Arctic Biodiversity Congress
December 2-4 2014
Trondheim, Norway

Cod predation on polar cod under warming conditions in the Barents Sea

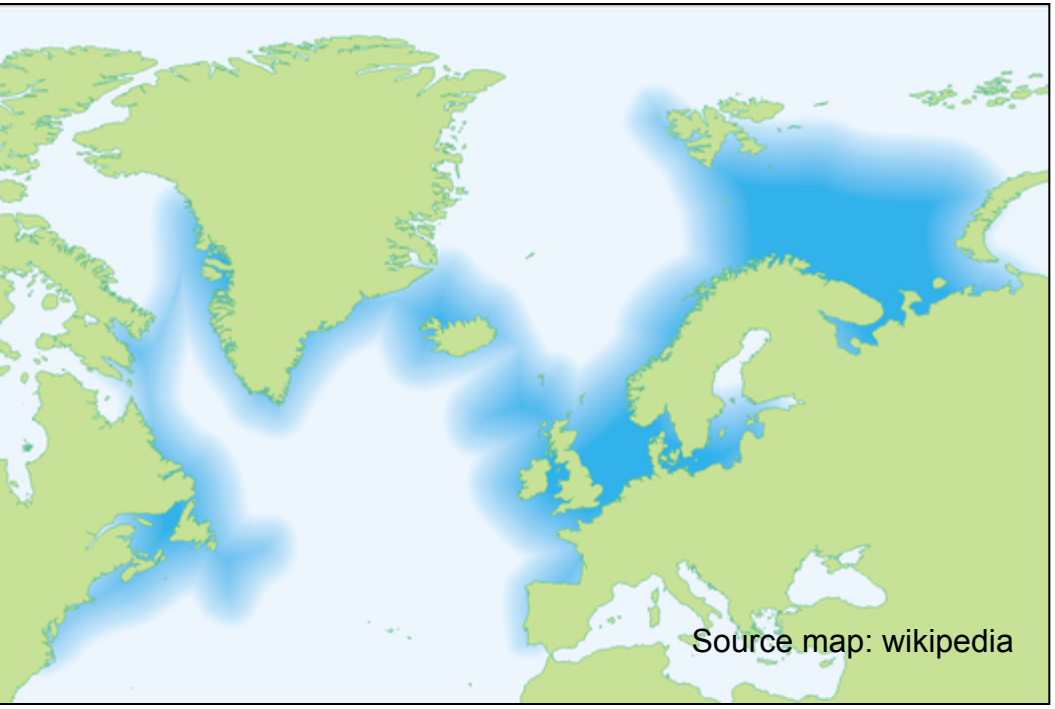
Edda Johannesen[1,4], Andrey Dolgov[2], Haakon Hop[3] and Harald Gjøsæter[1,4]

[1]Institute of Marine Research, Bergen, Norway,
[2]Polar Research Institute of Marine Fisheries and Oceanography, Murmansk, Russia
[3]Norwegian Polar Institute, Fram Centre, Tromsø, Norway
[4]Hjort Centre for Marine Ecosystem Dynamics, Bergen, Norway

From Mecklenburg *et al.* (2011)

Polar cod
(*Boreogadus saida*)

- Arctic, ice-associated
- Circumpolar distribution
- Pelagic/semipelagic and mainly planktivourous
- Abundant => important link in the Arctic food web
- Max size: 46 cm (commonly 20-30 cm)

