The Barents and Chukchi Seas: Comparison of Two Arctic Shelf Ecosystems

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Outline

- Geography and Fisheries
  - Location, Size, and Bathymetry
  - Physical Oceanography
  - Fishery Catches
- Comparisons of Standing Stocks and Productivity
  - Fish, Seabirds, Marine Mammals
  - Zooplankton
  - Nutrients, and Primary Production
- Potential Mechanisms Responsible for Differences in Fish
  - Water Depth and Carbon Export
  - Water Inputs and their Sources
    - Advection of Heat
    - Advection of Plankton

Location Map

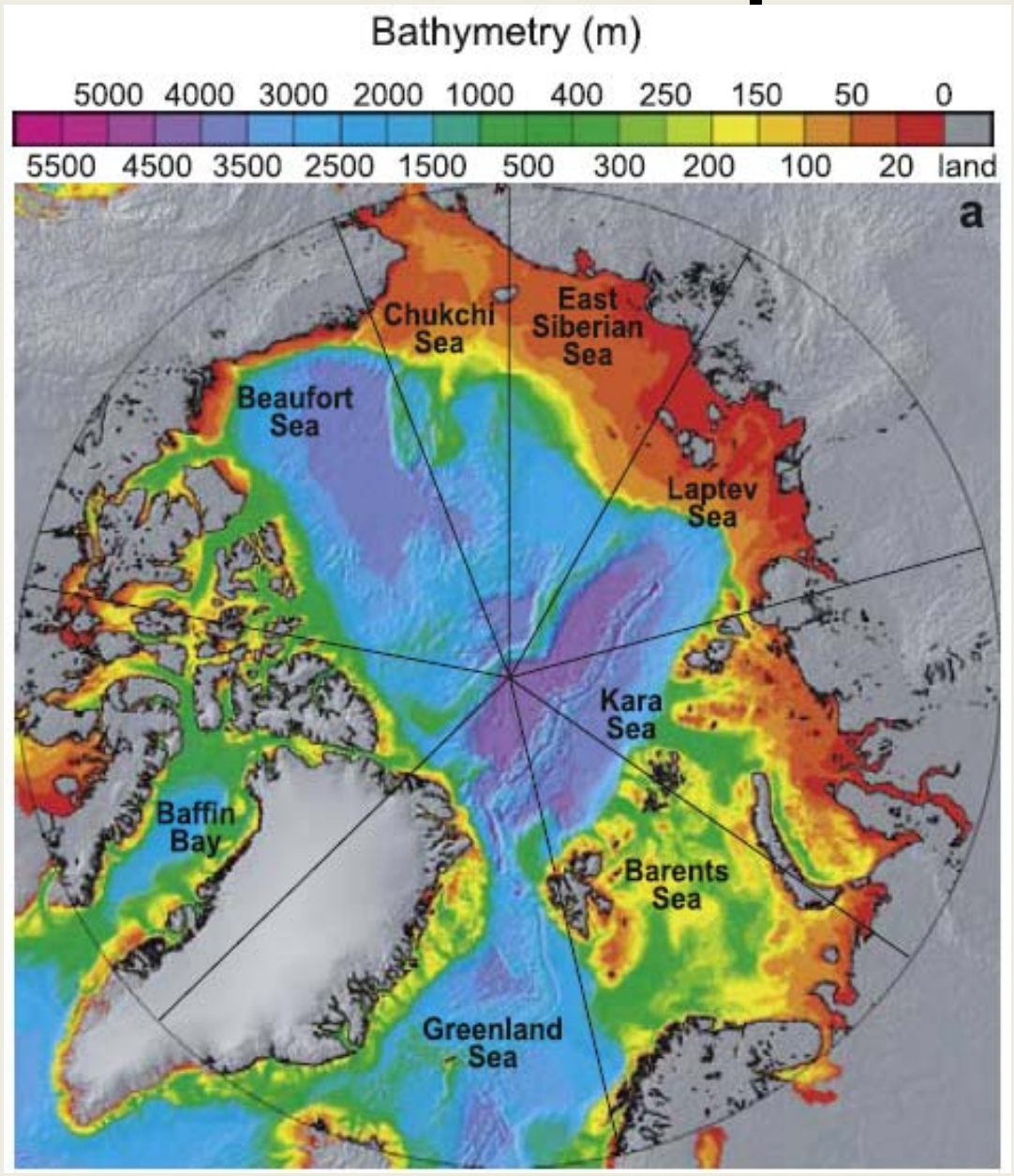
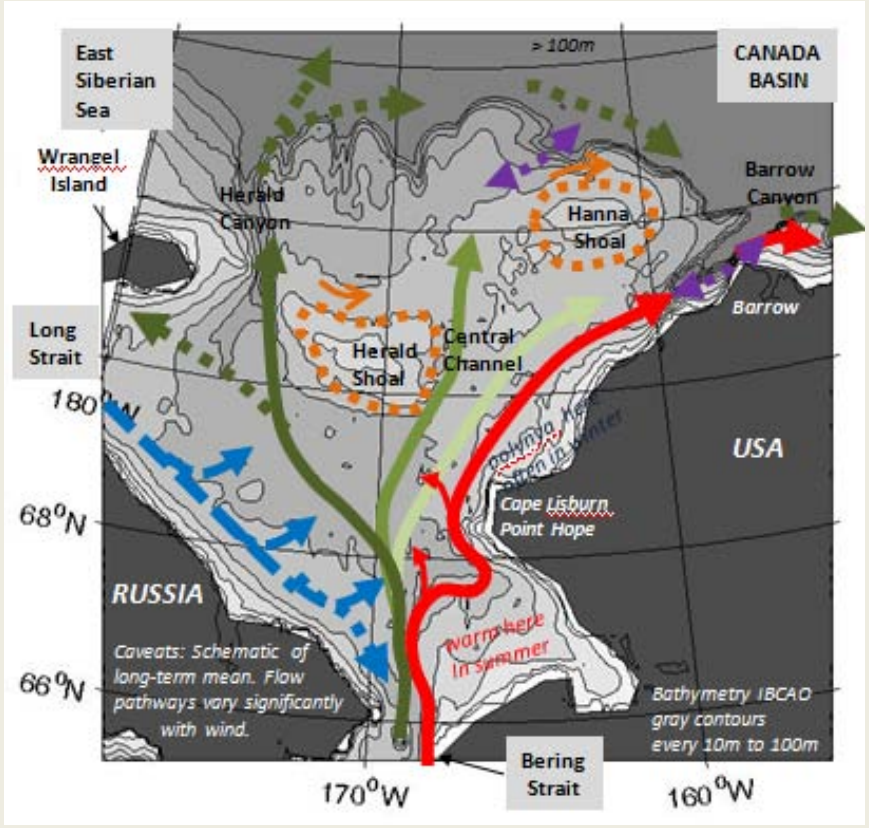


