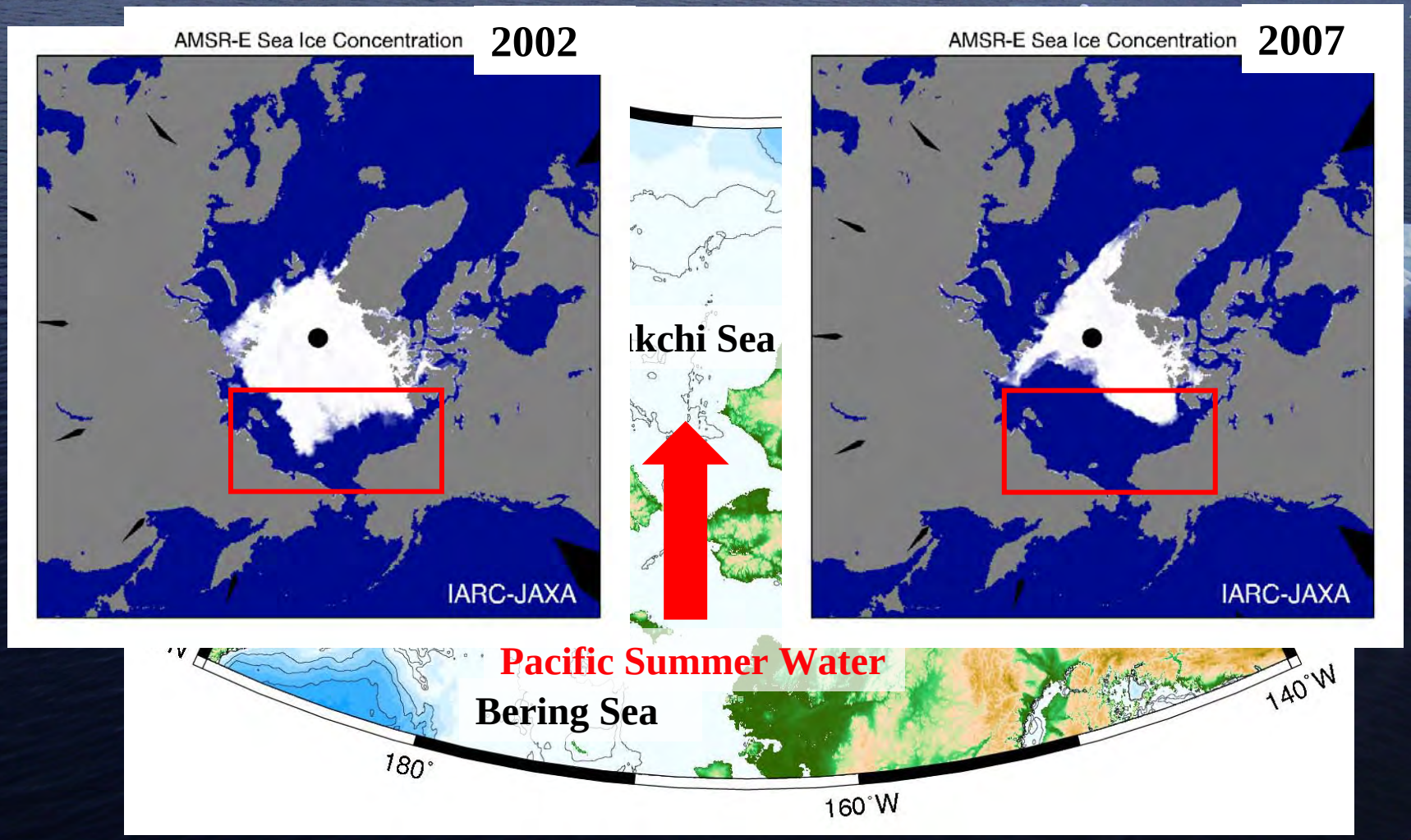
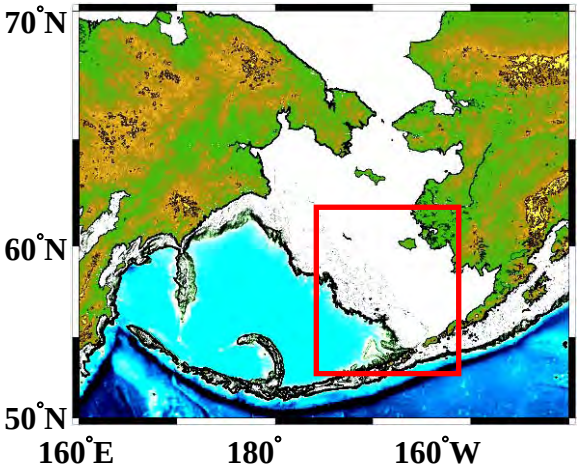
Interannual changes in the zooplankton community structure on the southeastern Bering Sea shelf and Chukchi Sea during summers of 1991–2009

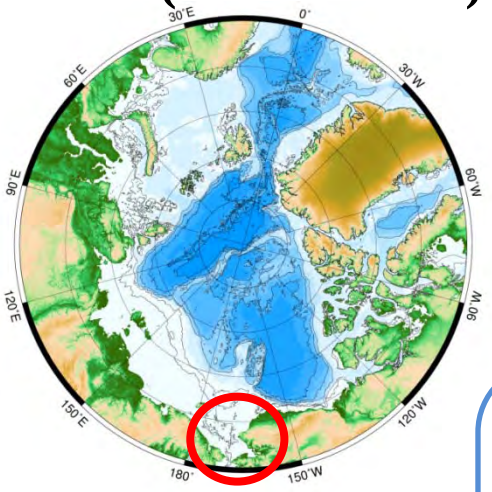


Background

Subarctic (SE Bering Sea)



Arctic (Chukchi Sea)



In the Pacific sector of the Arctic Ocean, SE Bering Sea shelf (subarctic) and Chukchi Sea (arctic) are comparable shelves.

While bathymetry is similar, zooplankton fauna is greatly varied with location: small copepods (*Calanus finmarchicus*) in the Atlantic, medium-sized copepods (*Calanus* spp. and *Metridia longa*) in the Arctic Ocean and large-sized copepods (*Neocalanus* spp.) in the Pacific.

