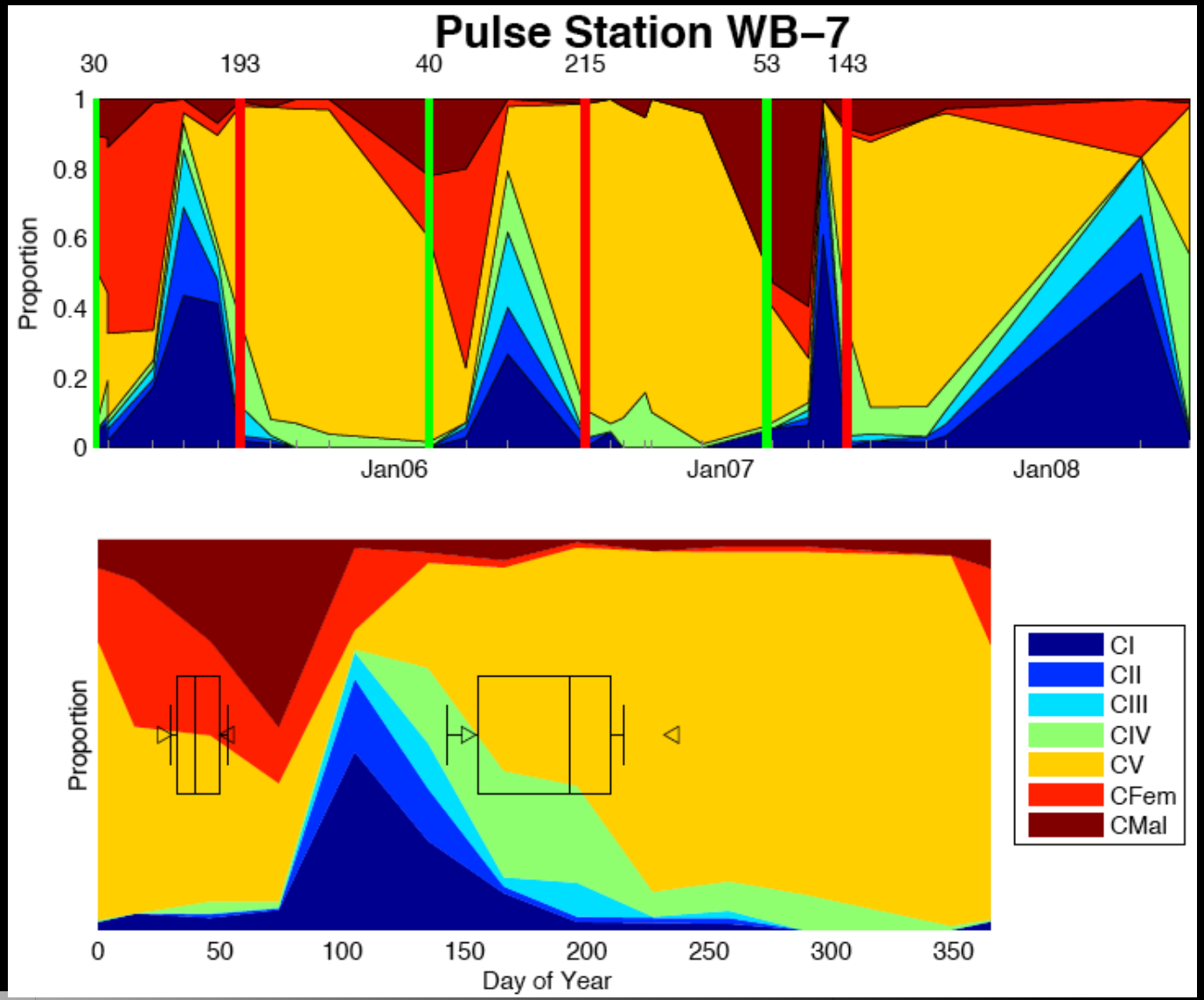


Best paramosome = warm phenotype



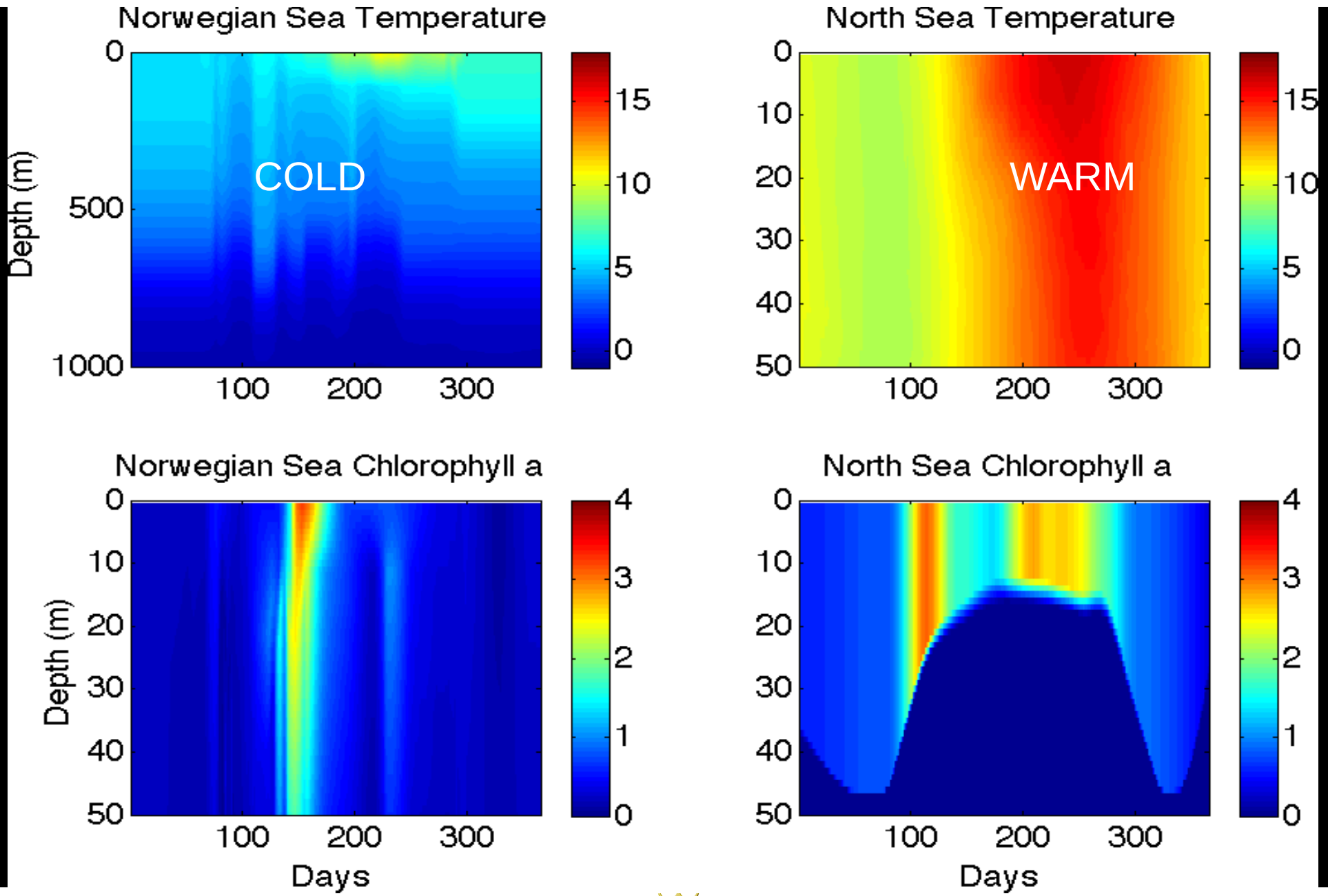
Developing the model in the North-West Atlantic

- Natural high interannual variability and occurrence of a fall generation hidden in the climatology...

