Oceanography, plankton and forage fish diet in the eastern Bering Sea: U.S. BASIS survey results 2002-2009

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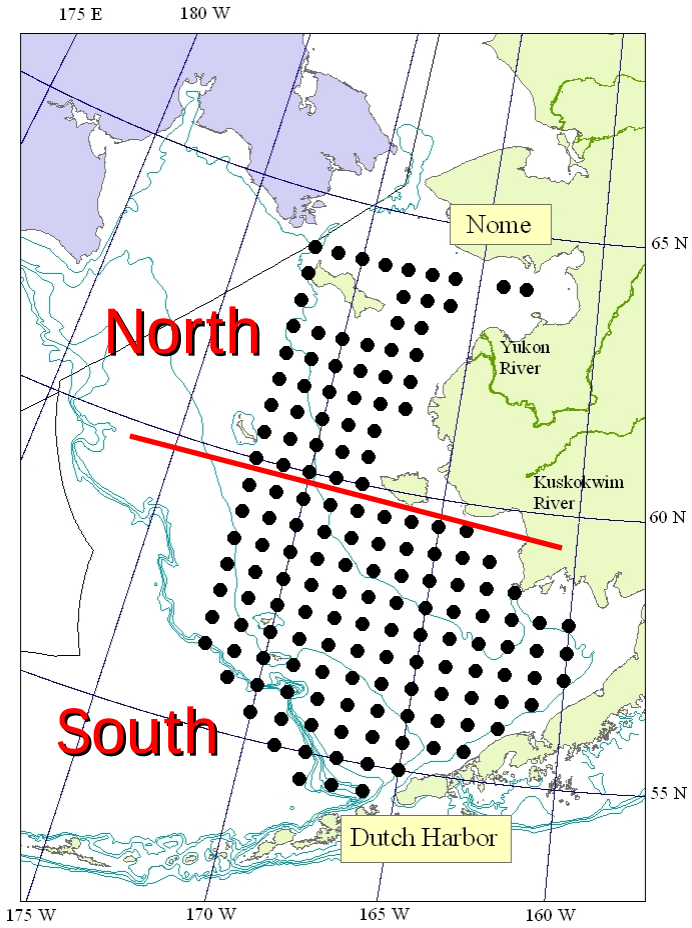
Alaska Fisheries Science Center
NATIONAL MARINE FISHERIES SERVICE

Methods



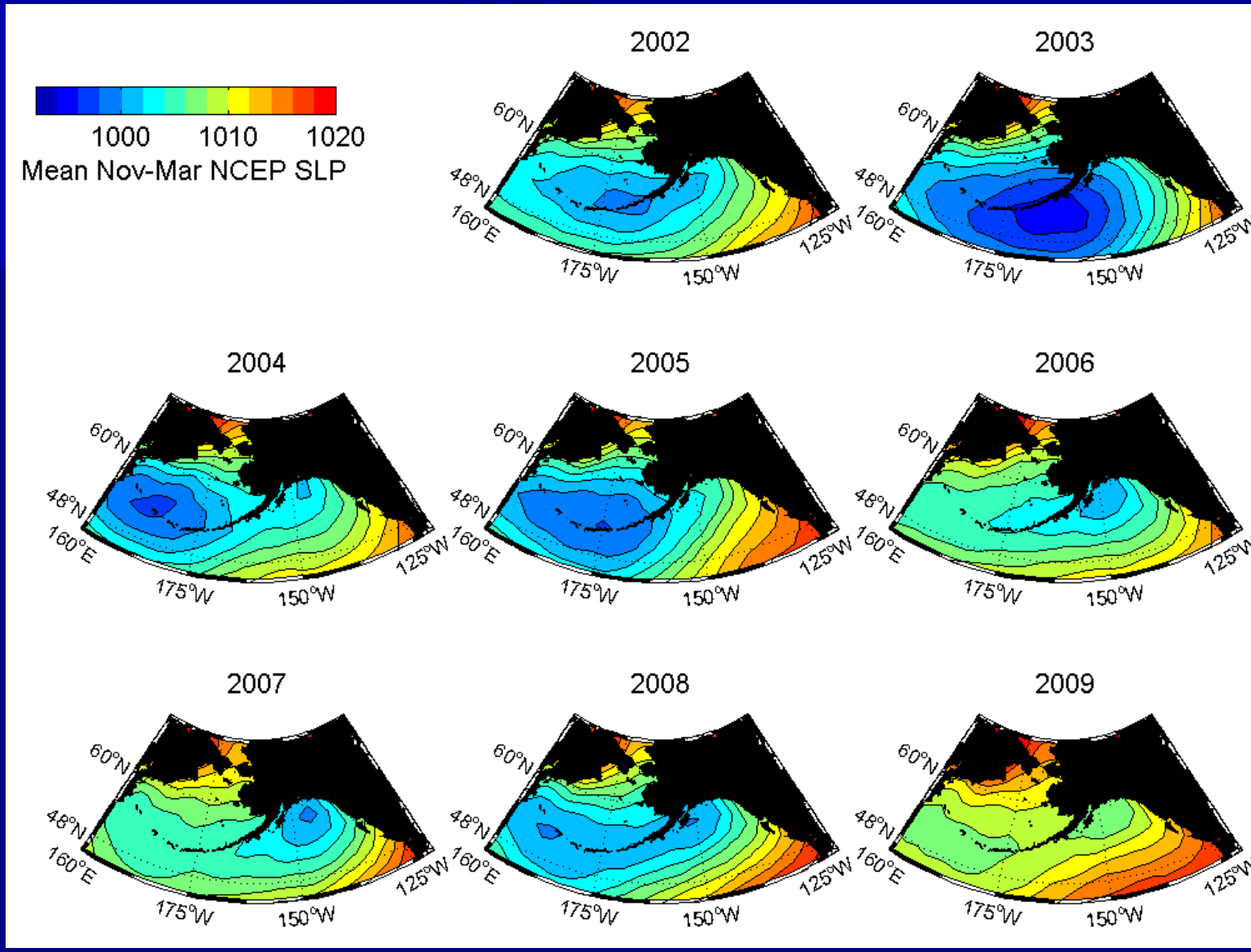
- 2002-2009
- Mid-Aug to early-Oct
- Oceanography
  - CTD
  - Nutrients
  - Chlorophyll a
- Zooplankton
  - Bongo oblique tow: 505 μm
  - Juday vertical tow: 163 μm (TINRO data)
- Forage fish (Juveniles)
  - Surface rope trawl (top 18 m)
  - Relative abundance
  - Diet (TINRO scientists)

F/V Sea Storm

R/V Dyson

Sea level Pressure

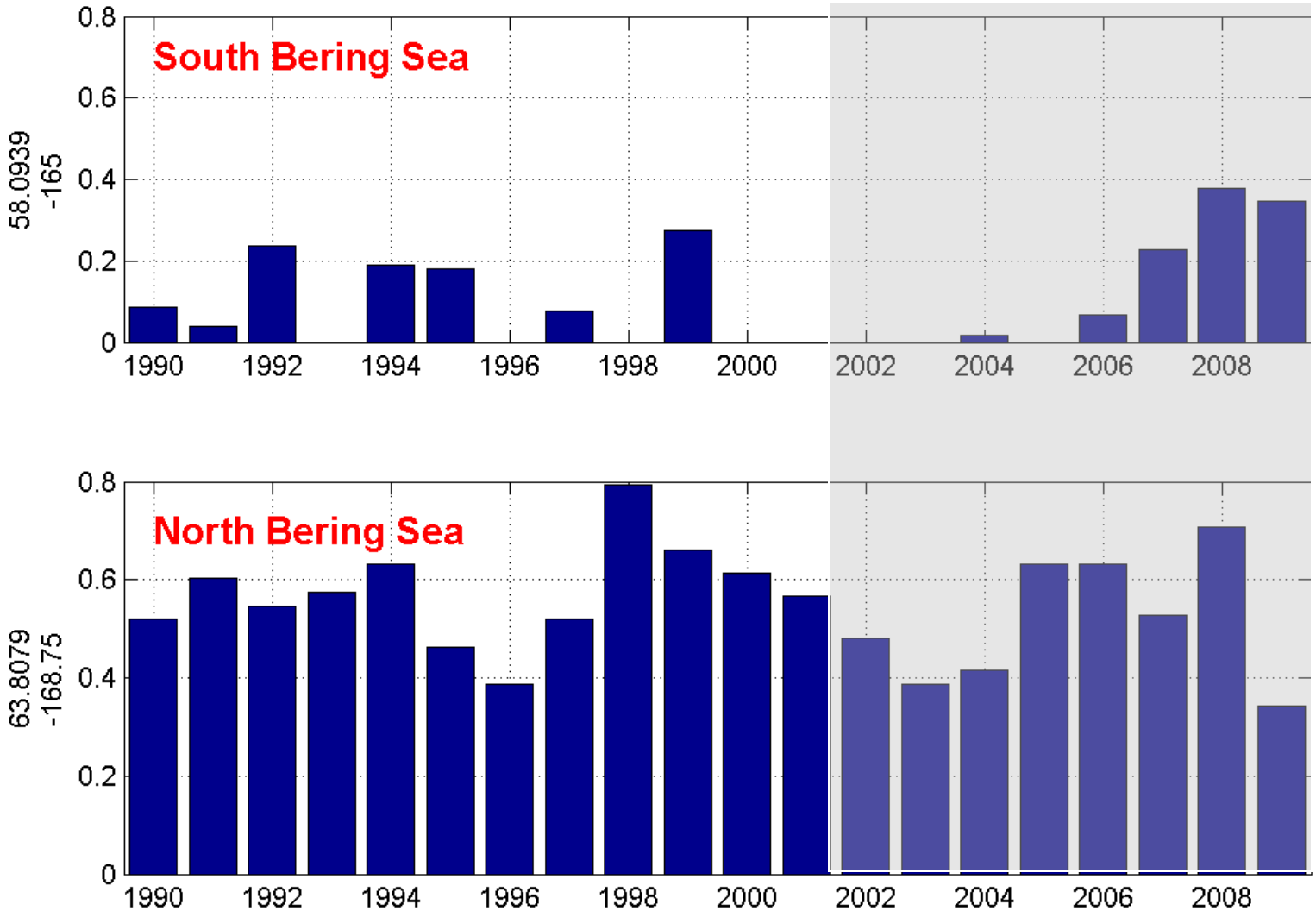
R~ -0.6 for lows in northern GOA and air T in eastern Bering Sea



