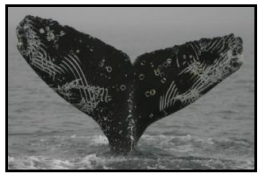
Bering Sea Highlights

Bering Sea Integrated Ecosystem Research Program 2007-2013

Francis Wiese
Science Director
North Pacific Research Board

Integration

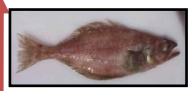
Humans

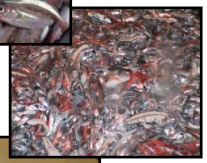


Humpback and fin whales

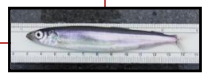
Commercial/subsistence fish: Pollock, cod, arrowtooth flounder

Kittiwakes and murres, fur seals, walrus



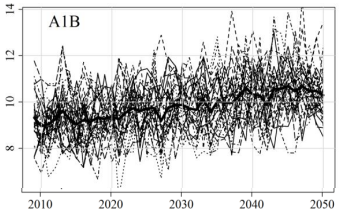


Forage species: Juvenile pollock, capelin, myctophids



NPZ: Ichthyoplankton, euphausiids, copepods, phytoplankton

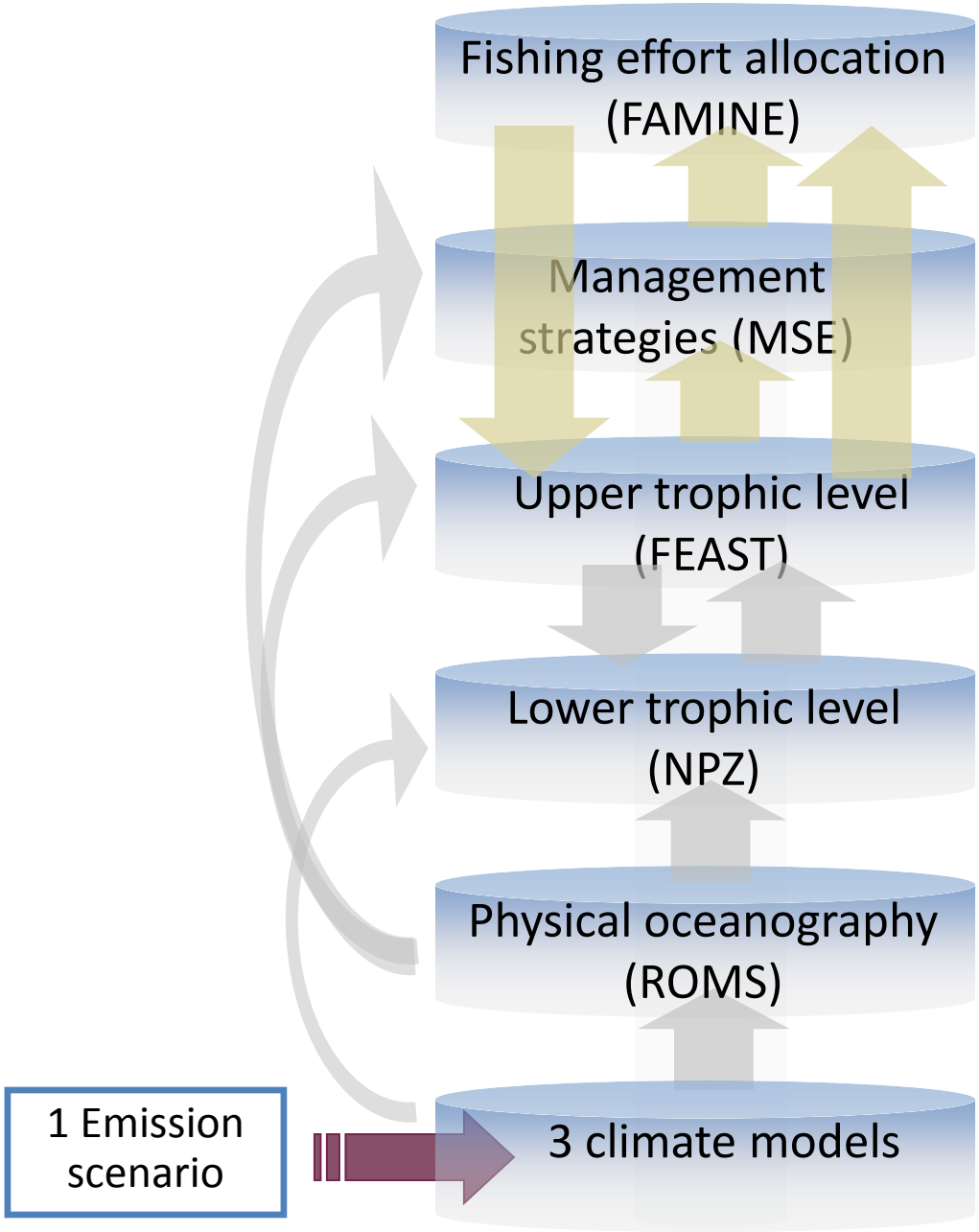
Infauna: Bivalves, gastropods, polychaetes



Atmosphere/ocean

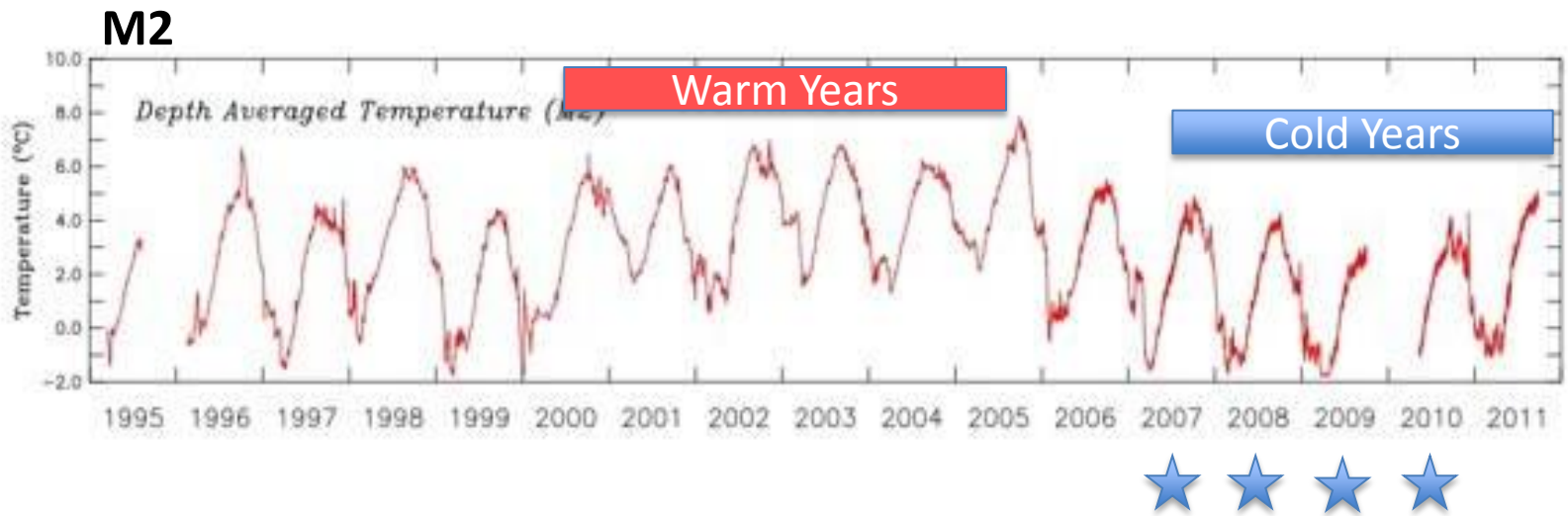
Climate Scenarios

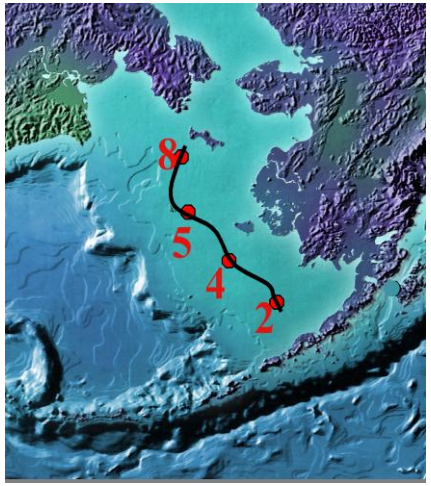
Vertically-Integrated, Coupled Ecosystem Model



