

Impact of oceanographic fluctuations on the northwestern Bering Sea ecosystem

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Svetlana Naydenko², and Alexey Somov²



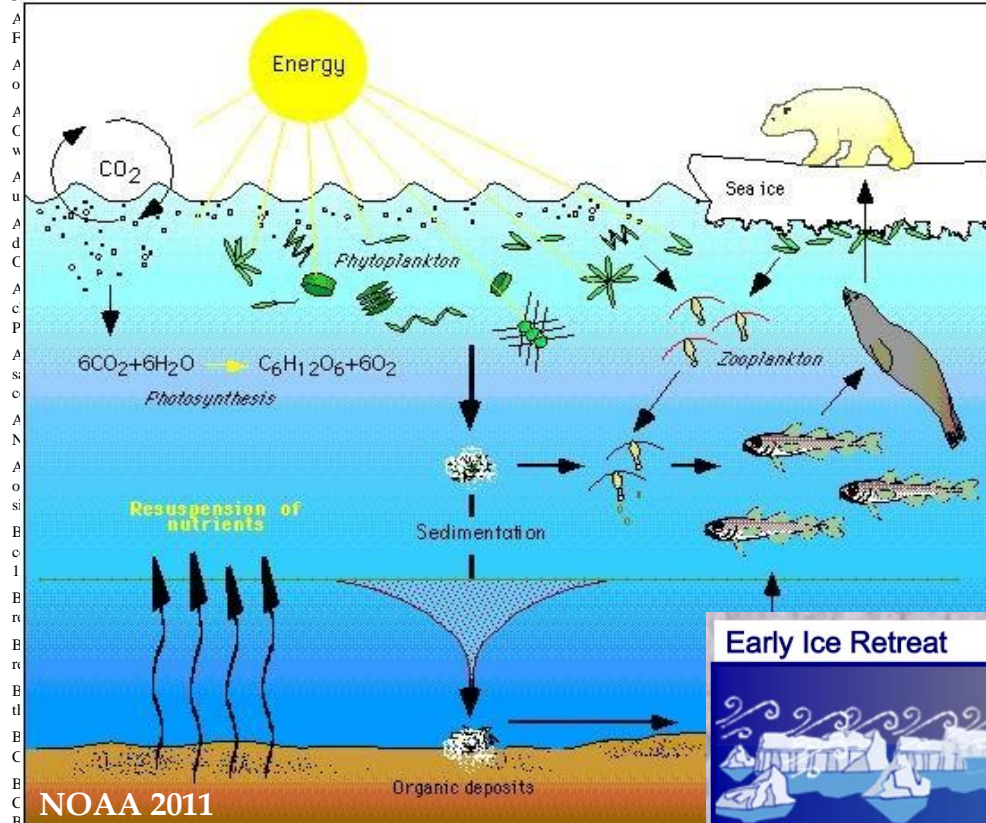
¹North Pacific Fisheries Commission (Tokyo);

²TINRO-Center (Vladivostok, Russia)

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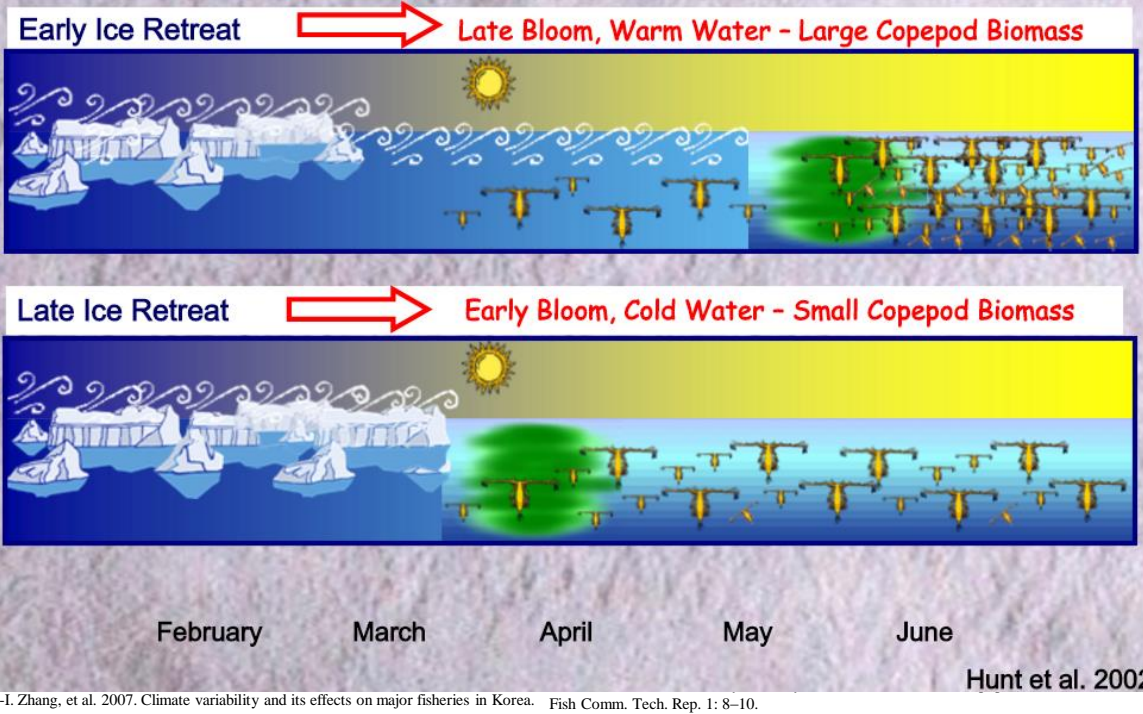
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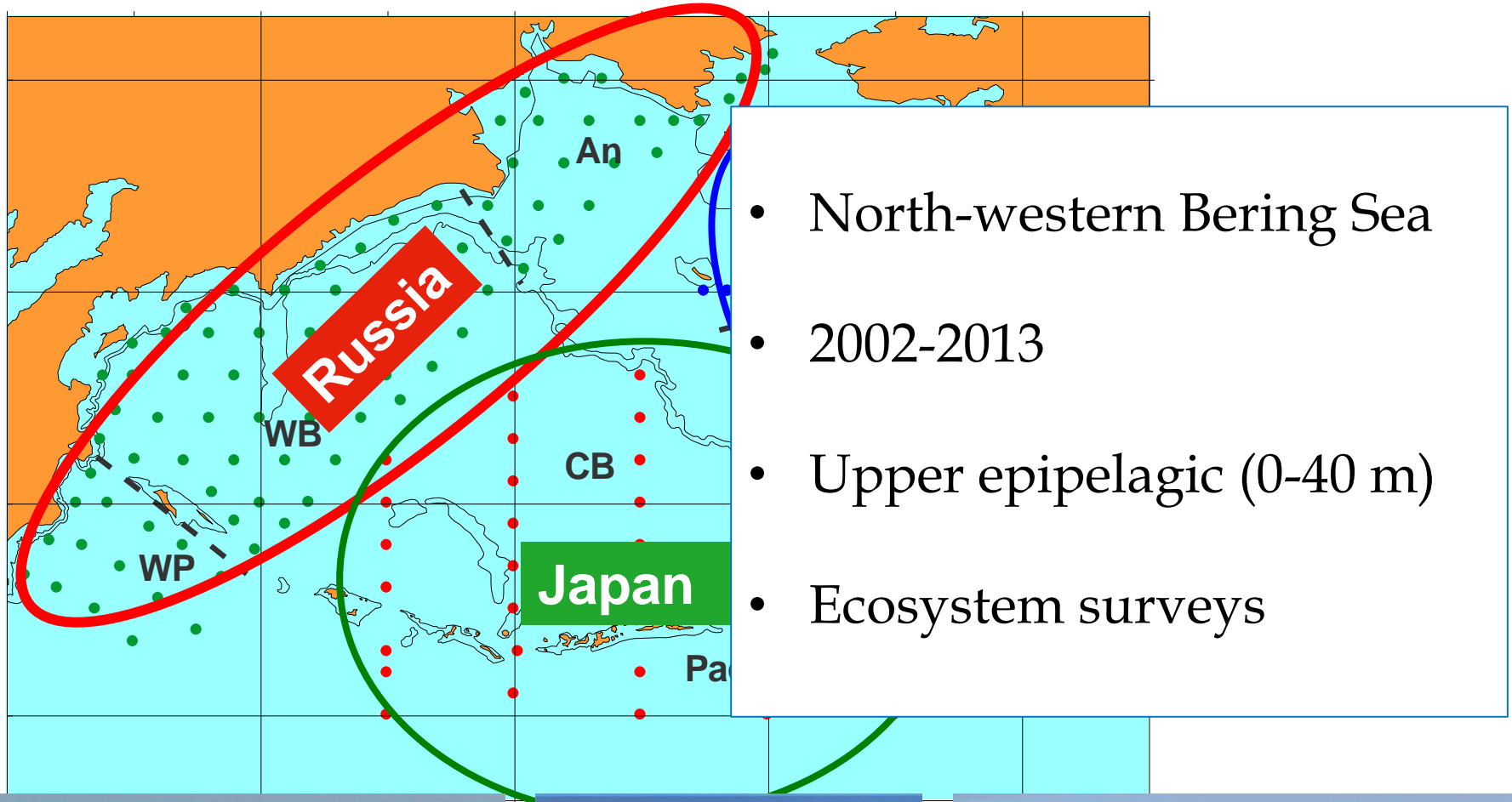
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Hunt et al. 2002

Bering-Aleutian Salmon International Survey (BASIS), 2002-2013

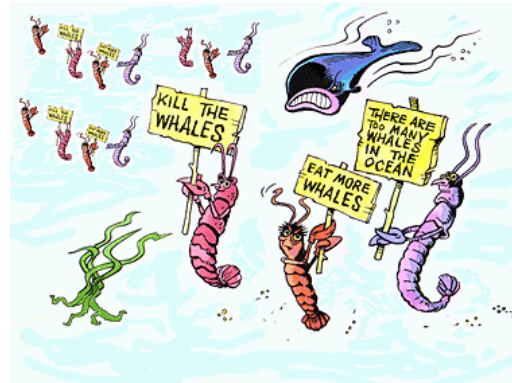
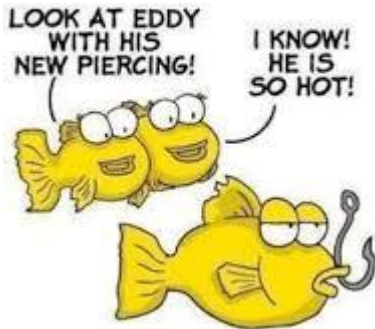


