The Bering Sea Project

BEST/BSIERP Research Program

climate & oceanography

fish, seabirds, marine mammals

phyto & zooplankton

Modeling

economics & management

traditional knowledge

Economics & spatial fisheries

Upper trophic level (FEAST)

Lower trophic level (NPZ)

physical oceanography (ROMS)

climate scenarios

FEAST

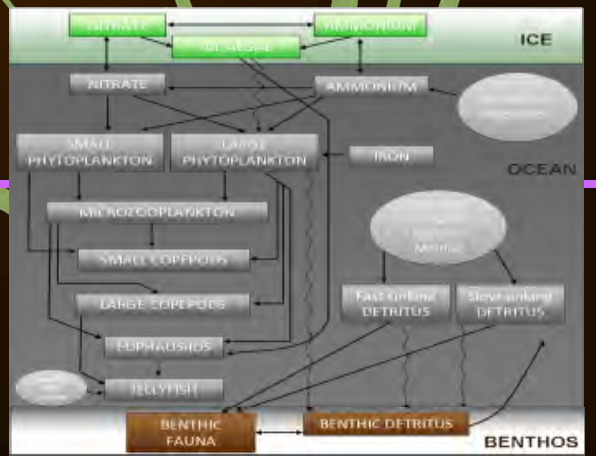
11 ages/ 15 lengths
high detail

15 lengths
medium detail

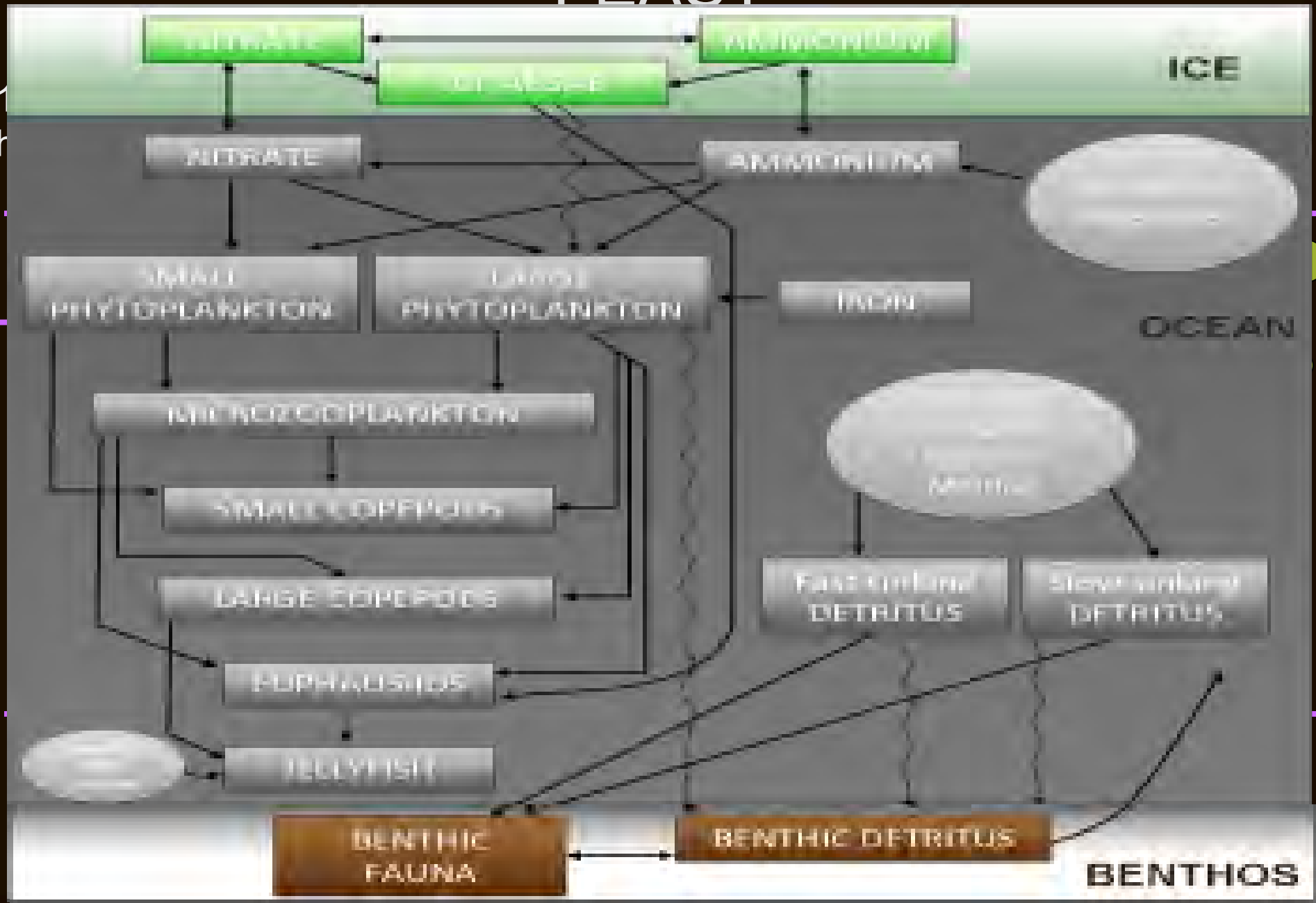
biomass pools
low detail

NPZ

cod
arrowtooth
pollock
salmon
herring
myctophid
capelin
squids
eulachon
sandlance
crabs
shrimp
epifauna
benthos

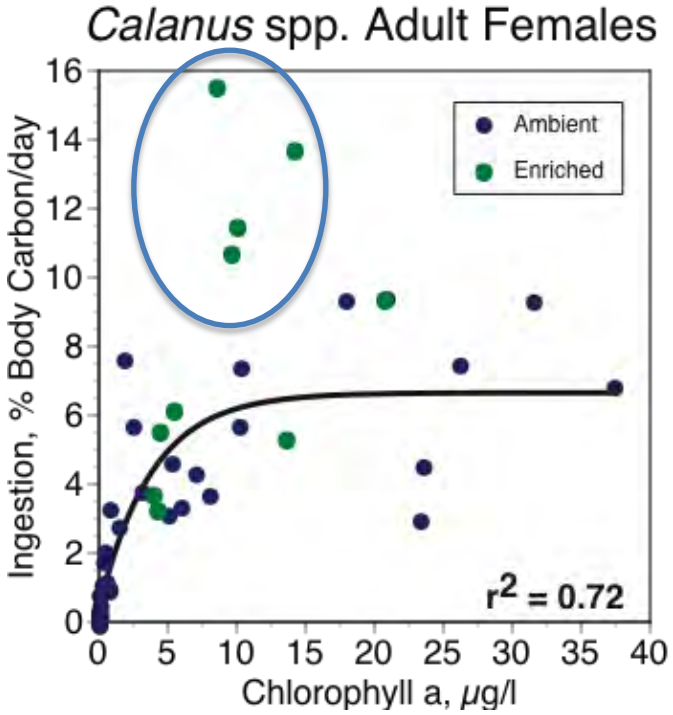


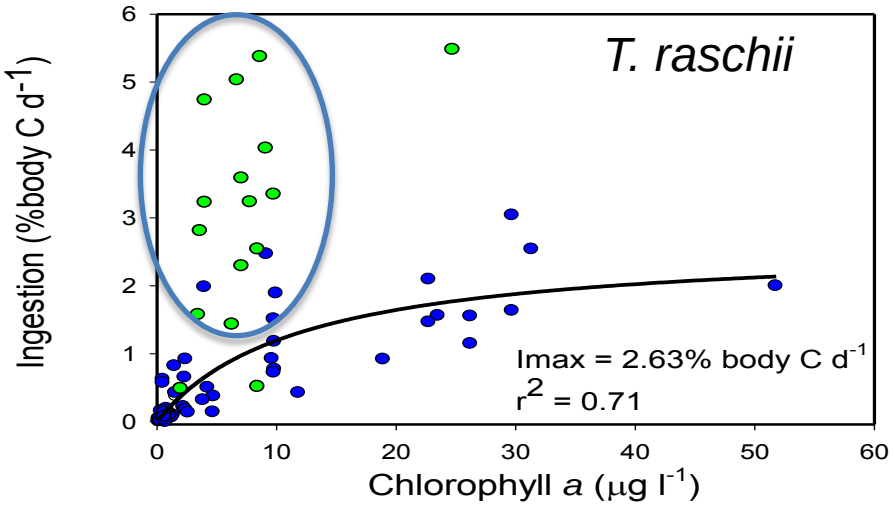
FEAST


ICE
NITRATE
AMMONIUM
SMALL PHYTOPLANKTON
LARGE PHYTOPLANKTON
IRON
OCEAN
MICROZOOPLANKTON
SMALL COPEPODS
LARGE COPEPODS
EUPHAUSIIDS
DETRITUS
DETRITUS
BENTHIC FAUNA
BENTHIC DETRITUS
BENTHOS

Importance of Seasonal Sea Ice:

Ice algae: Importance to early reproduction in copepods

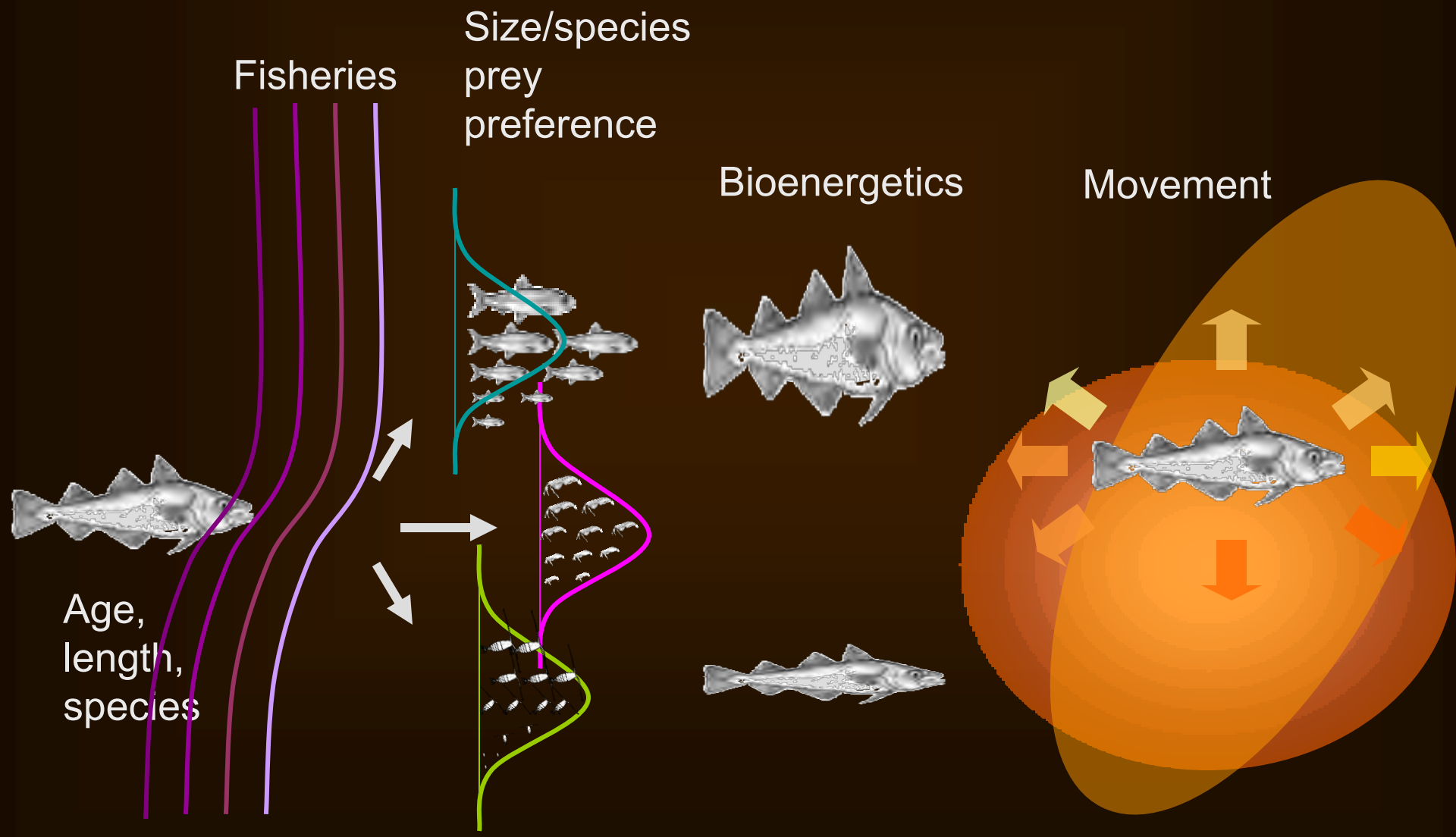




Both *Calanus* spp. and *T. raschii* have higher ingestion when feeding on ice algae (green) than when feeding on ambient water column phytoplankton (blue)

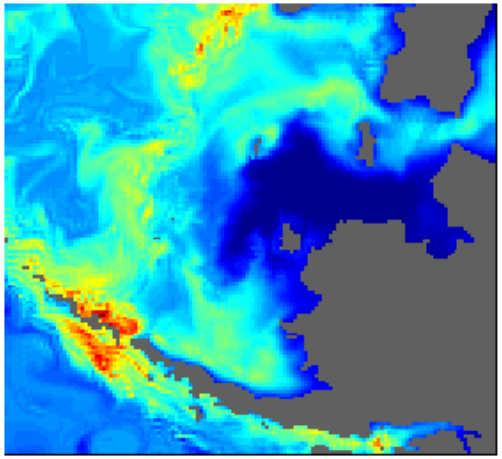
Campbell, Lessard, Ashjian

FEAST

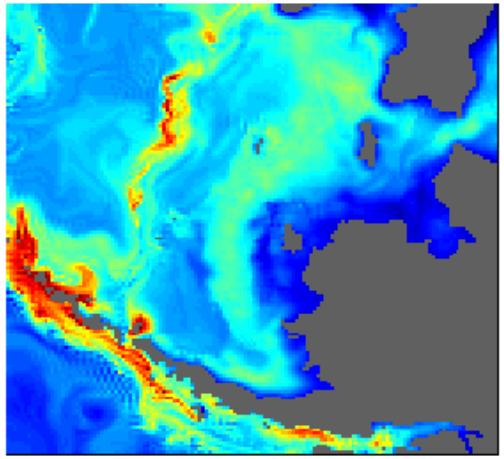

Fisheries
Size/species
prey
preference
Bioenergetics
Movement
Age,
length,
species

Prey Fields and temperature – foraging potential for an 8 cm (age 0) pollock

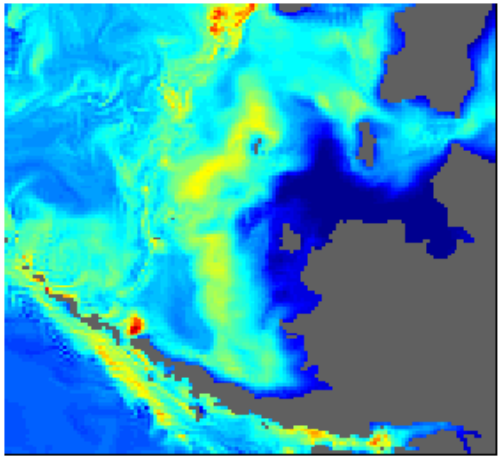
July 1975 (cold)



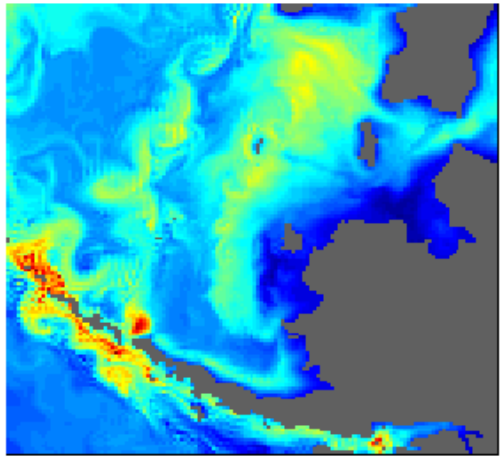
July 2004 (warm)



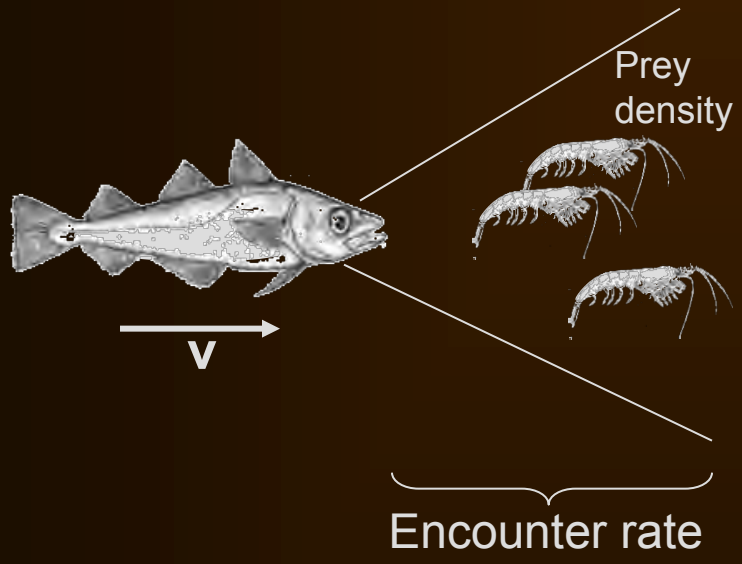
July 2008 (cold)

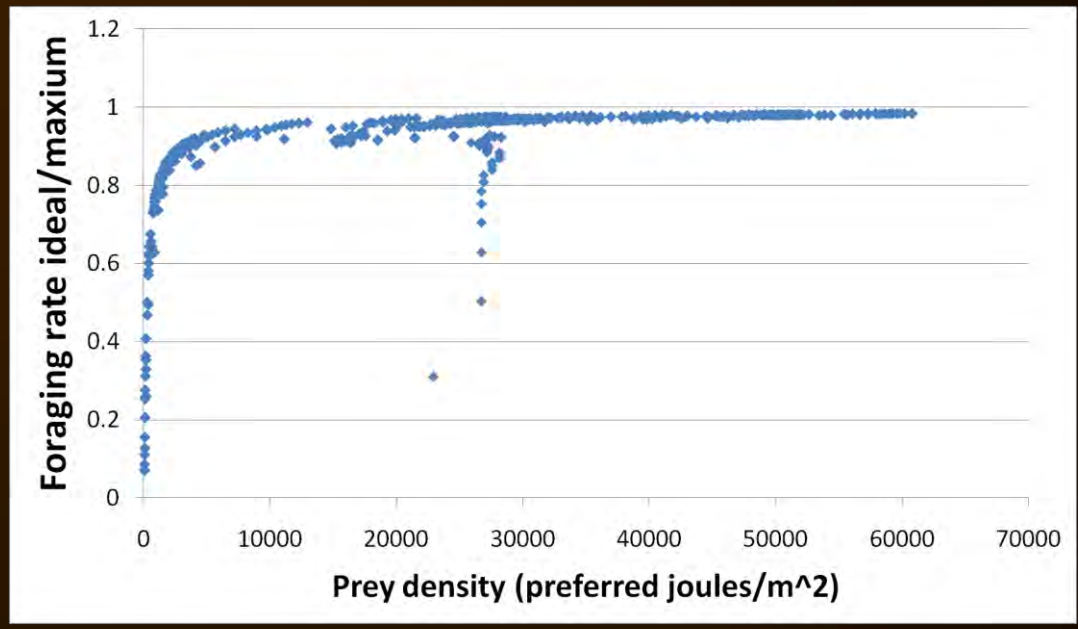


July 2040 (warm)