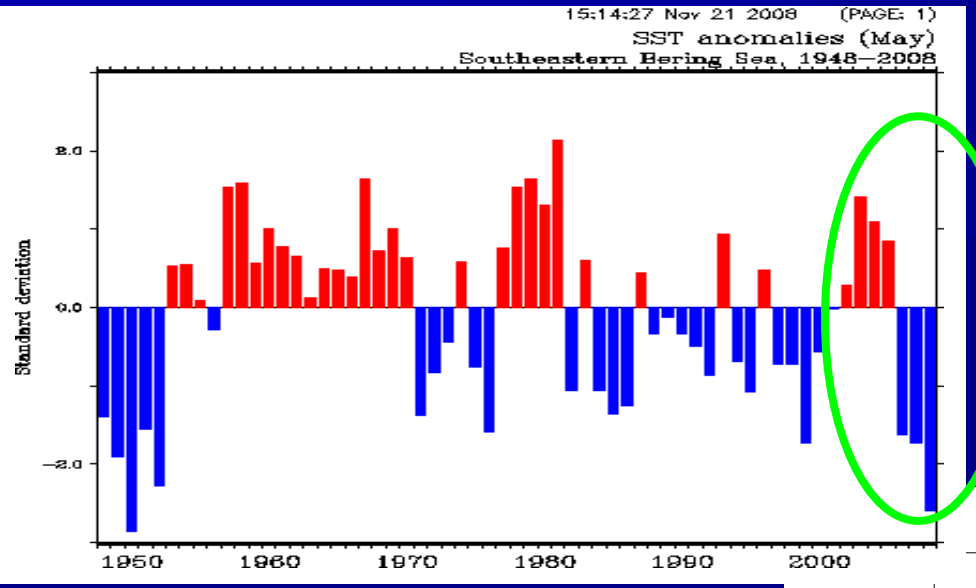
Warm years: Strong Aleutian Low centered over Aleutians

Cold years: Weaker low centered in northern Gulf of Alaska

Mean sea ice concentration, % (15 Mar-30 June)