Changes in water circulation

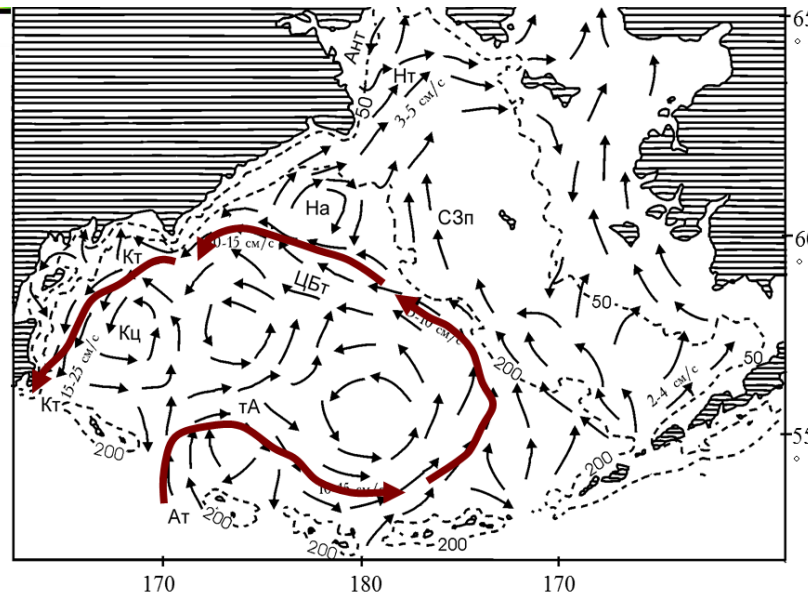
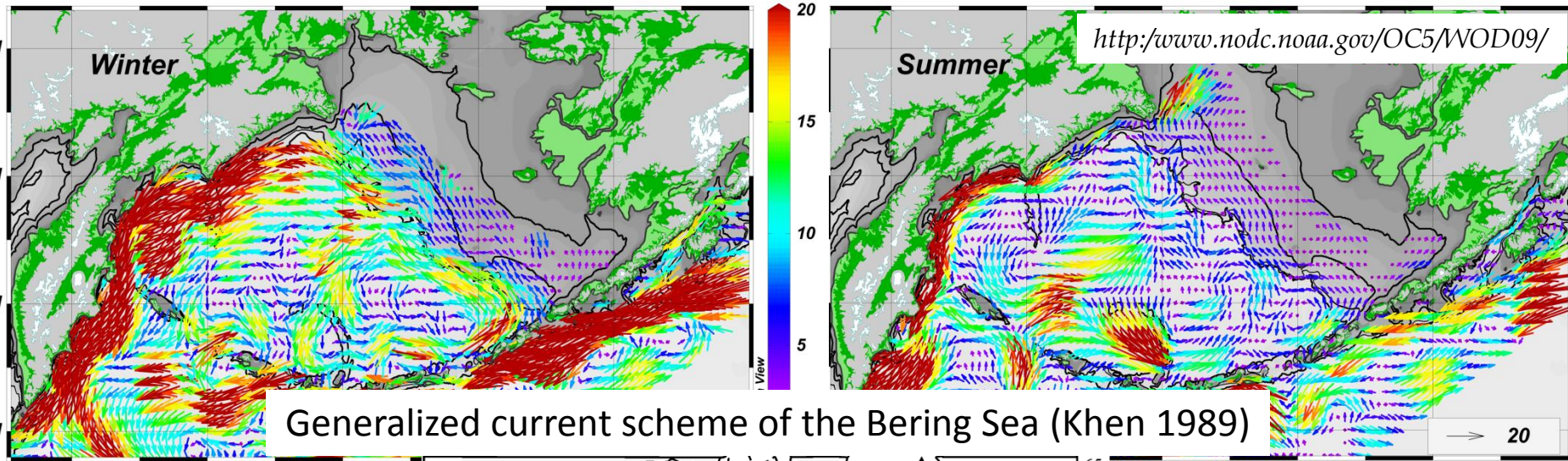
Pelagic fish

Zooplankton

Trophic interactions



Direction and speed of the currents in the Bering Sea in winter and summer, 40 m depth, based on the data of 510 drifting buoys, 1986-2007



Dynamic topography of the surface waters in the Bering Sea relative to 1000 db in **fall**

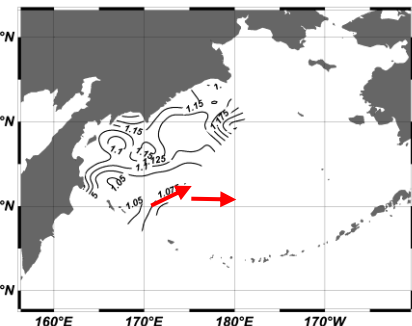
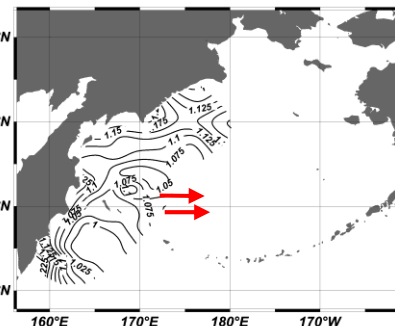
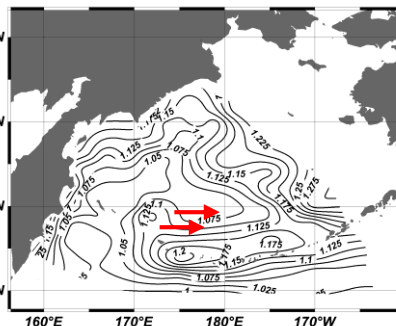
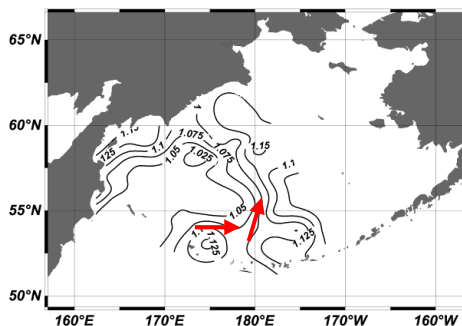
2002

2003

2004

2006

Before change



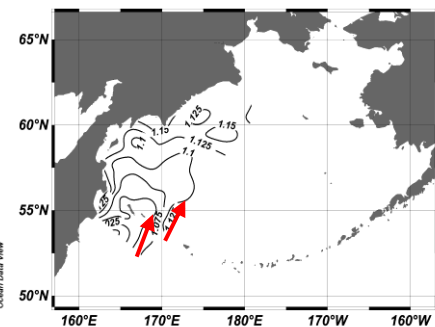
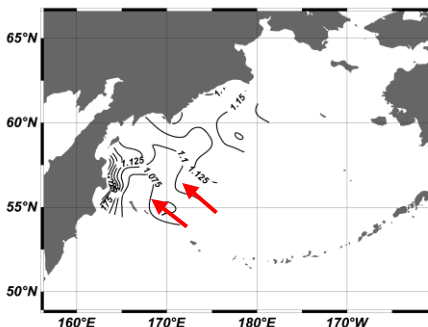
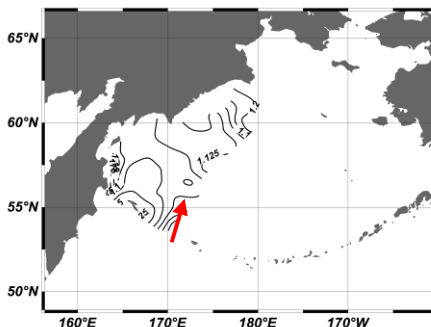
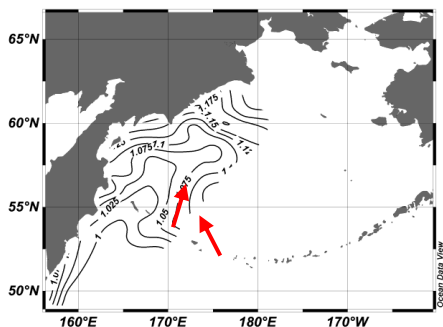
2007

2008

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2010

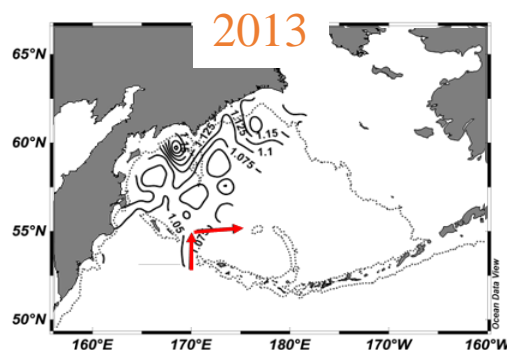
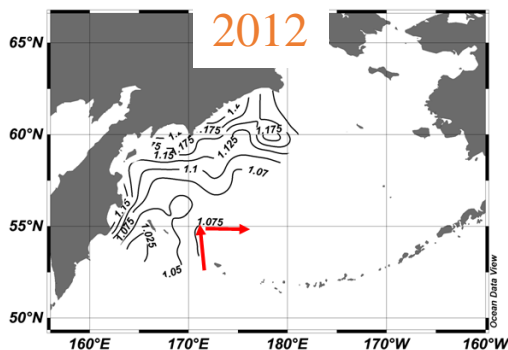
After change



2012

2013

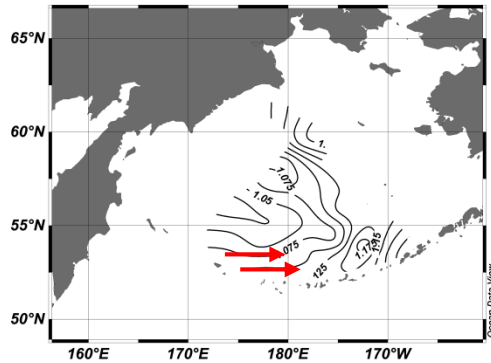
Change back



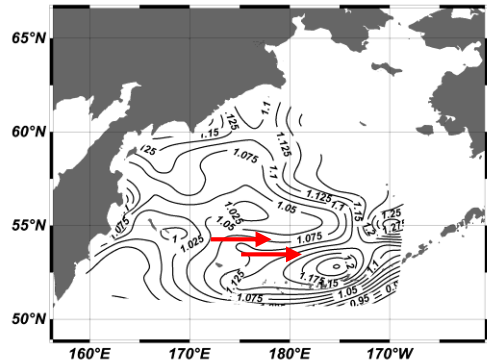
Dynamic topography of the surface waters in the Bering Sea relative to 1000 db in **summer**