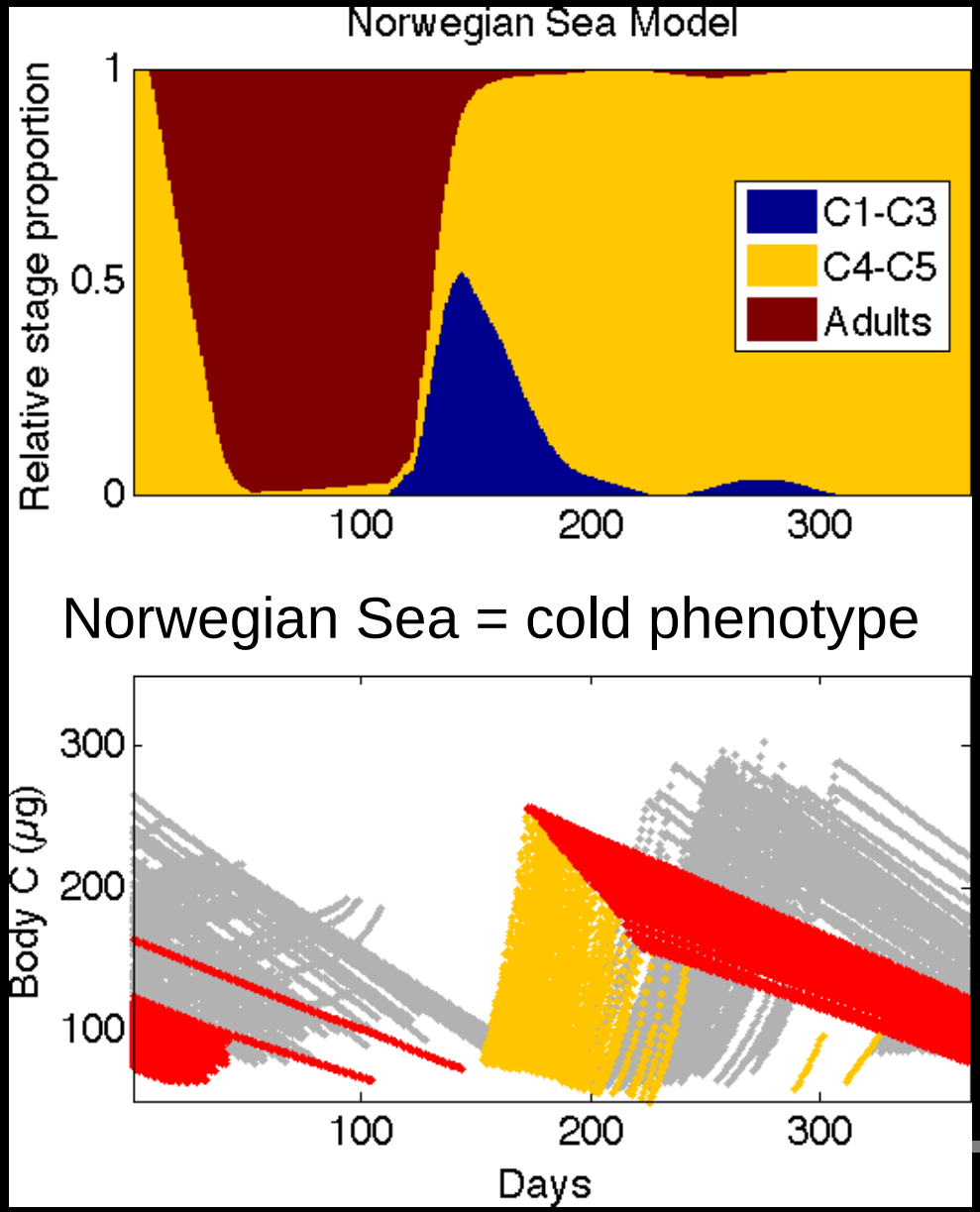