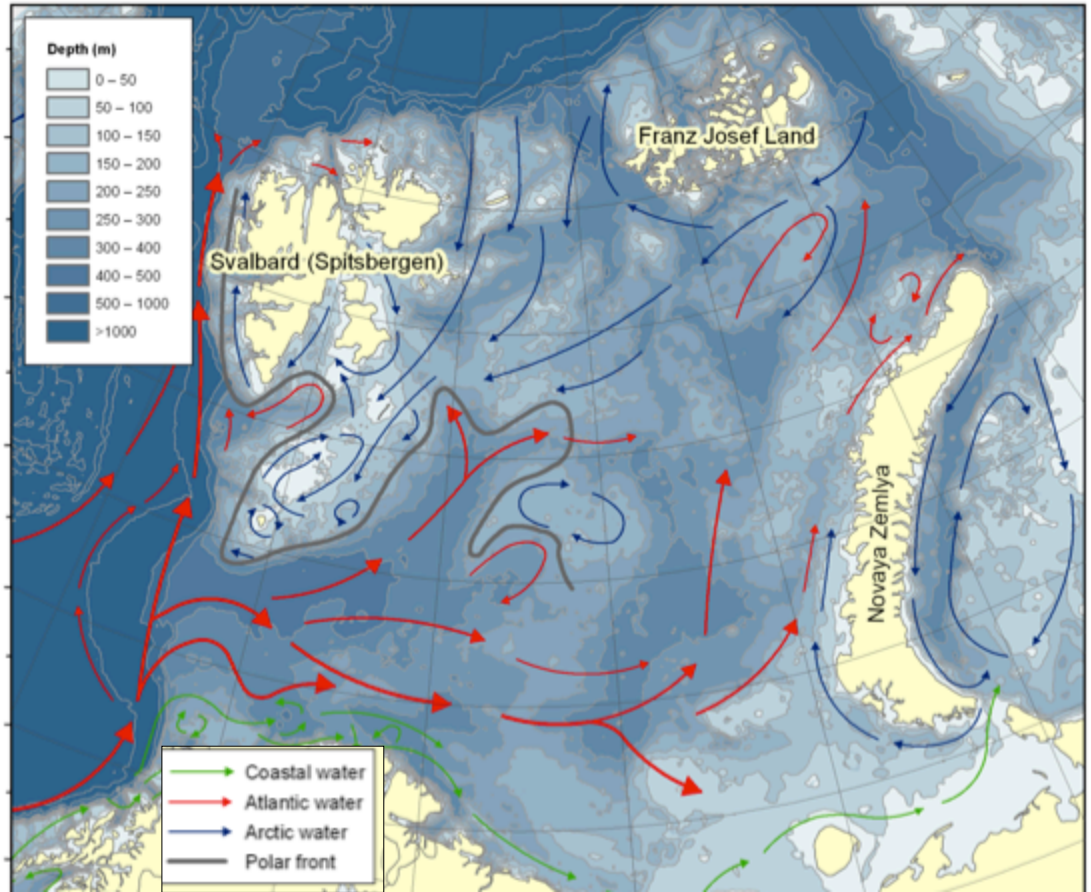


Atlantic cod
(*Gadus morhua*)

- Boreal
- Distributed in the North-Atlantic
- Generalist/piscivorous
- Dominant predator in boreal shelf seas
- Max size: 169 cm

Barents Sea

- High latitude shelf sea
- Large Marine Ecosystem
  ~1.6 million km^2
- Mean depth 230 m
- Sustains important fisheries
- Home of the world's largest cod and capelin (*Mallotus villosus*) stocks



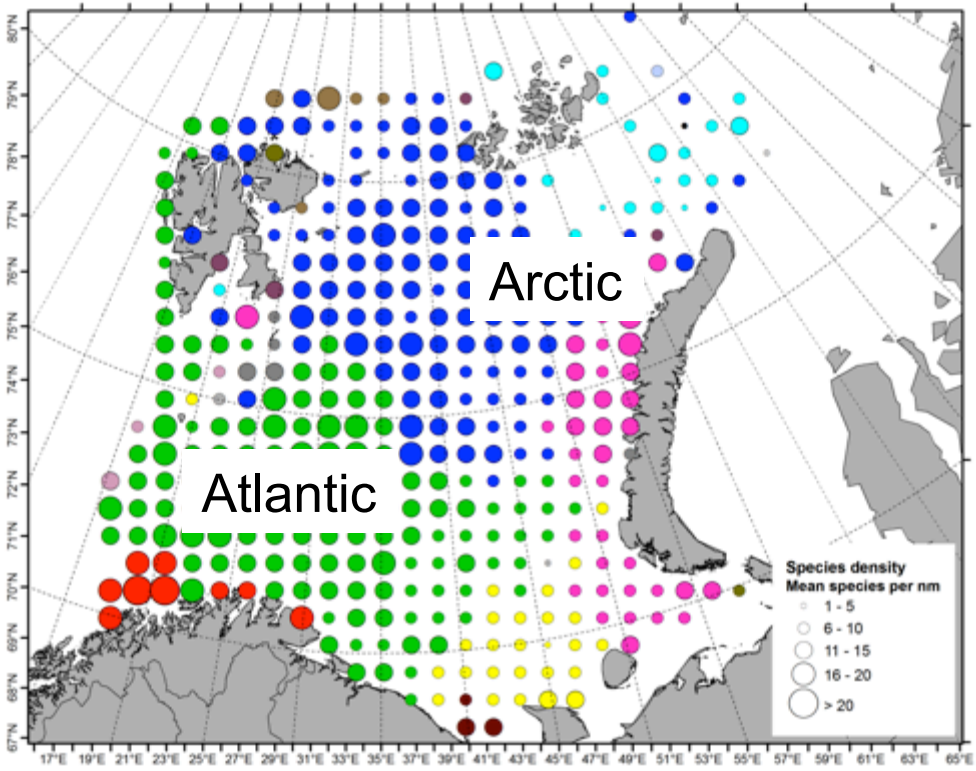
Arctic cold low-salinity water masses in the north/north-east