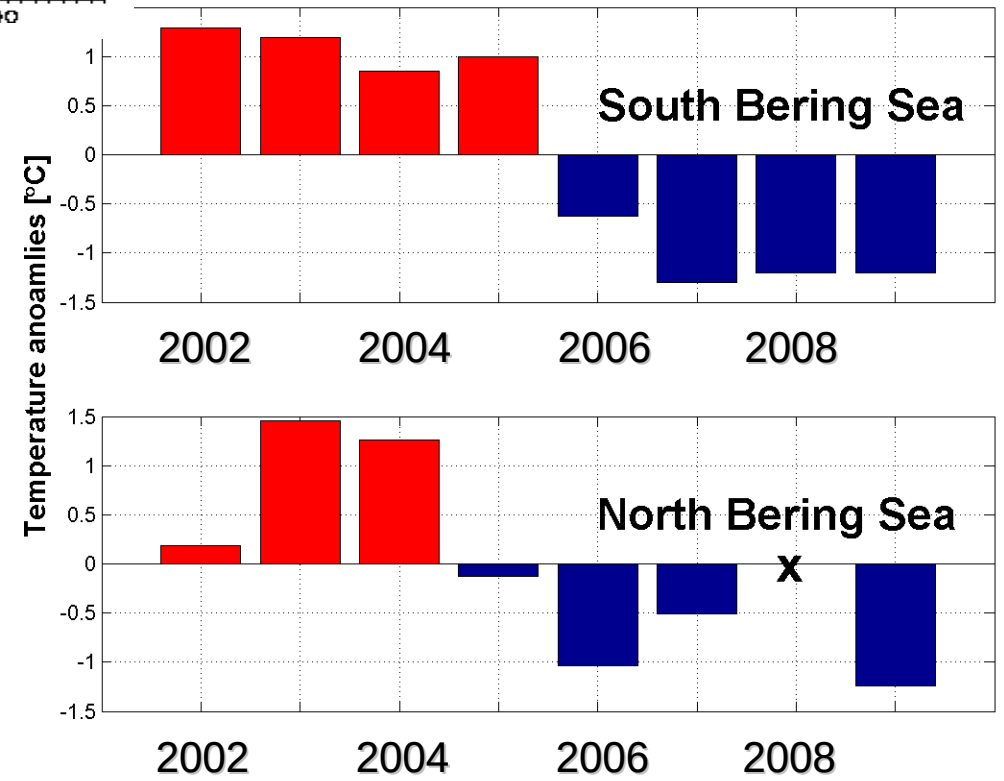
Temperature anomalies



SEBS May SST anomalies for 1948 to 2008

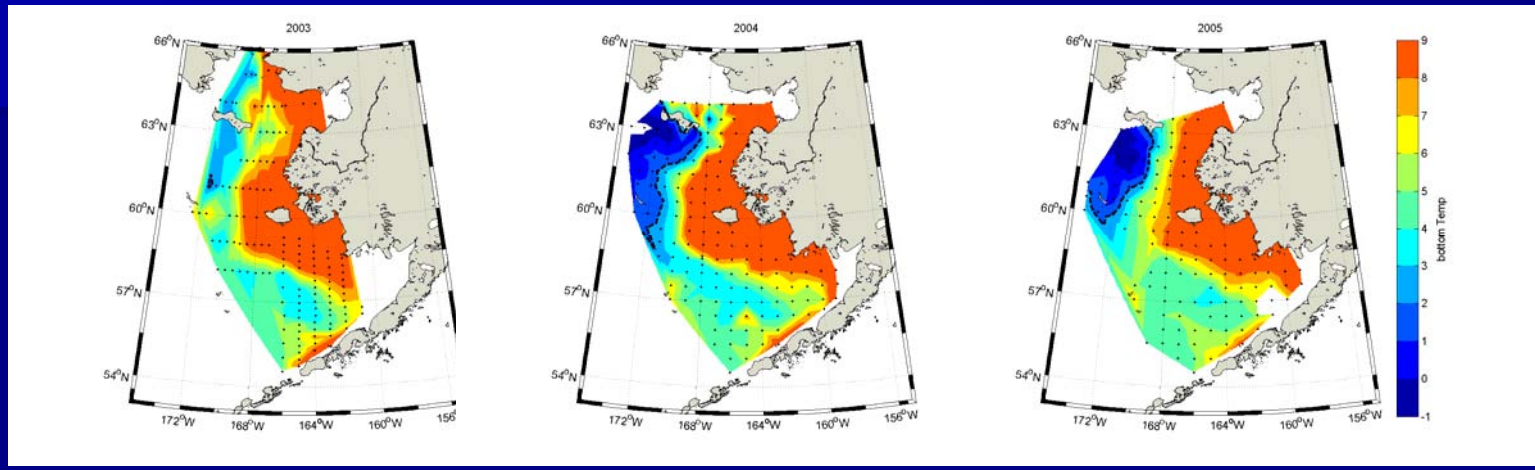
http://www.beringclimate.noaa.gov

BASIS Aug-Sept: mean water column T

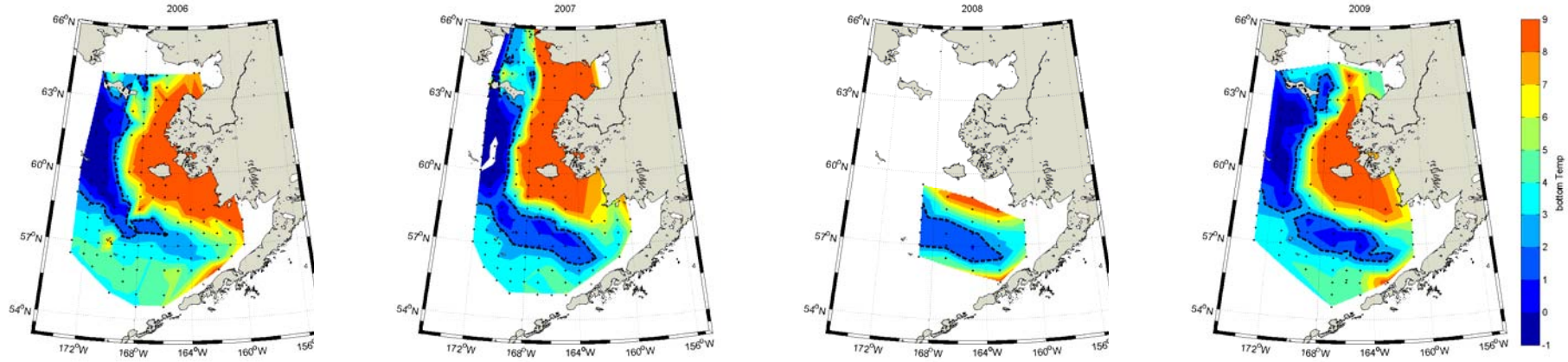


Deep Temperature: mean below the Mixed Layer Depth (MLD)

2003 2004 2005

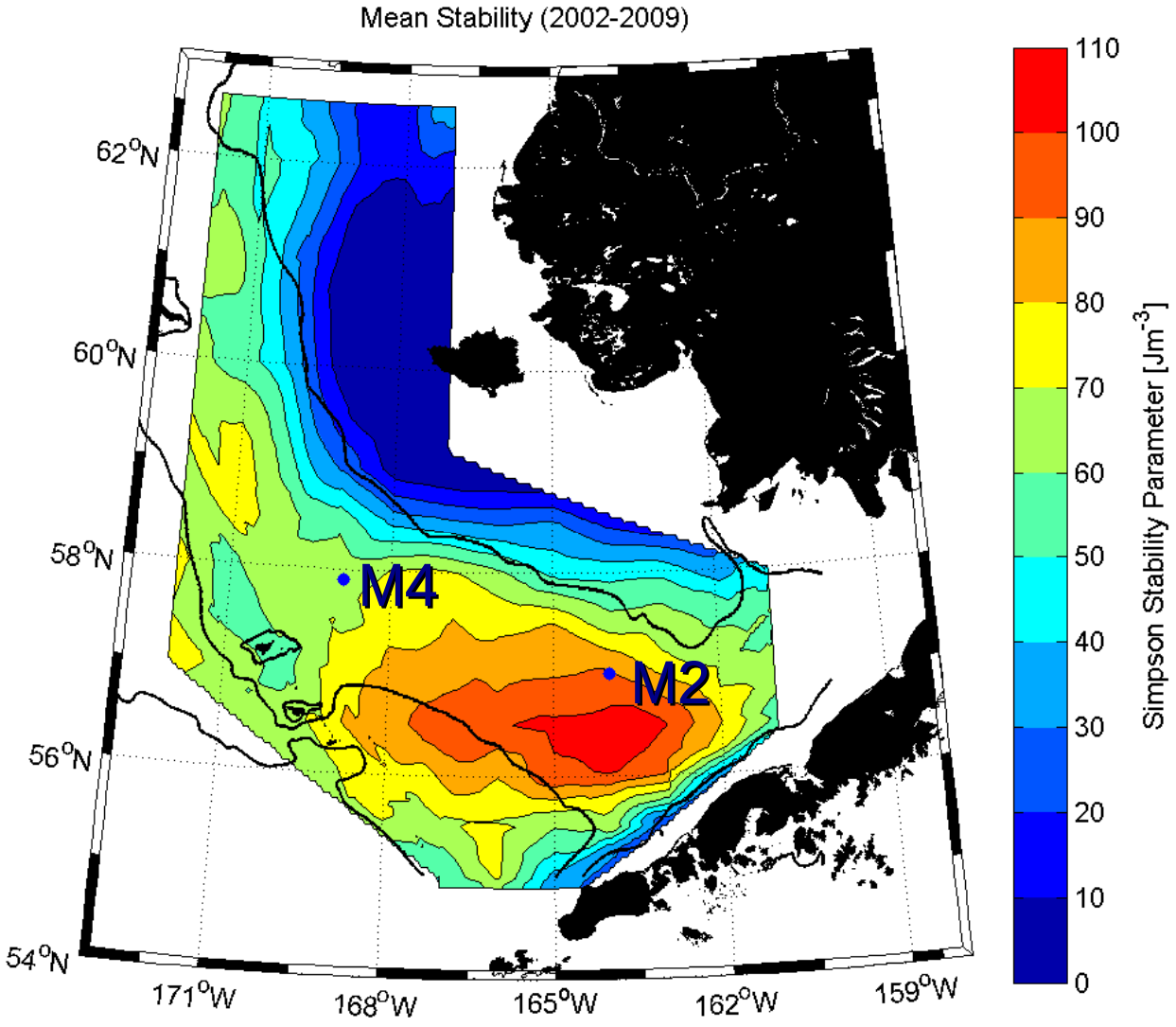


2006 2007 2008 2009



Cold pool (< 2°C) indicated by dashed black line.

2002-2009 mean stability (J m-3)



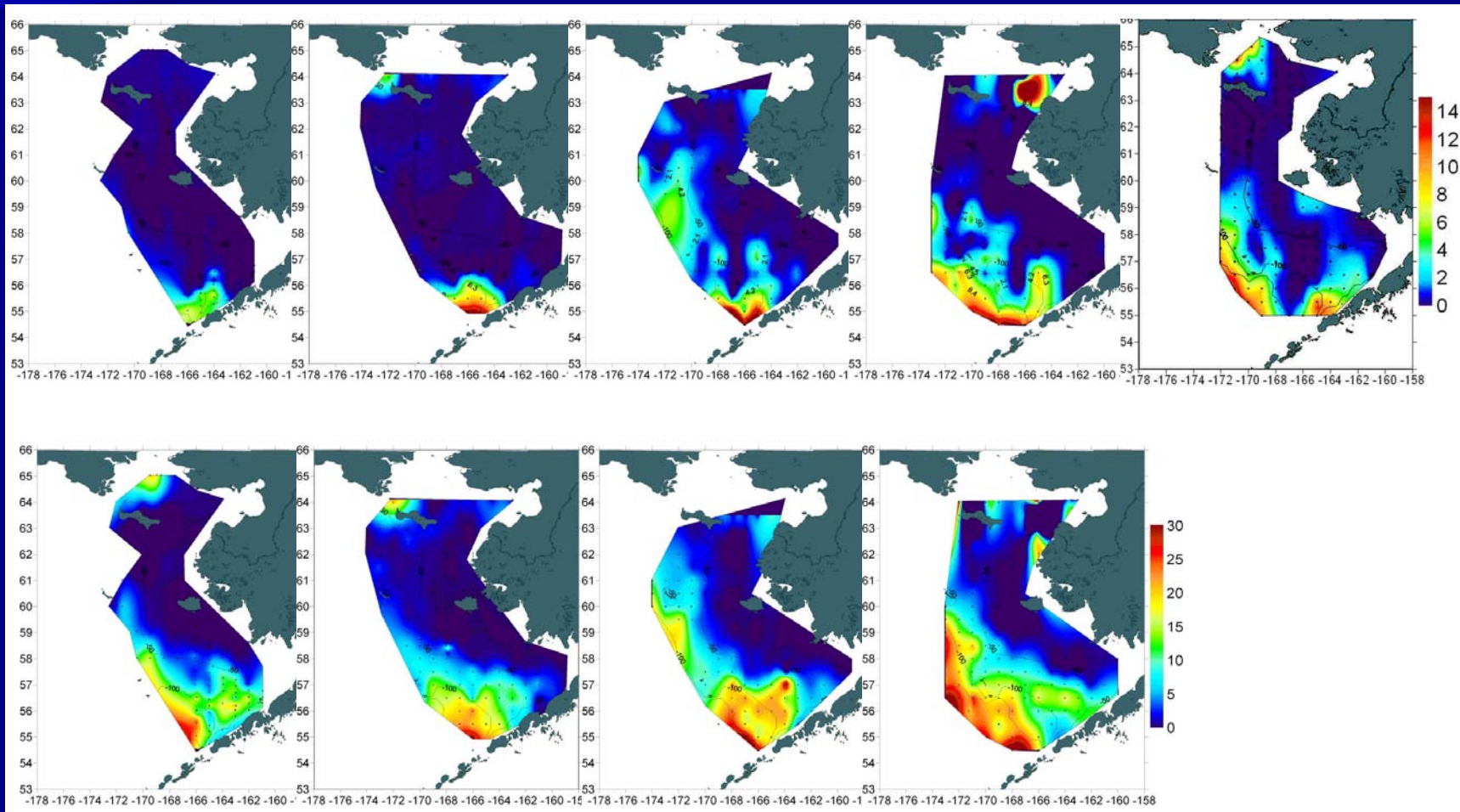
Nitrate (µM)