Dominant zooplankton

1 mm

Atlantic species

C. finmarchicus

Arctic species

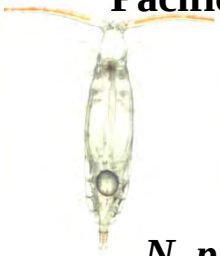
C. hyperboreus

C. glacialis

M. longa

Pacific species

N. cristatus



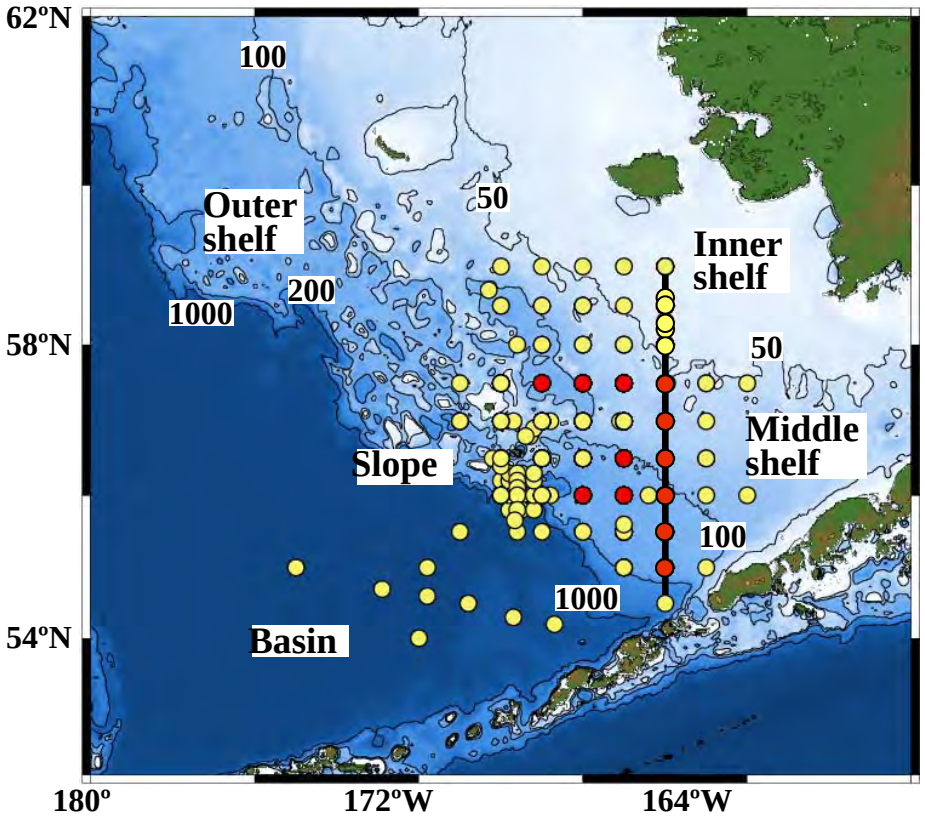
E. bungii

N. plumchrus

N. flemingeri

M. pacifica

Subarctic (SE Bering Sea)



Bathymetric clarification

- Inner shelf: < 50 m
- Middle shelf: 50–100 m
- Outer shelf: 100–200 m
- Slope: 200–1000 m
- Basin: > 1000 m

<Location and period>

- SE Bering Sea shelf
- Samplings were conducted ca. 1 week during late June to early August 1994-2009.

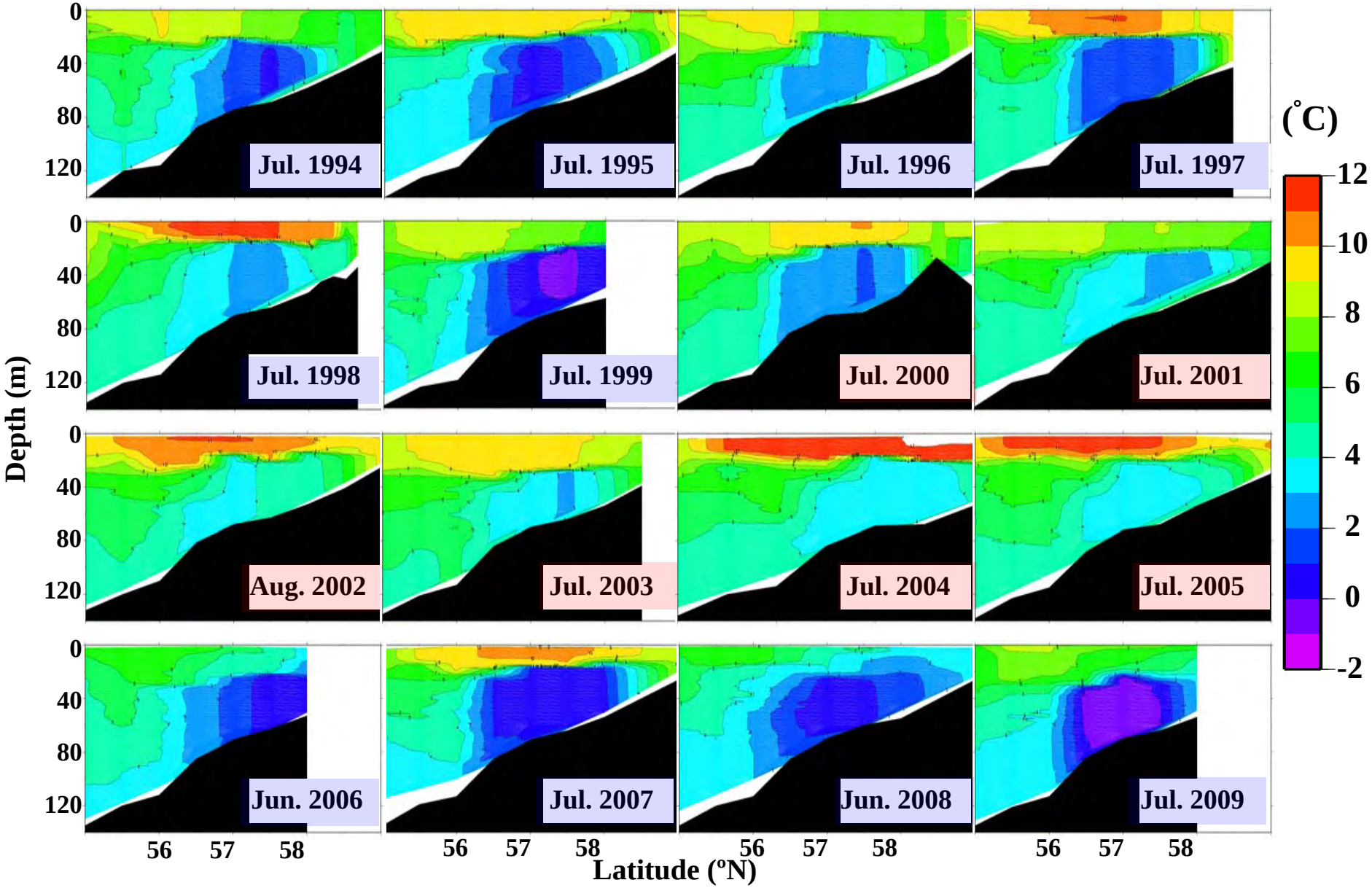
<Sampling and analysis>

- Vertical tow of NORPAC net (0.33 mm mesh) from 0-150 m or 5 m above bottom.
- Calanoid copepod abundance
  - ①Cluster analysis (Bray-Curtis similarity)
  - ②Length measurements and applying L-W relationship, dry mass biomass was estimated.
- Chaetognaths (dominated by *Sagitta elegans*)
  - ①Length measurements and applying L-W relationship, dry mass biomass was estimated.