Figure from Arrigo et al., 2008

Currents in the Chukchi and Barents Seas



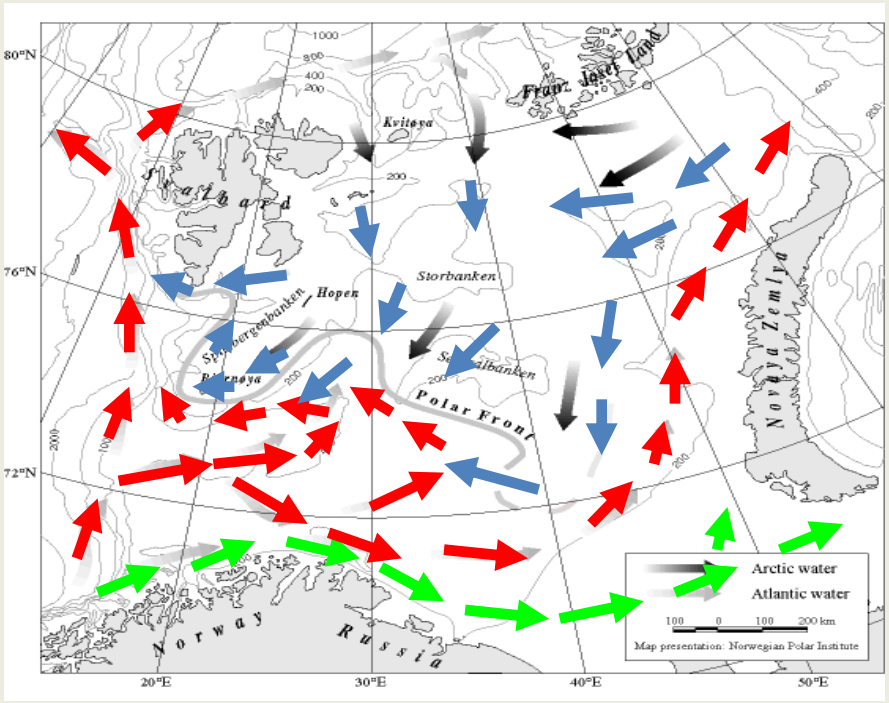
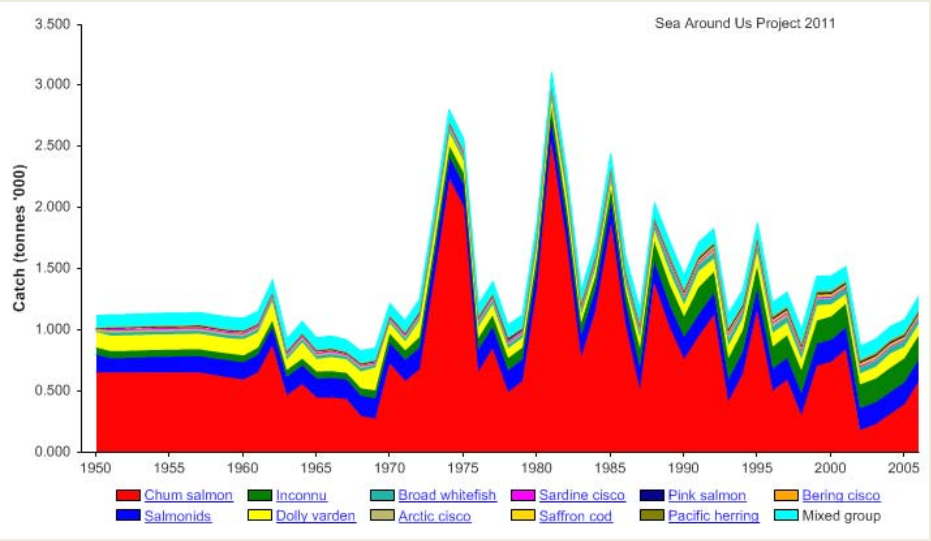


Figure from Norwegian Polar Institute

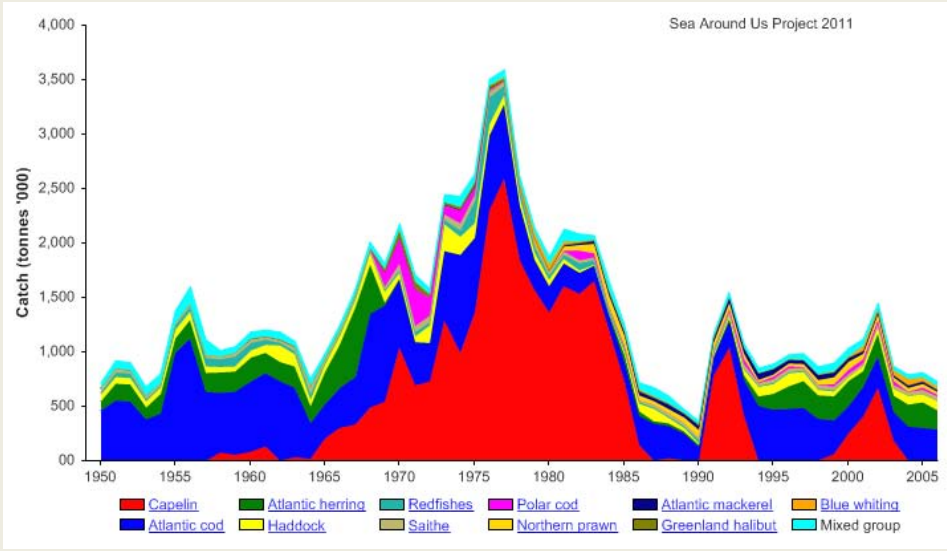
Bering Sea Water- Green
Alaska Coastal Current- Red
Siberian Coastal Current- Blue

Fishery Catches

Chukchi Sea Catch



Barents Sea Catch



Figures from the Sea Around Us Project

Primary Production & Nitrate

		Chukchi Sea	Barents Sea
Primary Productivity	Min	20	<20
1998-2006 gC m^{-2} y^{-1}	Max	>400	200
	Mean	100	102
Nitrate	ACW AW	5 µMl^{-1} 20-25 µMl^{-1}	Atlantic Water 12 µMl^{-1}