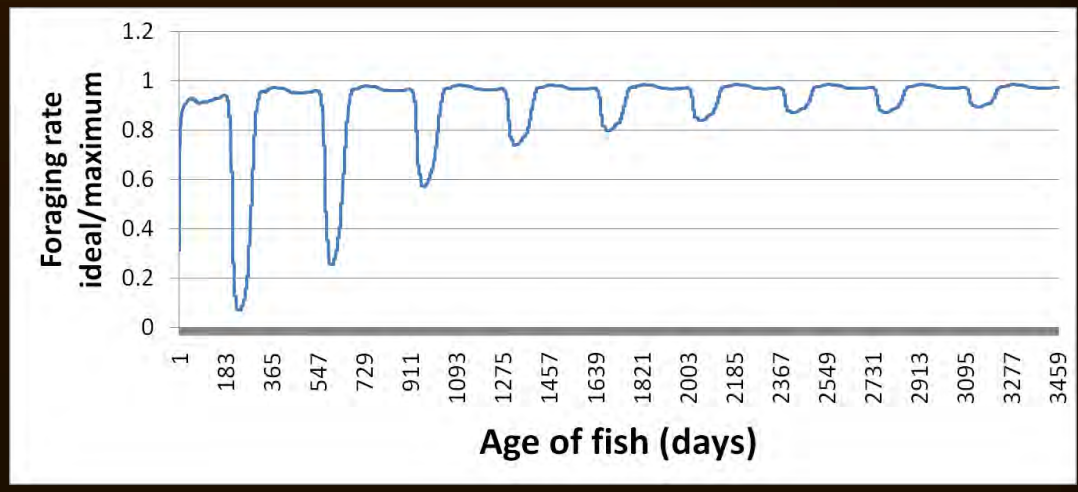
Linking foraging and bioenergetics into functional responses





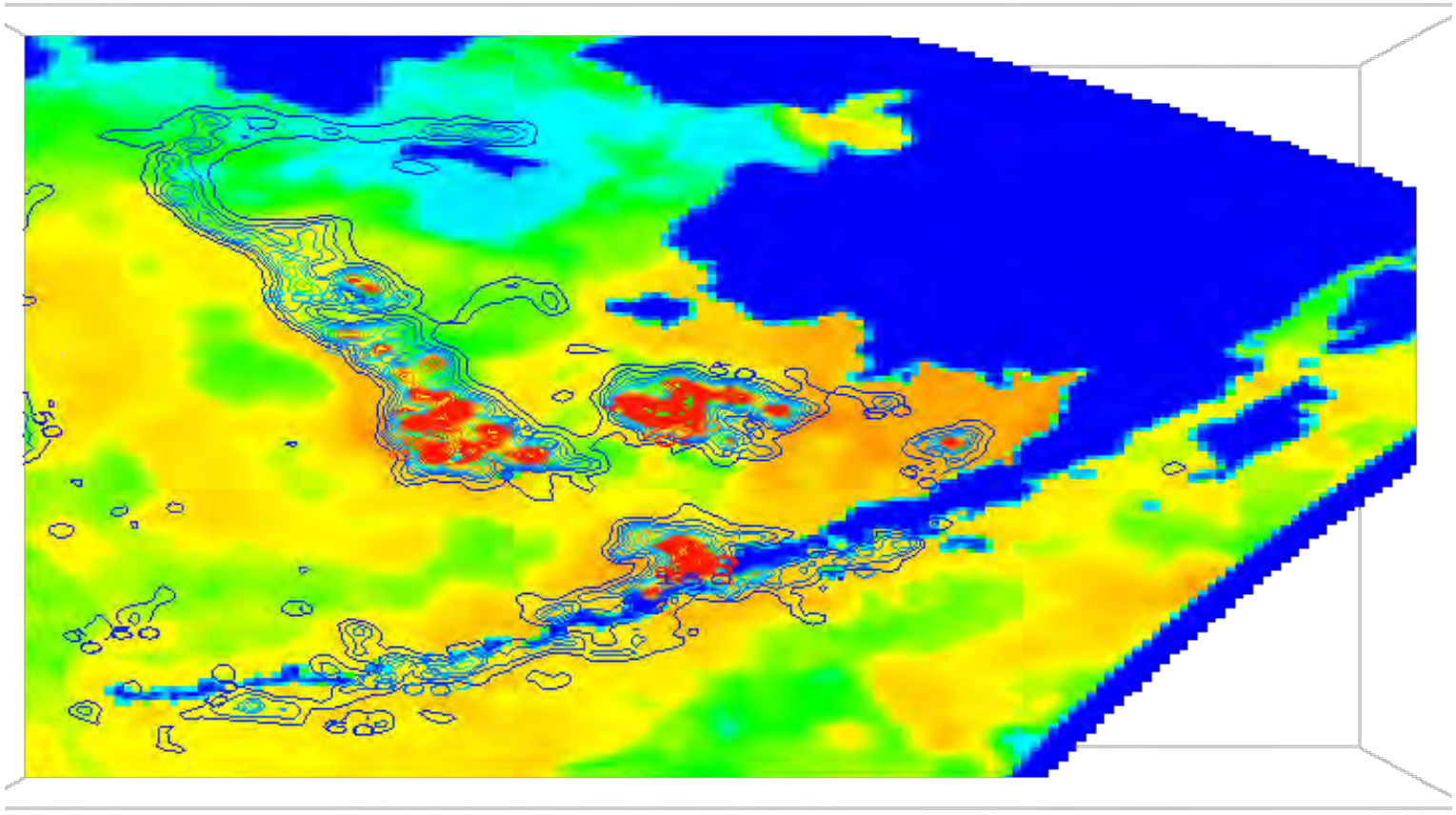
Useful consumption (joules) = **f(V,T,L)**

Respiration (joules) = $A_V V^{Bv}$ * $f_r(T)$



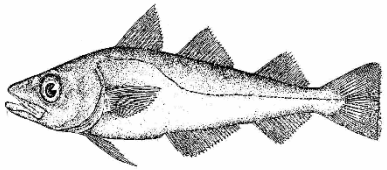
Pollock and euphausiid densities

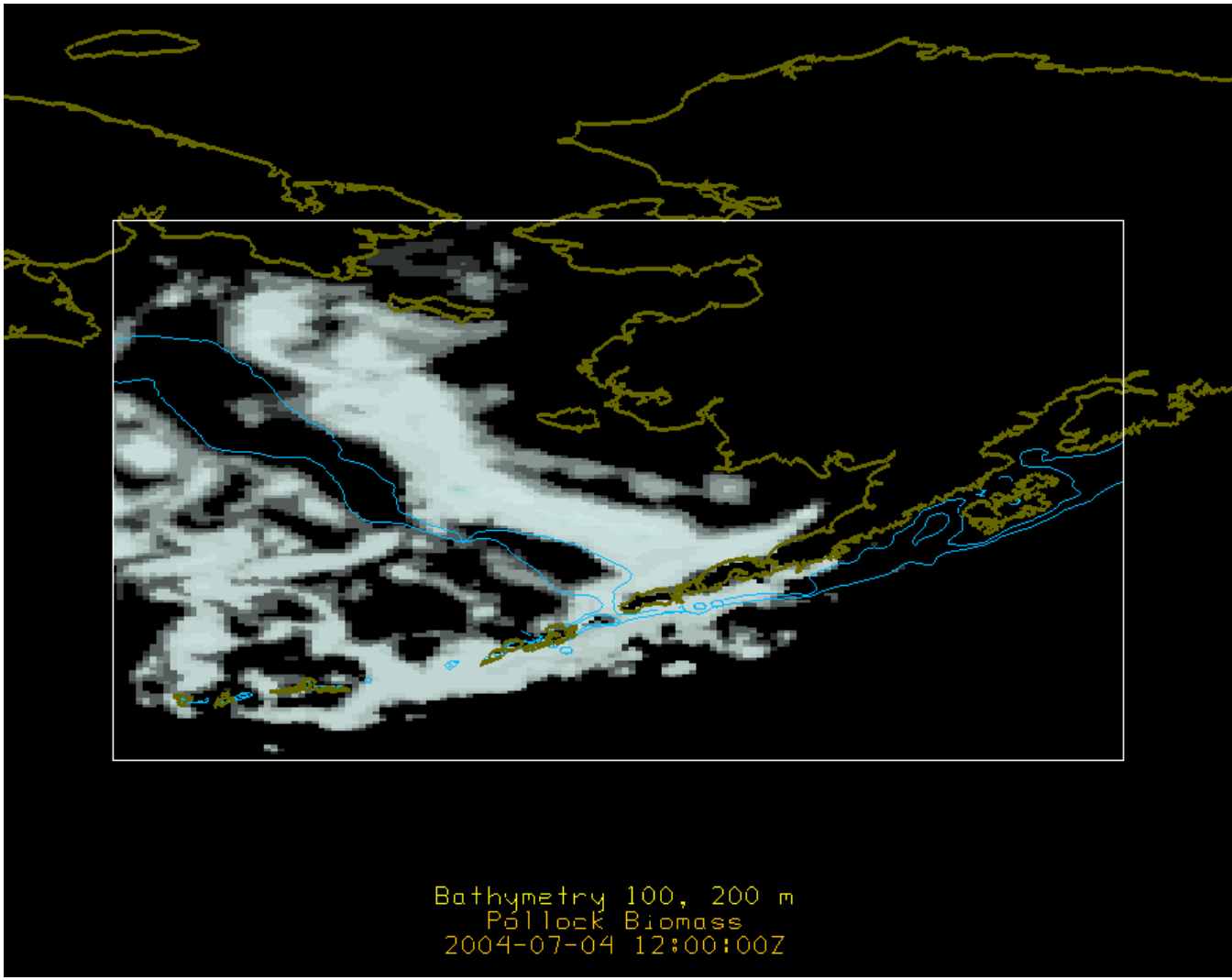
Modeled age 5 pollock biomass (colored contours) and 0-300m integrated euphausiid density (color field) for July, 2004. The location of primary pollock concentrations along the northwest shelf break and in the Unimak Pass area shows a strong correspondence with historical distributions.