<Hydrography>

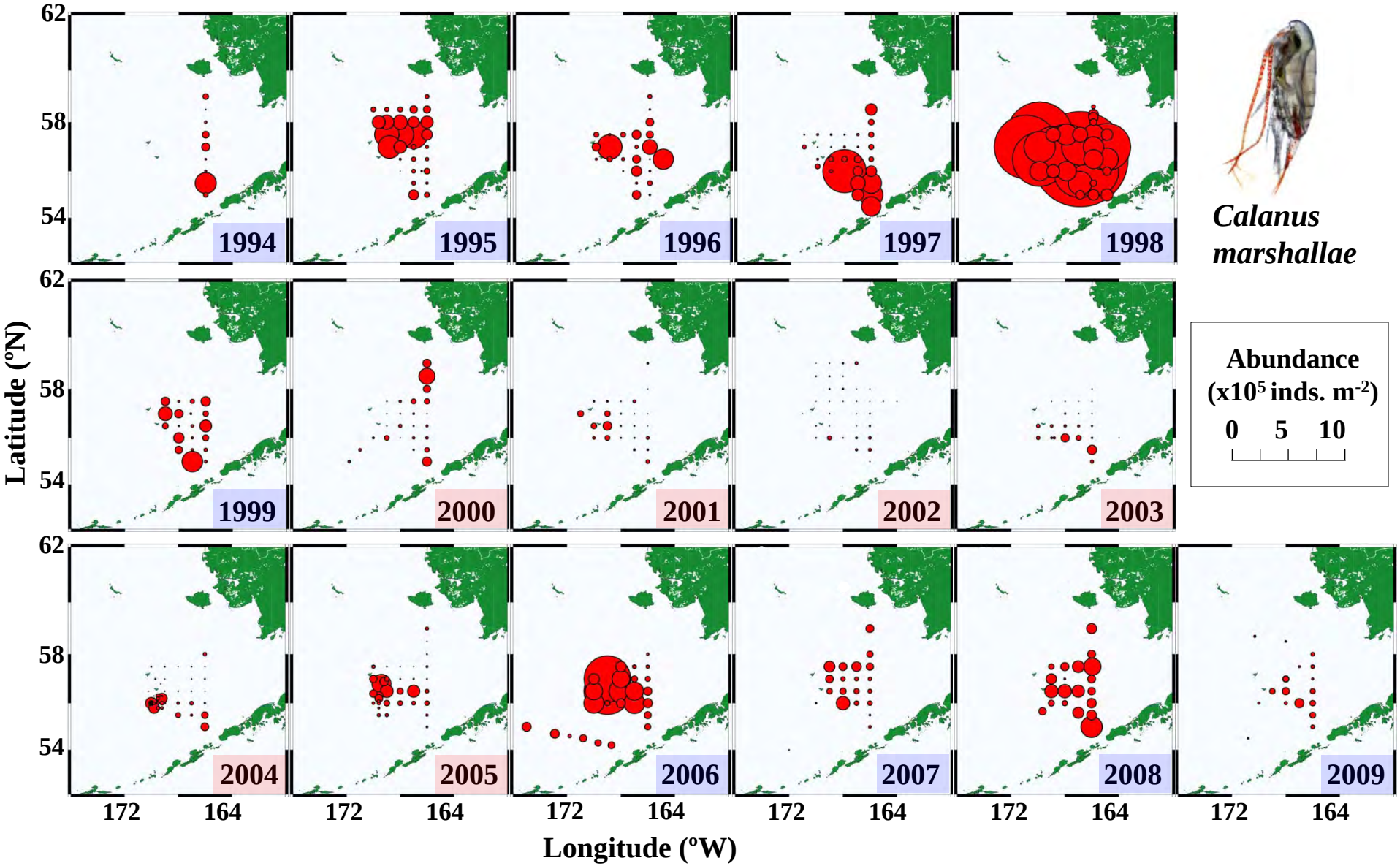
- Temp. and salinity were measured by CTD

Results: Temperature contours along 166°W transect



Relatively colder during 1994-1999, while warmer during 2000-2005, and colder again after 2006.

Results: Abundance of calanoid copepods

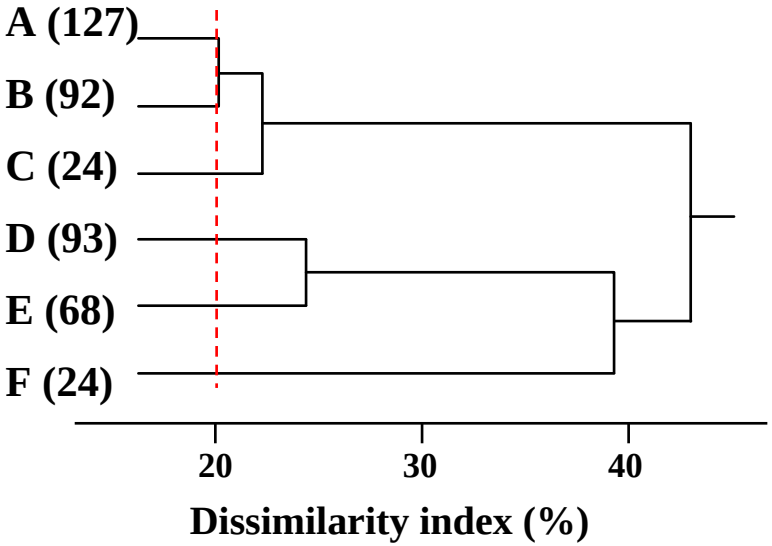


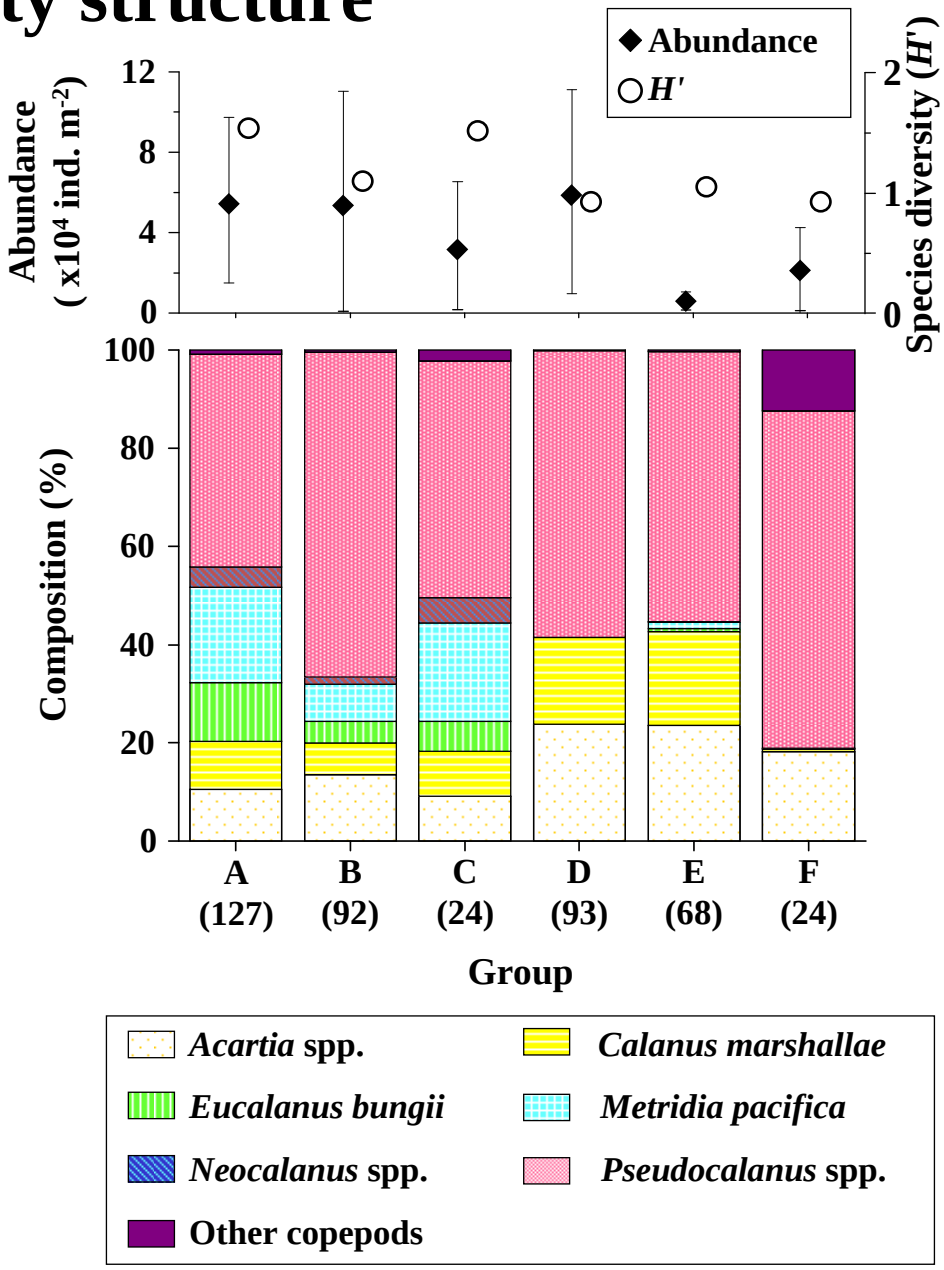
Calanus marshallae

Abundance
(x10^5 inds. m^{-2})
0 5 10

Copepod abundance showed large annual change: greater during cold years (1994-1999, 2006-2009), while lesser during warm years (2000-2005).