Harvest Surveys and Ethnographic Interviews

A Still Very Cold Bering Sea

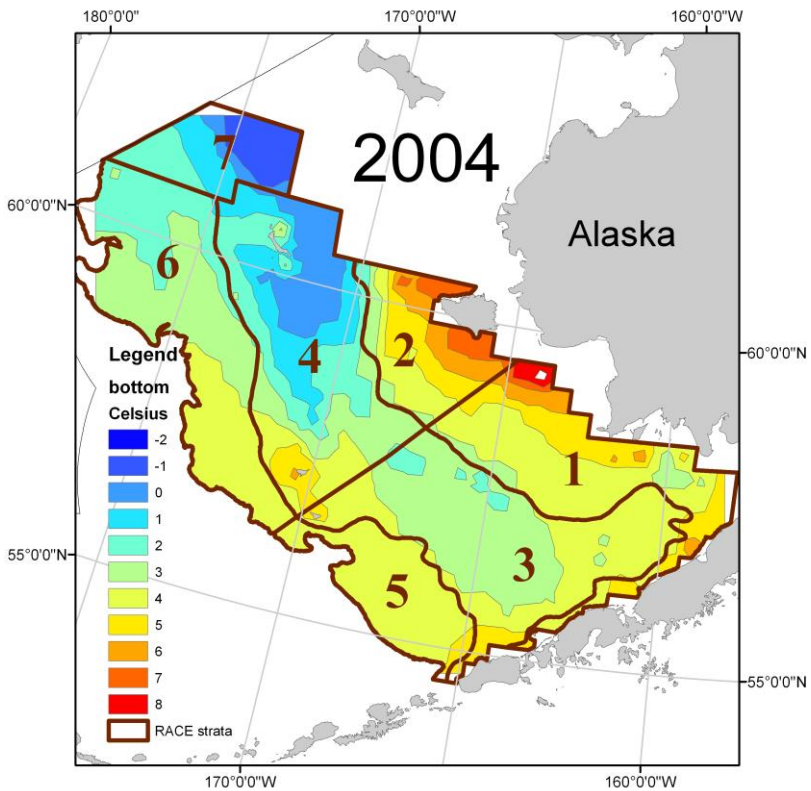




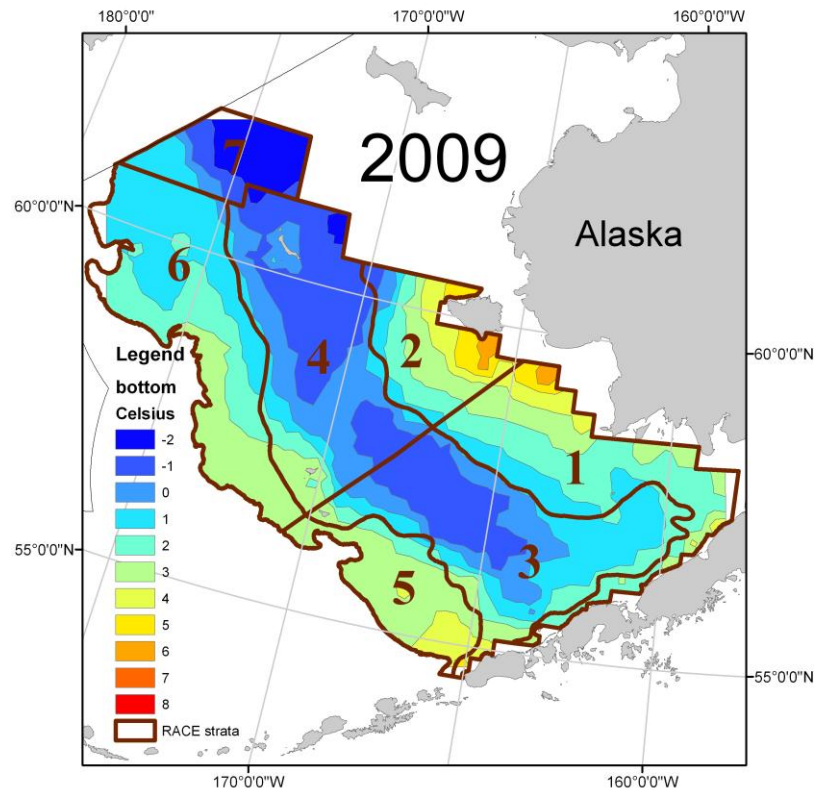
Stabeno

The Cold Pool Extends Farther South in Cold Years

Warm



Cold

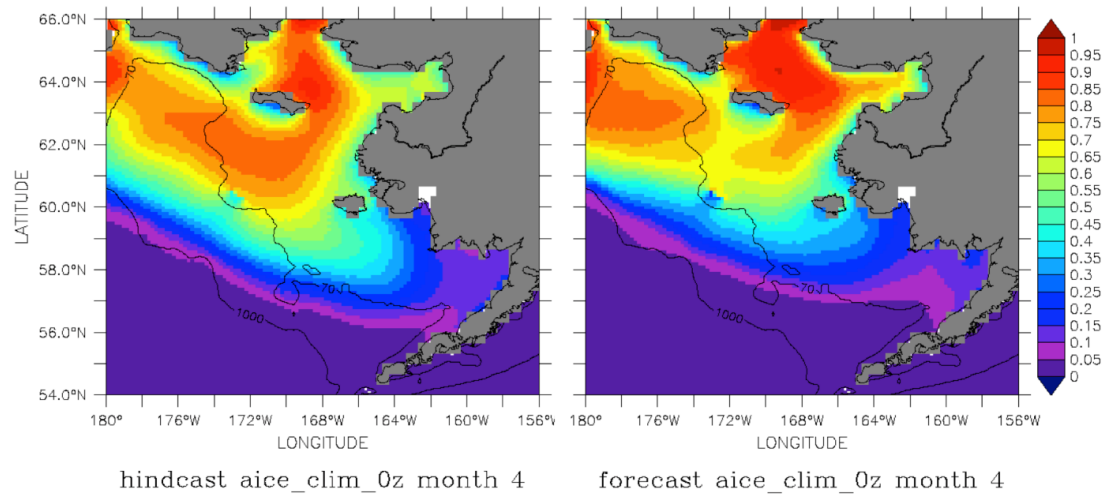


Hollowed

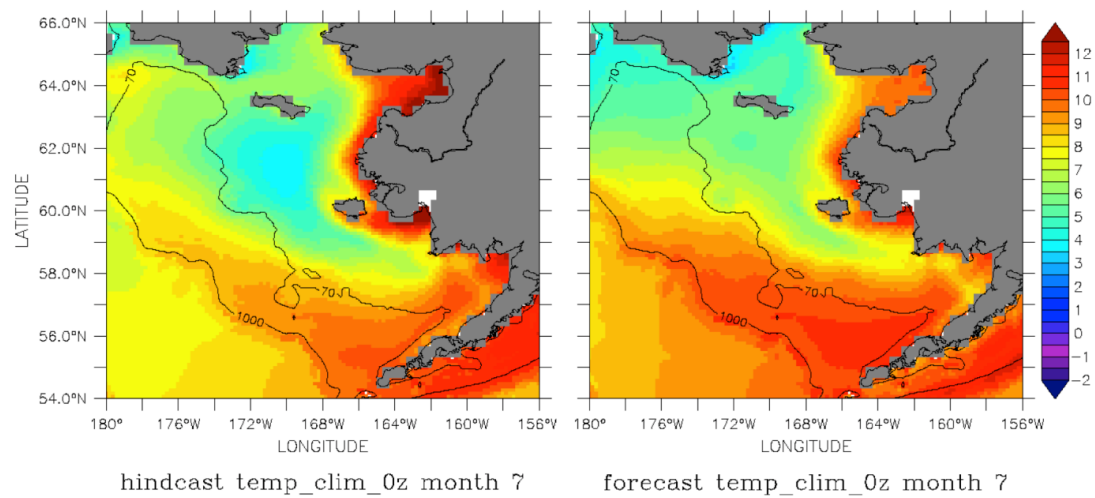
ROMS Model: Predicts that the Northern Bering Sea will Remain Cold

hindcast (1970-2004) **forecast (2020-2040)**

April Ice Cover (fraction)