Before change

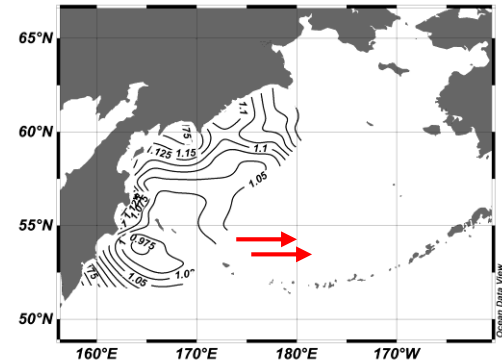
2002



2003

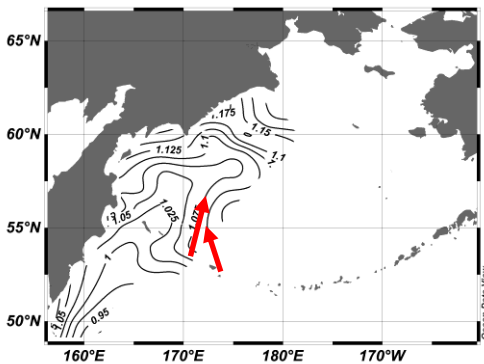


2005

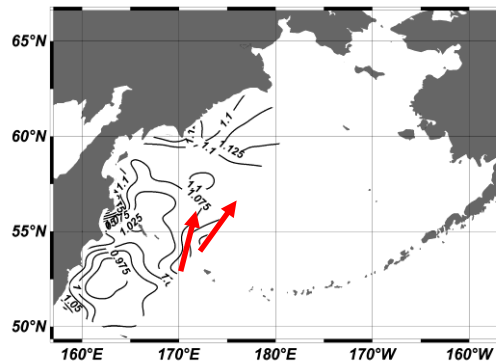


After change

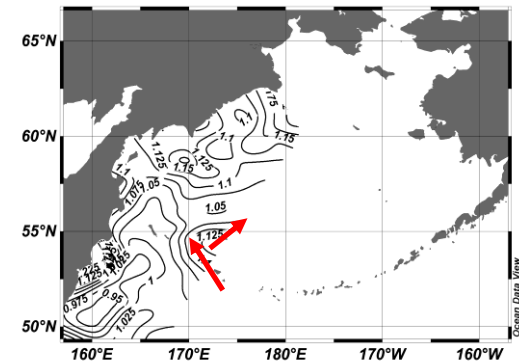
2007



2009

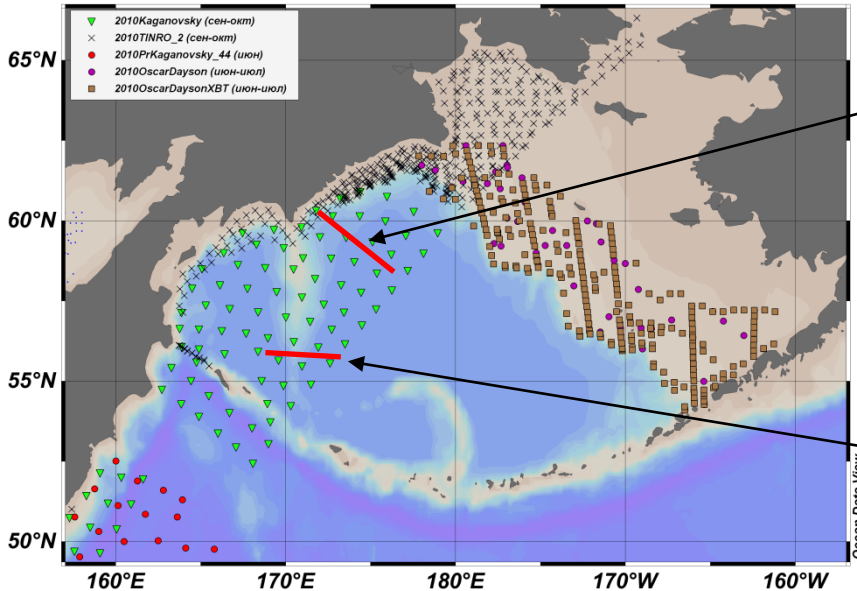


2011

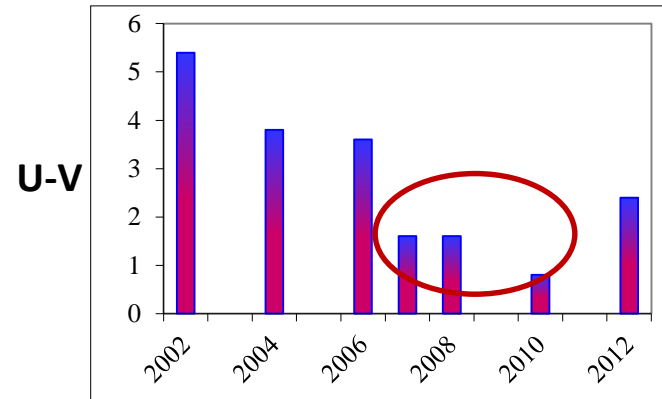
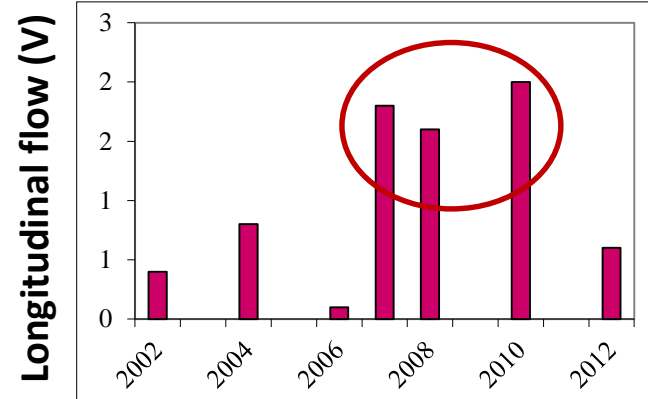
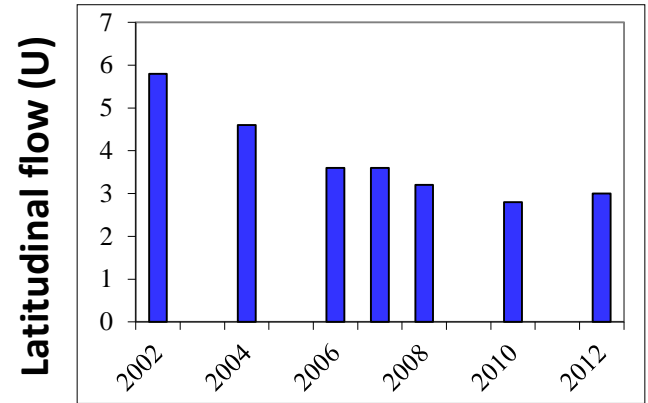


Water transport (Sv) from the Aleutian Basin to west (latitudinal flow) and from the Near Strait to north (longitudinal flow) in fall 2002-2012

Latitudinal and longitudinal transects

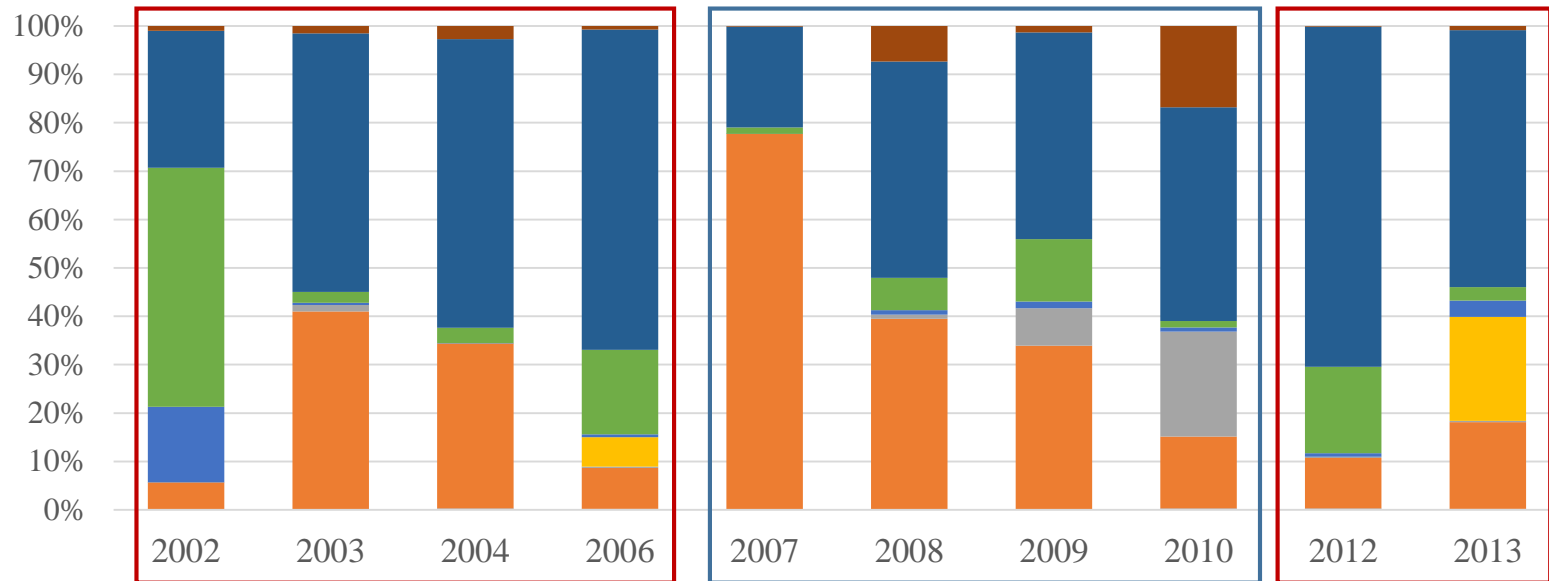


Significant change in water circulation occurred in the BS in 2007-2011 that probably resulted in lower water inflow to the north areas

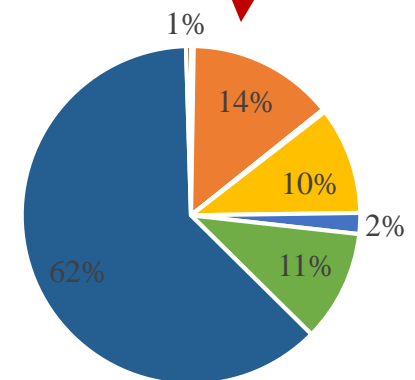
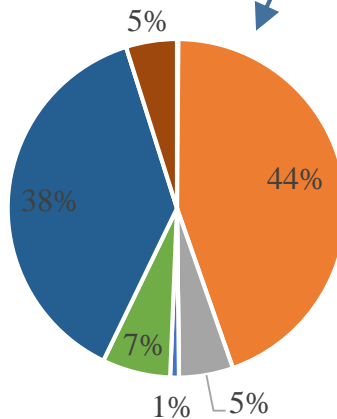
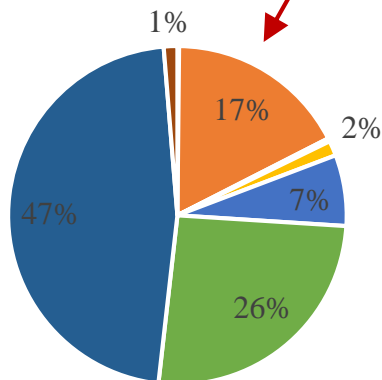


Pelagic fish

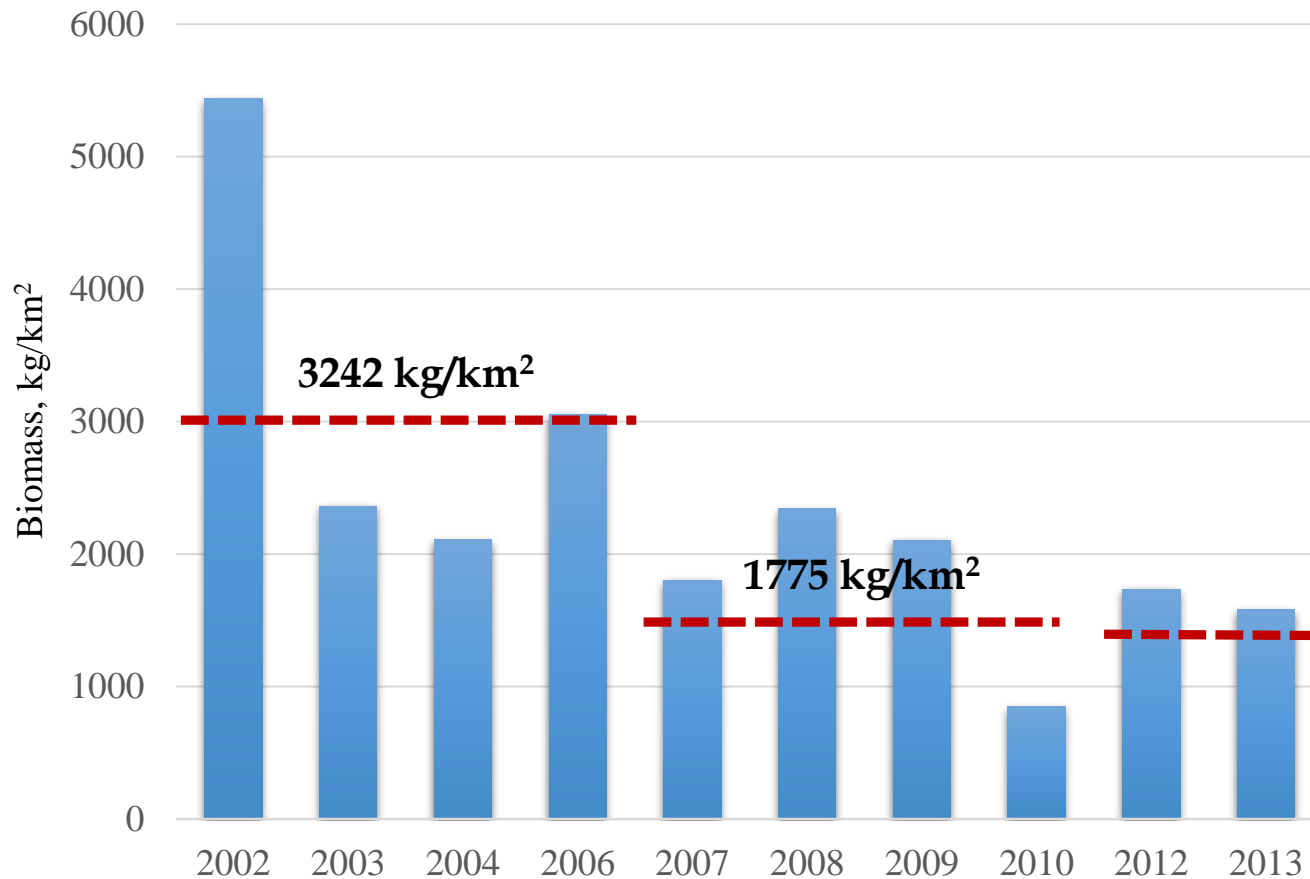
Changes of weight percentage of nekton species in the upper epipelagic layer of the Aleutian Basin in fall 2002–2013