Results: Copepod community structure





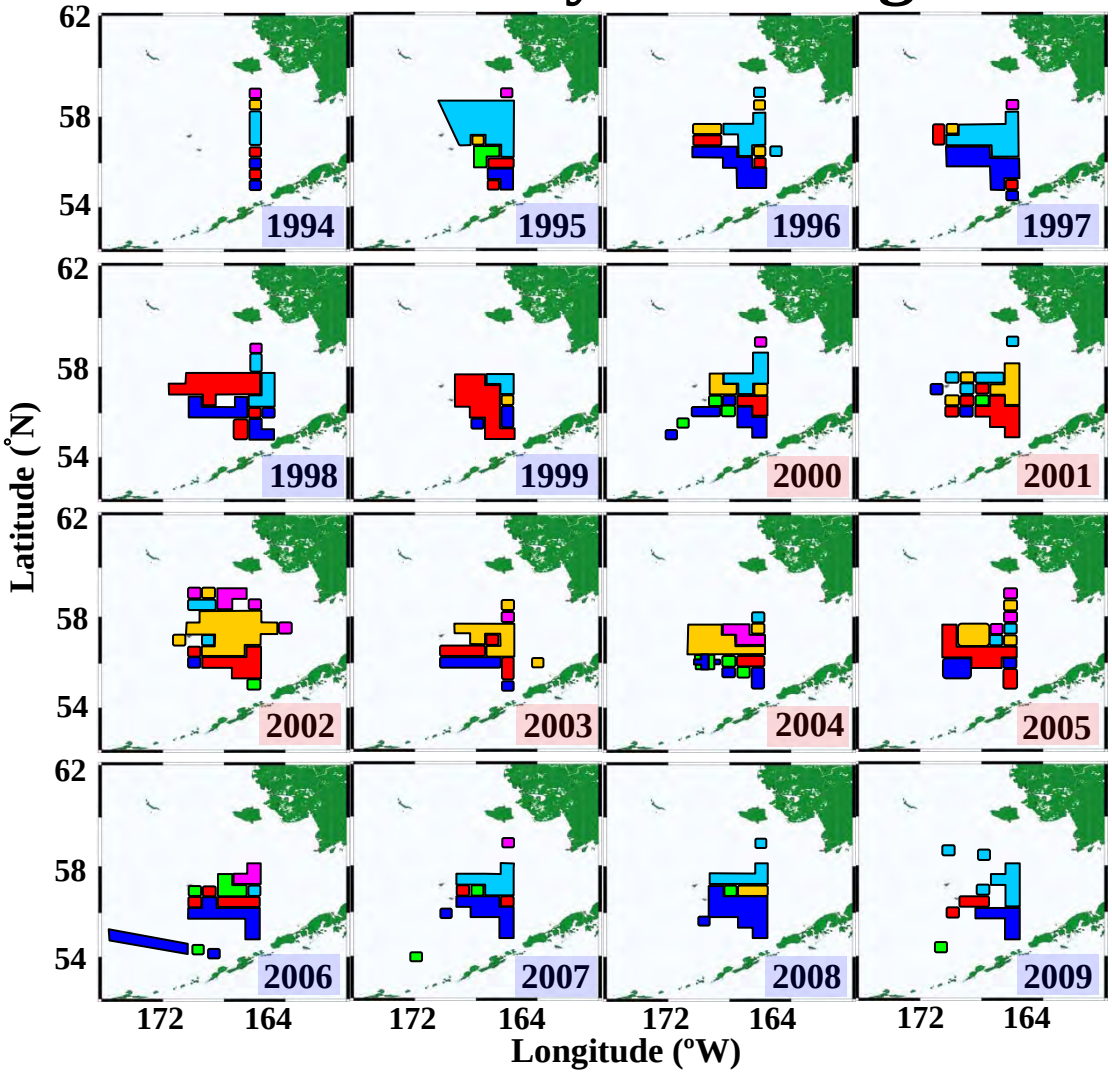
Characteristics of each group

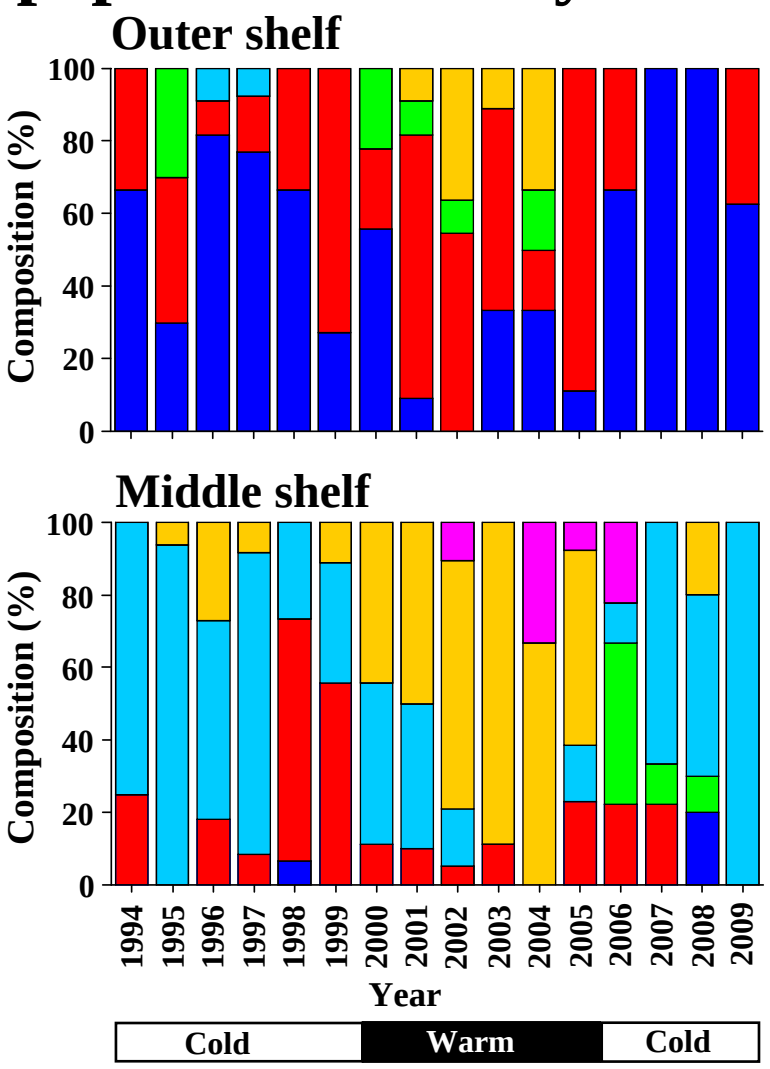
A, B, C: Oceanic species were occurred

D, E: Similar species composition, while extremely low abundance in E

F: Neritic species dominated