Walleye Pollock

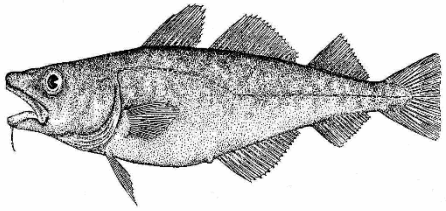
July 2004

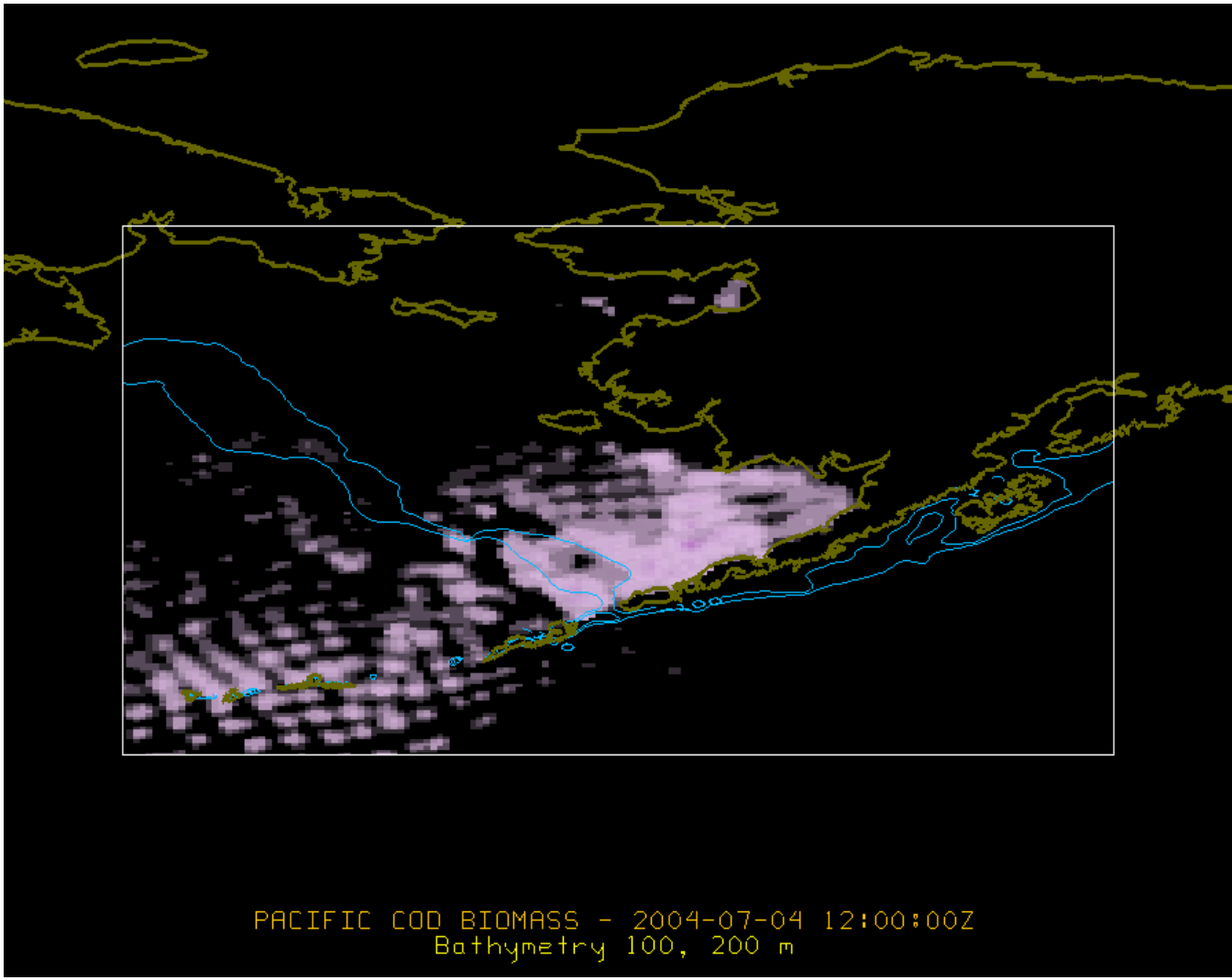




Pacific Cod

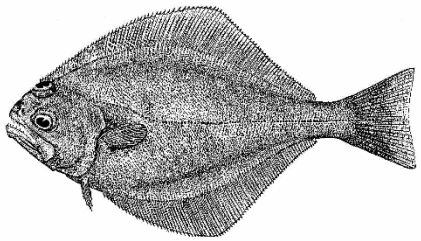
July 2004

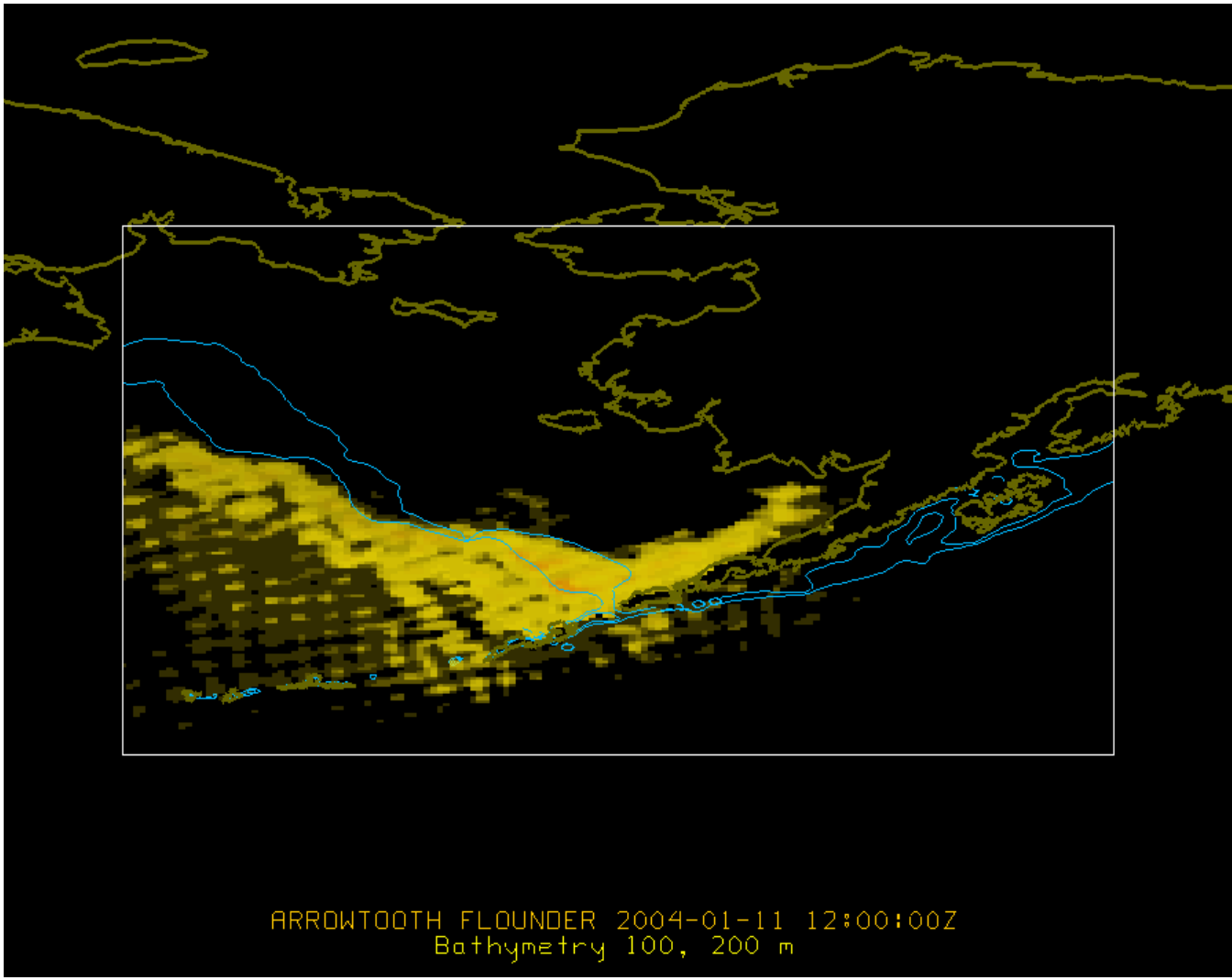


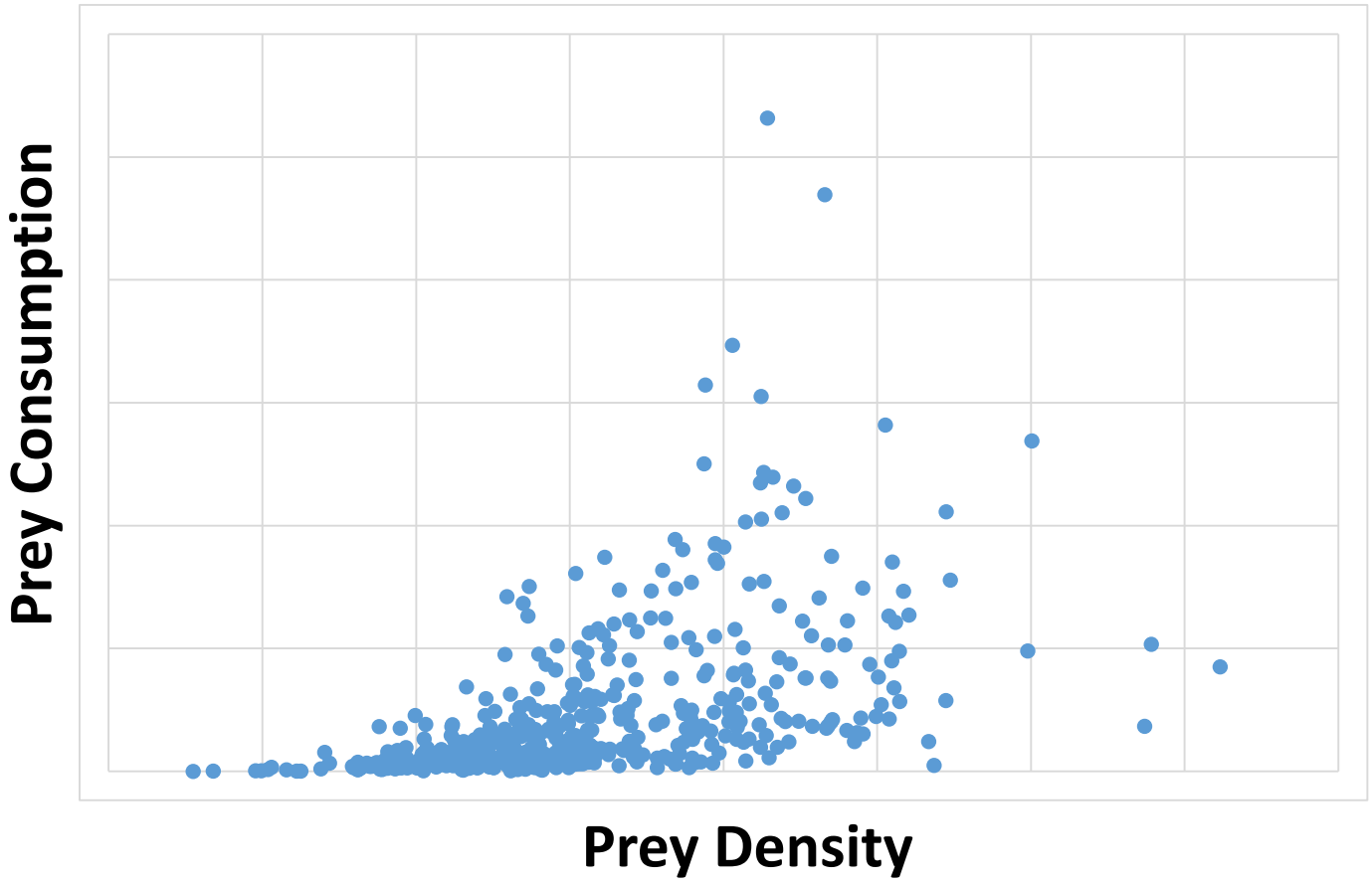