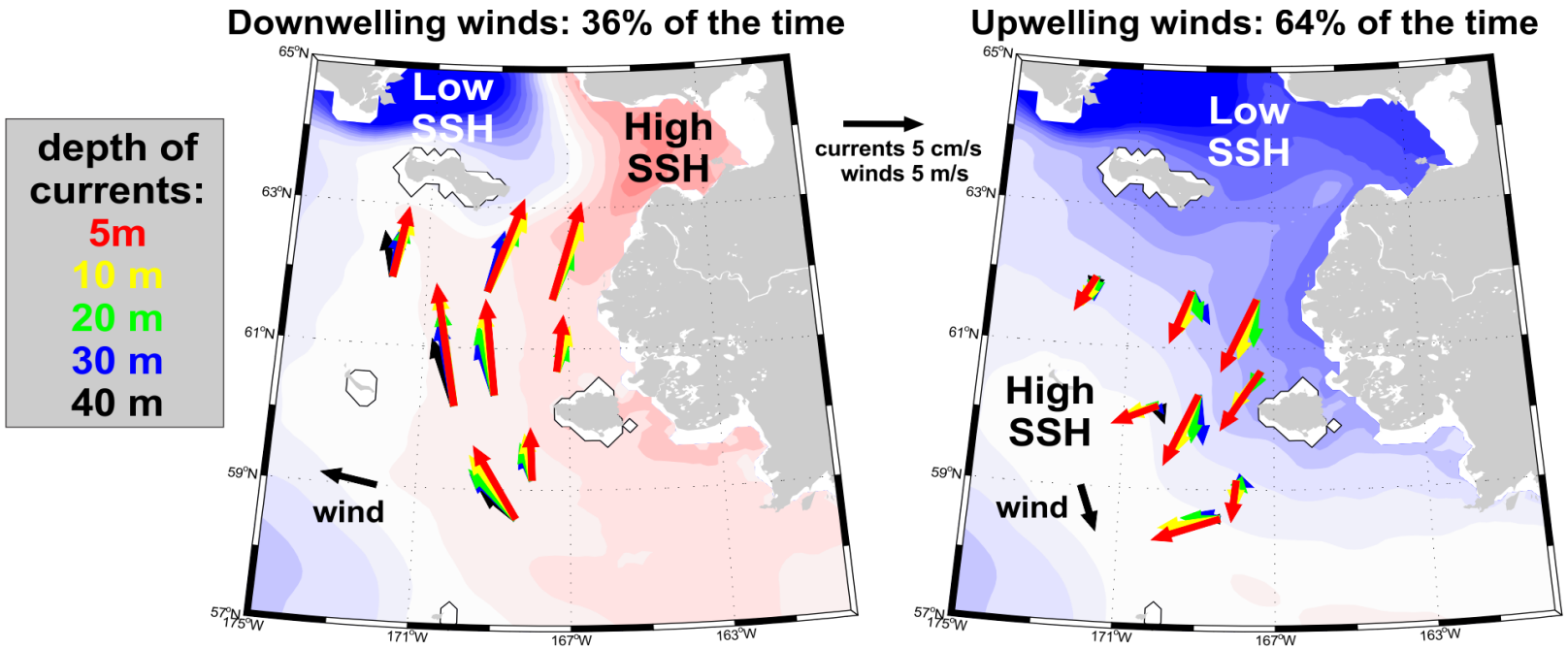


July SST (° C)



Hermann & Gibson

Surprisingly, Upwelling Winds Were Prevalent (64%) Producing Southerly Rather Than Northerly Flow



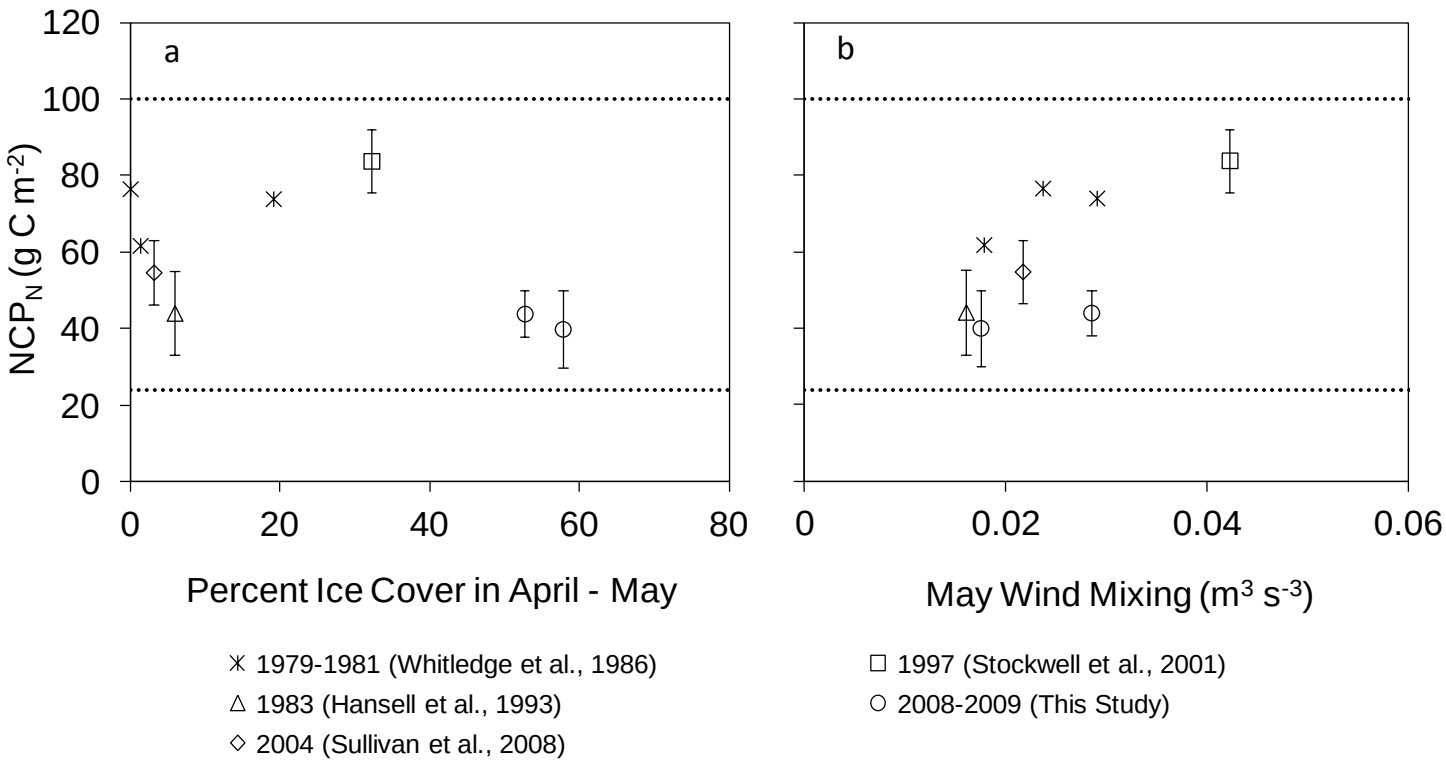
- Between July 2008 and July 2010, coastal upwelling conditions were prevalent (64%).