Means above and below the MLD

2003 2004 2005 2006 2007

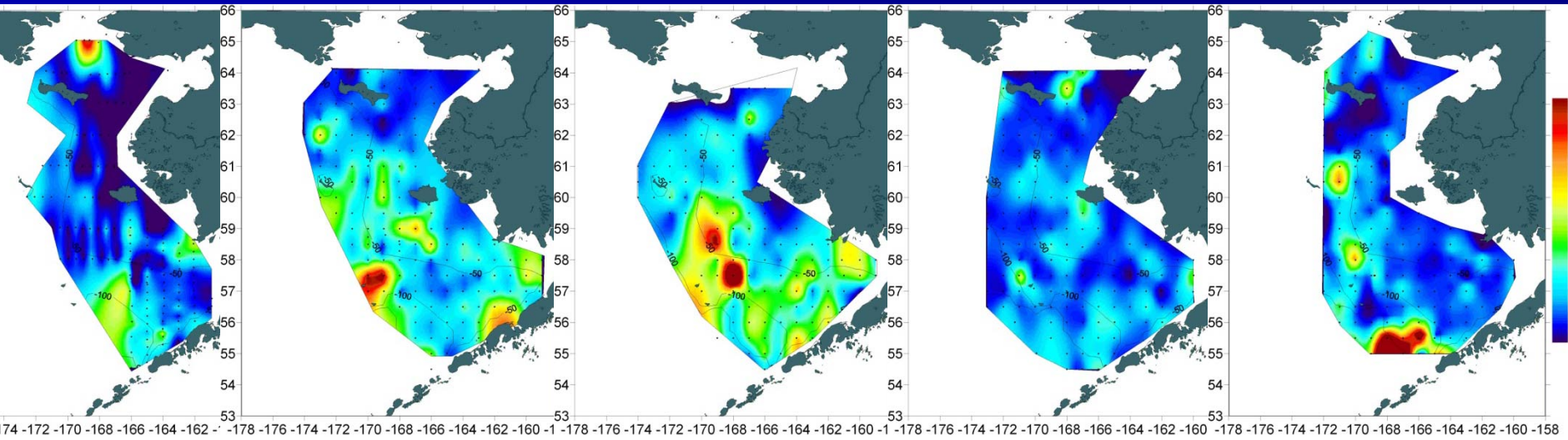
↑ MLD

↓ MLD



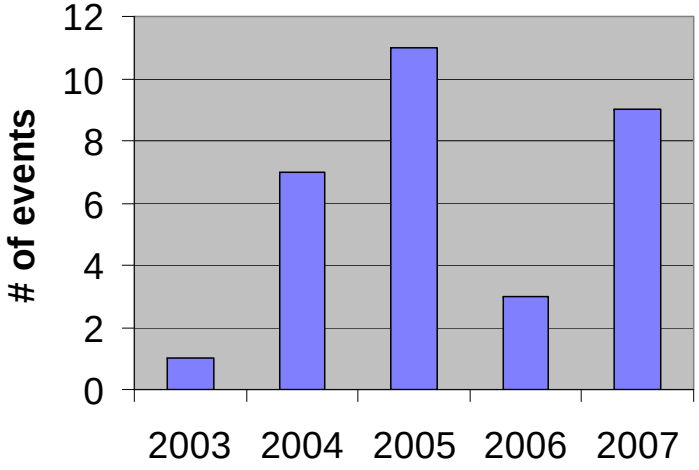
Integrated Chlorophyll a (mg m^{-2})

2003 2004 2005 2006 2007



Wind events (Aug-Sept)

(wind speed cubed > 0.4X10^4 m^3 s^{-3})

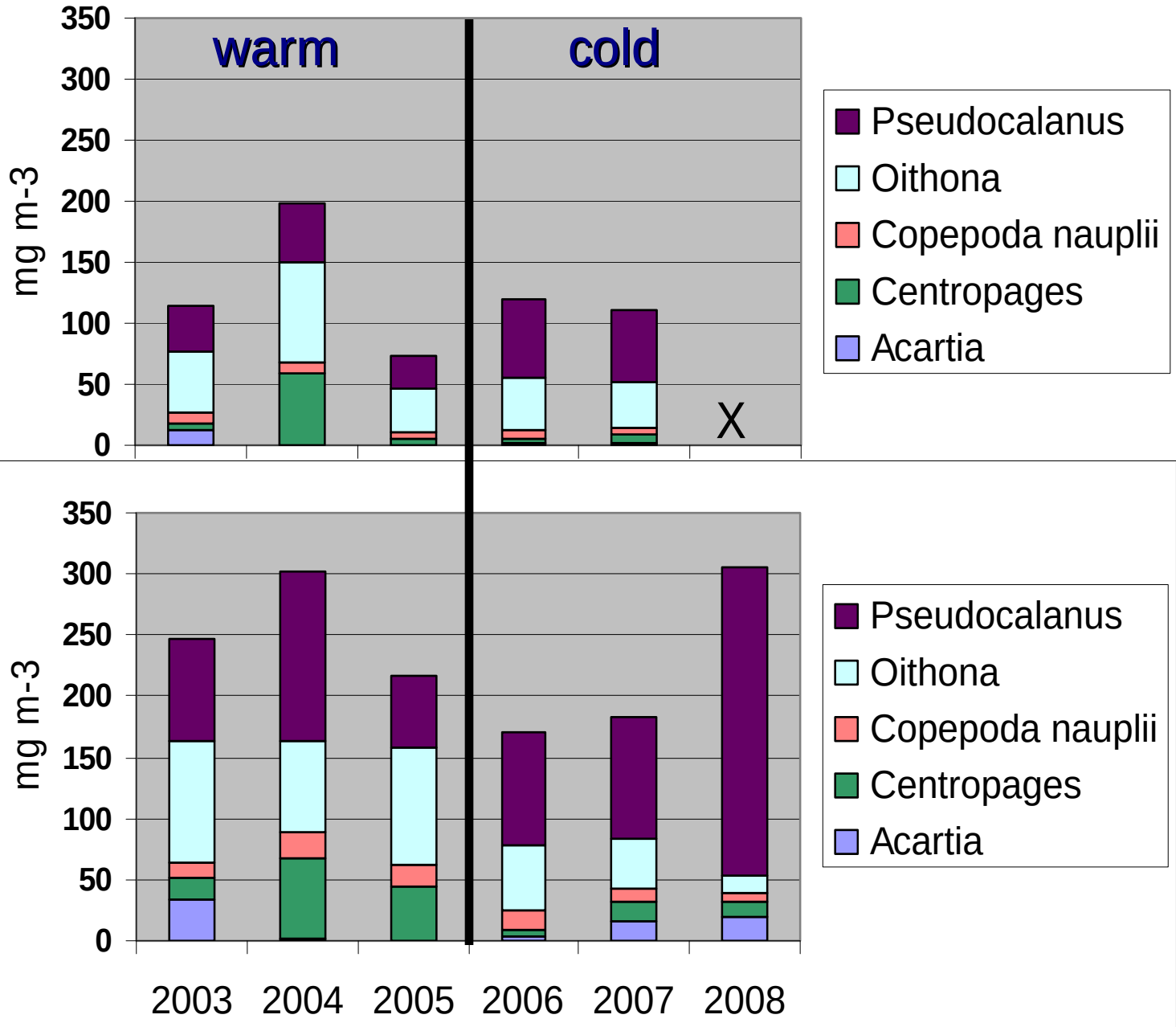


Mean biomass (mg m^{-3}) of small copepods

Juday 163 µm, Inner & Middle Domains (< 100 m)