(Sources: Pirmary Production: Sakshaug, 2004; Ellingsen et al., 2008; Walsh et al., 2005; Hill et al., 2005; Lee et al., 2007; Nitrate- Sakshaug 2004; Walsh et al., 2005)

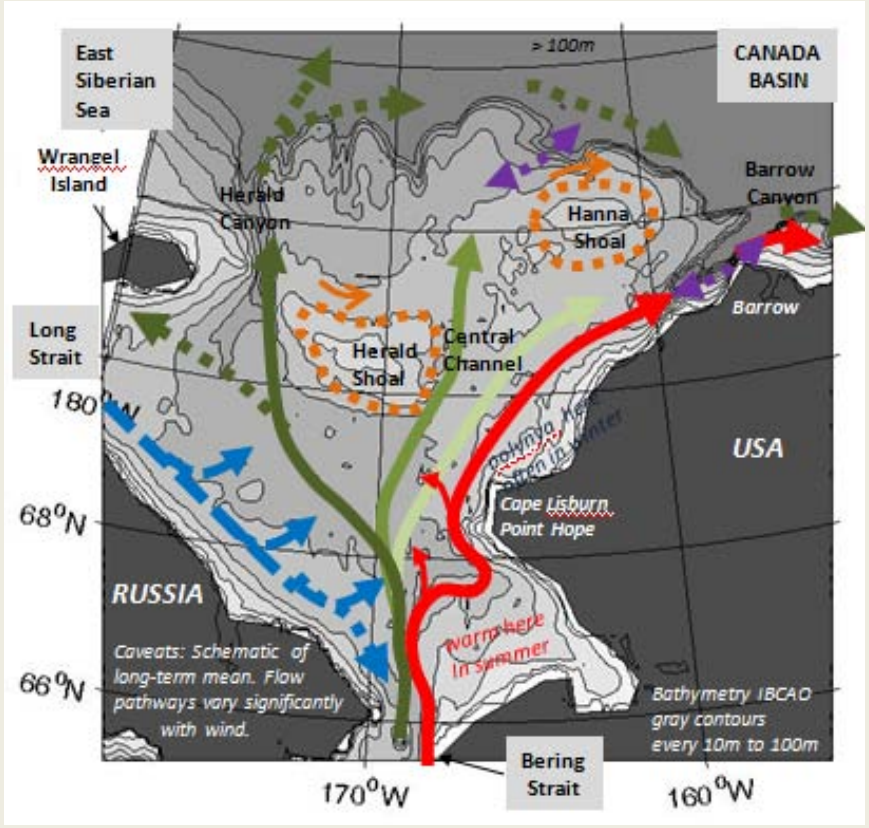
Summary of Stocks and Fluxes

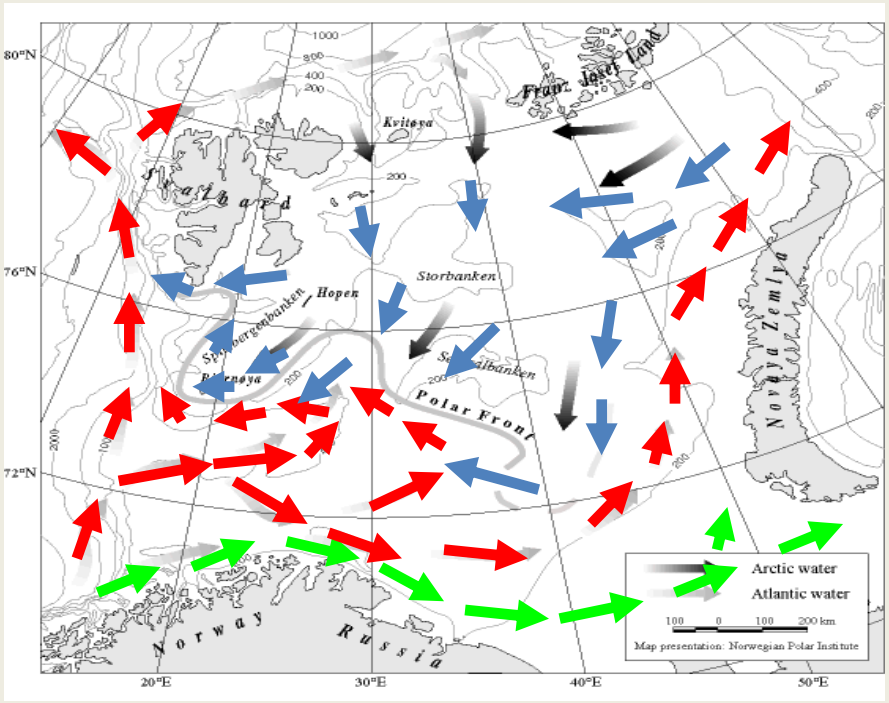
Stock or Production Measured	Barents Sea	Chukchi Sea (area adjusted)
Fisheries Removals (2010)	1.0×10^6 mt y^{-1}	0.0013×10^6 mt y^{-1}
Fish Stocks (5 most abundant species)	5.9×10^6 mt	0.25×10^6 mt
Nesting Seabirds (individuals)	8.0×10^6	4.5×10^6
Total Seabirds	16×10^6 + ??	24×10^6
Pinnipeds (individuals)	1.1×10^6	2.2×10^6
Cetaceans (individuals)	0.14×10^6	0.07×10^6
Crustacean Zooplankton (dry biomass)	6-7 g m^{-2}	2.1 g C m^{-2}
Primary Production (model results)	102 g C $m^{-2}y^{-1}$	100 g C $m^{-2}y^{-1}$
Export to Benthos (% total ann. Prim. Prod)	34-47%	56%
Benthos, overall mean, wet biomass	166 g m^{-2}	381 g m^{-2}