- Currents are sensitive to the **wind direction**: a 90° shift from southward to westward winds changes the system from strong upwelling to strong downwelling conditions.

- Wind direction is determined by the location of Aleutian Low, which also drives changes in ice extent, air temperatures and precipitation.

Sea surface height (SSH) contours from BESTMAS model (Zhang & Woodgate)
Current meter vectors from moorings (Danielson, Weingartner, Aagaard)

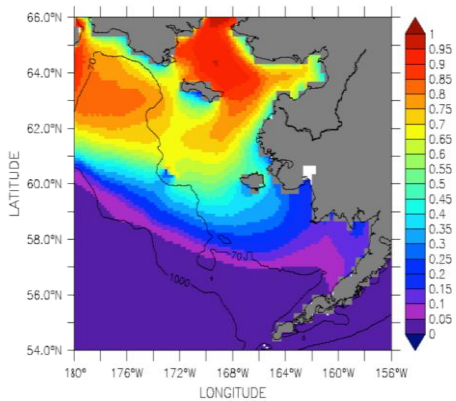
Wind Induced Mixing (Not Ice or Stratification) is Associated with Elevated Net Community Production at M2

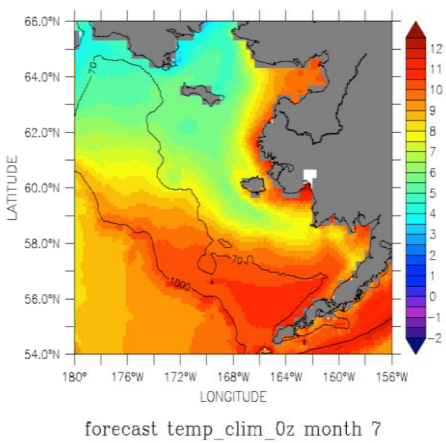


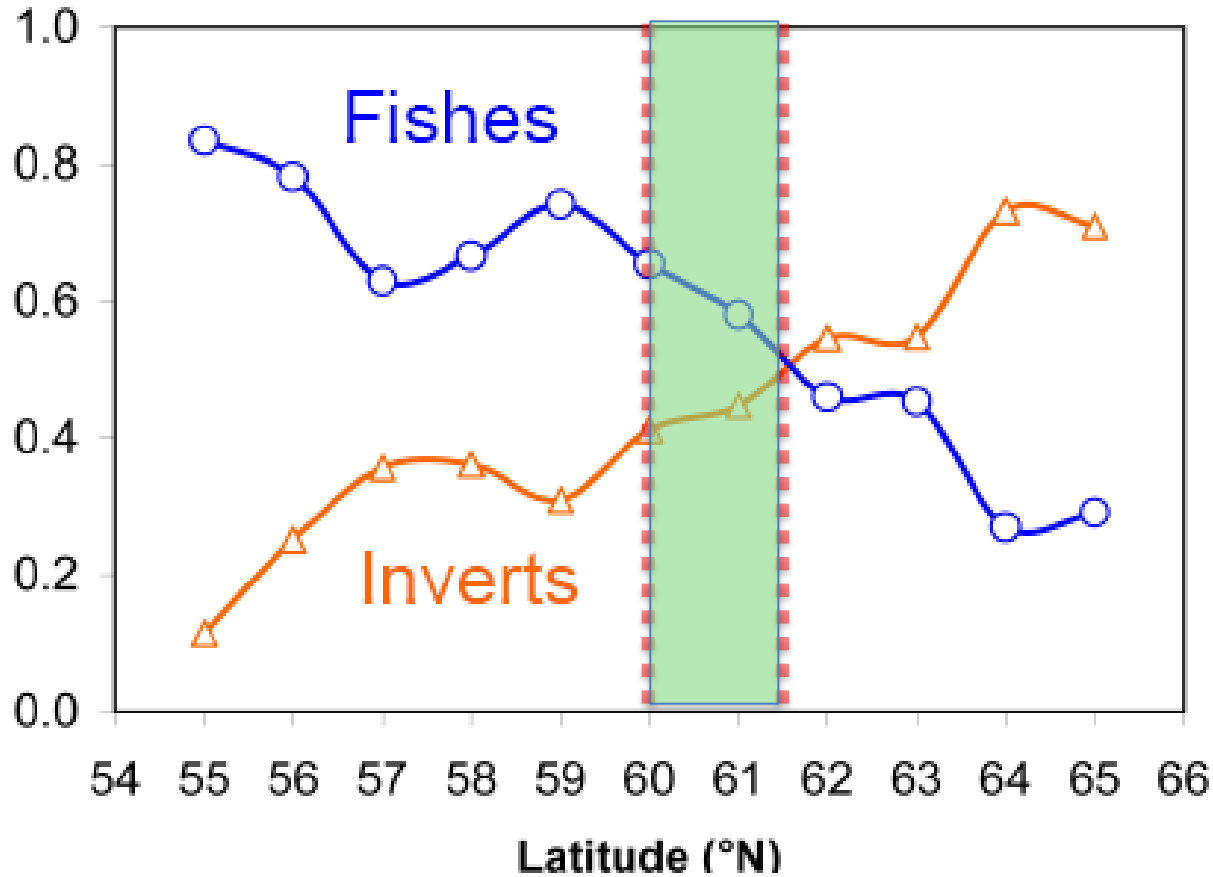
- Variability in NCP not controlled by ice cover (left) or stratification (Ladd and Stabeno, in press).
- Higher values of NCP were associated with stronger wind mixing events (right), supporting Sambrotto et al. (1986).