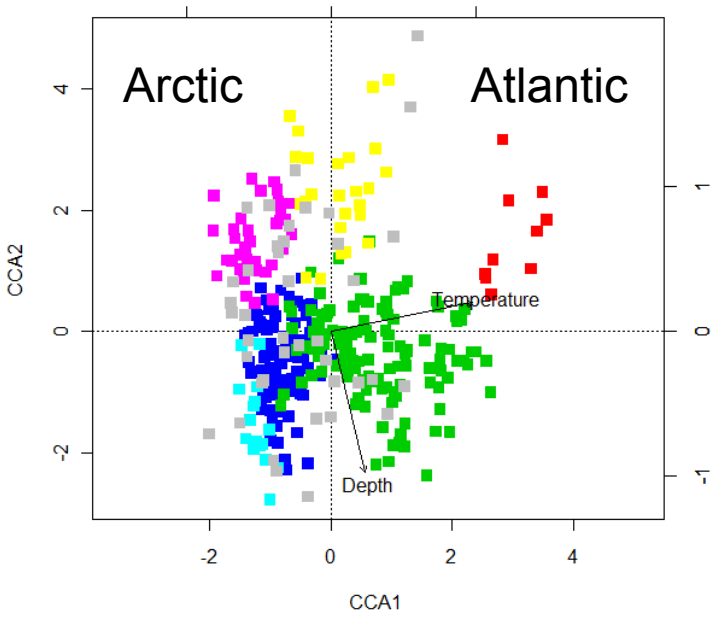
Warmer, high-salinity Atlantic inflow dominates in the west/south-west

Barents Sea

•Transition zone between Arctic and boreal species

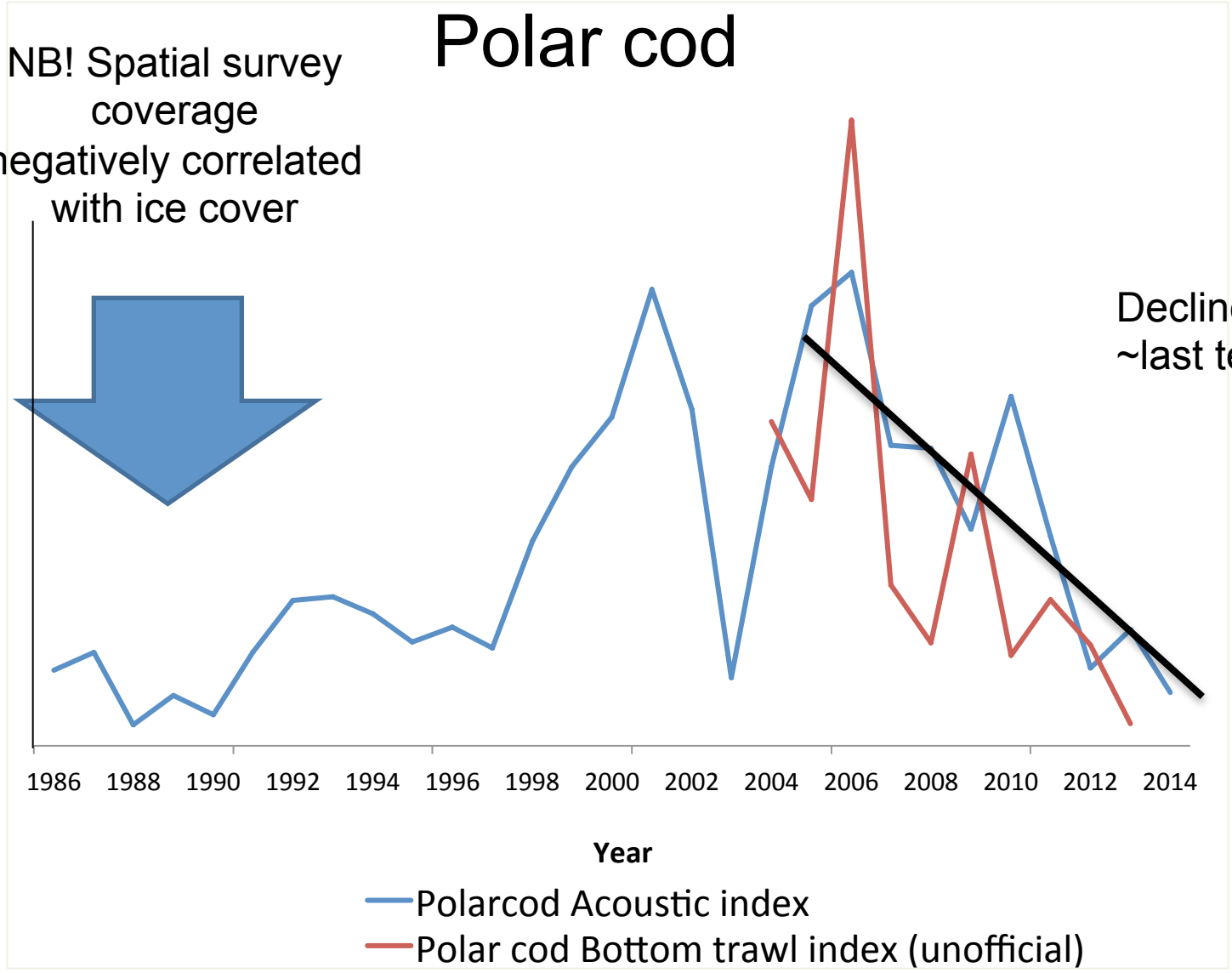
•Boreal species like cod migrates northwards in summer
=> overlaps and interacts with Arctic species like polar cod