Arrowtooth Flounder

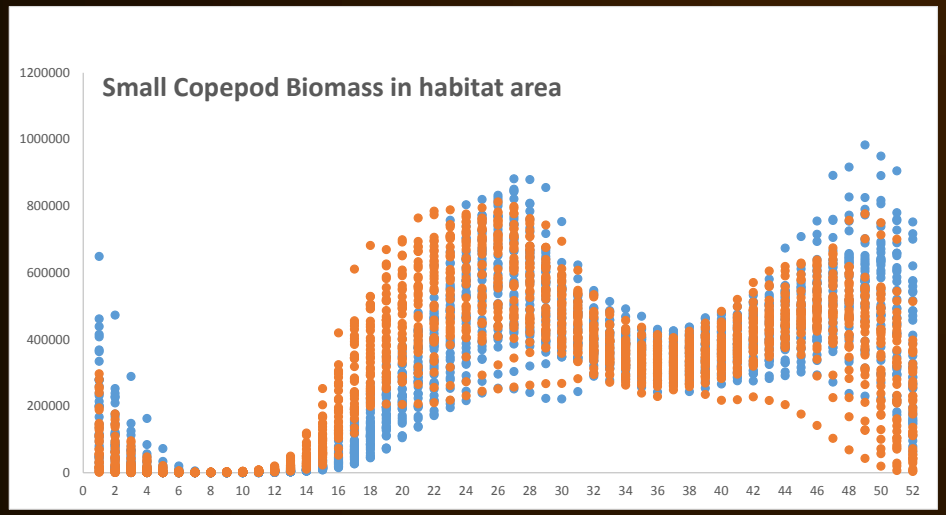
July 2004

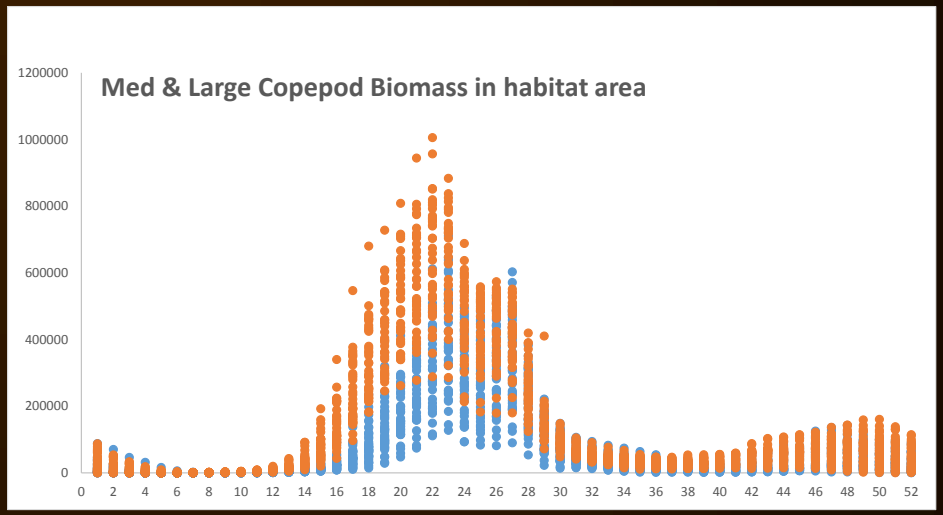





Prey Consumption
Prey Density

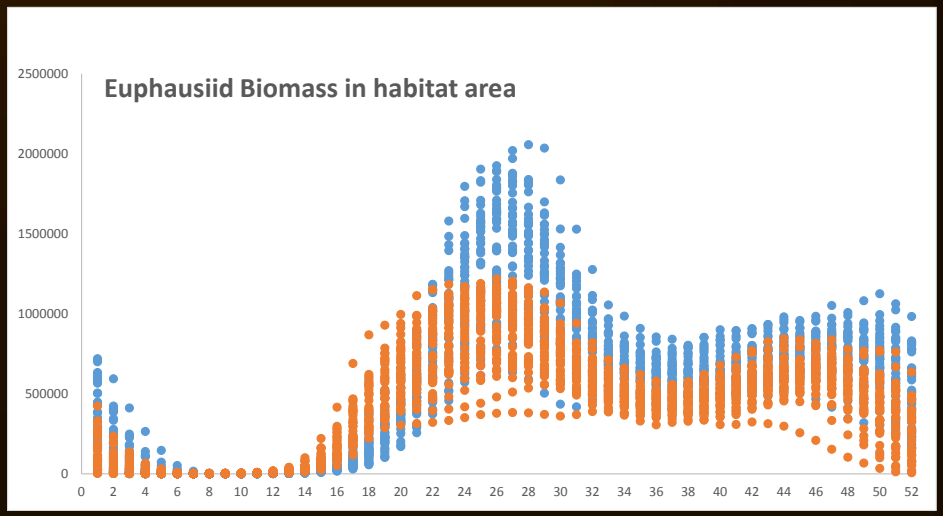
Seasonal cycle: coupled versus uncoupled