North
60-63.5 N

South
55-59.5 N

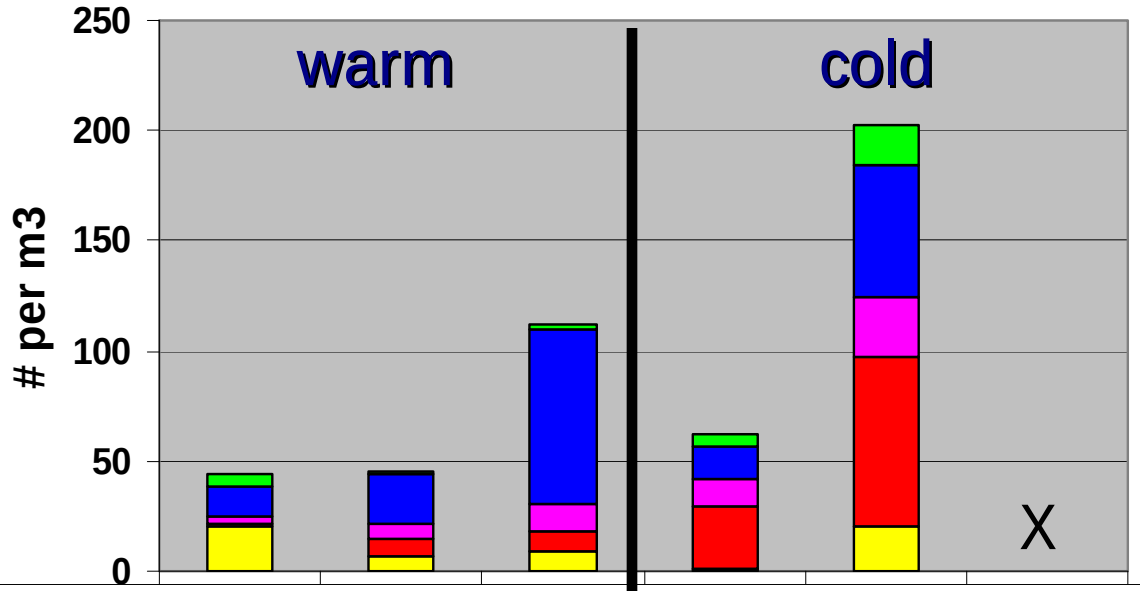


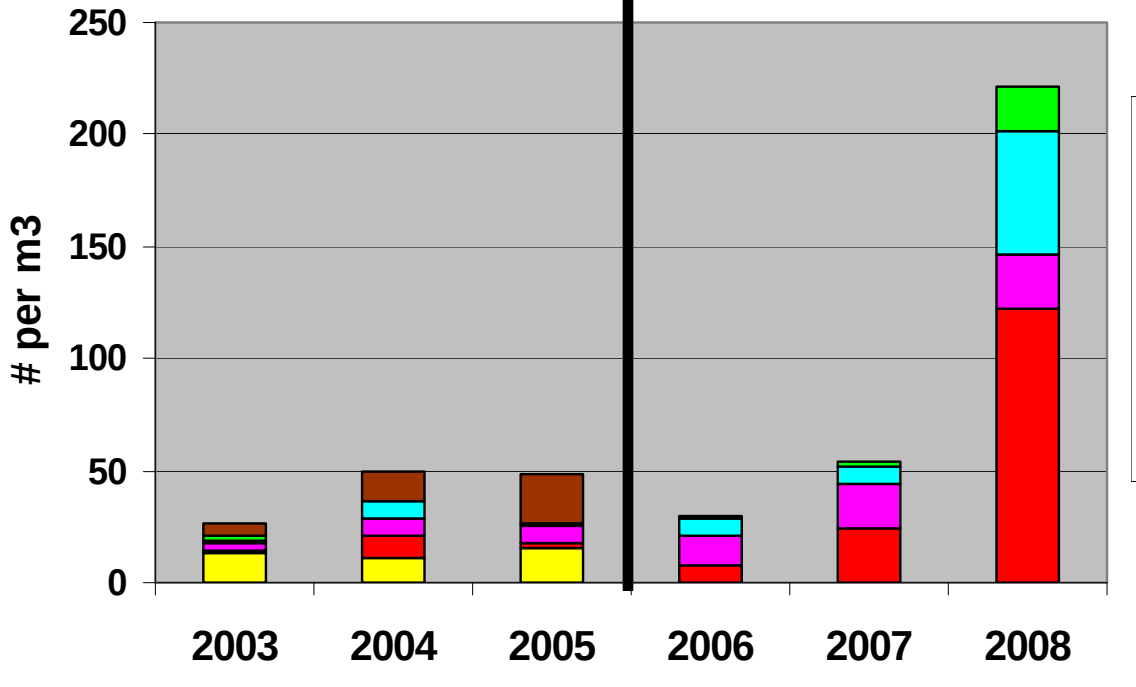
Mean abundance (# per m^3) of large zooplankton

Bongo 505 µm, Inner & Middle Domains (<100 m)

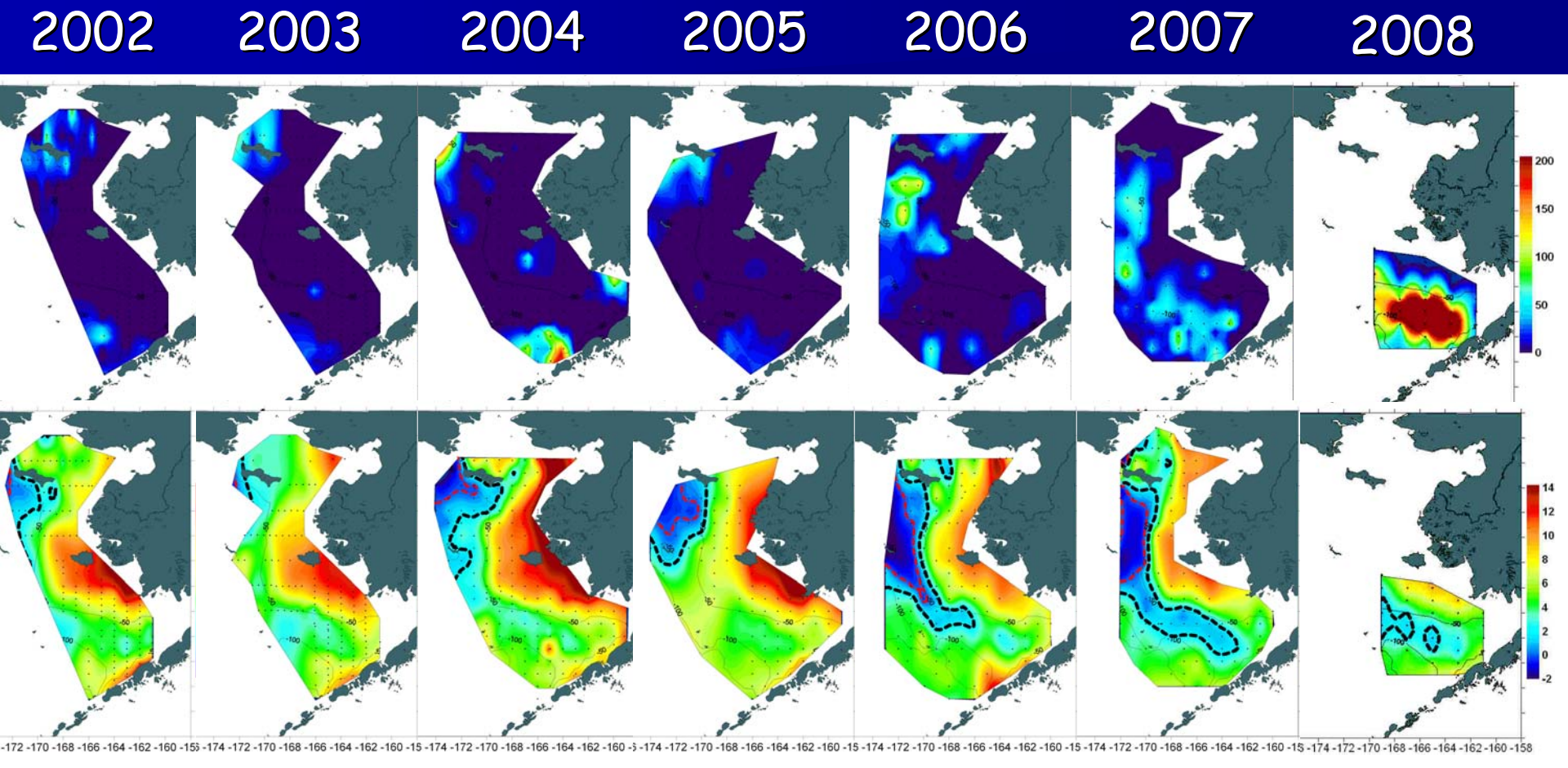
North
60-63.5 N

South
55-59.5 N





Calanus Marshallae (large copepod) abundance (# per m^3), Bongo Tow, 505 µm mesh net