Preliminary Findings

- **Is the Barents more productive than the Chukchi?**
  - **Fisheries stocks and catches YES**
  - **Marine Birds and Mammals not clear**
  - **Primary production NO**
- **Possible Mechanisms**
  - **Orientation of Currents**
  - **Heat content of advected waters**
  - **Temperature at the surface and at depth**
  - **Depth (bathymetric profile)**
  - **Abundance of zooplankton in advected water**

Currents in the Chukchi and Barents Seas





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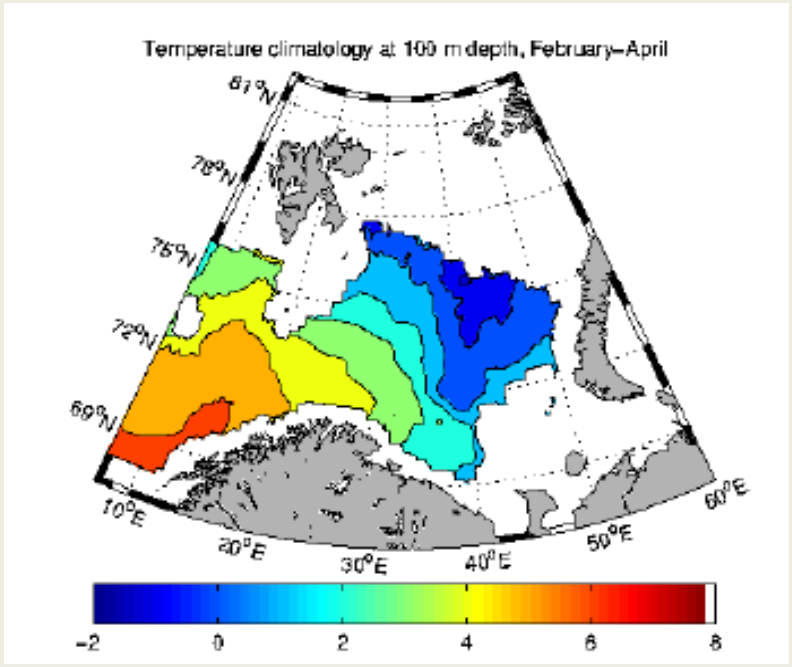
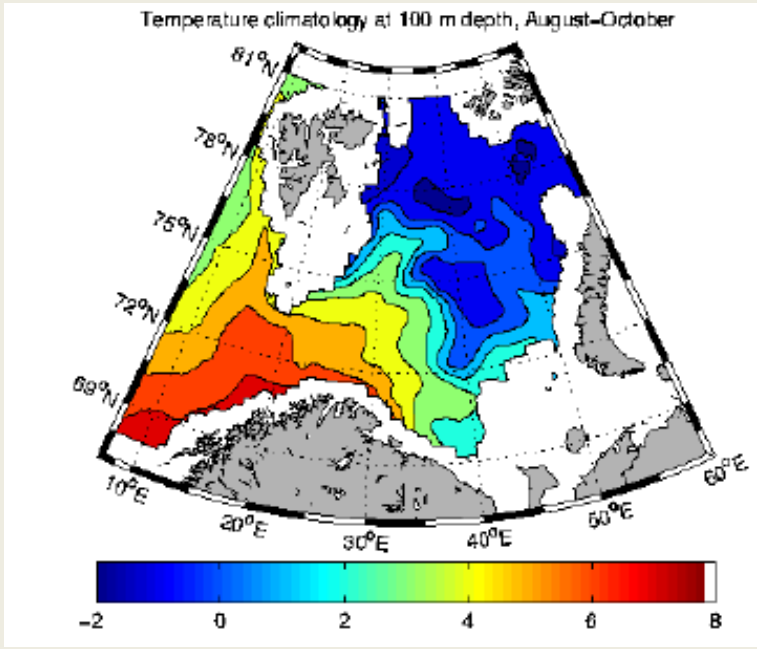
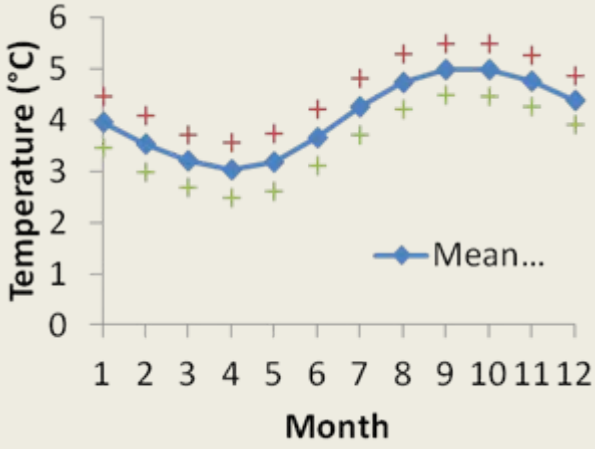
100 m Mean Temperatures (1977-96)