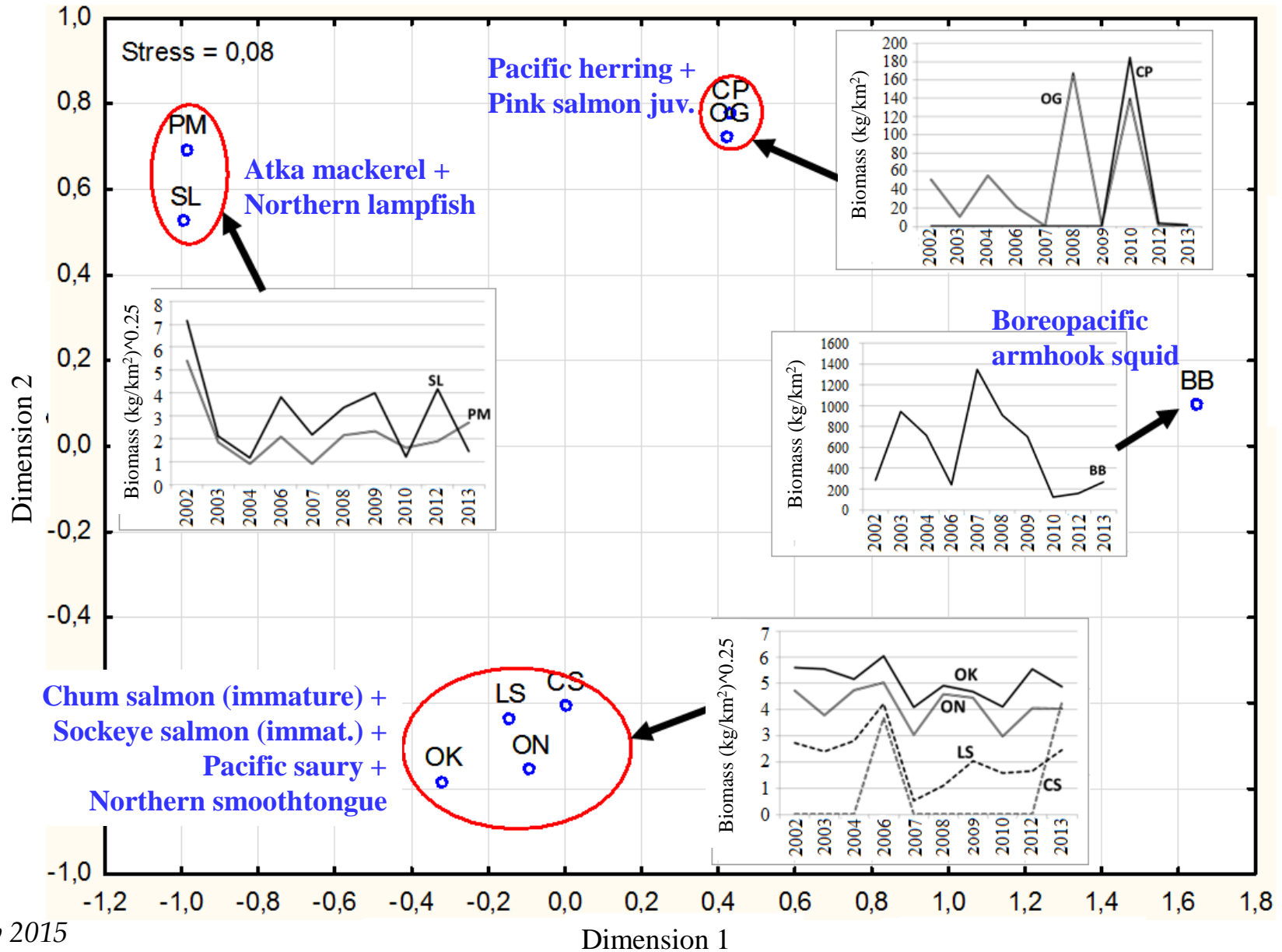
- Other
- Squids
- Shelf fish
- Pacific saury
- Atka mackerel
- Mesopelagic fish
- Pacific salmon (adult)
- Pacific salmon (juv)



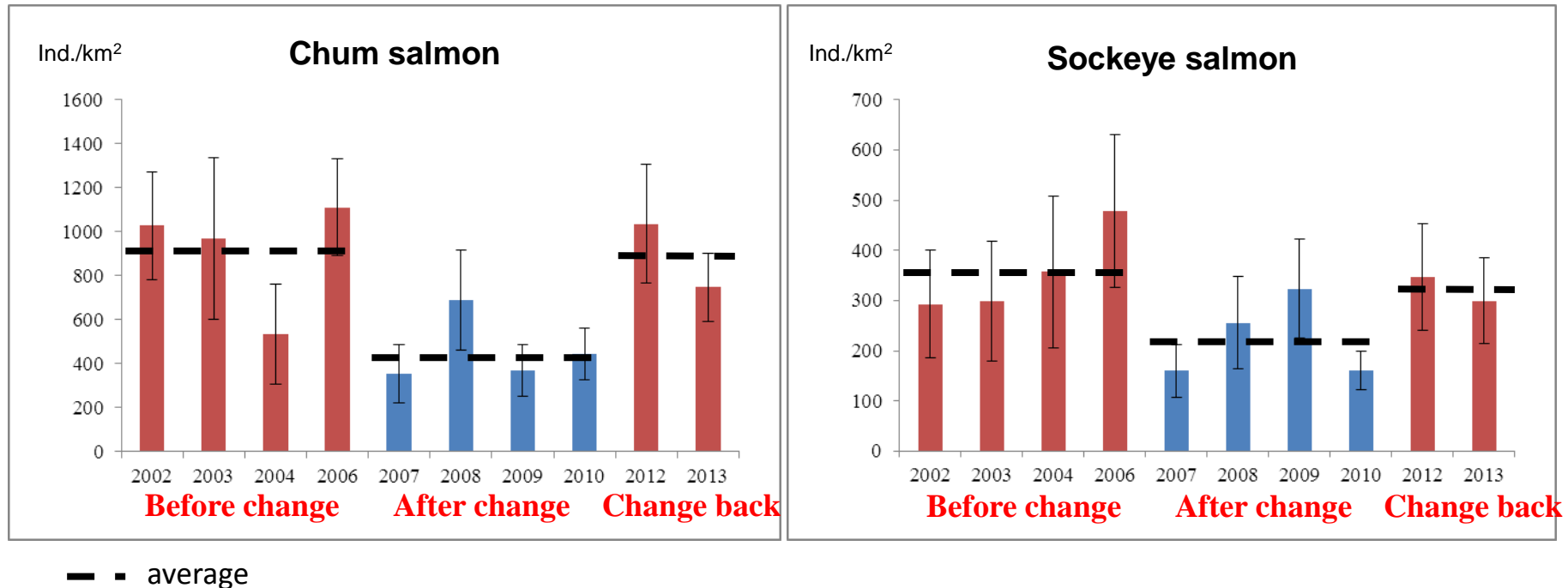
Year-to-year changes in total nekton biomass in the upper epipelagic layer of the Aleutian Basin



Classification of the dominant nekton species by similarity of year-to-year dynamics of their biomasses in the Aleutian Basin



Changes in immature salmon abundance in the western Bering Sea in fall 2002-2013



Abundance of immature salmon in the western Bering Sea sharply decreased after change in water circulation (2007-2010) and then increased as soon as water circulation changed back (2012-2013) probably resulting from weakening of oceanic water inflow to the Bering Sea

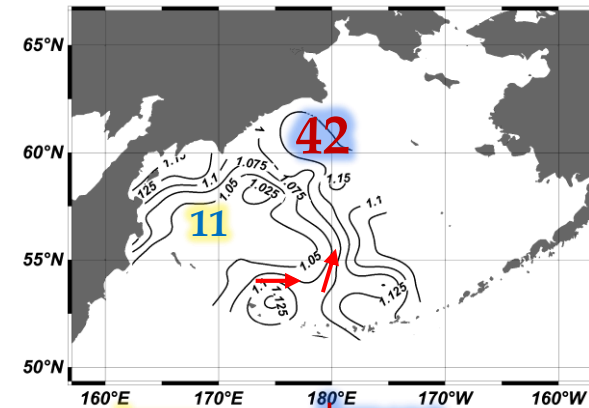
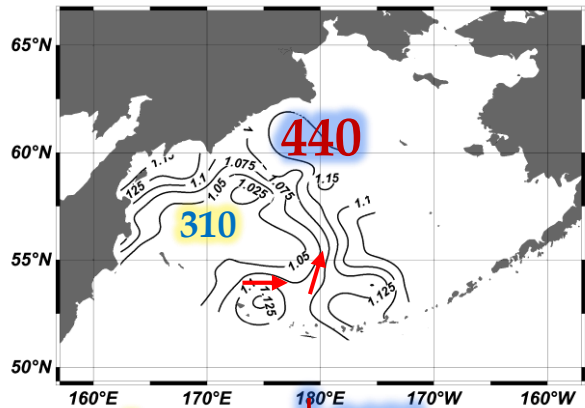
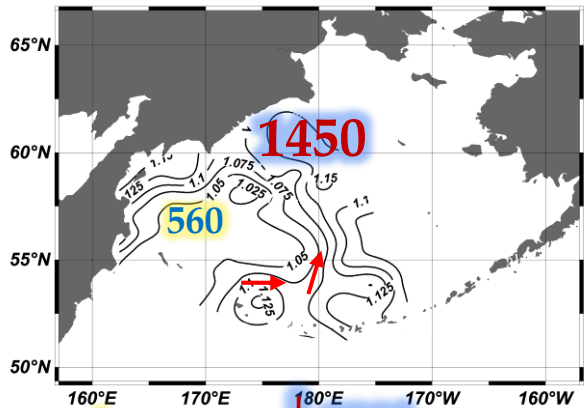
Changes in salmon abundance in the Aleutian and Commander Basins

Chum salmon

Sockeye salmon

Chinook salmon

Before change
2002-2006

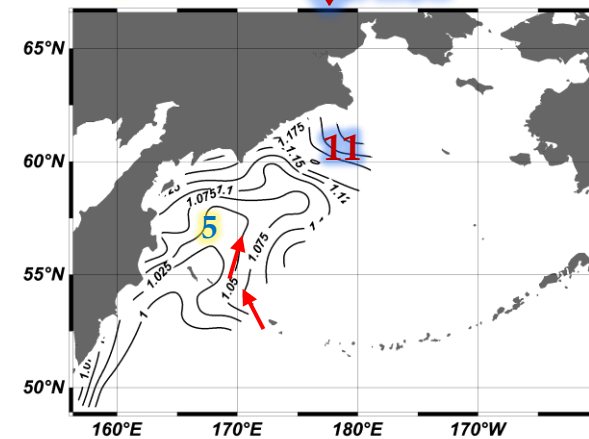
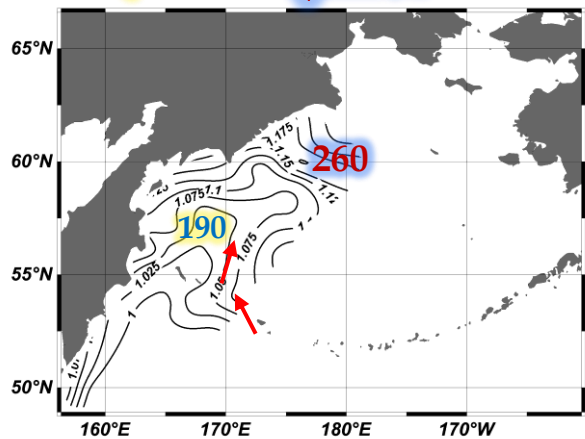
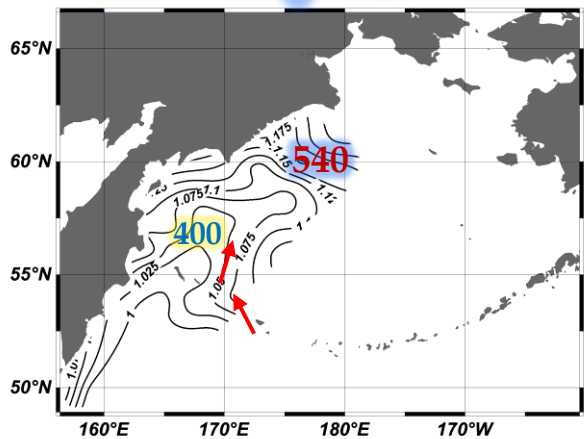