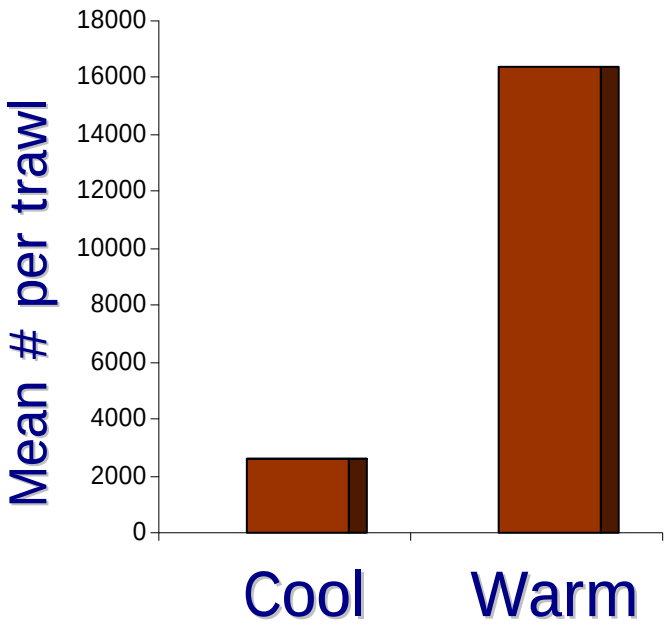
Bottom panel: Mean Temperature Below MLD

Cold pool (< 2°C) indicated by dashed black line.

0°C indicted by dashed red line.