Results: Year-to-year changes in copepod community

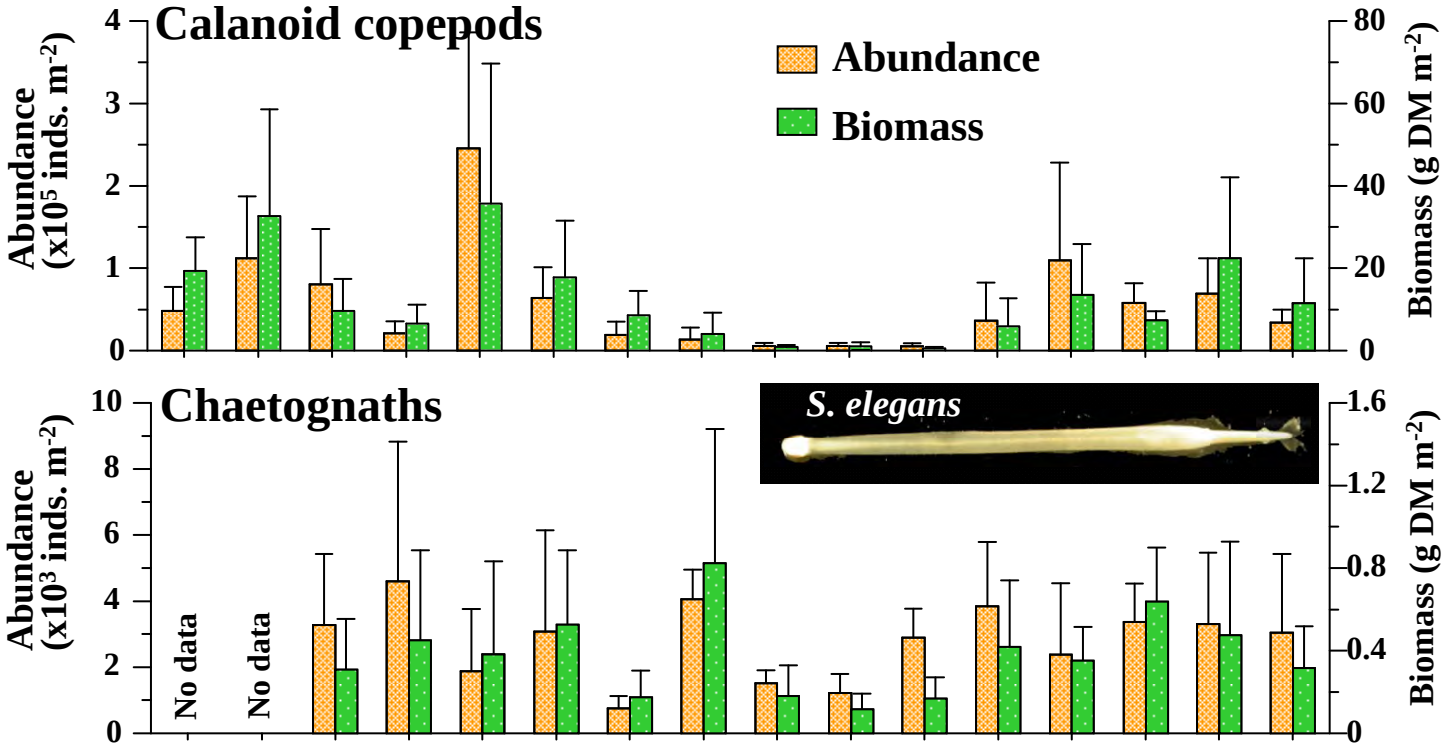


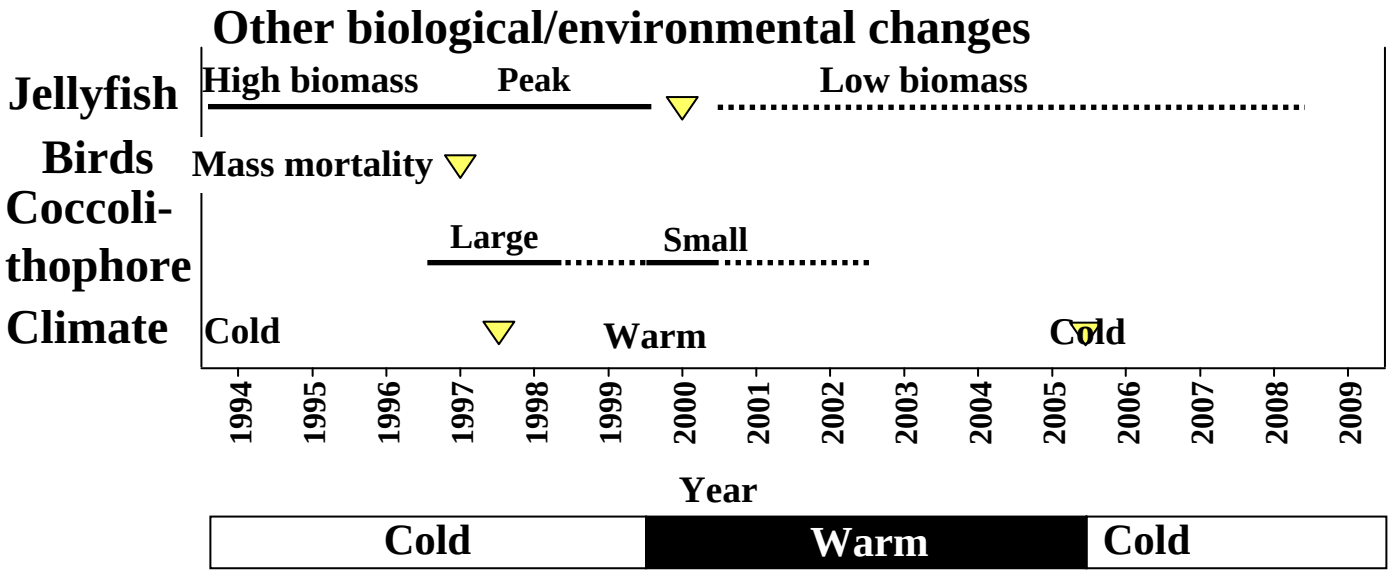


A: Outer-cold
B: Outer-warm
C: Outer-Basin
D: Middle-cold
E: Middle-warm
F: Inner

- Outer shelf: A (1994–1998) → B (1999–2005) → A (2006–2009)
- Middle shelf: D (1994–2001) → E (2002–2006) → D(2007–2009)