↓29% ↓63%

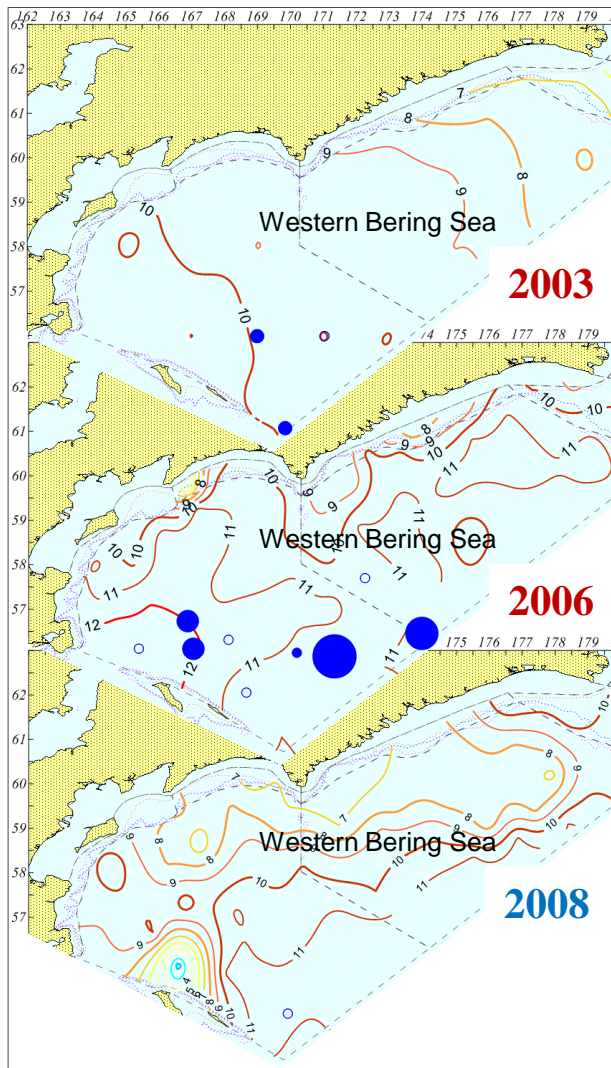
↓39% ↓41%

↓55% ↓74%

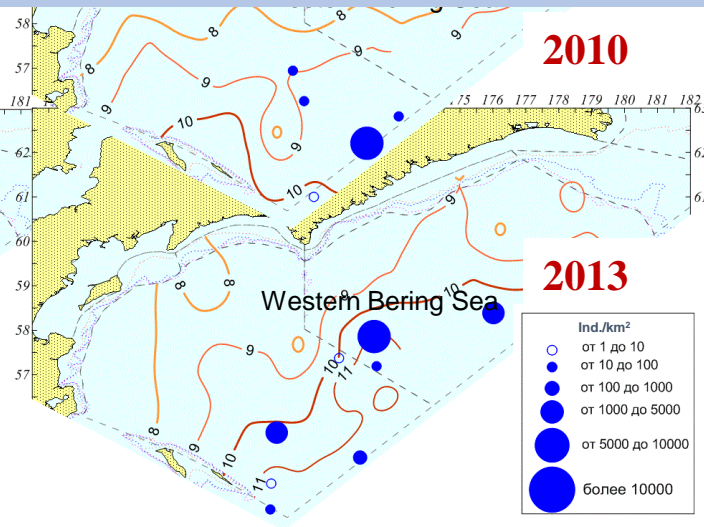
After change
2007-2011



Pacific saury distribution in the western Bering Sea in September-October

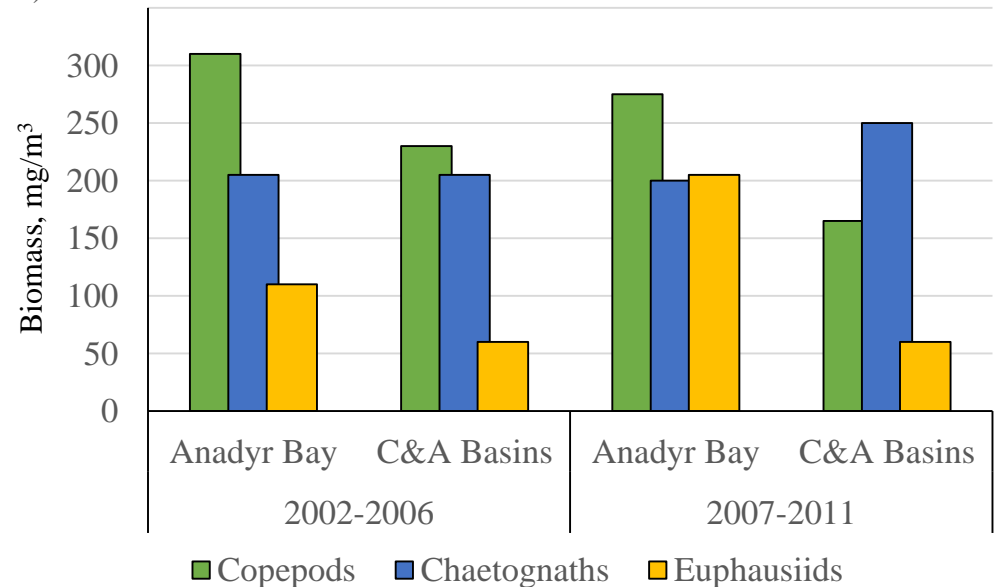
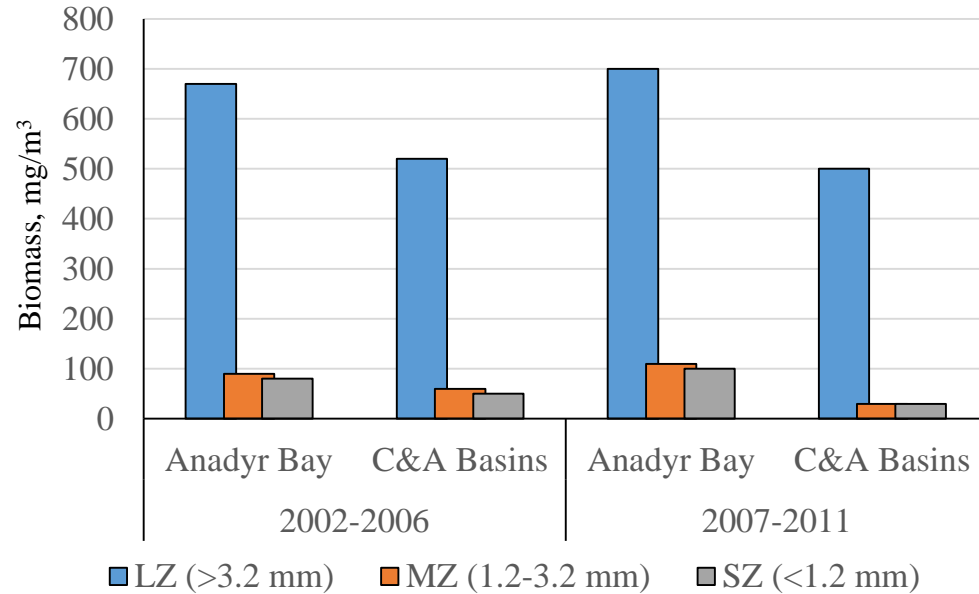


Changes in water circulation apparently affected distribution and abundance of highly migratory fish (salmon, saury) and might cause biomass fluctuations of squids and mesopelagic fish

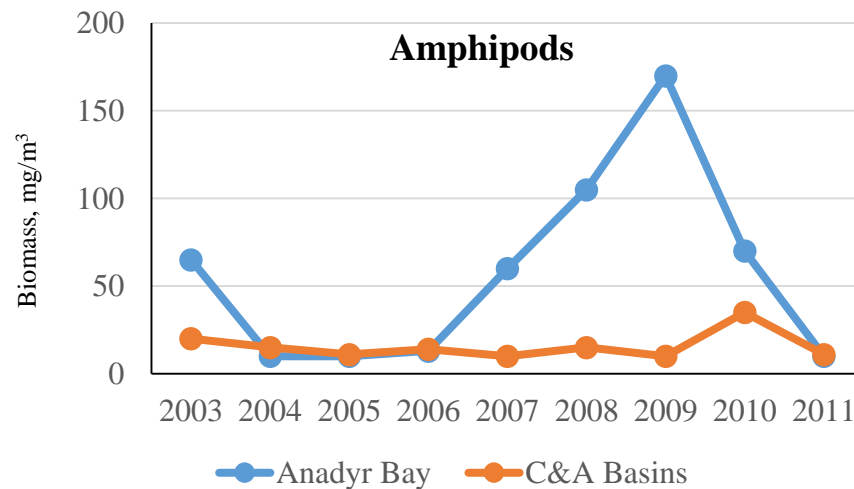
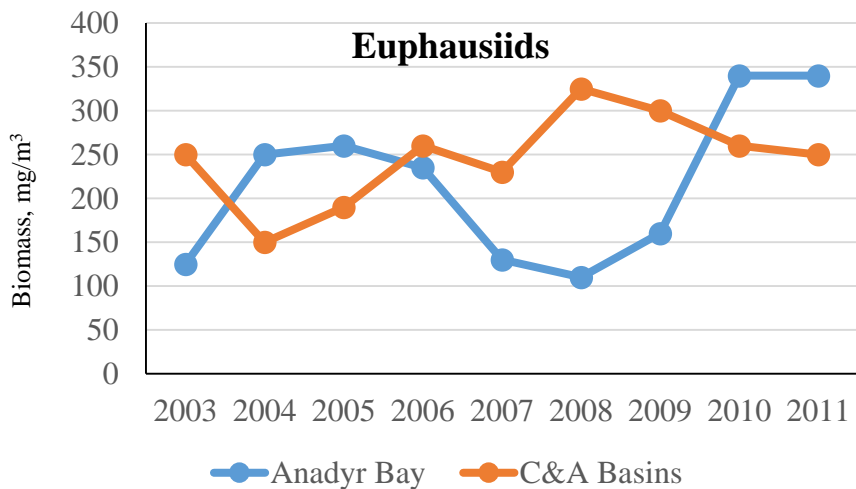
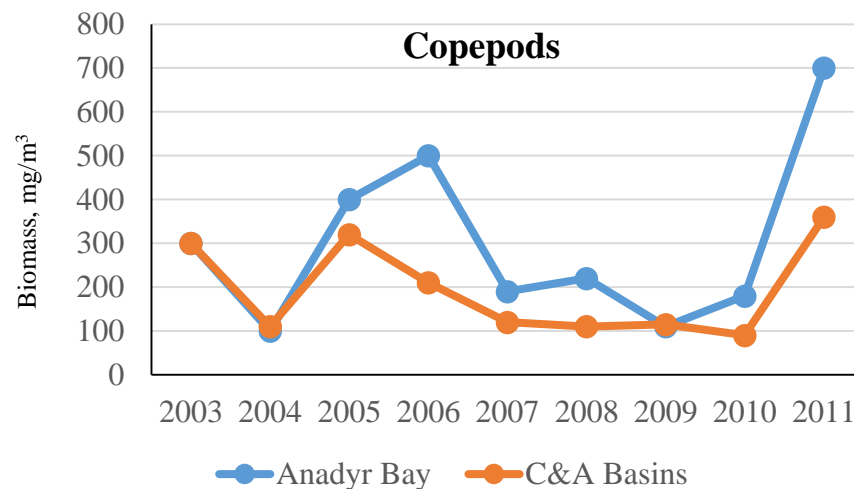
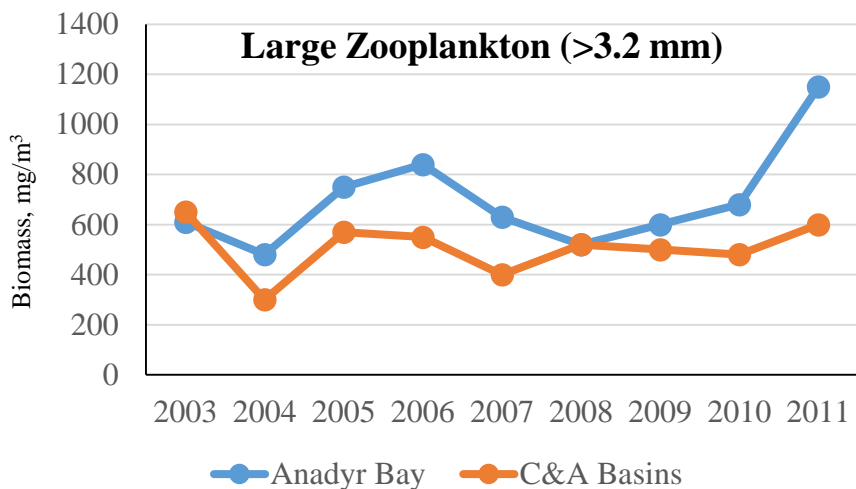