Mordy et al., in press

Fish and Epi-benthic Communities Change as a Function of Latitude

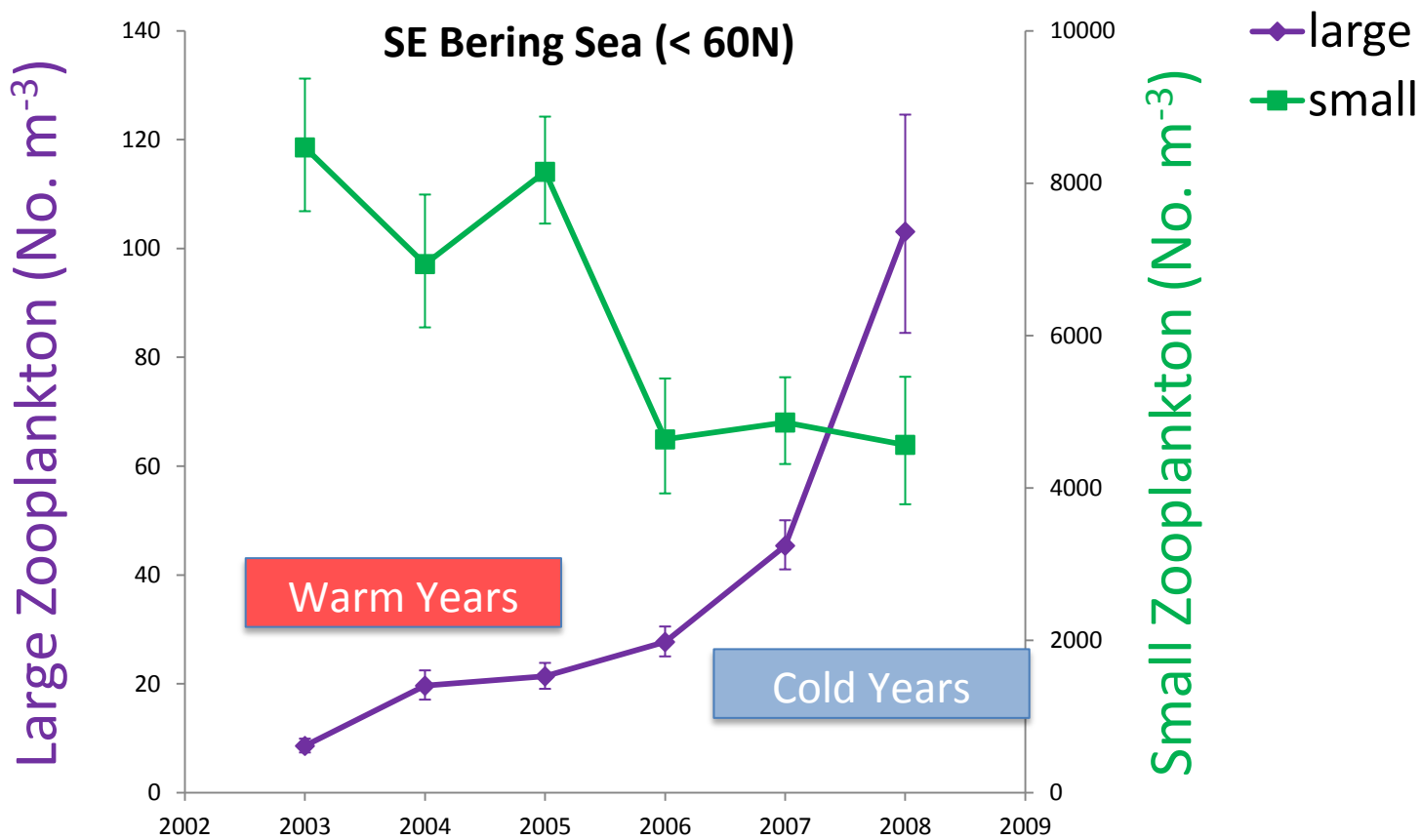






Stevenson and Lauth, in press

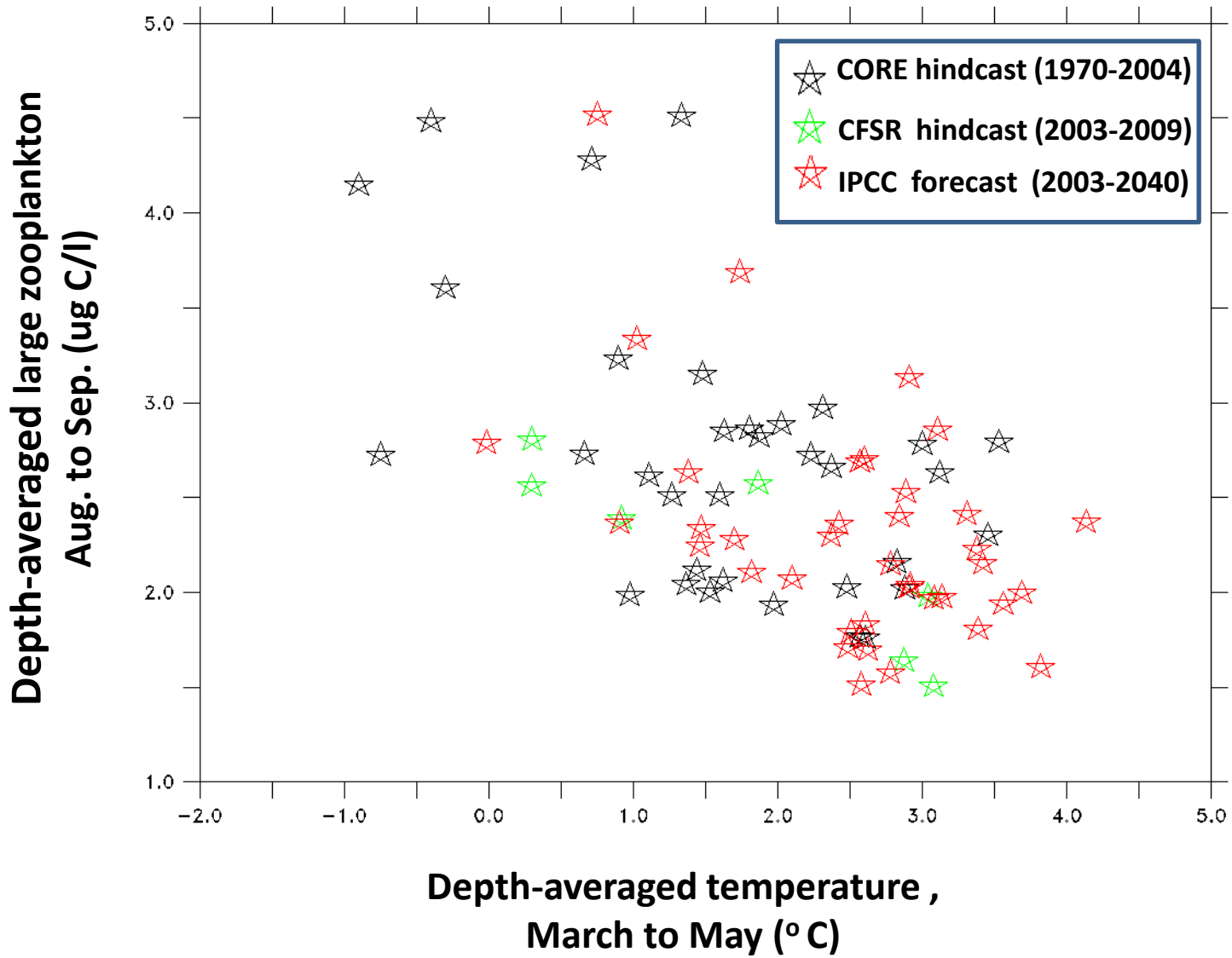
Large Zooplankton Increased in Cold Years



North: Biomass of large fraction tripled in 2007 (*E. bungii*, *P. elegans*, *Calanus* spp.)
South : Biomass of large fraction doubled in 2008 (*Calanus* spp., *P. elegans*, *E. indicans)*