Winter (Feb-April)



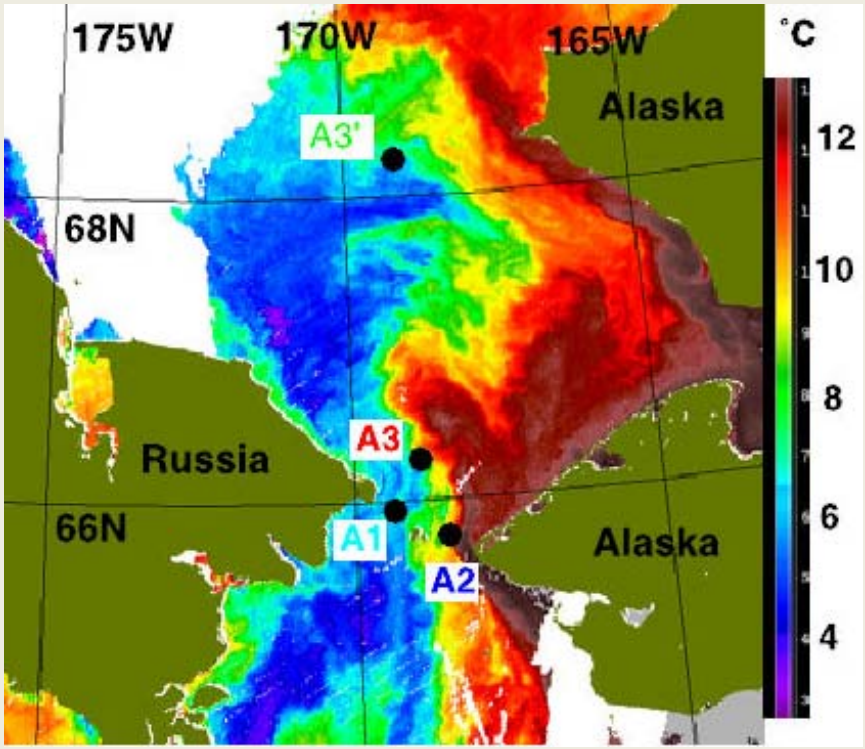
Summer (August-October)