Zooplankton

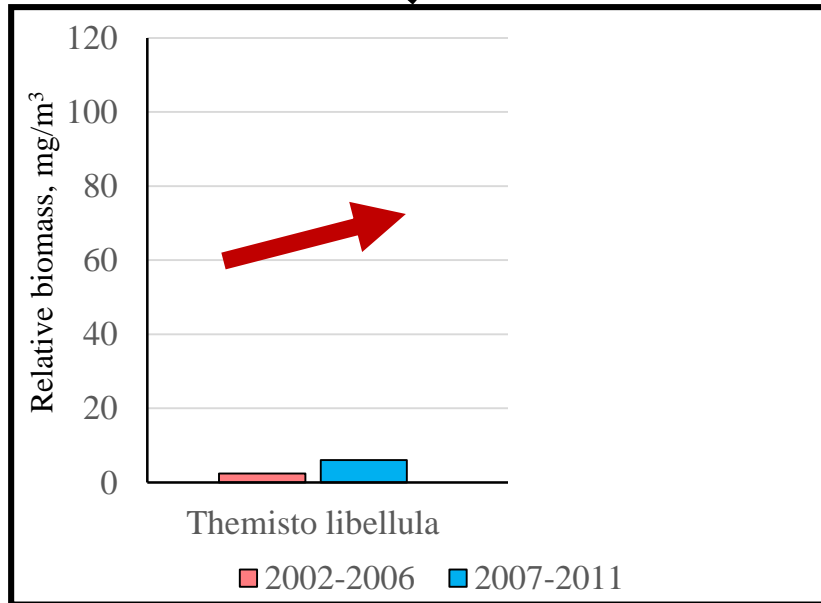
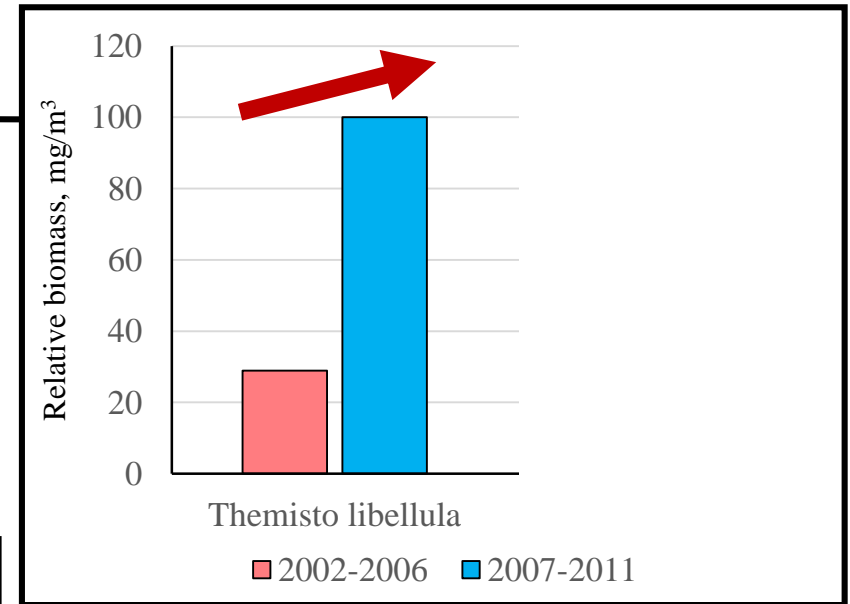
Zooplankton biomass in the western Bering Sea averaged for 2002-2006 and 2007-2011



Changes in zooplankton biomass in the western Bering Sea in 2002-2011



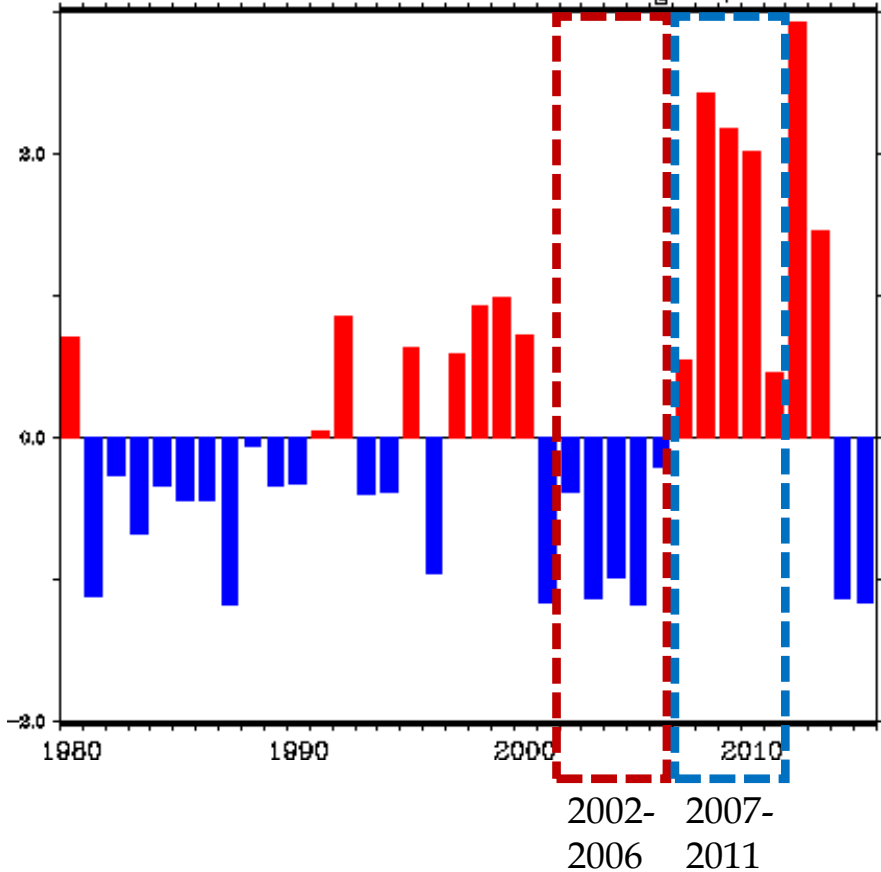
Relative biomass of *Themisto libellula* and *Oithona similis* averaged for 2002-2006 and 2007-2011



Winter ice cover anomalies, Bering Sea, and SST anomalies, Pribilof Islands

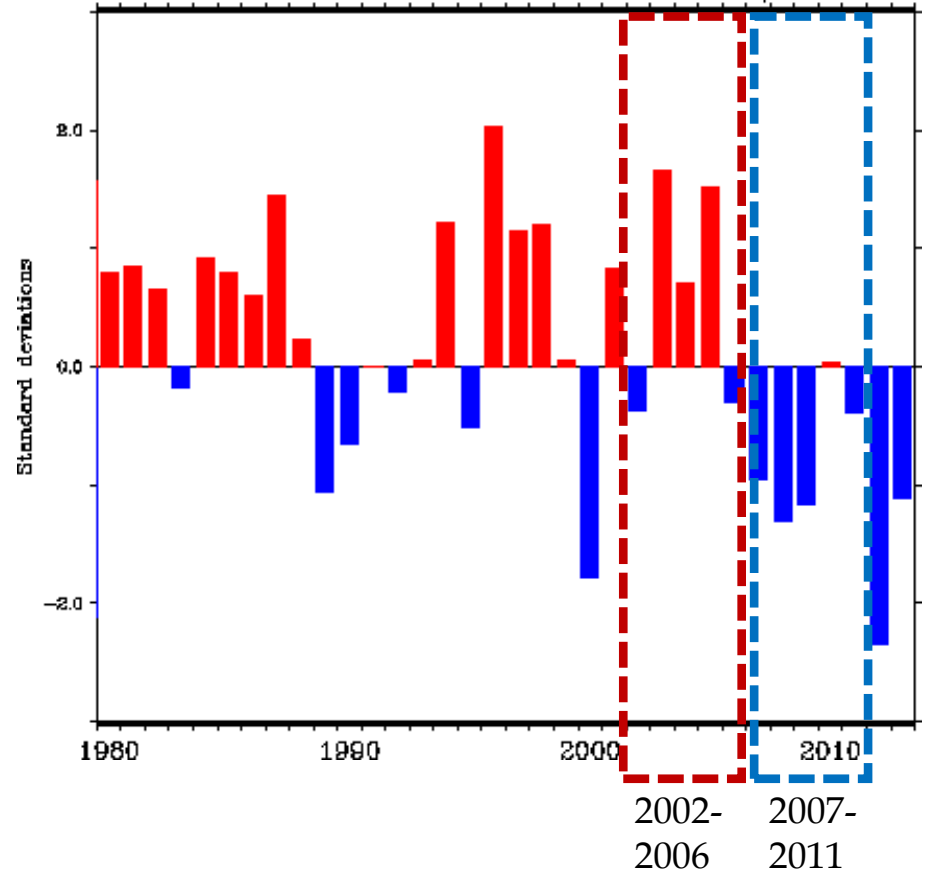
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Winter Ice Cover Index Anomalies (Winter)
Bering Sea, 1980-2016

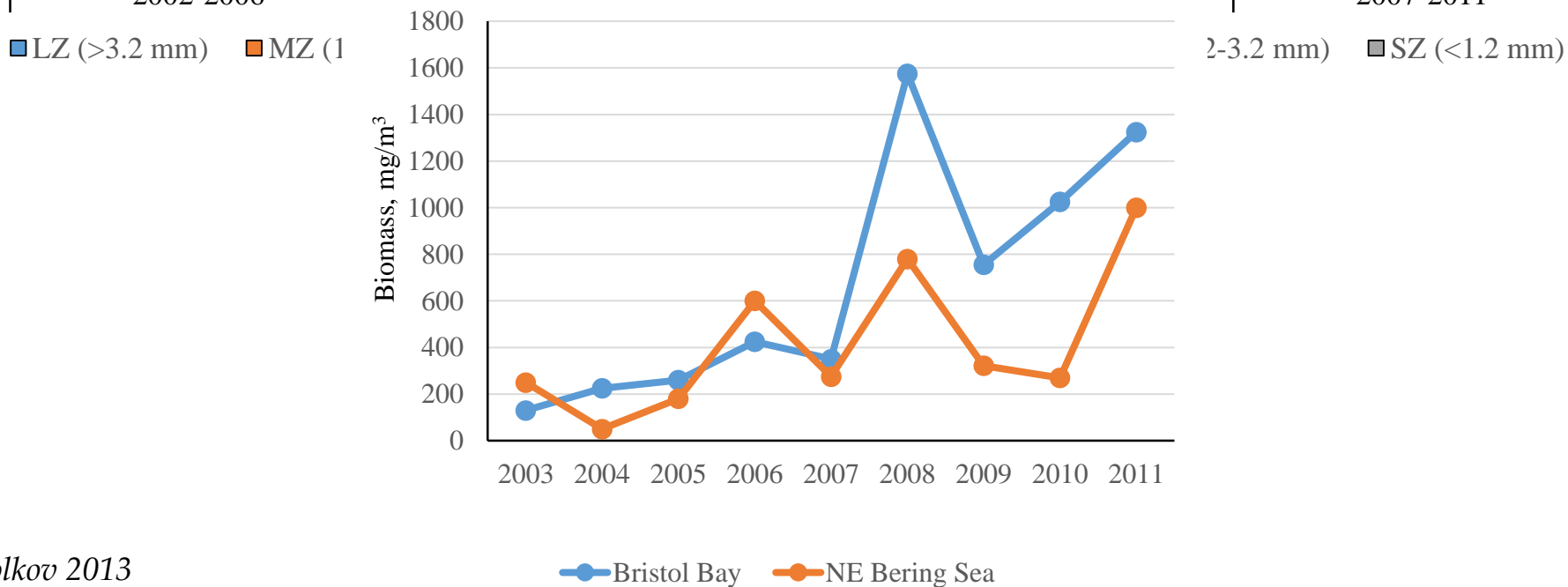
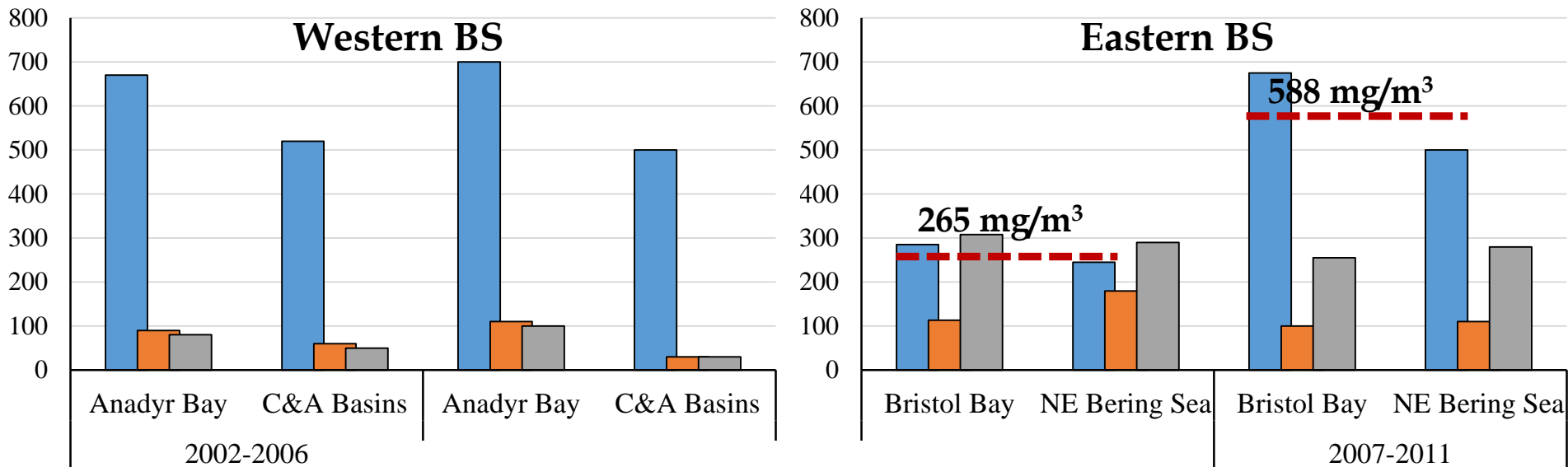