L. Eisner

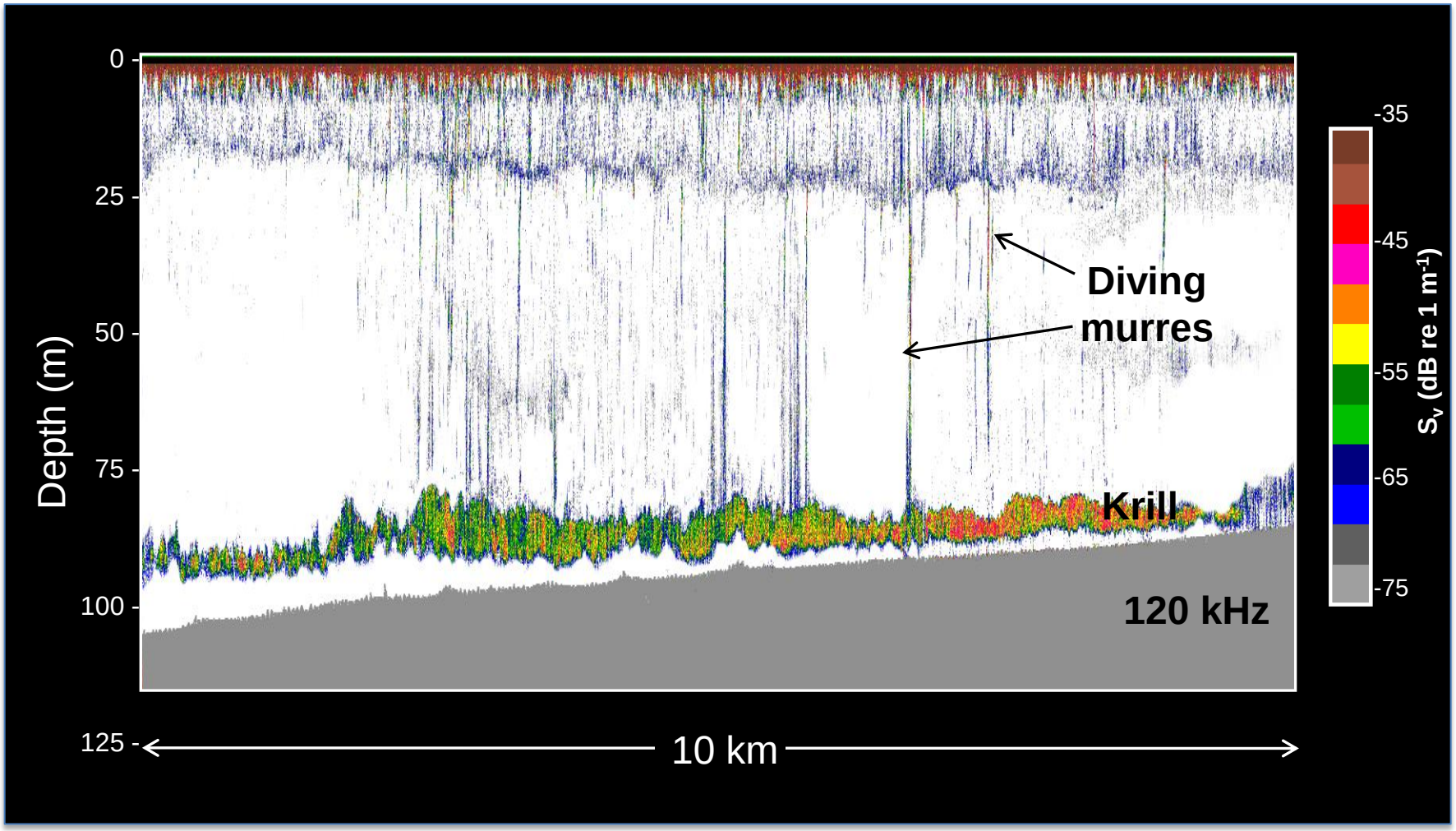
Model Replicates Observation: More Large Crustacean Zooplankton in Cold Years