Seasonal Changes in Kola 0-200 m average temperature

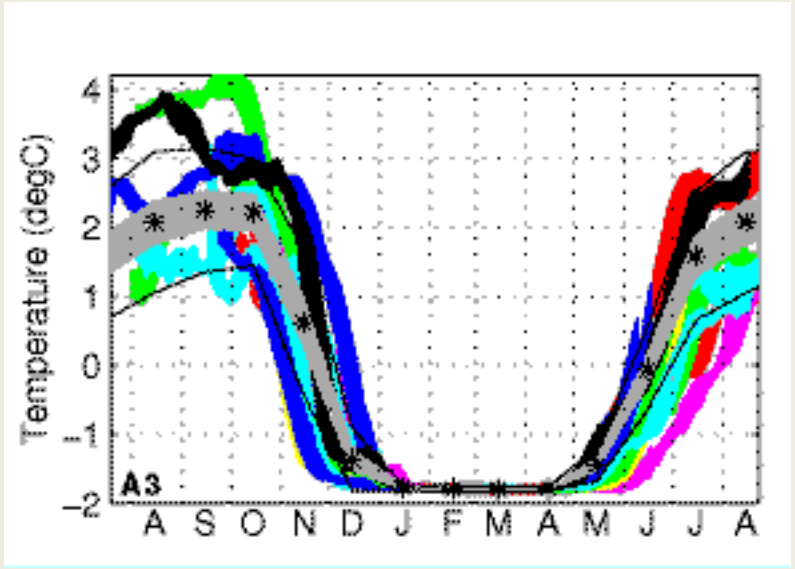
Source: K. Drinkwater, IMR, Bergen

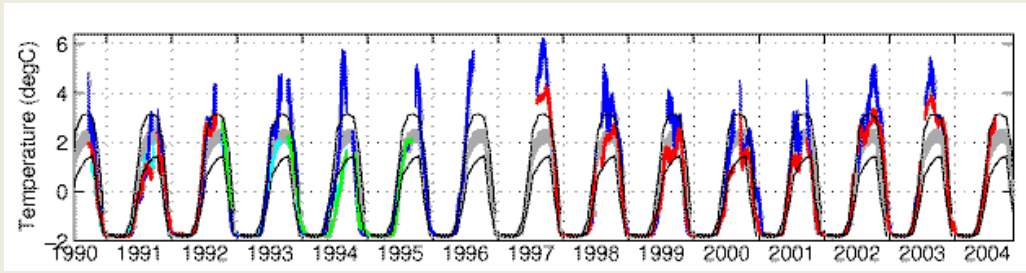
Bering Strait Temperatures



SST 26 August 2004

Woodgate & Aagaard 2005

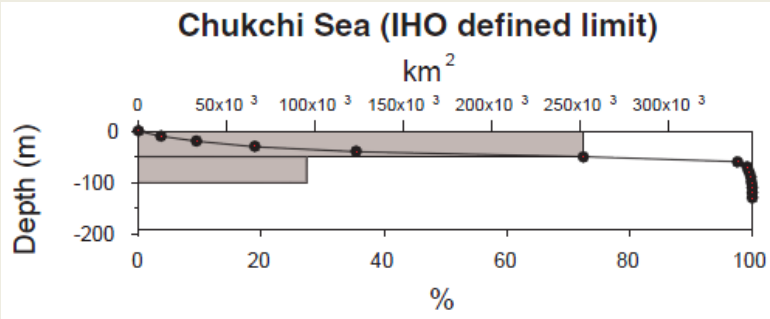


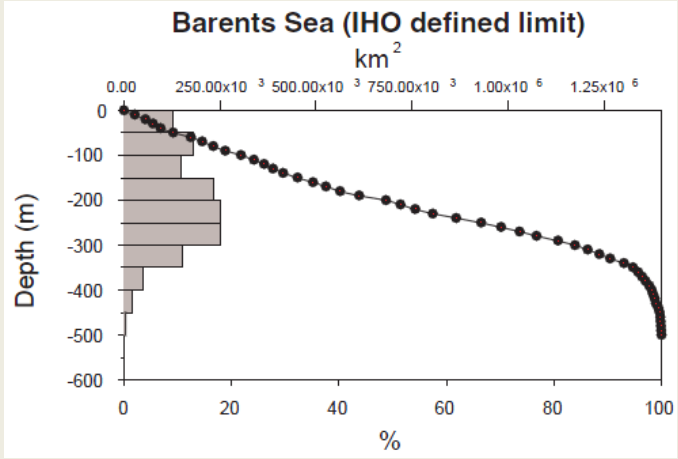


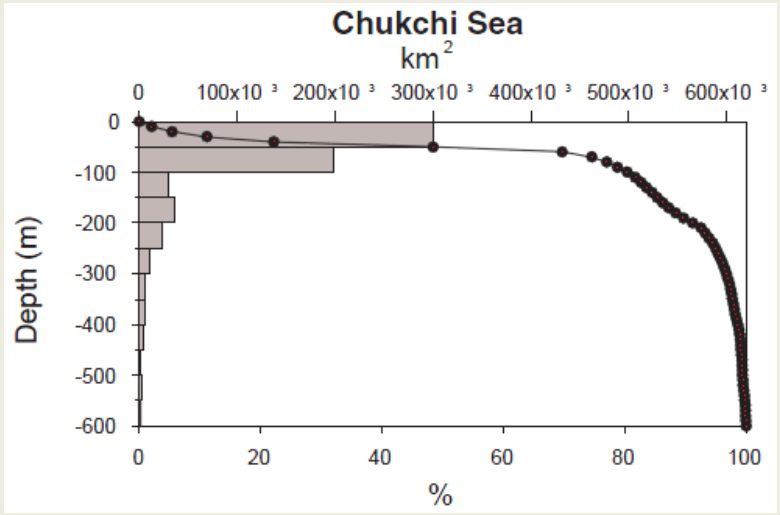
Temperatures at 9 m above the bottom
Colors in lower figure coded to moorings at left

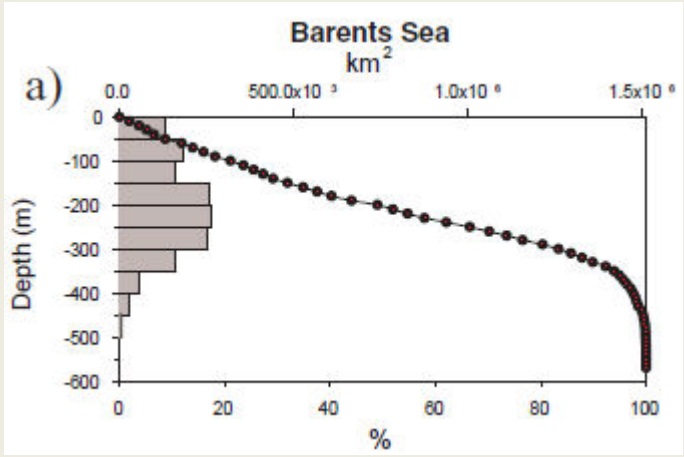
Woodgate

Areal Distribution by Depth









Figures from Martin Jakobsson, 2002

Zooplankton Biomass

Chukchi Sea Water Mass	Chukchi Sea Biomass (gm^{-2} dry weight)		Barents Sea Water Mass	Barents Sea 2008 Biomass (gm^{-2} dry weight) /SD (number of stations)	Barents Sea 2009 Biomass ($g\ m^{-2}$ dry weight) /SD (number of stations)
Coastal Water	<0.5		Coastal Water	3.90/2.57 (3)	13.5/9.12 (4)
Anadyr Water	2-4		Arctic Water	4.52/3.50 (6)	5.34/4.73 (28)
Bering Shelf Water	0.2-1.2		No. Atlantic Water	8.49/7.01 (41)	7.32/4.21 (73)
Overall	2.1		Polar Front Water	5.99/2.35 (8)	5.78/6.79 (58)

Barents Sea Data courtesy of P. Dalpadado; Chukchi data from Piatt & Springer, 2003; Hopcroft et al., 2010

Conclusions

- **Is the Barents more productive than the Chukchi?**
  - **Fisheries stocks and catches** **YES**
  - **Marine Birds and Mammals** **not clear**
  - **Primary production** **NO**
- **Possible Mechanisms**
  - **Orientation of Currents:** **Chukchi- N/S; Barents- E/W**
  - **Heat content of advected waters:** **Chukchi-cold; Barents-Warm**
  - **Temperature at the surface and at depth:** **Warmer in So. Barents and at depth in north**
  - **Depth (bathymetric profile):** **Chukchi much shallower**
  - **Abundance of zooplankton in advected water:** **Barents richer, available earlier in spring; also from north**