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SST anomalies (Jan-Mar)
Pribilof Islands, 1948-2013

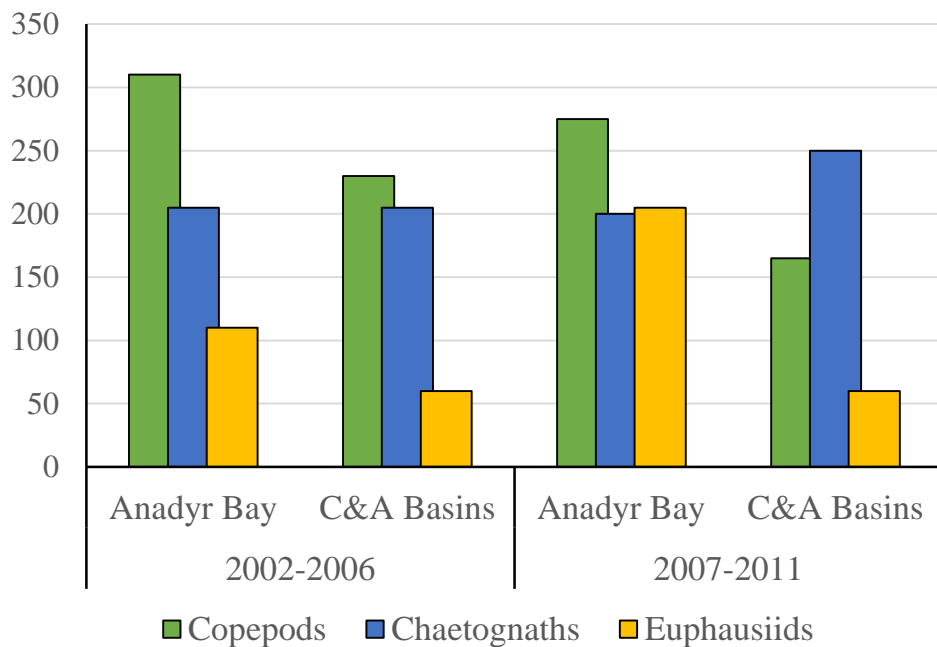


Zooplankton biomass, **western vs eastern** Bering Sea, averaged for 2002-2006 and 2007-2011

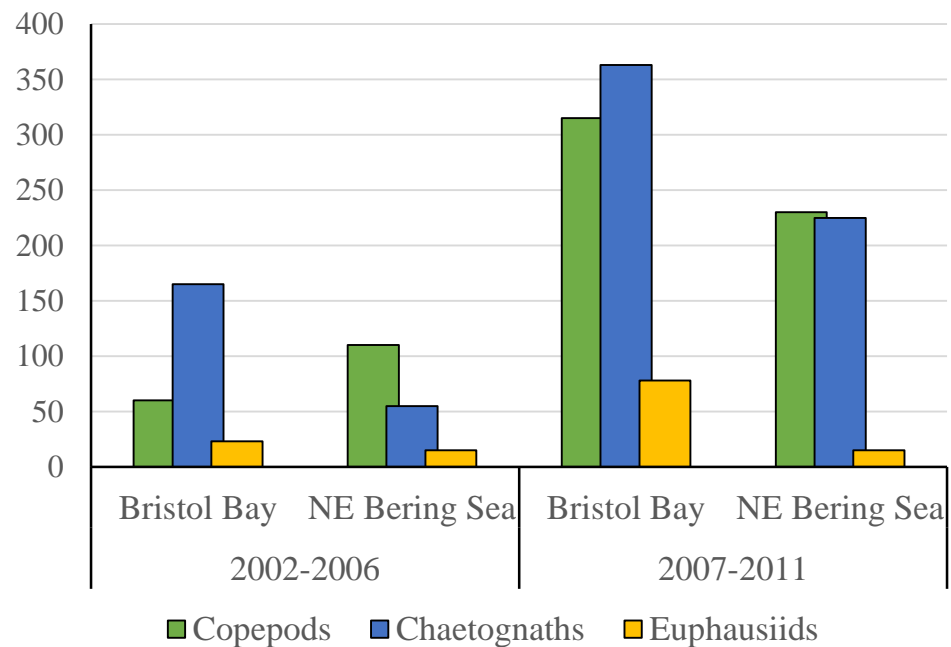


Zooplankton biomass, **western vs eastern** Bering Sea, averaged for 2002-2006 and 2007-2011

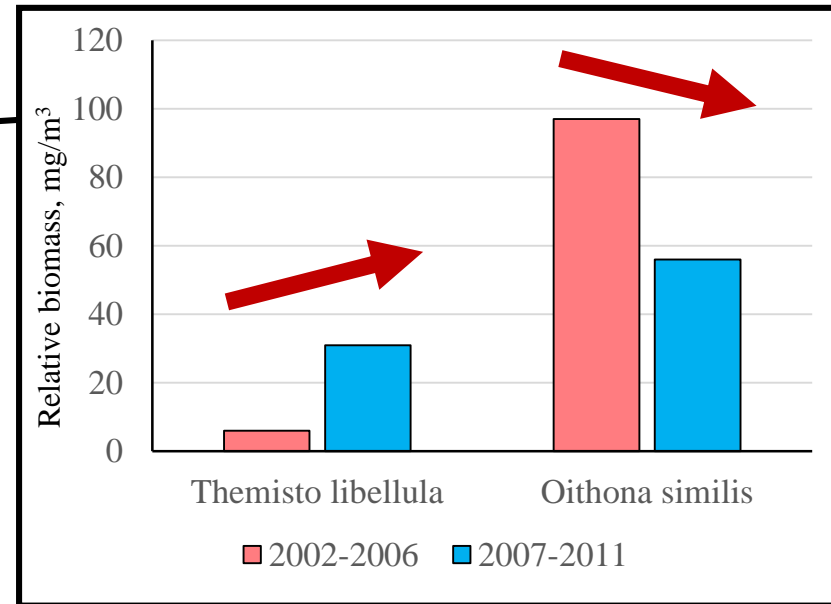
Western BS



Eastern BS

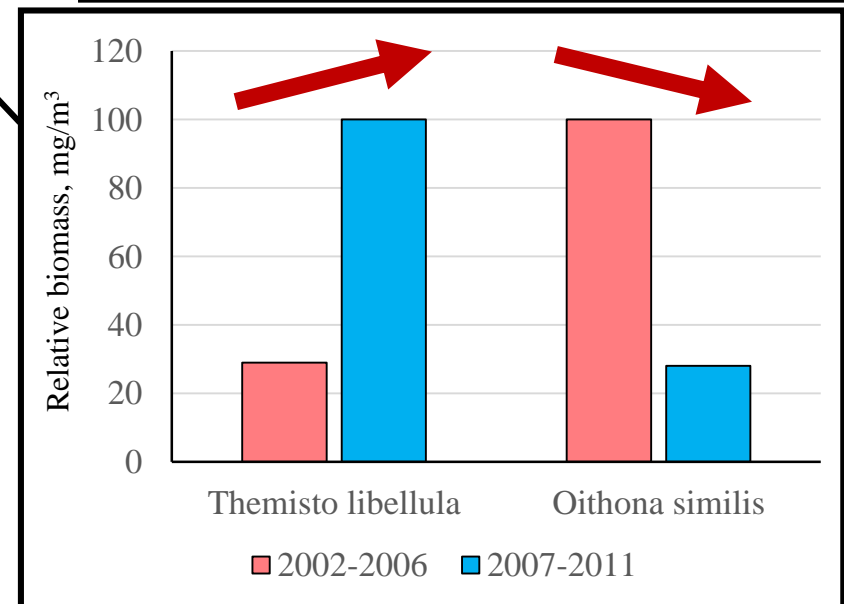


Relative biomass of *Themisto libellula* and *Oithona similis* averaged for 2002-2006 and 2007-2011



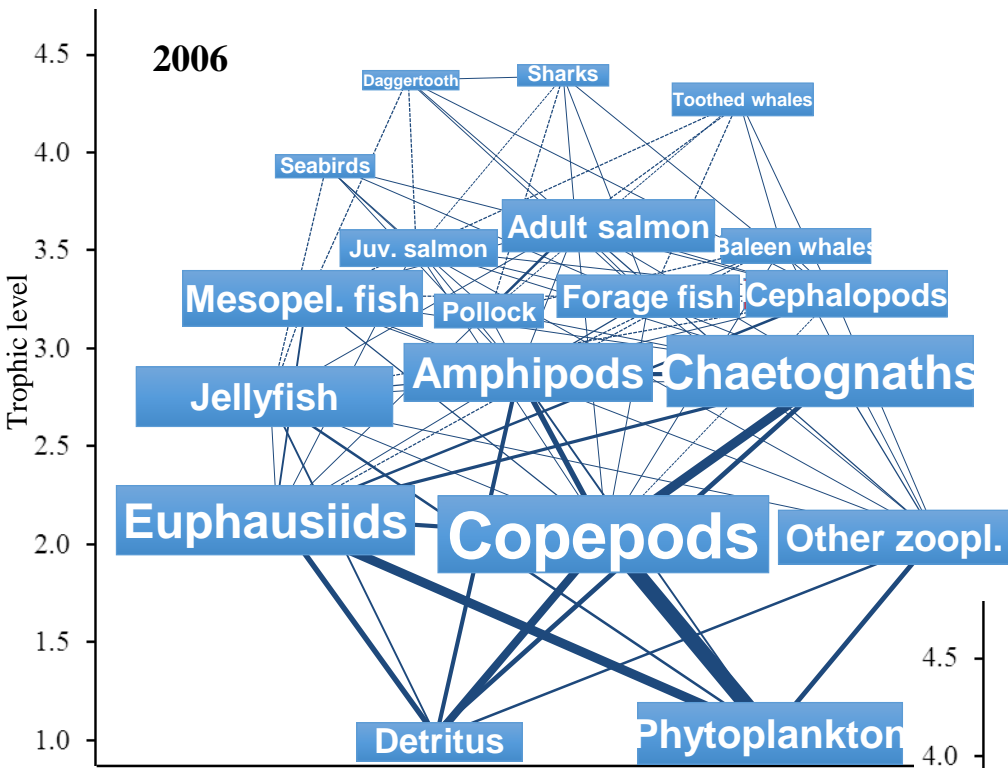
Oceanographic shift in 2006/2007 temporarily coincided with sharp increase in zooplankton biomass in the EBS.

Throughout the sea, biomass of cold-water species *T. libellula* increased while biomass of *O. similis* decreased after the change in water circulation.