Summary: Year-to-year changes in ecosystem





Coccolithophore

Less effect

Copepods

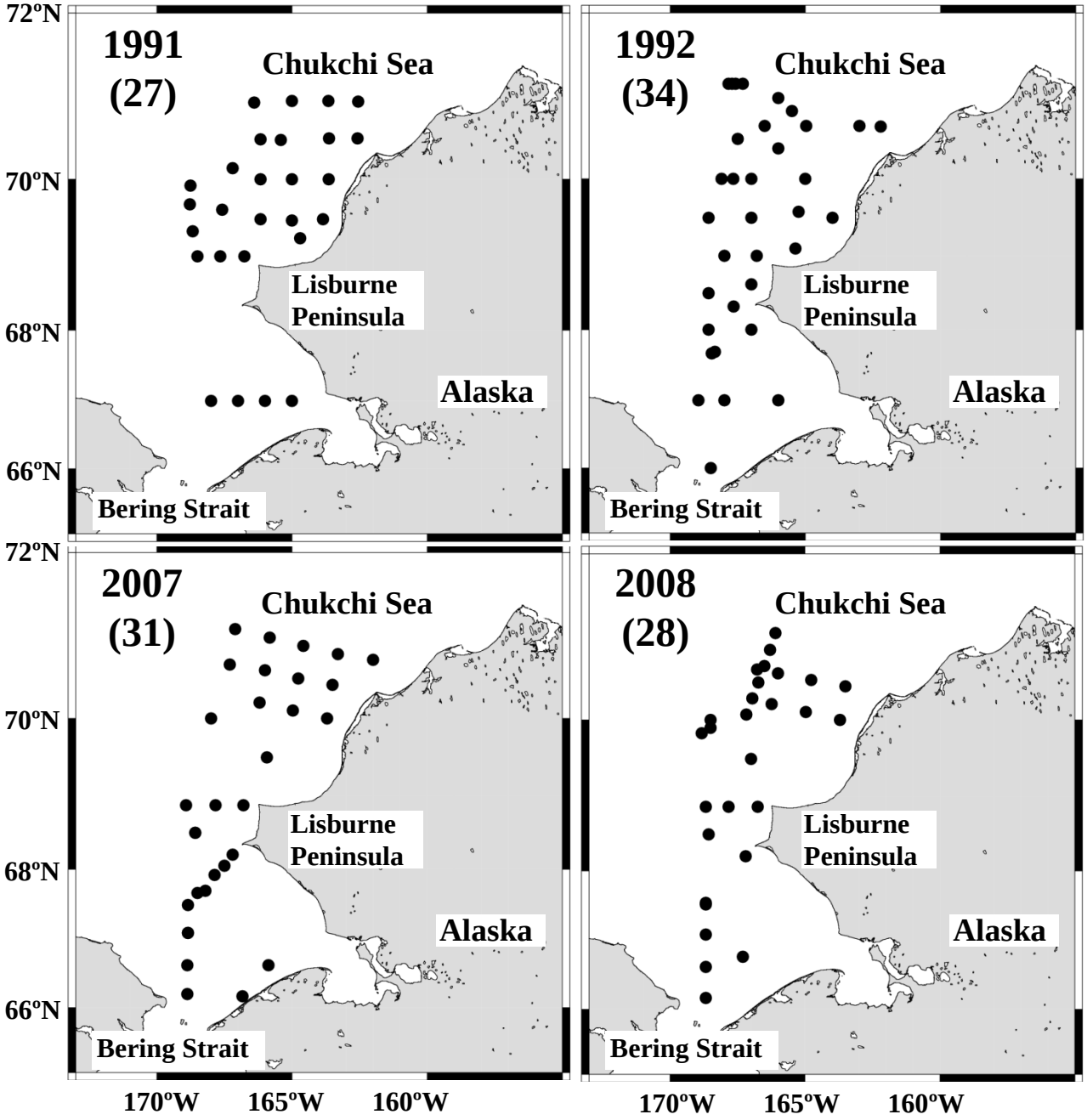
Chaetognaths

Jellyfish

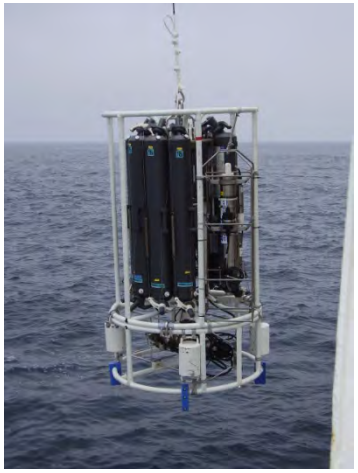
Similar pattern

Arctic (Chukchi Sea)