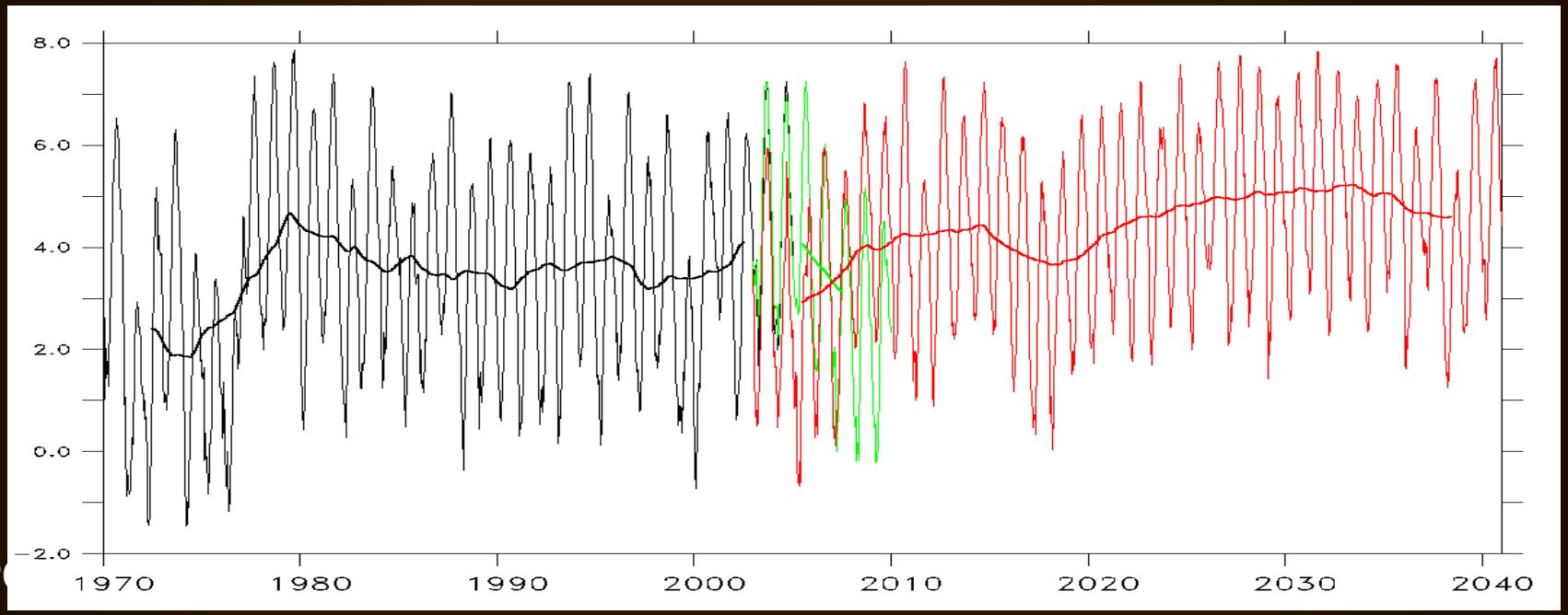


NPZ ——> Fish

NPZ <——> Fish



Results Examined



Original plan

Hindcast (1970-2005)

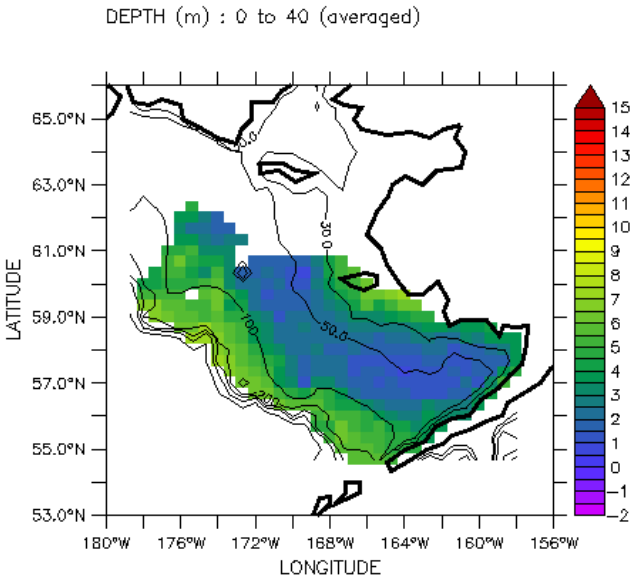
Forecast (2005-2039)

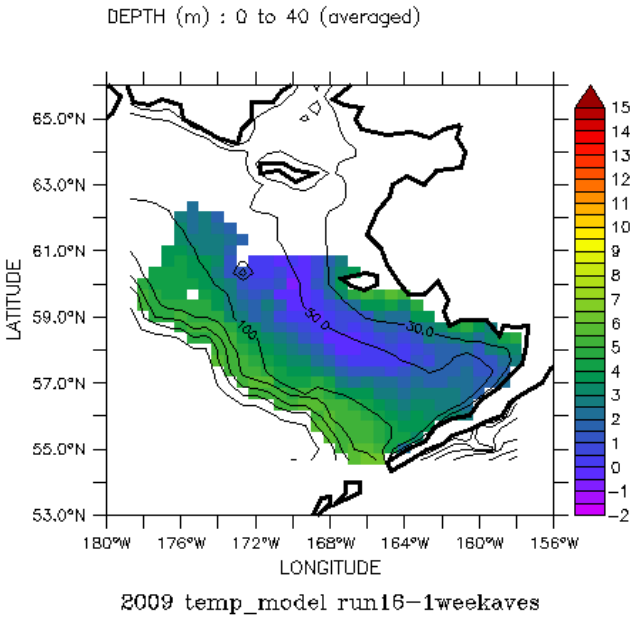
Realized results

Hindcast + field years (1970-2010)

Forecast NPZ only (2005-2039)

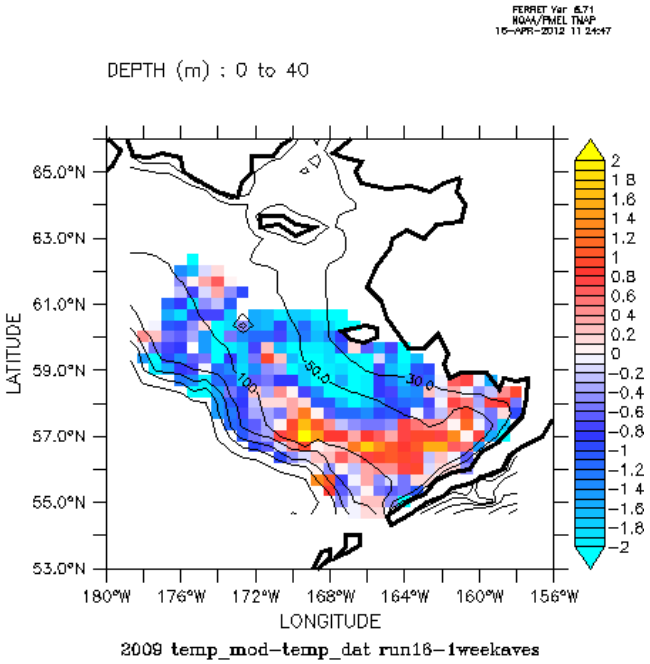
Modeled water temperature results



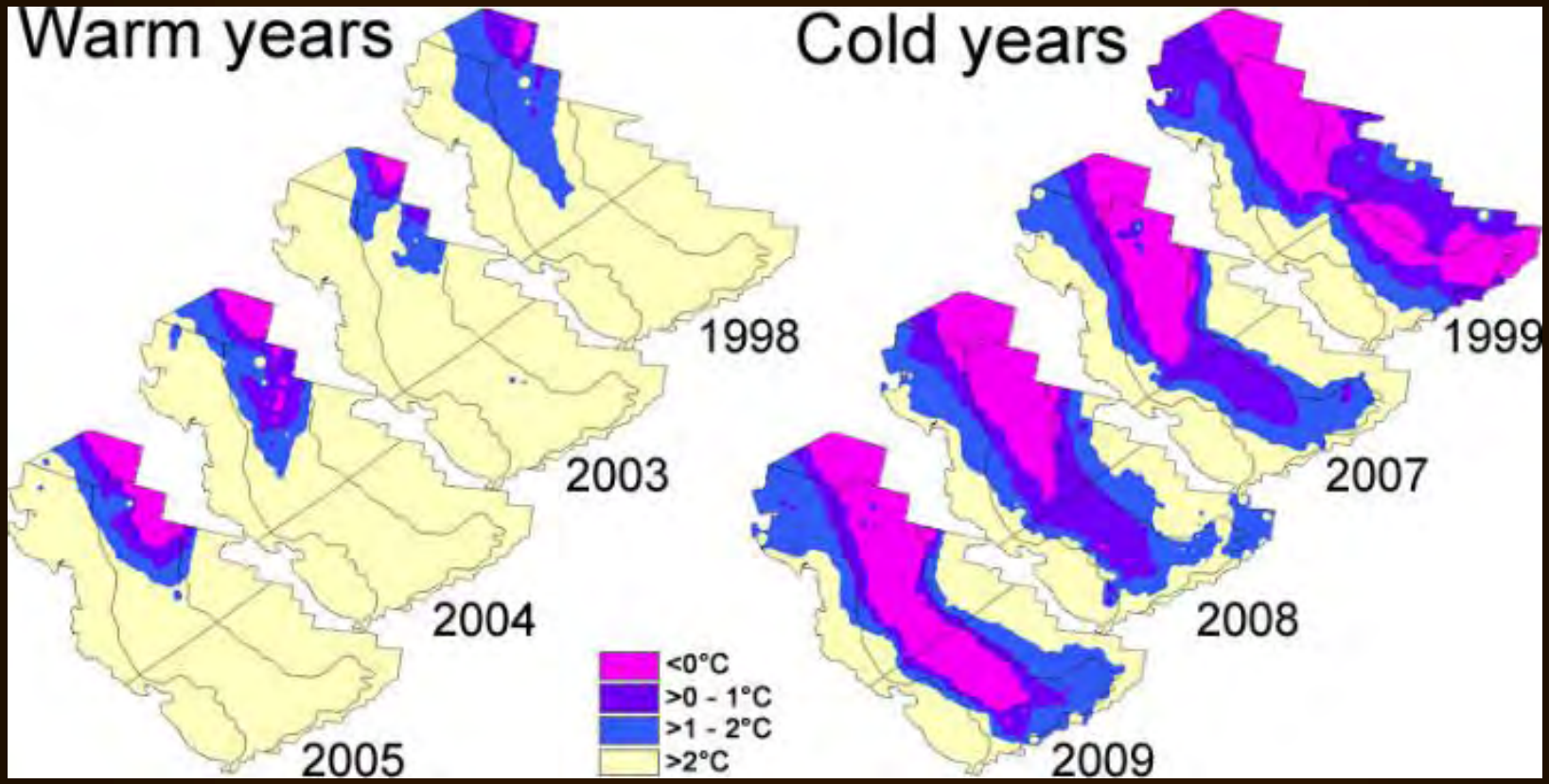


Measured 2009 summer groundfish survey 0-4m water temperature (top left) and ROMS modeled survey temperature (top right), data-model anomalies (bottom).