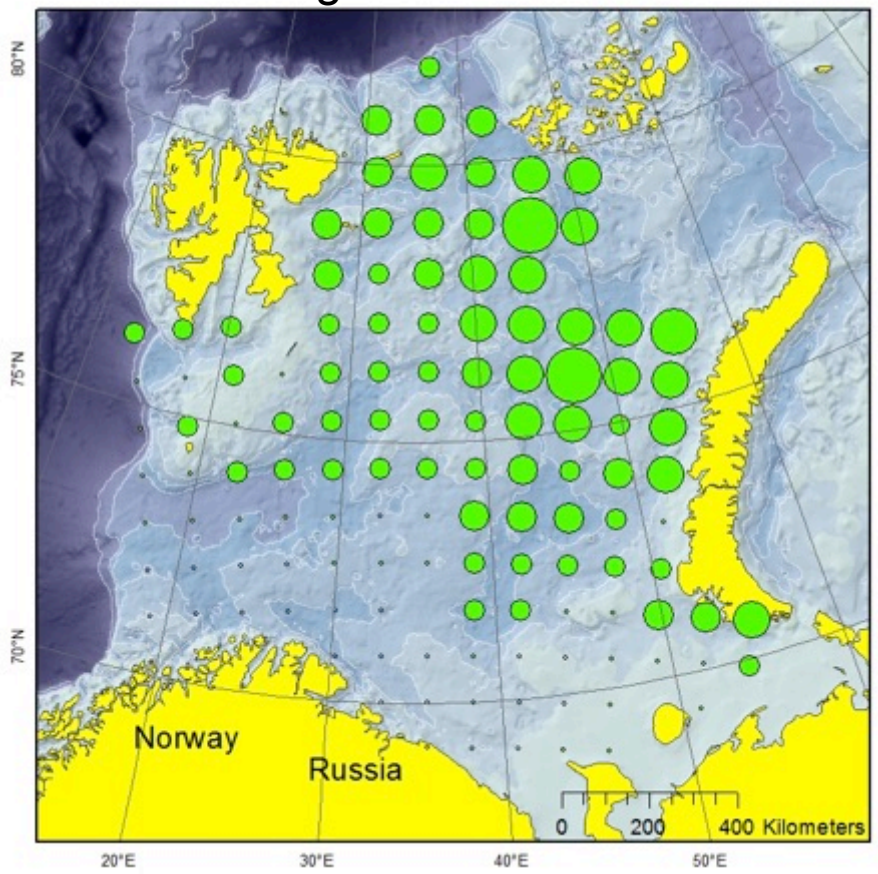
Fish assemblages in the Barents Sea
From Johannesen et al. (2012)