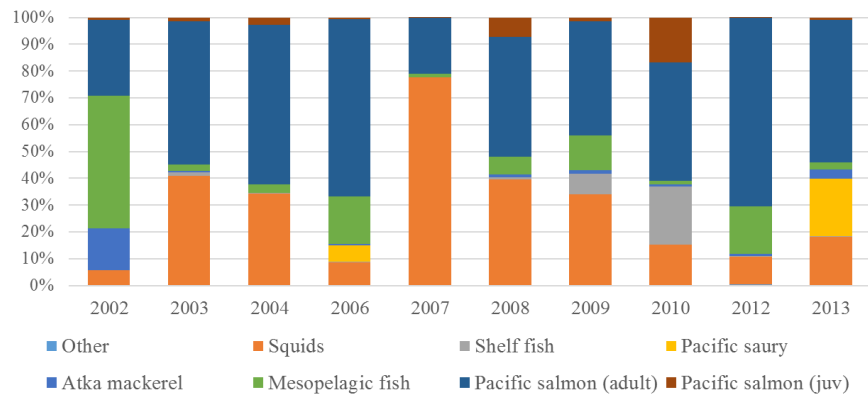
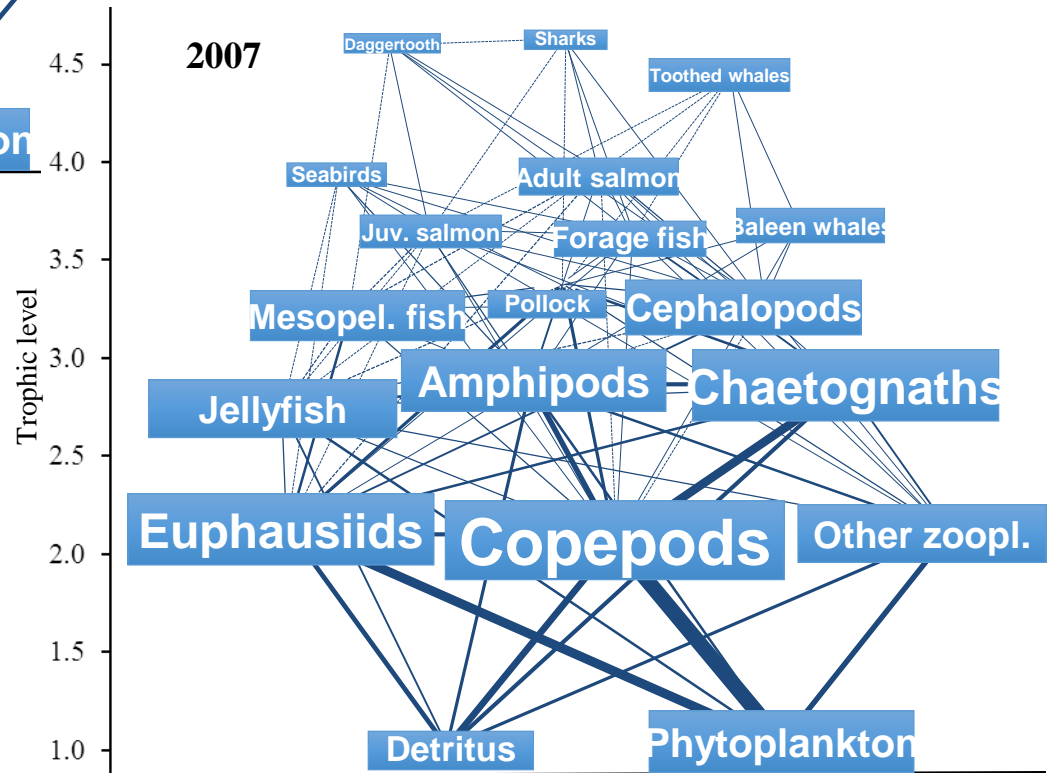


Trophic interactions

Model of the trophic web of the upper epipelagic layer in the western Bering Sea in 2006 and 2007

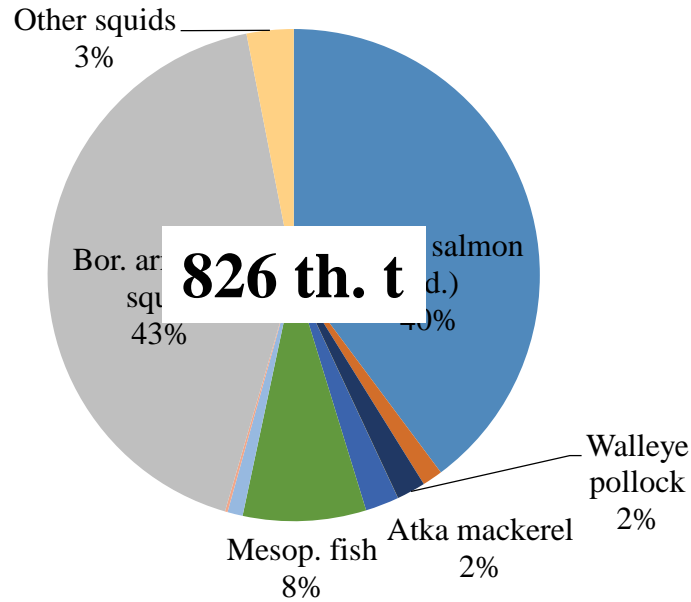


Box heights are proportional to eighth root of the biomass (t/km^2); the width of each predator/prey flow is proportional to the eighth root of the volume of the flow ($t/km^2/year/2$).

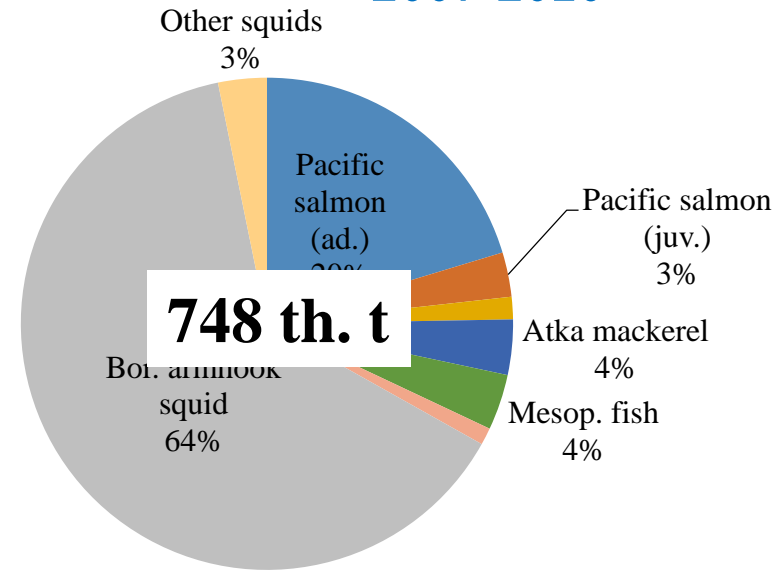


Food consumption by fish and squids in the Aleutian Basin

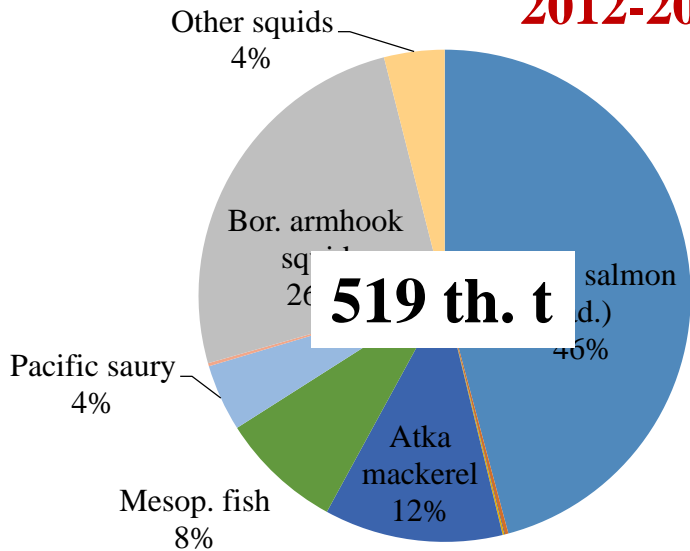
2003-2006



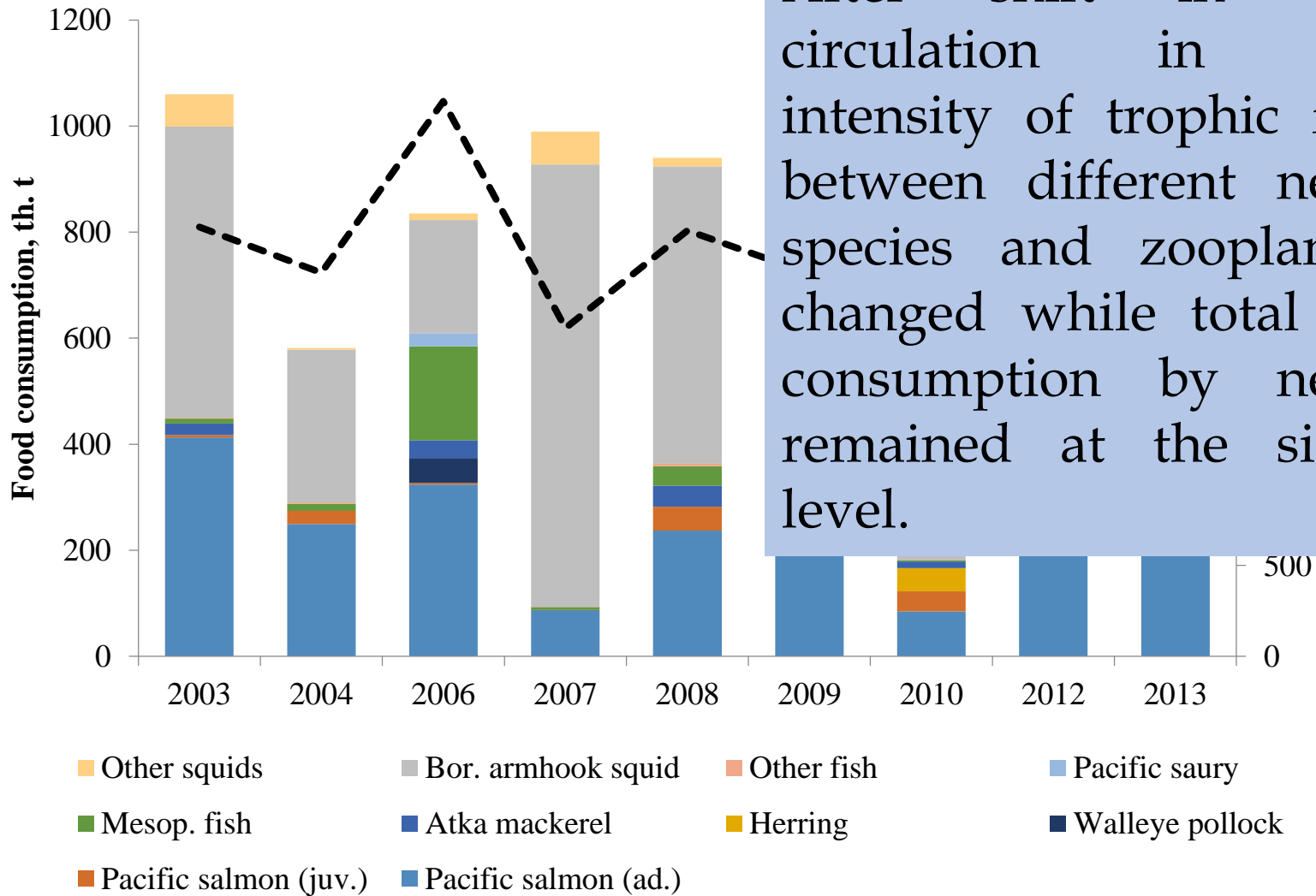
2007-2010



2012-2013



Food consumption by fish and squids in the Aleutian Basin



After shift in water circulation in 2006, intensity of trophic flows between different nekton species and zooplankton changed while total food consumption by nekton remained at the similar level.

SUMMARY

Change in water circulation in 2007-2011

Affected distribution and abundance of highly migratory fish and might cause biomass fluctuations of squids and mesopelagic fish

No pronounced changes in total zooplankton biomass in the WBS. Increase in biomass of *T. lubellula* and decrease in biomass of *O. similis* throughout the sea

Intensity of trophic flows between different nekton species and zooplankton changed while total food consumption by nekton remained at the similar level

NW BS ecosystem

A photograph of a sunset over the ocean. The sun is low on the horizon, partially obscured by a layer of clouds, creating a bright orange and yellow glow. The sky is filled with scattered, soft clouds, some of which are illuminated by the setting sun. The ocean in the foreground is dark blue with small, choppy waves.

Thank you

Northwestern Bering Sea, 2006