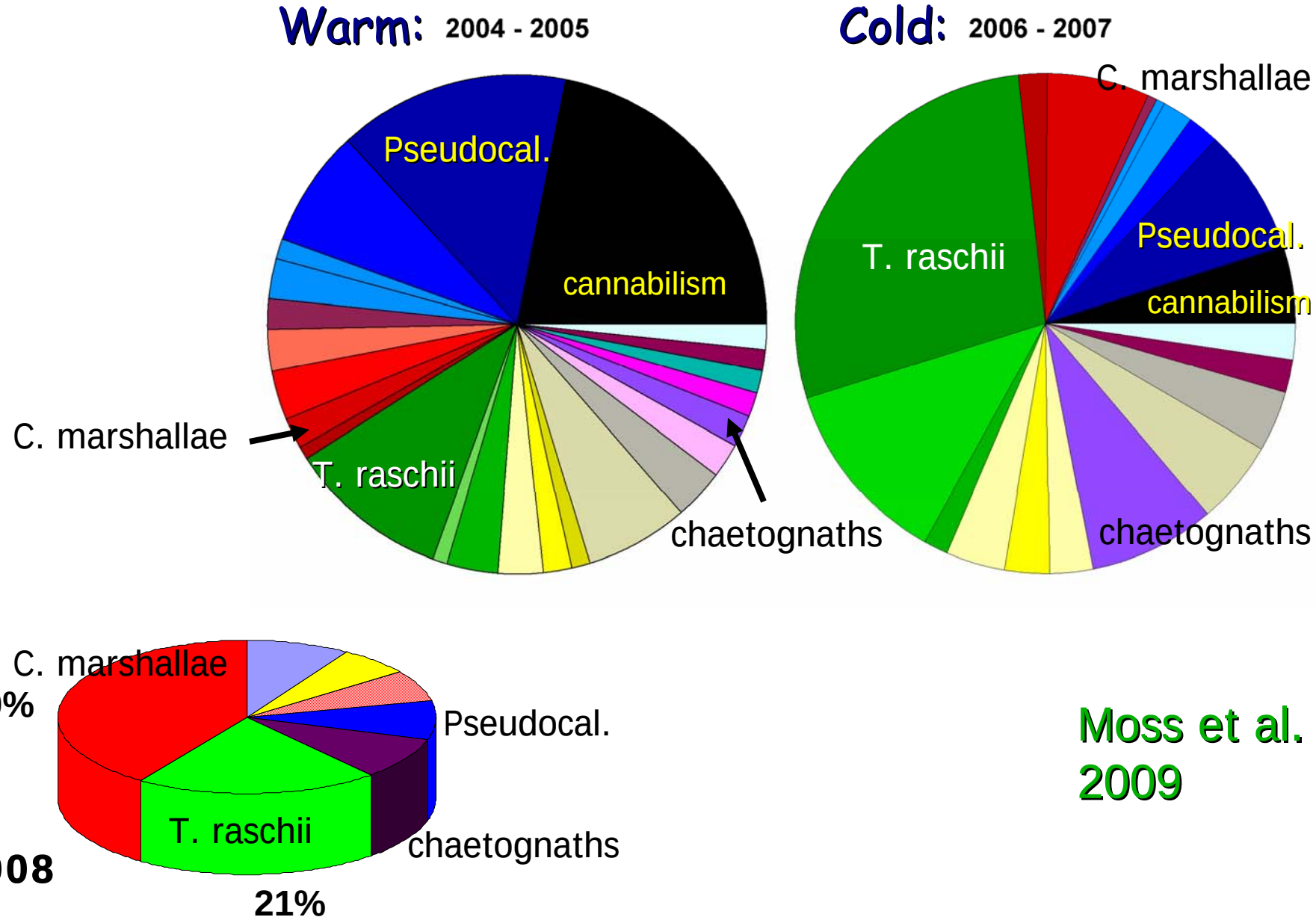
Age 0 Pollock Relative Abundance

WARM



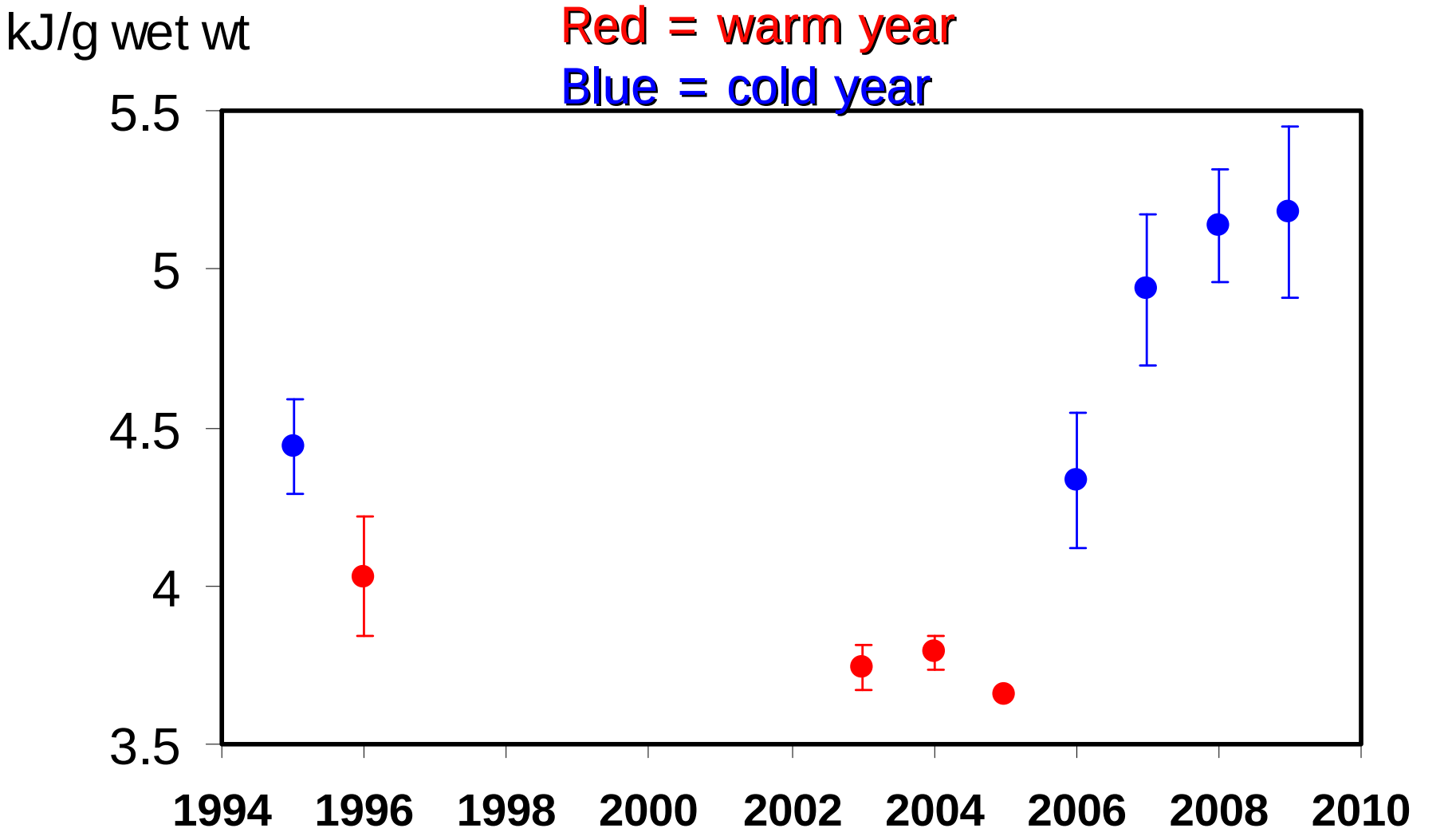
COOL

Age-0 pollock diet (% wet weight) in SE Bering Sea



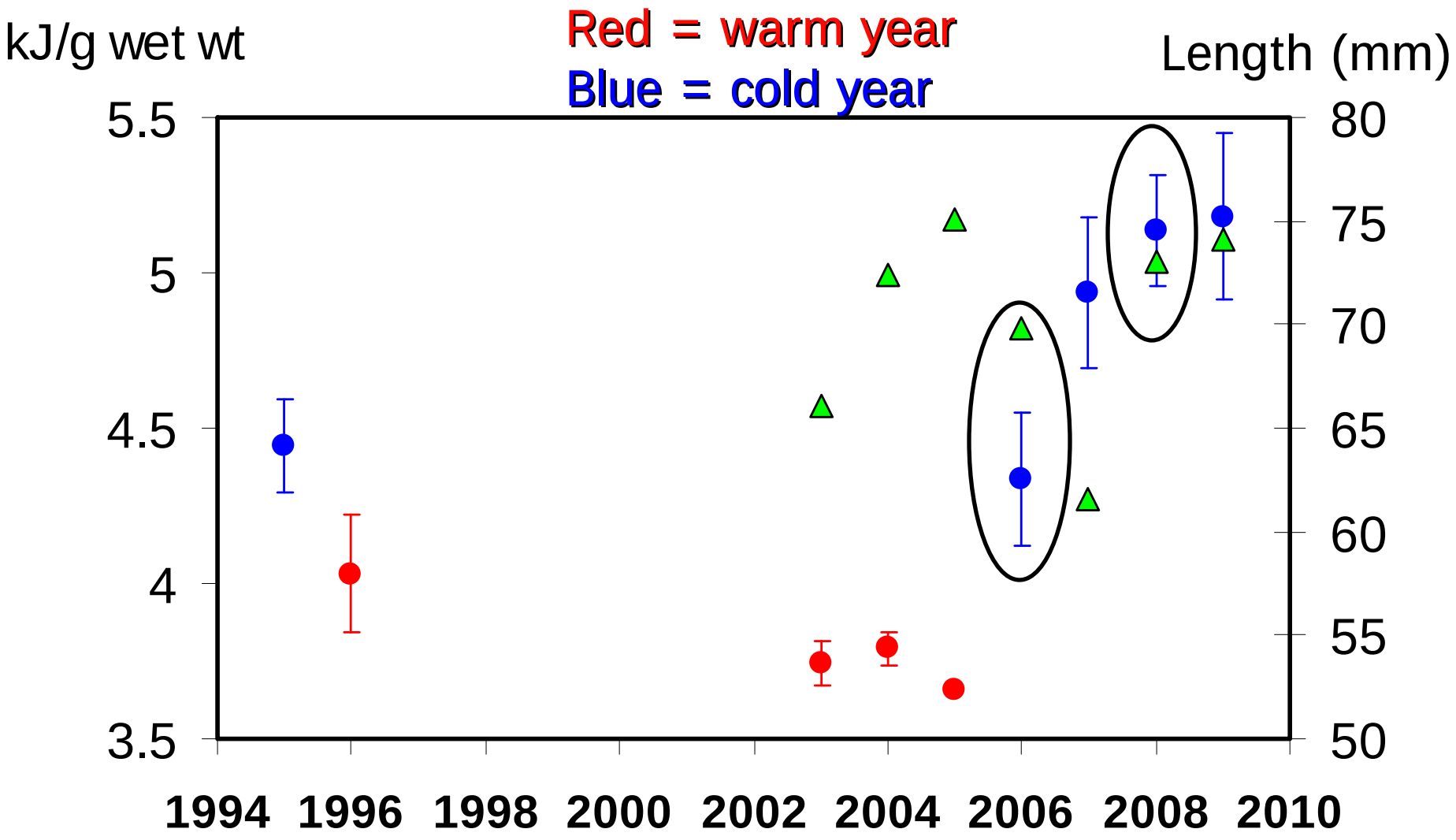
Moss et al. 2009

Age-0 pollock energy density for SEBS



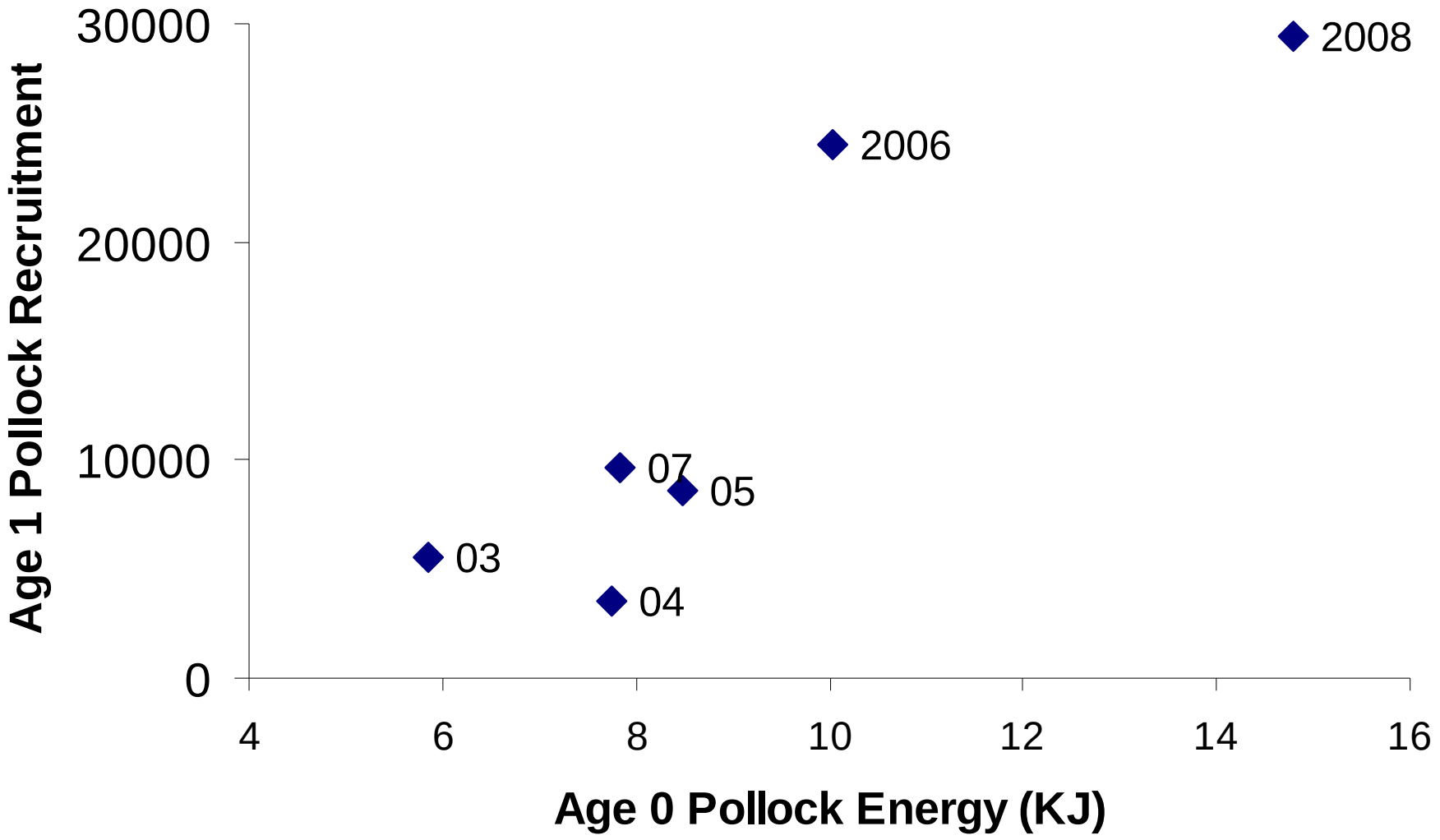
Courtesy of Ron Heintz, AFSC, NOAA

Age-0 pollock energy density and length for SEBS



Courtesy of Ron Heintz, AFSC, NOAA

BASIS 2003-2008: Whole body energy and age-1 recruitment



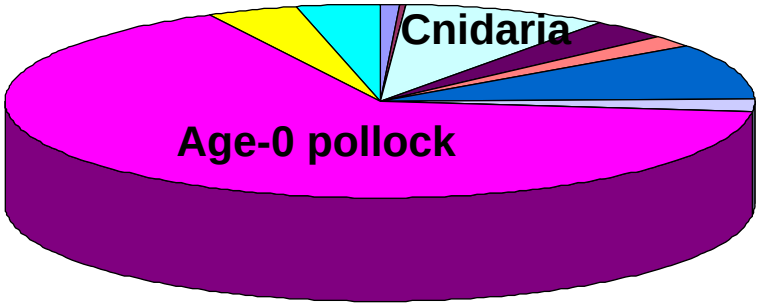
KJ = KJ/g wet wt X wet wt

Juvenile Chum Salmon Diet
% wet wt

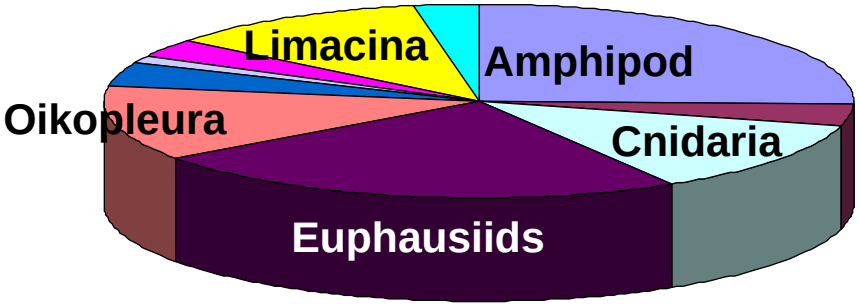
WARM

COLD

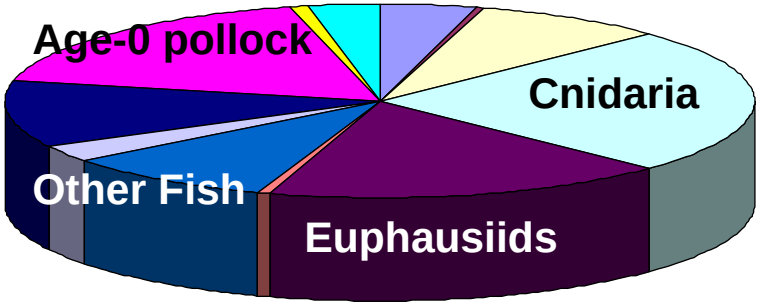
South



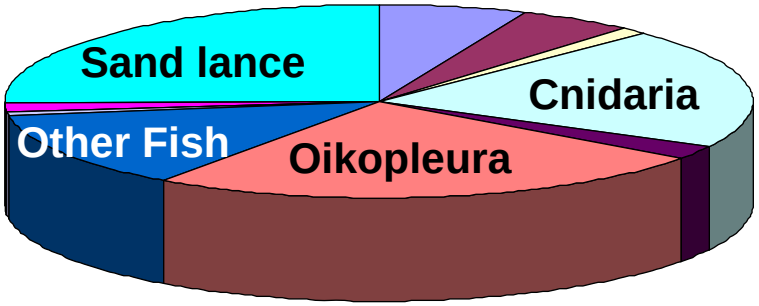
South



North



North



Farley et al. *In press*