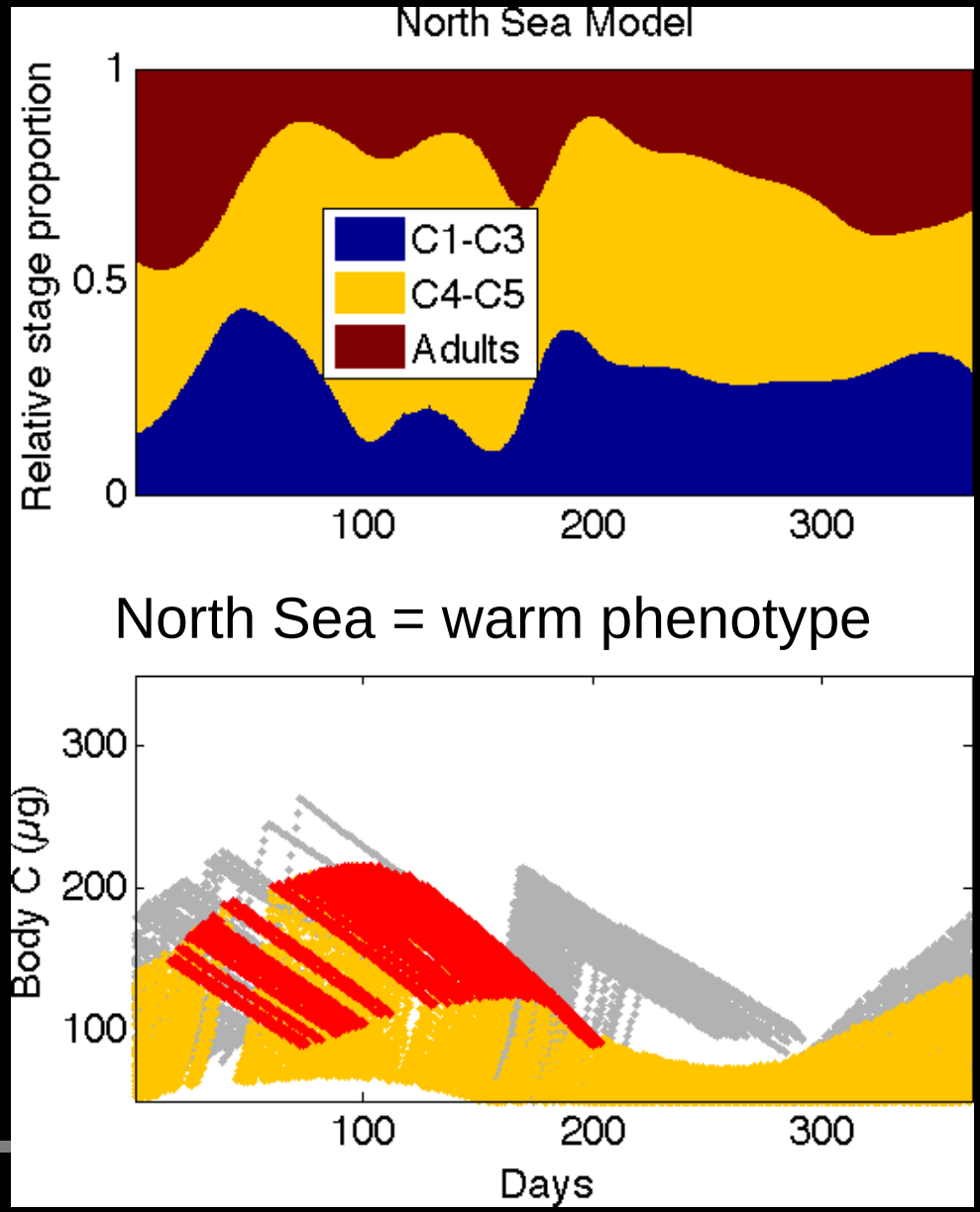
Pierson et al.