Temporal development in the Barents Sea

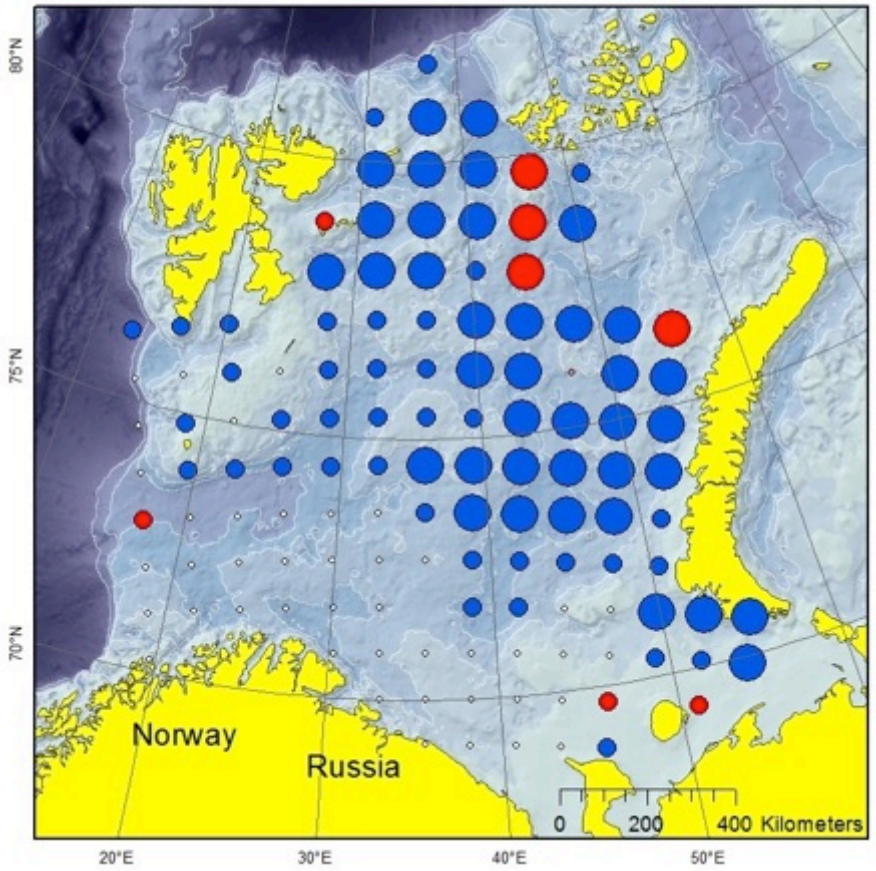


Temporal development in polar cod distribution

Average local abundance



Change in polar cod local abundance



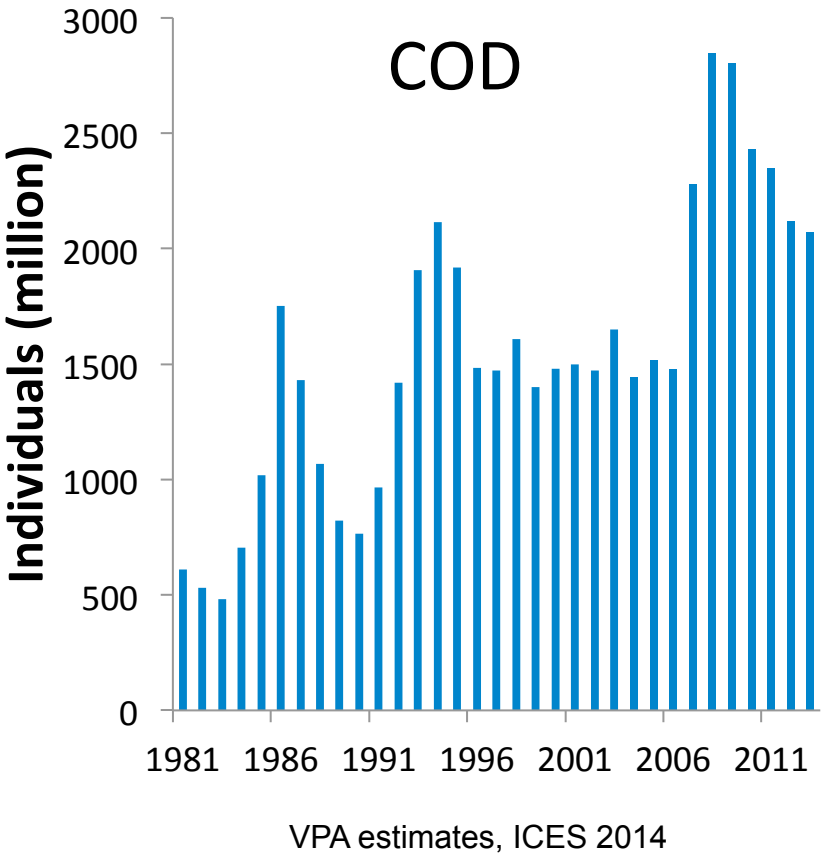
Red:
Increase

Blue:
decrease

2004-2013, 100 x100 km grid cells, n>6 years

Barents Sea

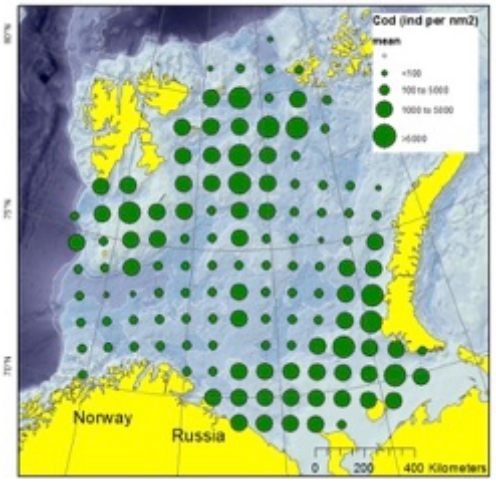
Increased cod stock size



VPA estimates, ICES 2014

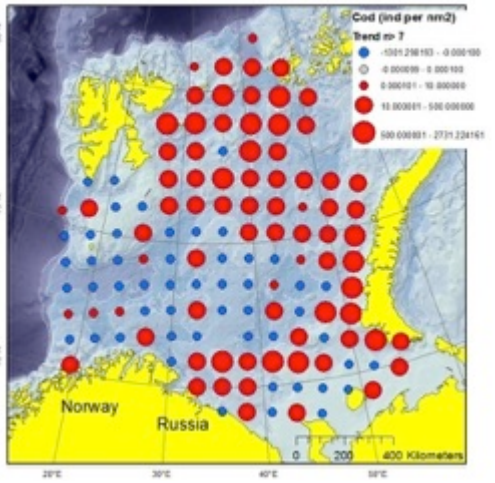
Northwards expansion of distribution area of cod in August-September

Average distribution 2004-2013



Red: increase in cod (2004-2013)

Blue: decrease in cod (2004-2013)



=Increased predation pressure from cod on polar cod?