ca. 1 week during 7 July to 13 August

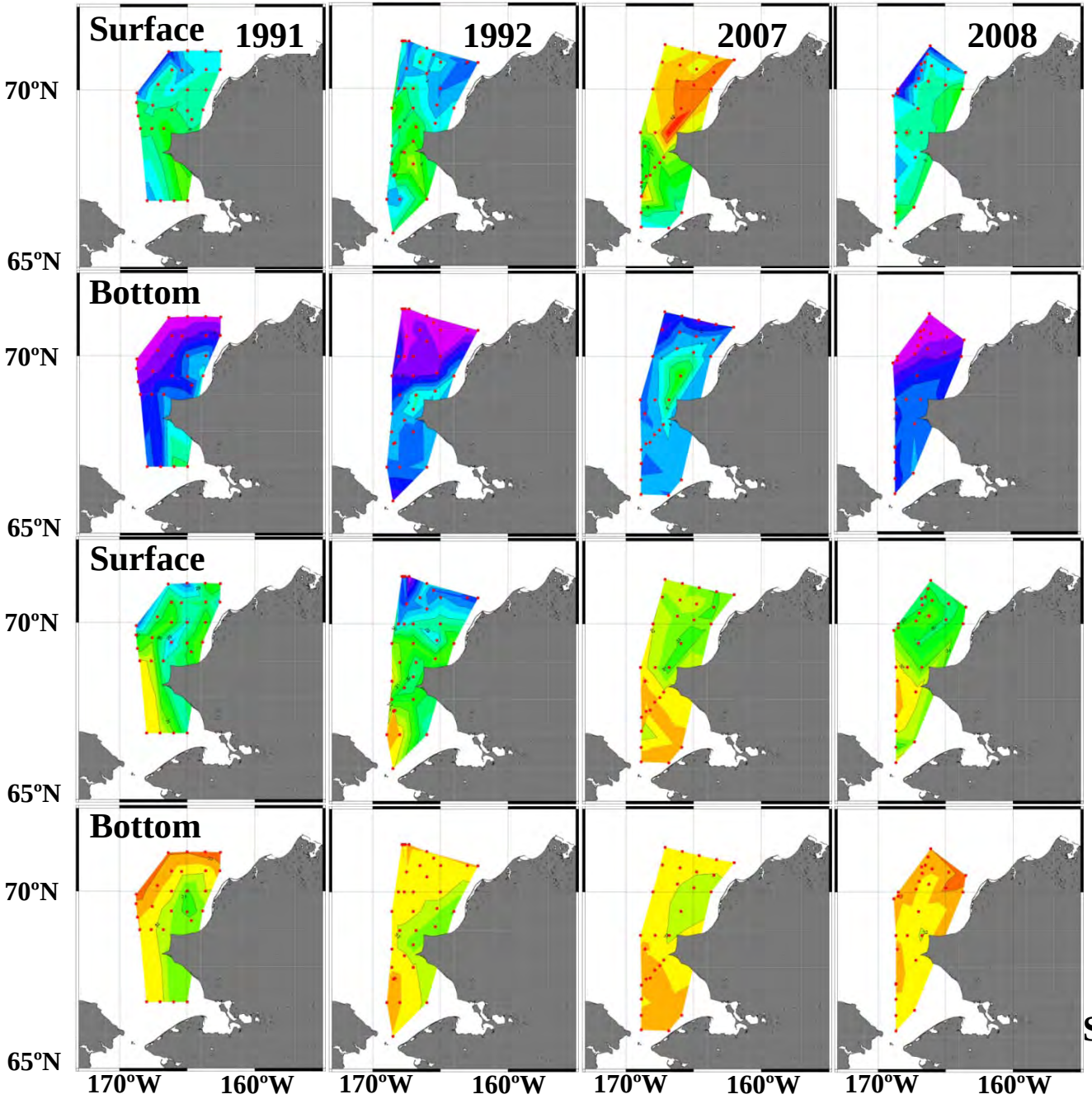


NORPAC net



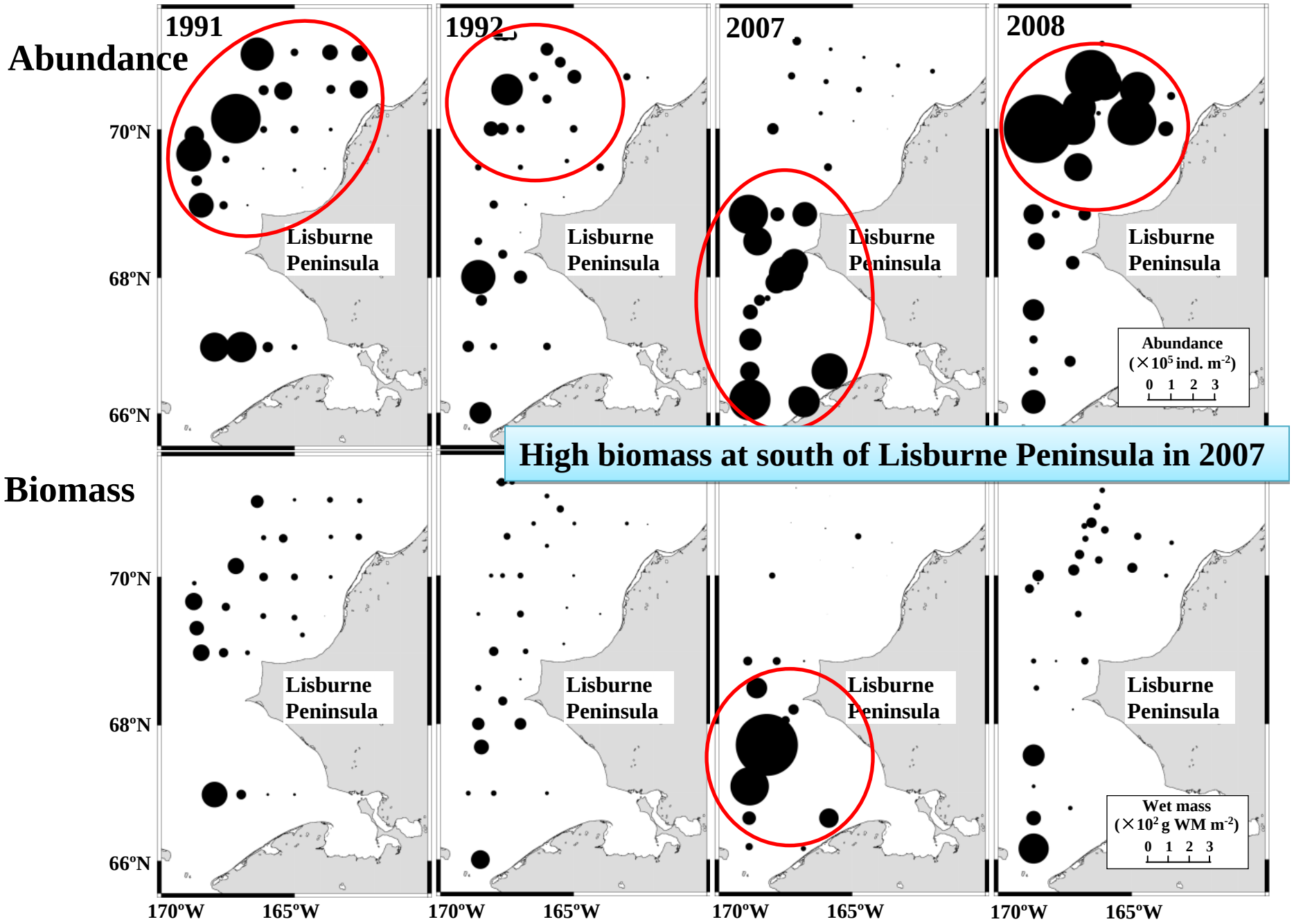
CTD

Results: Spatial distribution of temperature

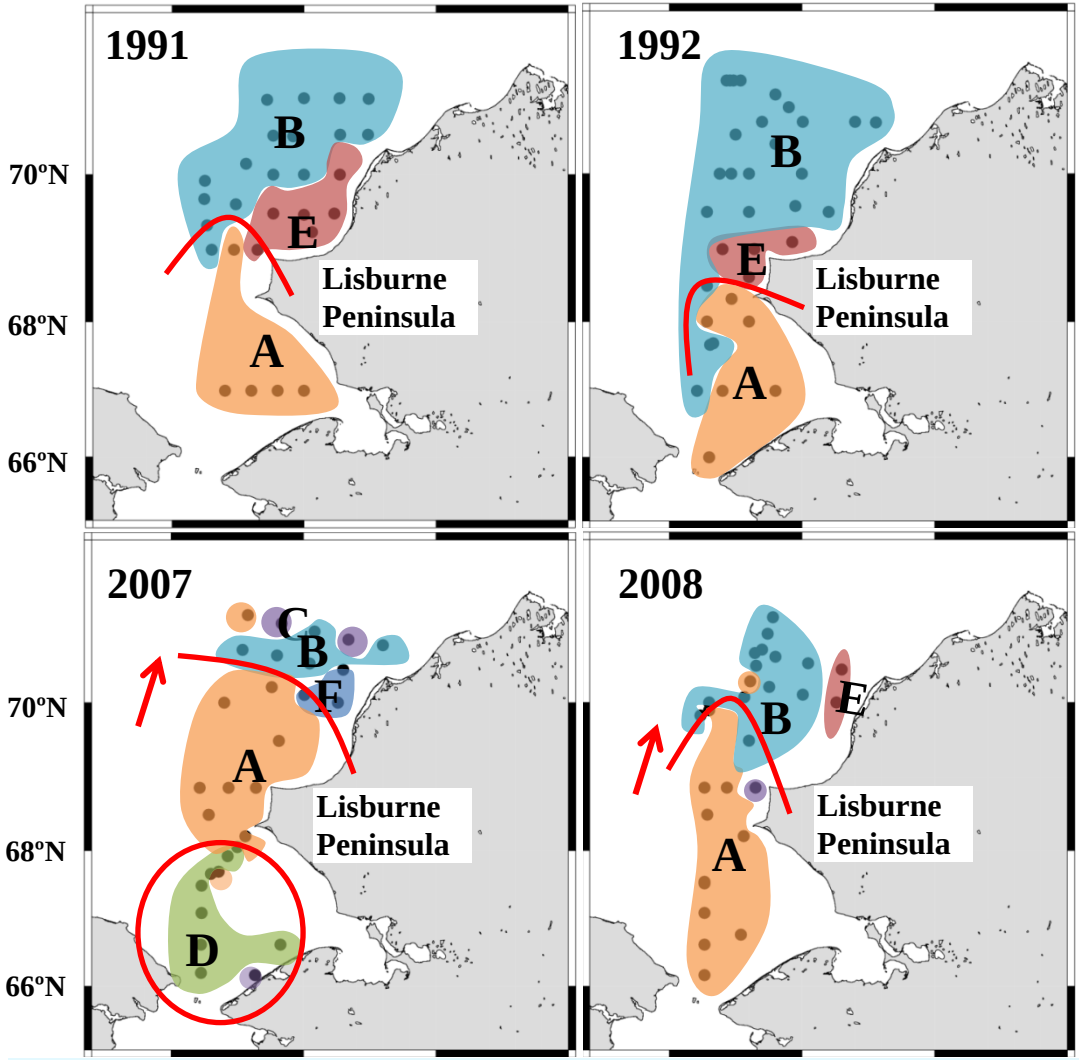


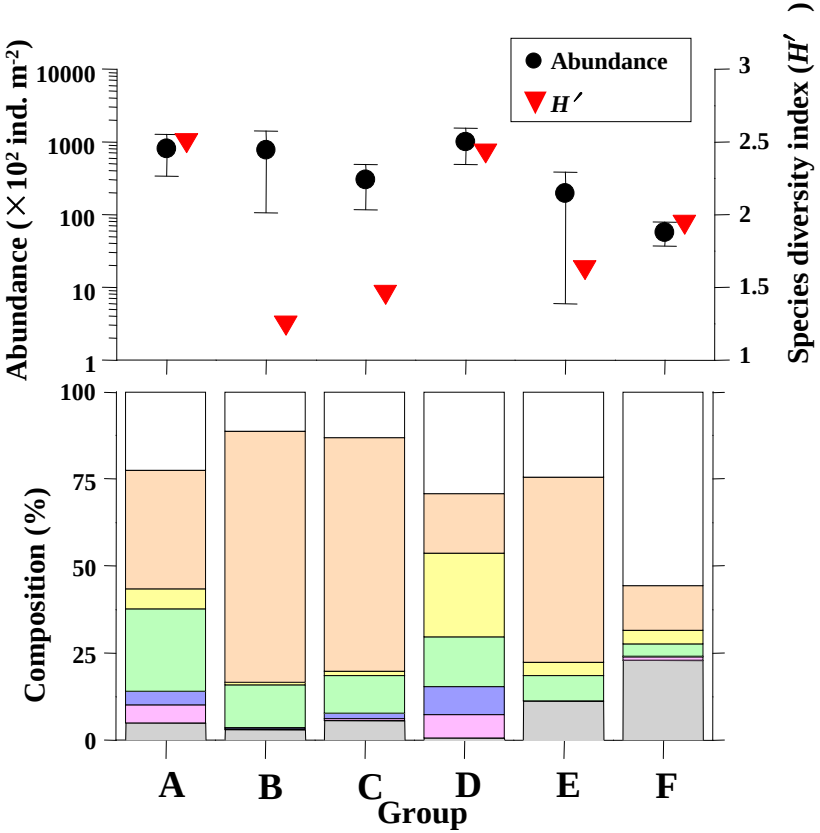
High temperature and salinity in 2007 may caused by the increased inflow of the PSW

Results: Zooplankton abundance and biomass



Results: Zooplankton community structure



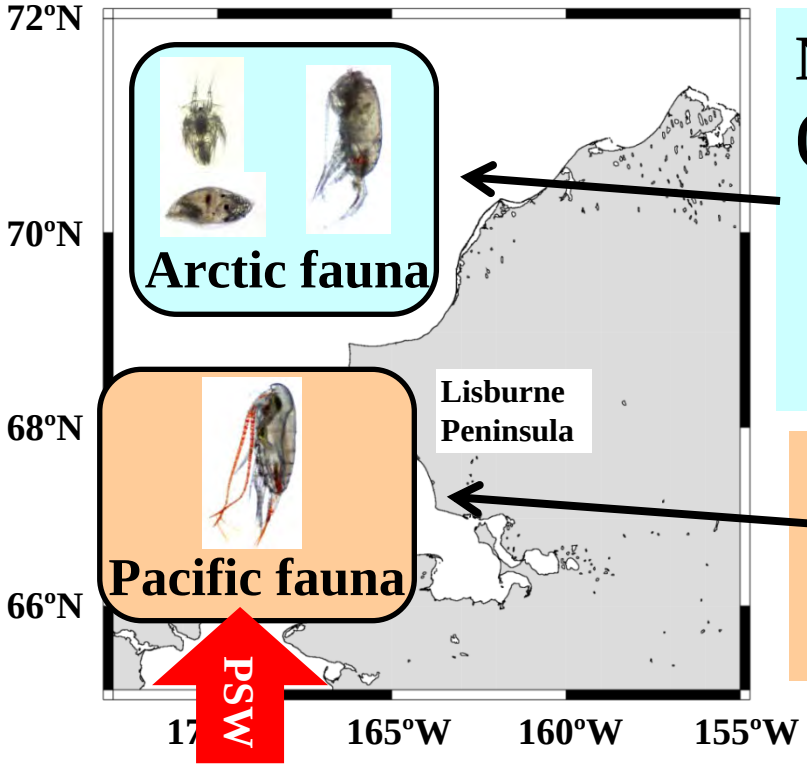


Calanus glacialis | *Eucalanus bungii*
Metridia pacifica | *Pseudocalanus* spp.
Other copepods | *Balanus* larvae
Other zooplankton taxa

In 2007, group D, characterized with Pacific species, was occurred in the south of Lisburne Peninsula. High biomass, species diversity and faster growth were the case of 2007.

Species	Mean copepodid stage			
	1991	1992	2007	2008
*C . glacialis***	3.32	3.61	4.34	2.92
E . bungii	3.44	3.85	2.91	3.85
*M . pacifica***	1.94	3.14	4.42	3.25

Summary: Zooplankton changes in the Arctic Ocean



North of the Lisburene Peninsula (Arctic fauna)

- 1991, 92: Normal condition
- 2007: Low biomass
- 2008: Dominance of barnacle larvae