Proof of concept: preliminary application to the NE Atlantic



Proof of concept: preliminary application to the NE Atlantic





Implications for *C. f nmarchicus* in changing ecosystems

- Both sides of the Atlantic don't present the same vulnerabilities to climate changes in terms of dormancy habitat ...

  - Western shelves under inf uence of cold sub-arctic currents
    + refuges (shelf basins) for locally produced dormant copepods

  ➔ Vulnerable to an increase of temperature in those refuges

Implications for *C. finmarchicus* in changing ecosystems

- Both sides of the Atlantic don't present the same vulnerabilities to climate changes in terms of dormancy habitat ...

  - Eastern shelves under influence of warm Atlantic currents
    + supplied directly by the deep basin (no local refuges on shelves)

  ➔ Vulnerable to an increase in surface temperature

Implications for *C. finmarchicus* in changing ecosystems

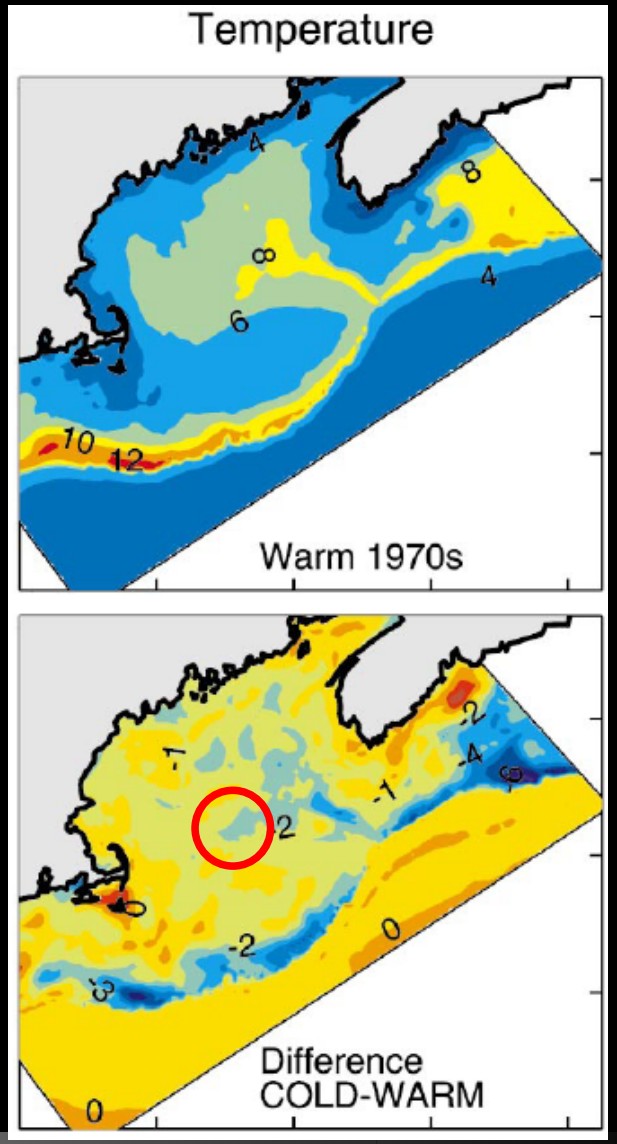
- Both sides of the Atlantic don't present the same vulnerabilities to climate changes in terms of dormancy habitat ...

- ... but both are vulnerable to an increase in Atlantic water masses temperature

➔ How far are we from tipping points ?