Summary

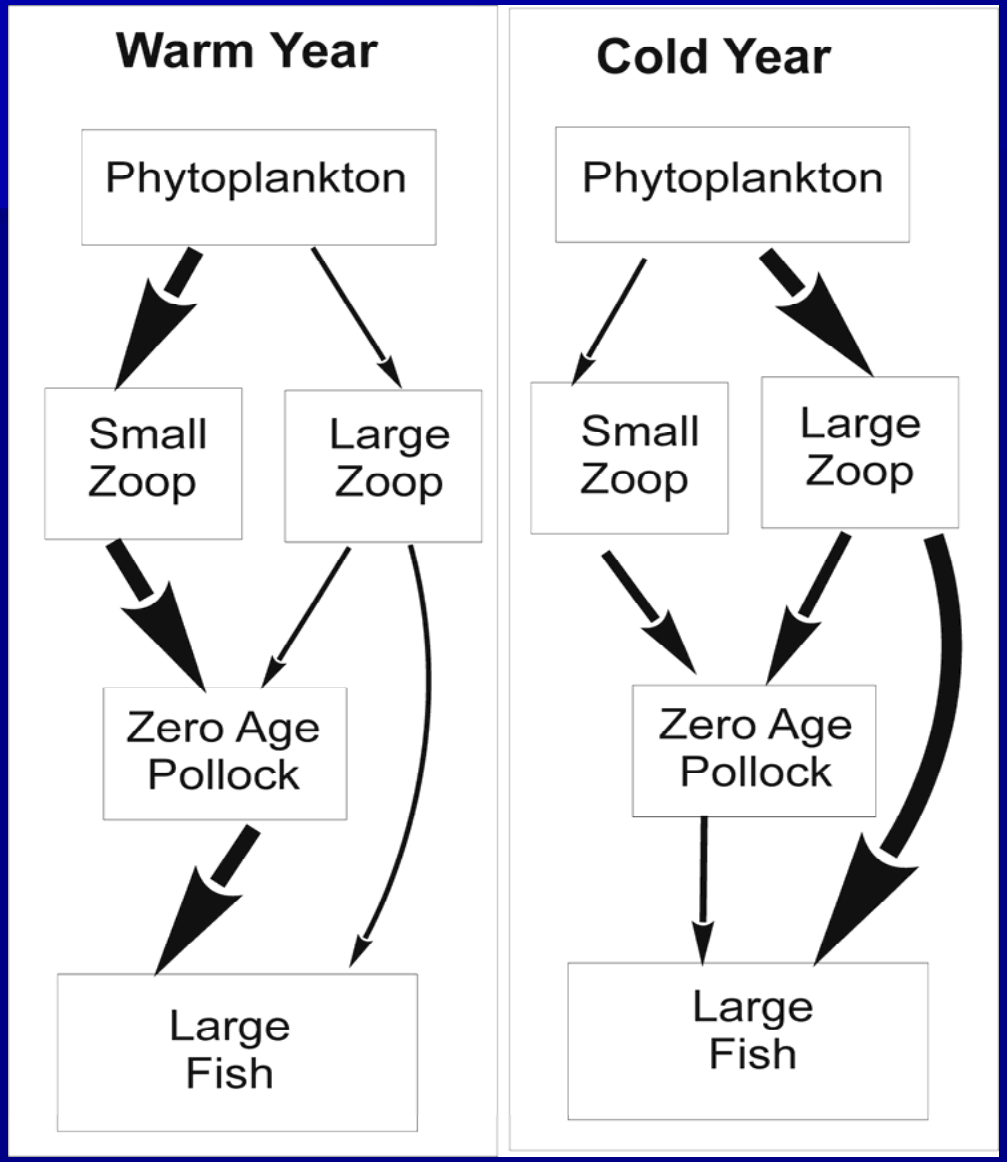
Warm Vs. Cold:

- Warm years
  - more small zooplankton,
  - higher abundances of forage fish (age-0 pollock, sockeye salmon)
  - age-0 pollock important prey item for forage fish (juv. chum, sockeye, pink salmon, herring, age-0 pollock)
- Cold years
  - more large zooplankton in water and in forage fish diets
  - higher energy density in age-0 pollock (Heintz et al.) and juv. salmon (Farley et al.)

North Vs. South:

- N-S variations in zooplankton (e.g gelatinous zoopl in N, more small copepods in S) and fish diets.

Conclusions



Climate warming may reduce concentrations of large zooplankton prey in water and in fish diet, and subsequently affect energy density, over-winter survival and recruitment of forage fish.

K. Coyle