Gibson & Hermann

Murres Select Krill by *Patch Density* and *Vertical Accessibility*

Not Patch Size, Krill Abundance, or Biomass



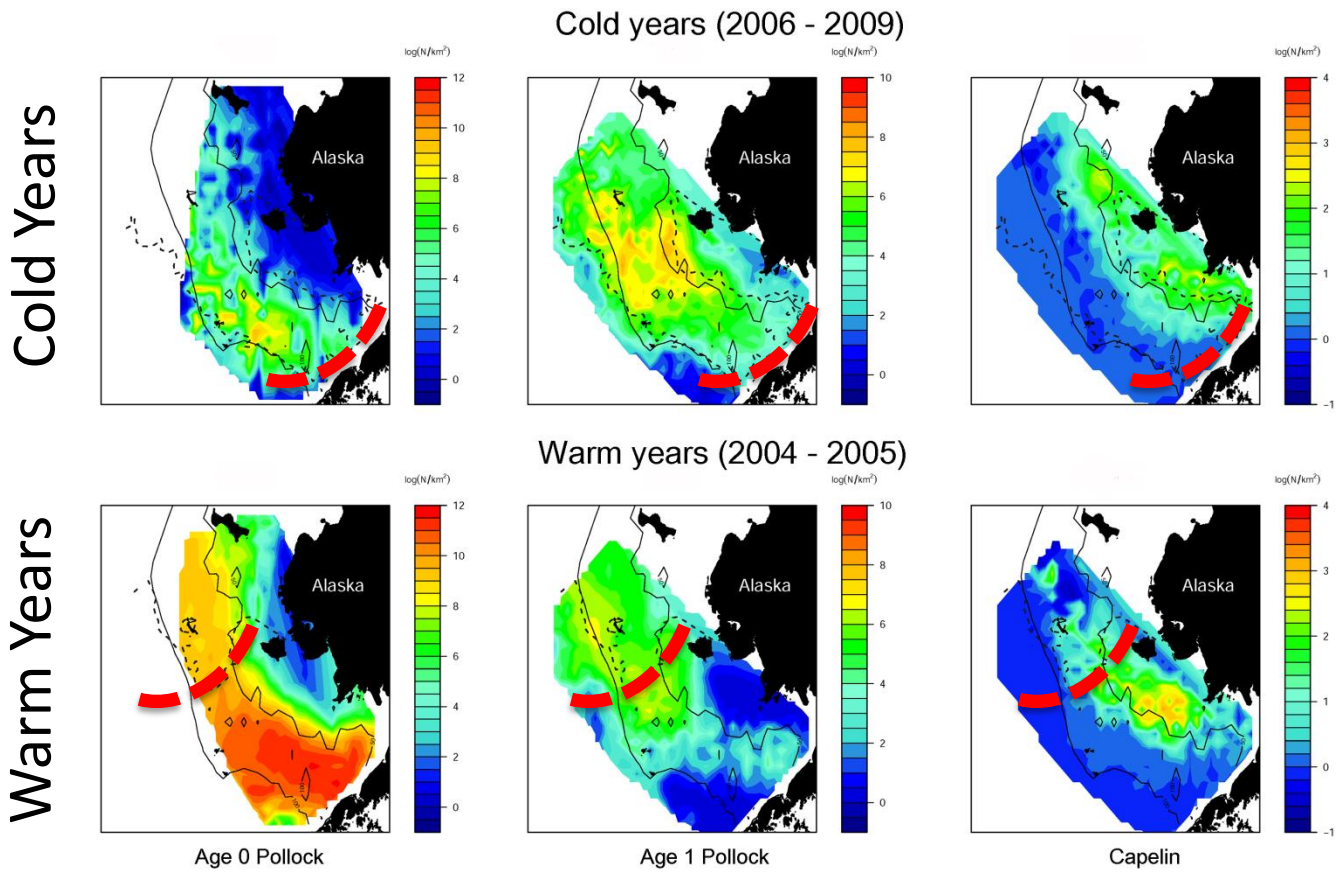
Benoit-Bird et al., 2011, MEPS

Temperature Determines the Spatial Pattern of Forage Fish

Predicted spatial surfaces of fish density from General Additive Models

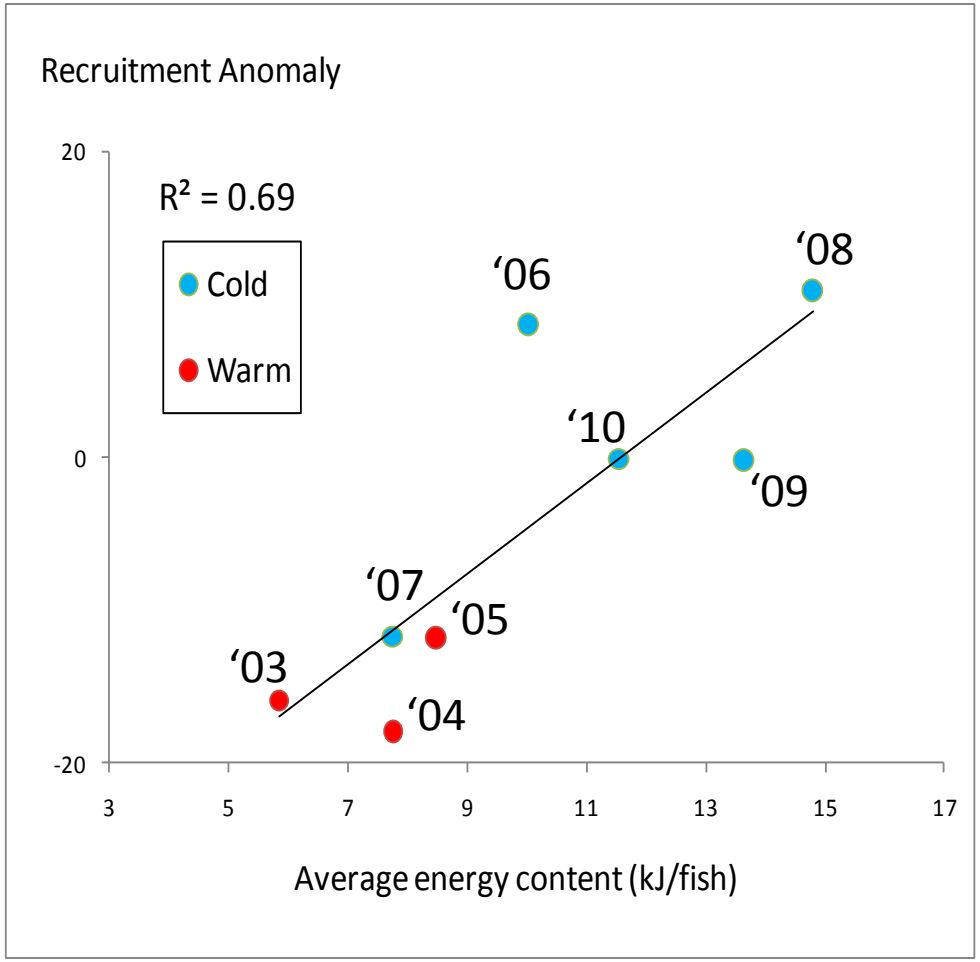
2 °C isotherm,

solid lines are 50m and 100m isobaths.



Hollowed et al., in press

Pollock (to Age-1) Have Higher Energy Content And Recruitment in Cold Years



- Diets in cold years are high in lipid
  → more energy stored before winter.
  → high energy content before winter increases survival.

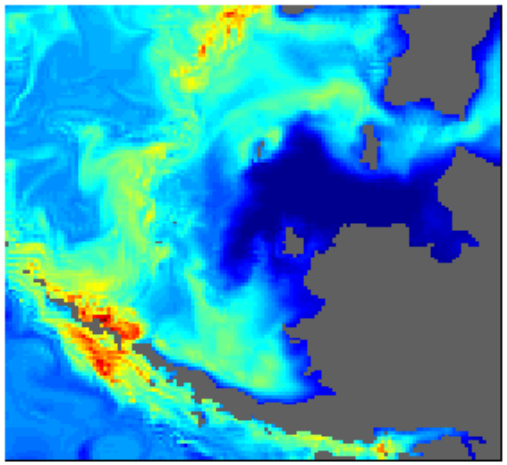
- Juveniles have a short critical period for lipid storage (Siddon et al.)

Heintz et al., in prep

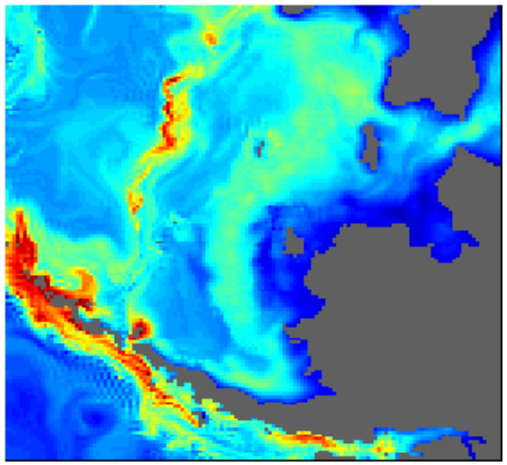
The Distribution of Foraging Hotspots for Pollock Change

Food supply for age-0 pollock

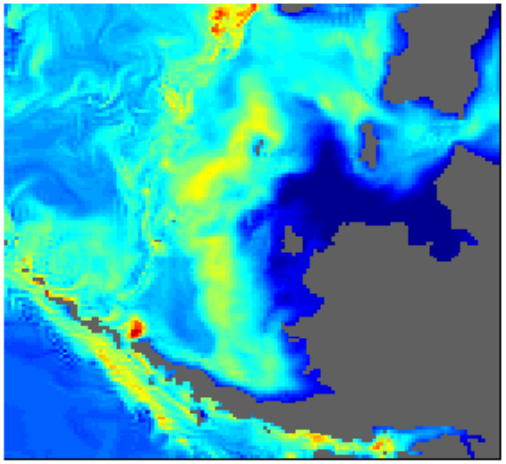
July 1975 (cold)



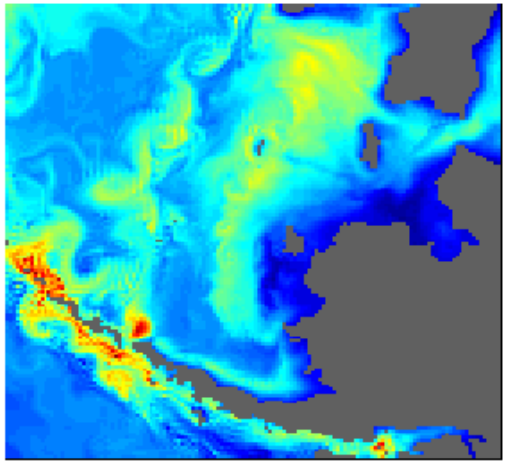
July 2004 (warm)



July 2008 (cold)



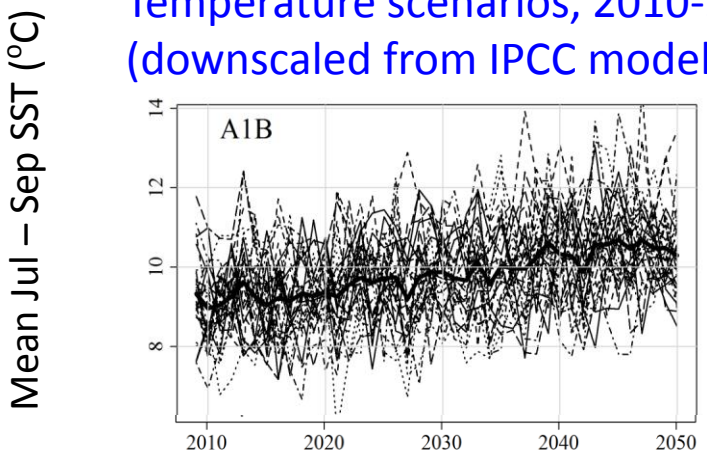
July 2040 (warm)



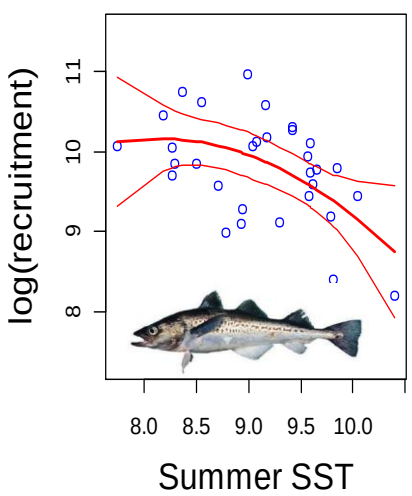
Aydin et al.