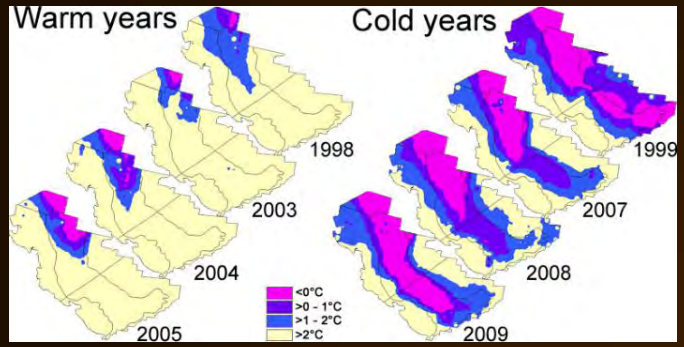
While there is still a pattern in the resulting anomalies, the overall mean water temperature anomaly is very near zero.

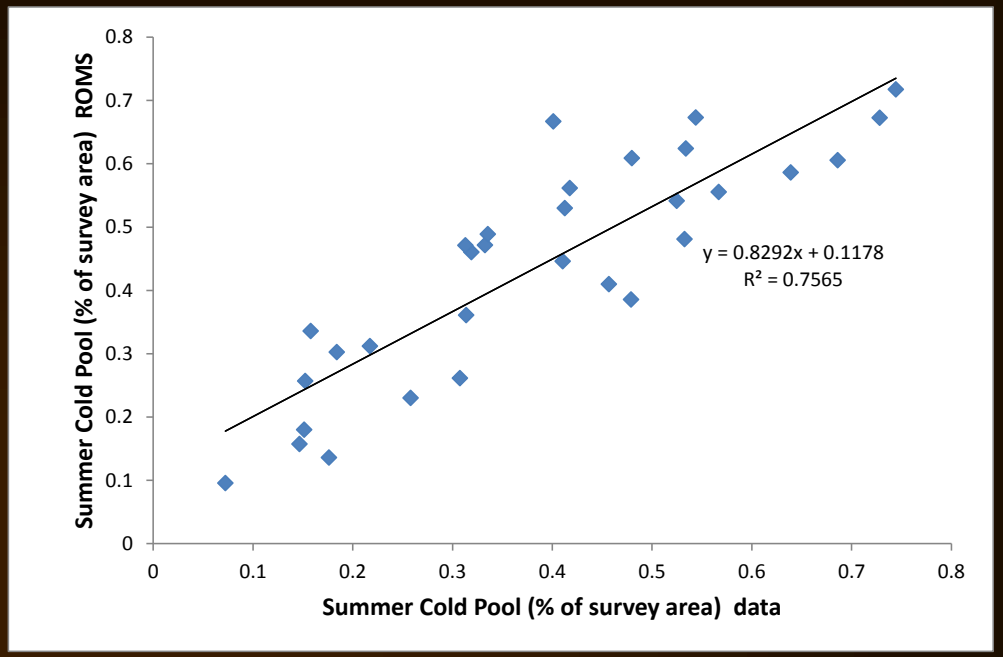


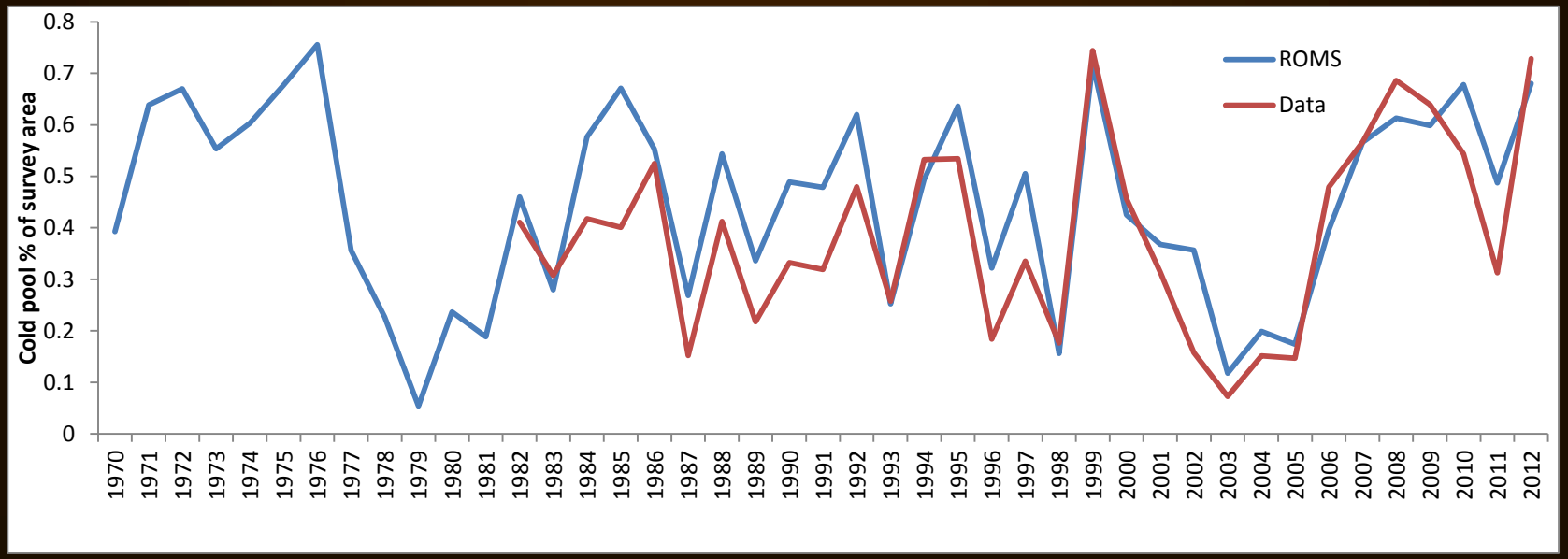
Focus on dynamic habitat (e.g. Barbeaux, Spencer et al.)



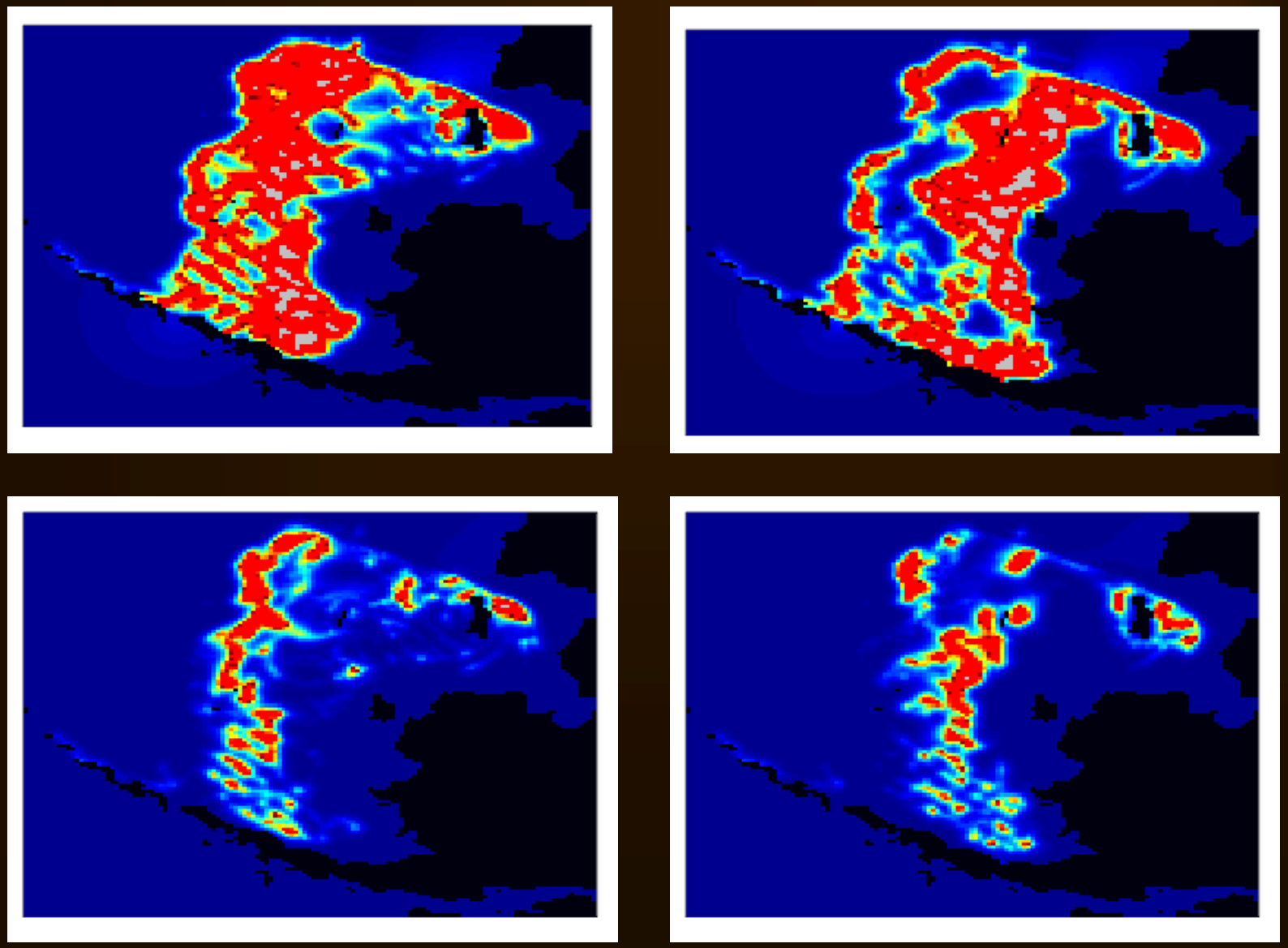
Focus on dynamic habitat (e.g. Barbeaux, Spencer et al.)