Predation mortality determined by:

1. Size of the prey population

Polar cod (1986-):
- **Acoustic abundance estimate:** varies because of variable/incomplete spatial survey coverage
-**Stock identity:**
-separate BS stock, or continous with the Kara Sea stock?

2. Size of the predator population

Cod: good estimate (1946-)

3. How much prey each individual predator eats determined by:
   i. Local availability of prey – spatial overlap

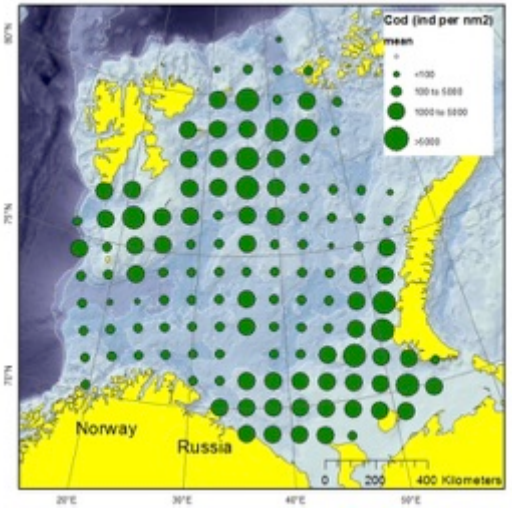
      Overlap index August-September (2004-)

   ii. Prey profitability in relation to alternative prey

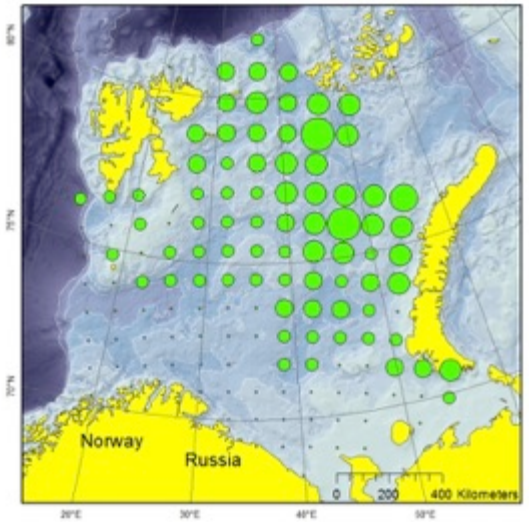
      ?

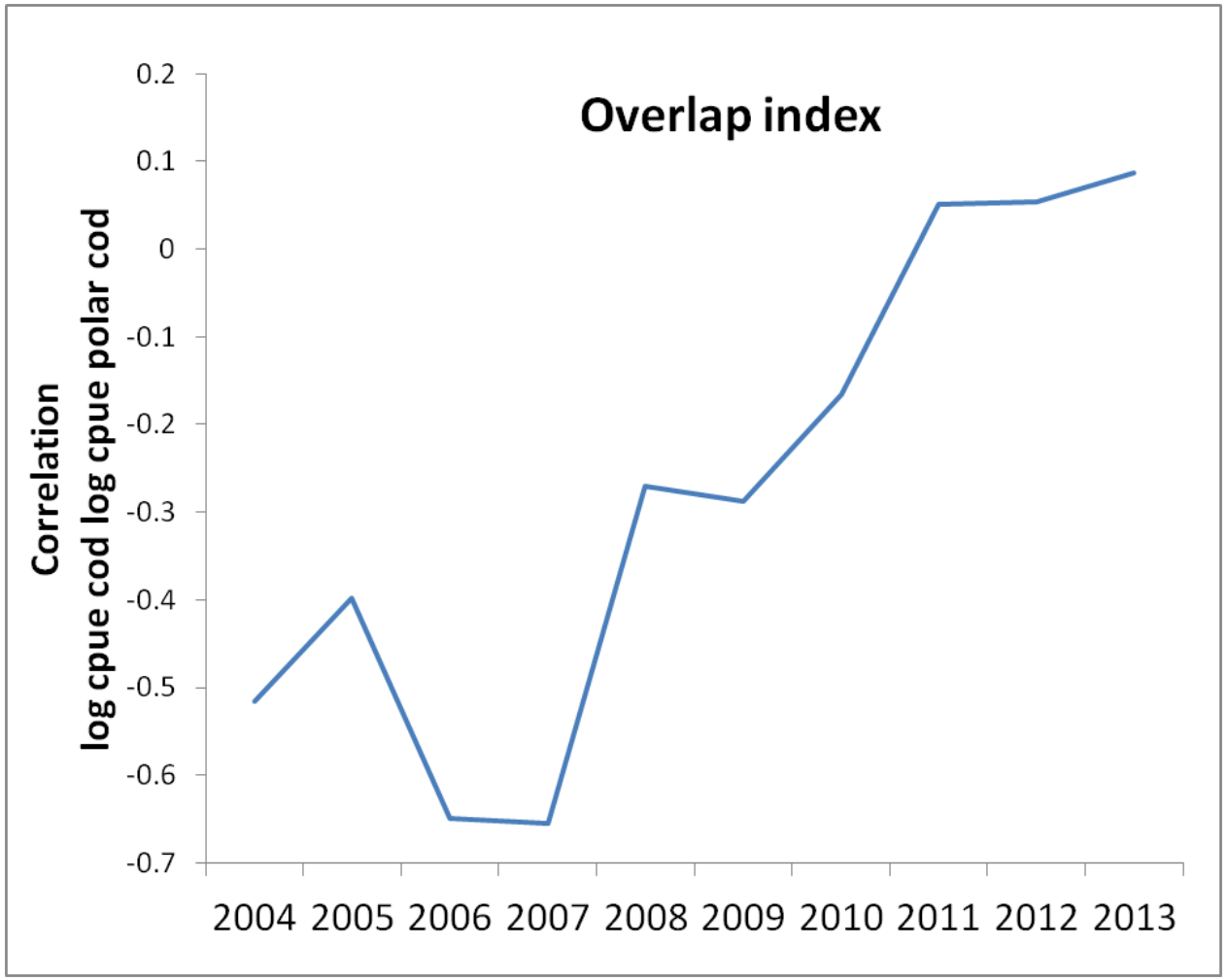
Temporal development in spatial overlap between cod and polar cod