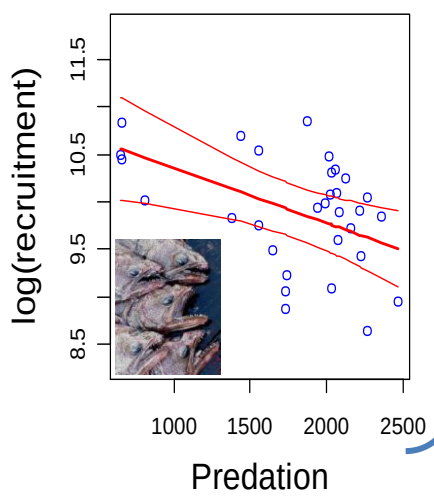
Pollock Recruitment Will Decline With Increased Temperatures

Temperature scenarios, 2010-2050 (downscaled from IPCC models)

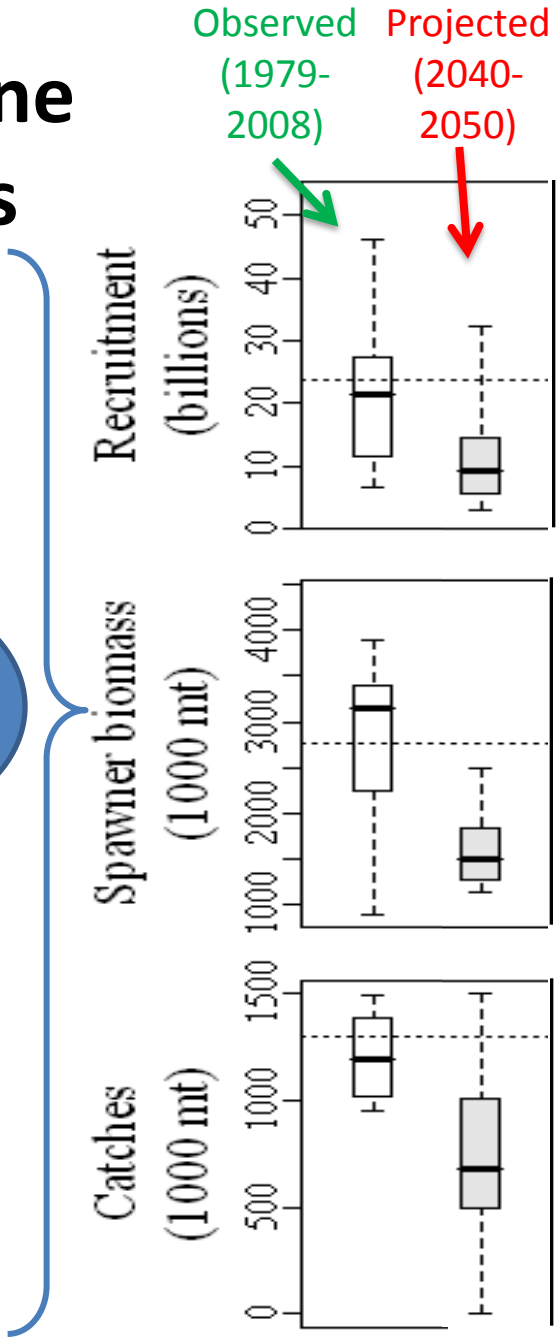


Estimated effects of SST & predation on recruitment





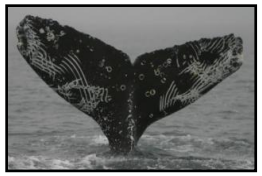
Projection model



Mueter et al (2011, ICES JMS)

Integration

Humans



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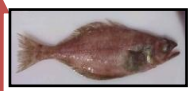
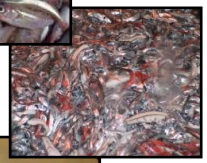
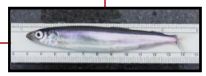




Forage species: Juvenile pollock, capelin, myctophids



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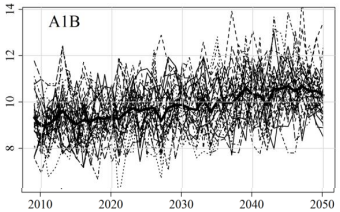
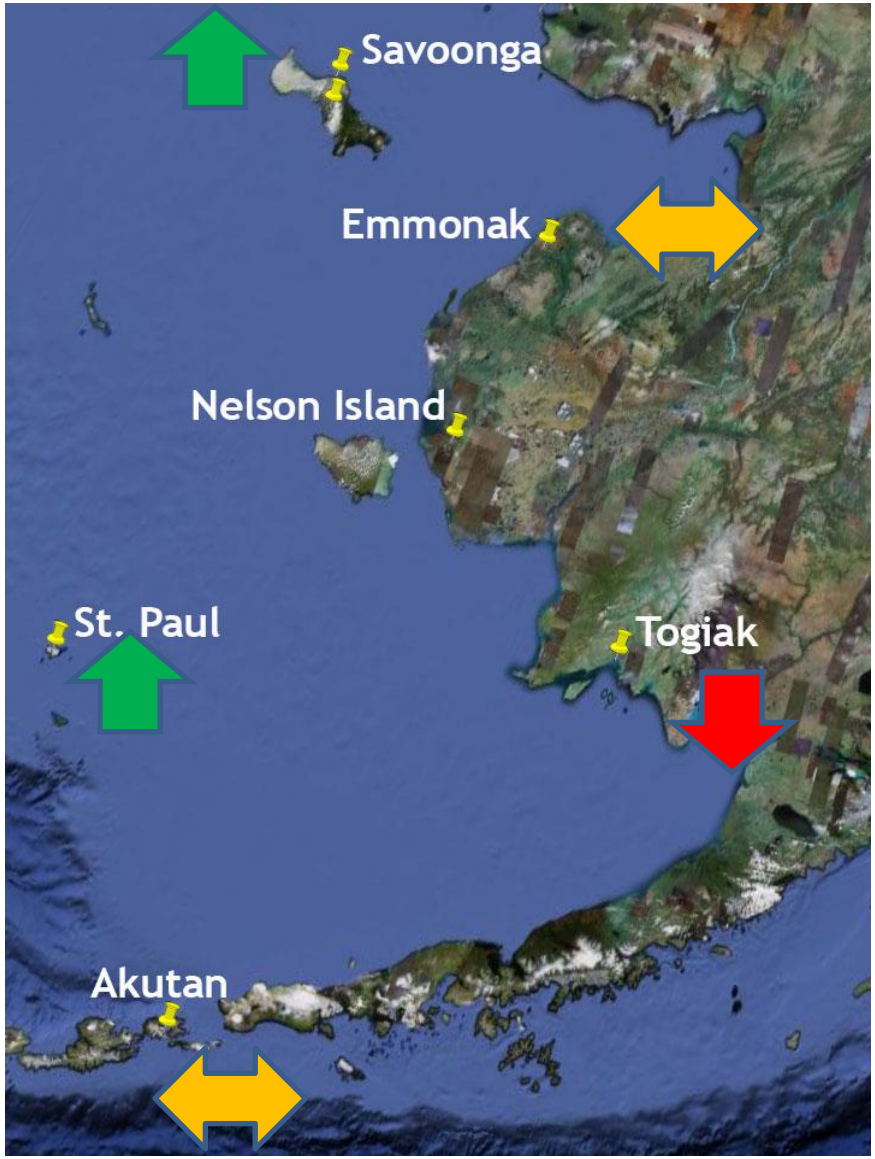


Atmosphere/ocean

Climate Scenarios

People have a Regional Perception of their Ecosystems



Perceptions of the state of the ecosystem related to environmental health, subsistence production, etc. (i.e., may use different metrics in different communities)

•Savoonga: ecosystem healthy, hunting is good

•Emmonak: many changes, king salmon issues are a major concern

•Togiak: most species in decline (harvests less clear)

•St. Paul: environmental quality generally seen as good, stable

•Akutan: environment okay, some declines/changes

Huntington et al.

Changes relevant to the coast?

- Temperature changes
- Wind changes
- Ice changes
- Changes in ocean productivity
- Changes in communities