Implications for *C. finmarchicus* in changing ecosystems

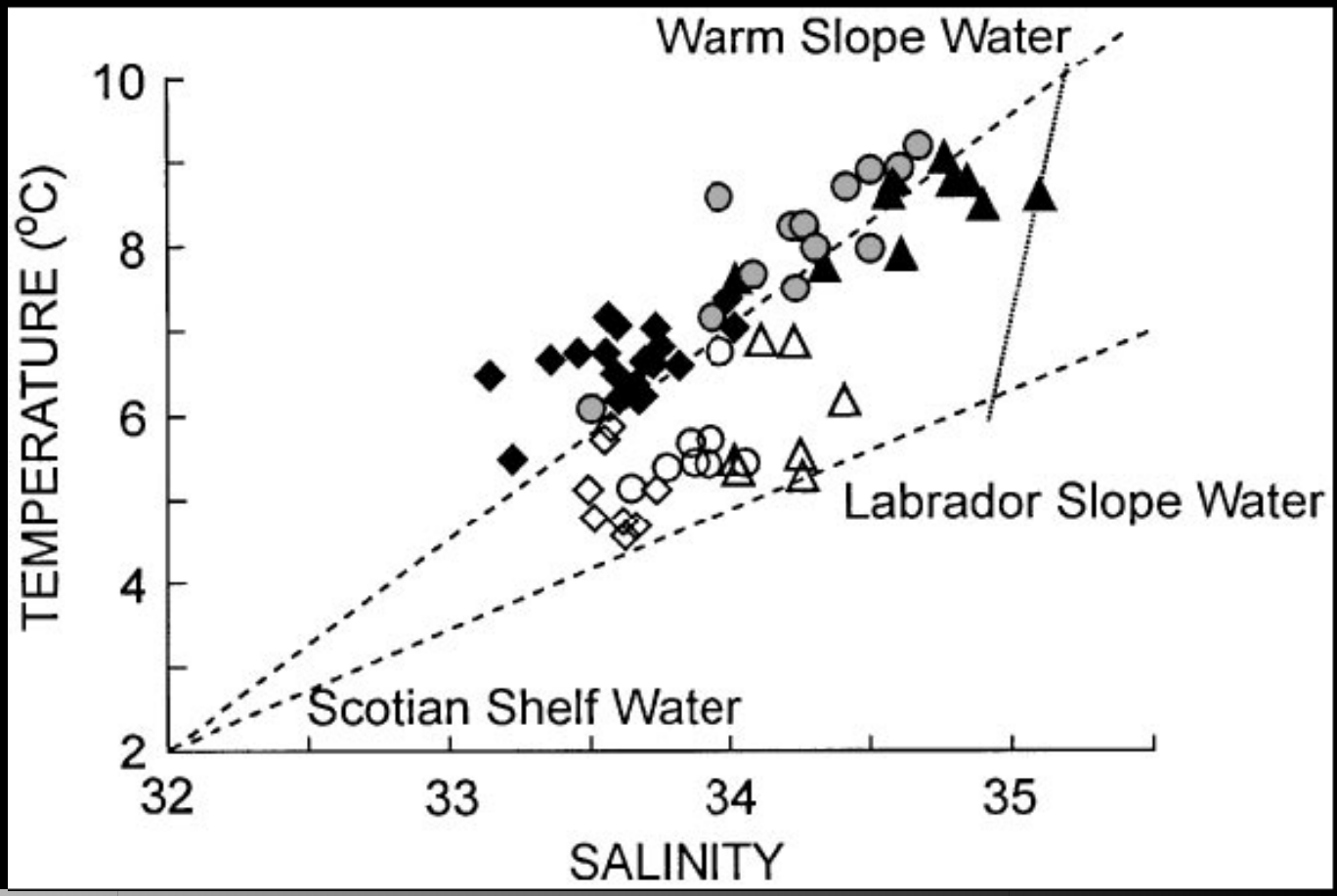
- Horizontal distributions of bottom temperature in winter
- Warm 1970s : upper panels
- Differences with the cold 1960s : lower panels