South of the Lisburne Peninsula (Pacific fauna)

- 2007: High biomass, faster growth

North of the Lisburne Peninsula

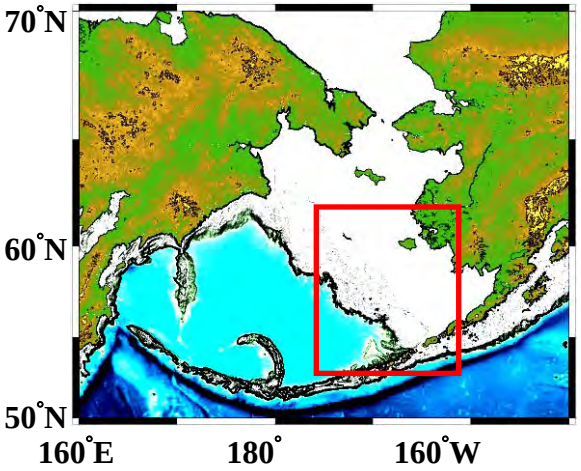
- Annual changes in sea ice coverage and benthic larvae
- Greatly varied with season and year

South of the Lisburene Peninsula

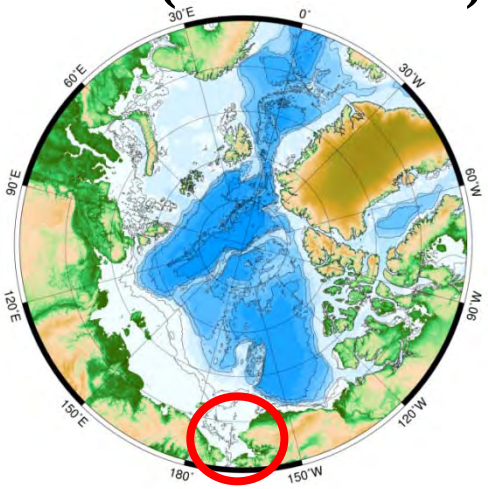
- Continuous inflow of the Pacific Summer Water (PSW)
- Productive ecosystem, less annual changes

Conclusion (future prospect)

Subarctic (SE Bering Sea)



Arctic (Chukchi Sea)



In the Pacific sector of the Arctic Ocean, amount of the Pacific fauna increased with increasing the Pacific Summer Water (PSW).

Since the Pacific fauna is completely different with the original Arctic fauna, the consequence of their invasion should be noticed. If once they colonize in the Arctic Ocean, because of the free niche, they might be possible to complete their life cycles.

Dominant zooplankton

1 mm

Atlantic species

C. finmarchicus

Arctic species

M. longa

C. glacialis

C. hyperboreus

Pacific species

N. plumchrus ***M. pacifica***

N. cristatus ***E. bungii*** ***N. flemingeri***