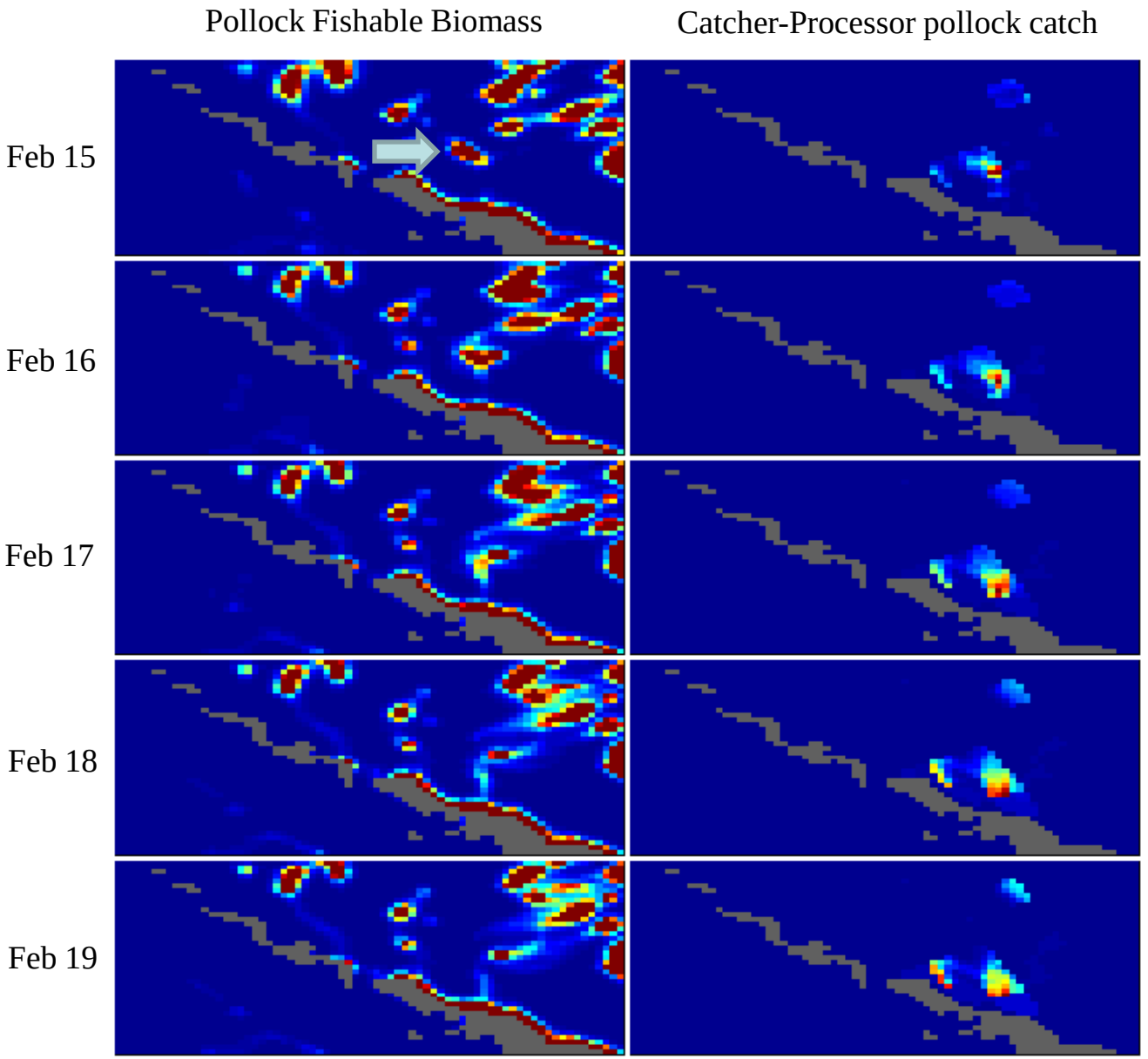




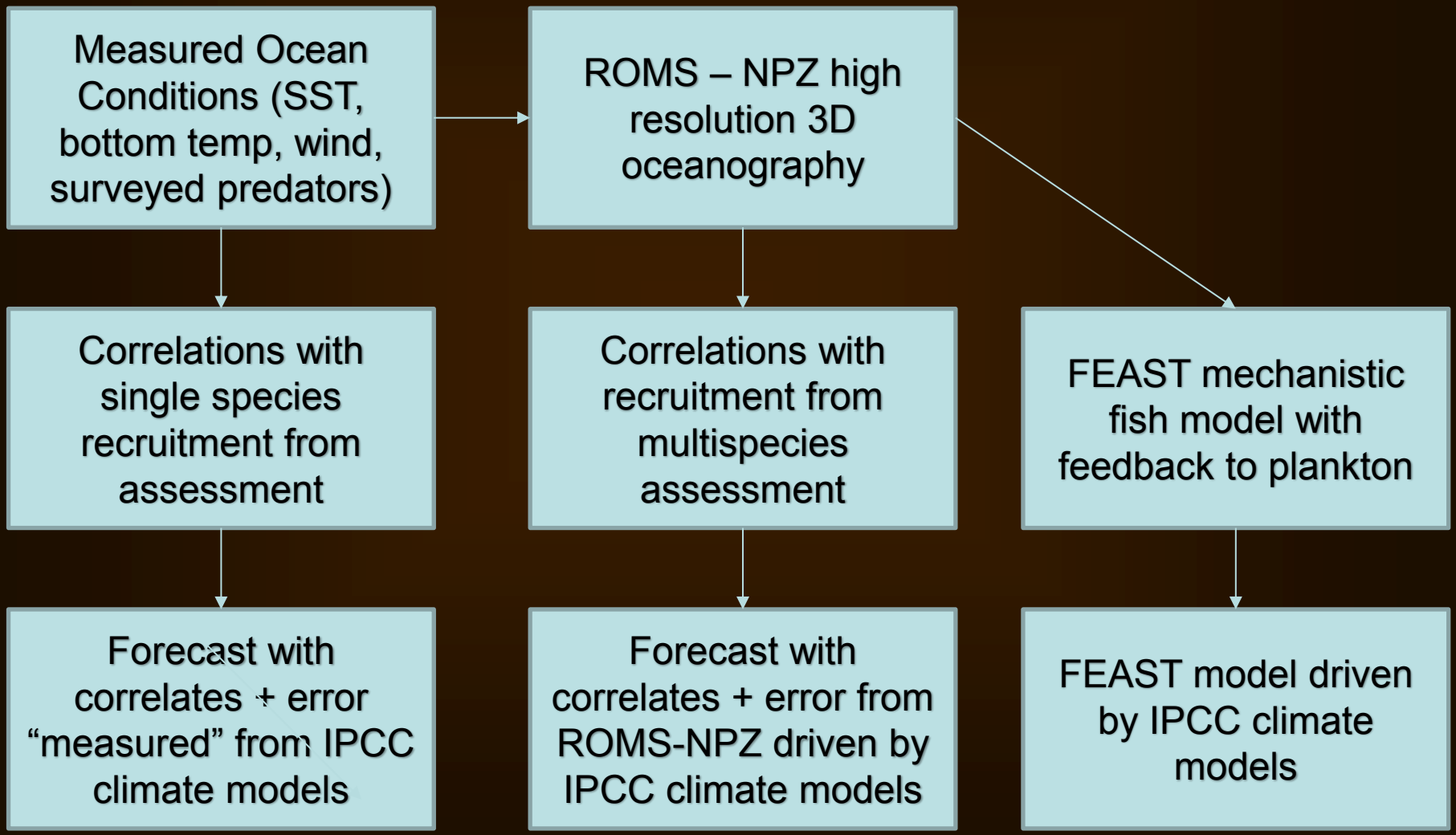
Age 3+ pollock biomass distribution



Modeling fish and fisheries catch



Note: *Catch and Biomass color scales differ by orders of magnitude.*

- **Strengths**
  - Functional responses emergent, tied to mechanisms to expand beyond range of current correlations
  - Tied to explicit, dominant physical processes
  - Considerable advances in modeling ice dynamics and ice-related productivity
  - Will predict fisher responses on a community level
- **Issues**
  - It's a big, big model
    - Computationally challenging (for a fisheries model)
    - Needs lots of parameters
    - Still needs considerable data comparison

“Competing” methods for recruitment examination