Loder et al. 2001

Implications for *C. finmarchicus* in changing ecosystems

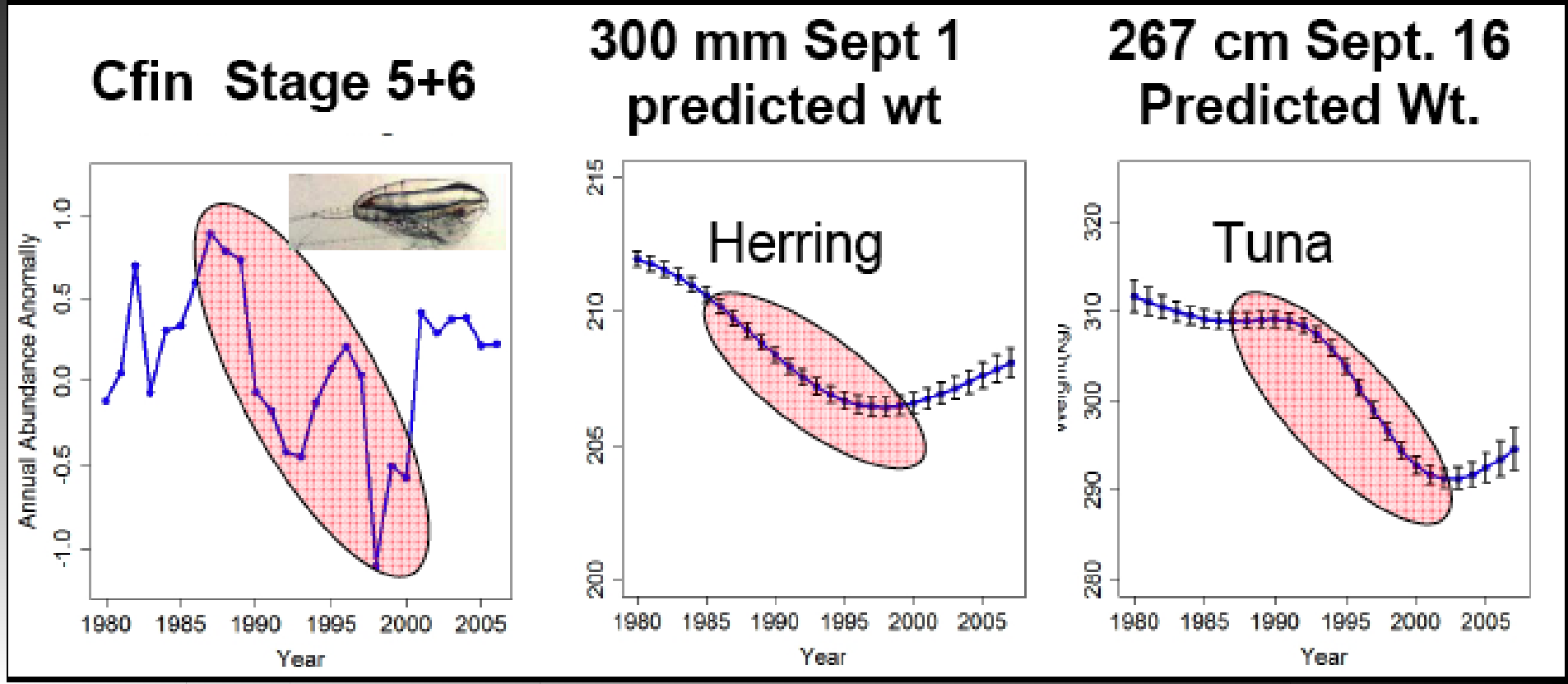
- TS for deep basin layers (150 - 200m)
- Comparing
  1990s (solid)
  1960s (open)



Smith et al. 2001

Implications for *C. finmarchicus* in changing ecosystems

- Example of trophic implications in the GoM



Golet et al.

THANK YOU