Cod

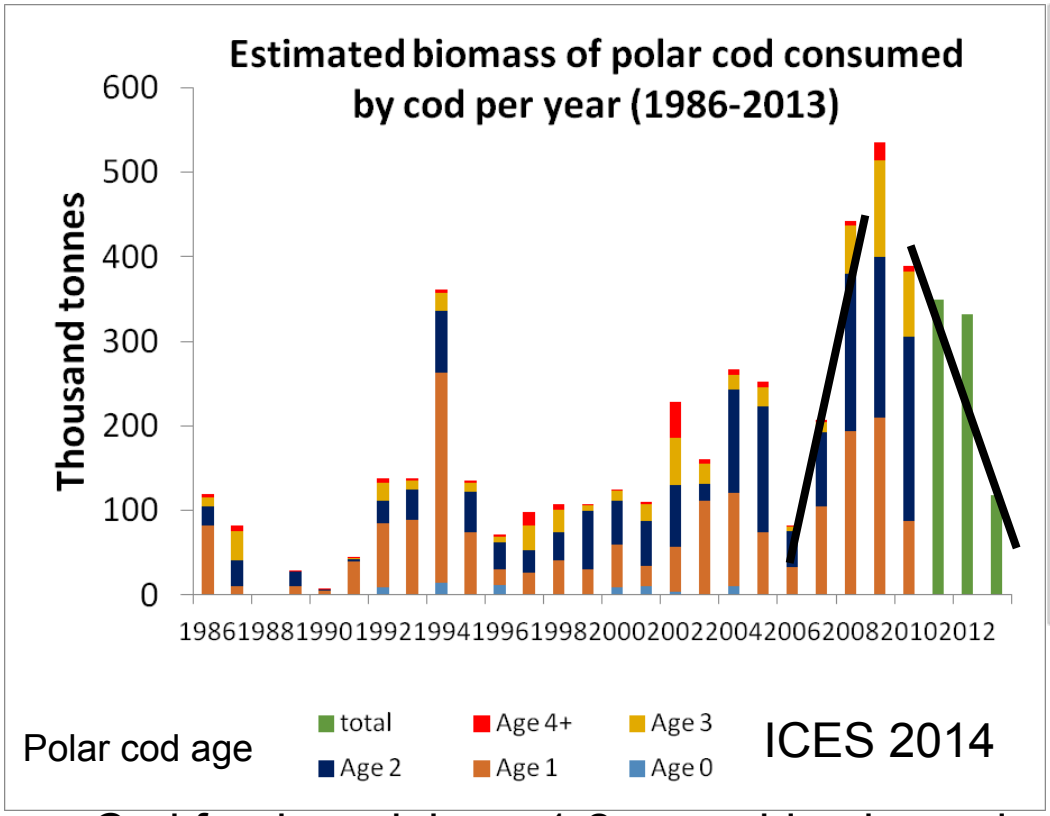


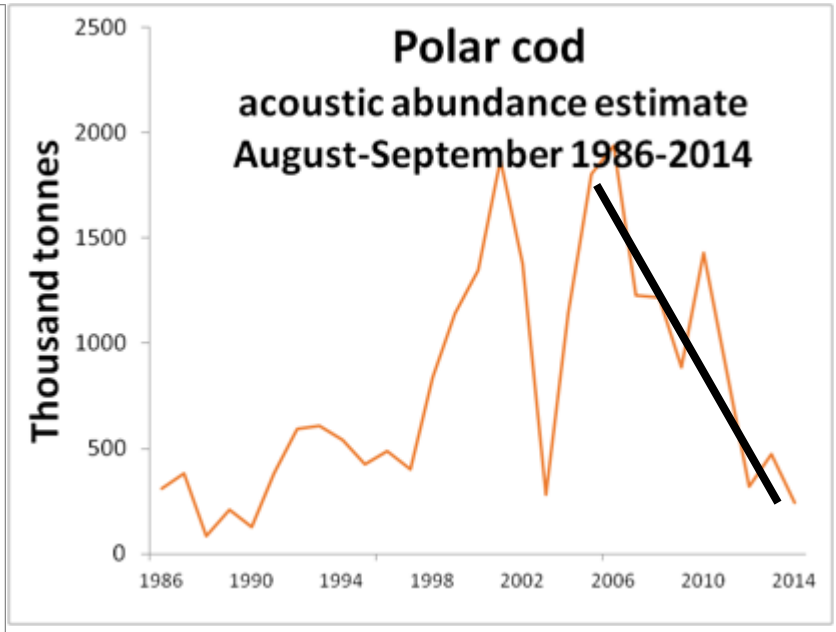
Polar cod



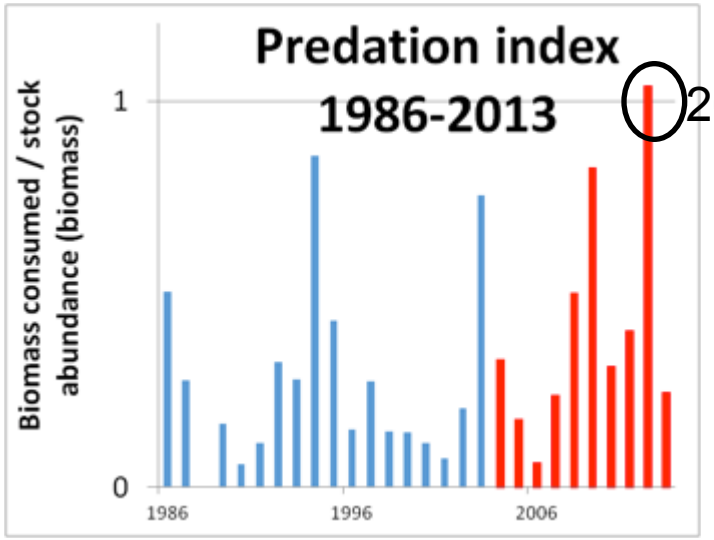


Total amount of polar cod eaten by the cod stock:
Individual consumption x size of the cod stock





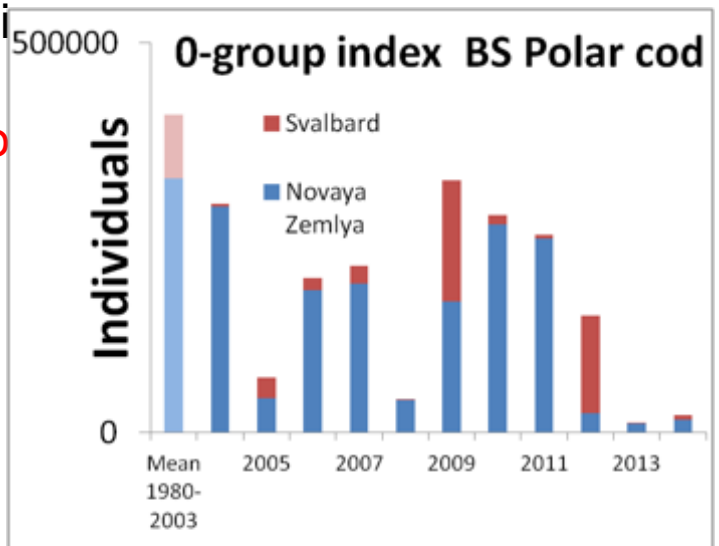
=> Cod feeds mainly on 1-2 year old polar cod



Conclusions:

1.The polar cod stock has decreased from 2004-2013
2.At the same time
- the cod stock has increased and moved northwards
- the spatial overlap between cod and polar has increased
3. The total consumption peaked in 2009, but has afterwards declined
⇒ *too low abundance of polar cod in the overlap area to make it profitable as prey?*
4. ”Predation index” variable but peaked in 2012

Has cod contributed to the decline in polar cod?
⇒ Yes, most likely
but…
- The size of the polar cod stock is difficult to assess
- The consumption estimates are uncertai



Therefore the importance of cod predation relative to
•Predation from other predators (harp seals)
•Movement of polar cod out of the area
• - are the BS and Kara Sea polar cod separate stocks?
•Loss of ice
⇒ Reduced spawning habitat
⇒ Recruitment failure
cannot be assessed without further investigations!

Question related to Arctic Biodiversity Assessment recommendation 16:

Are there stressors that are expected to have rapid and significant impacts related to your topic and issues where knowledge is lacking?

Stressors:

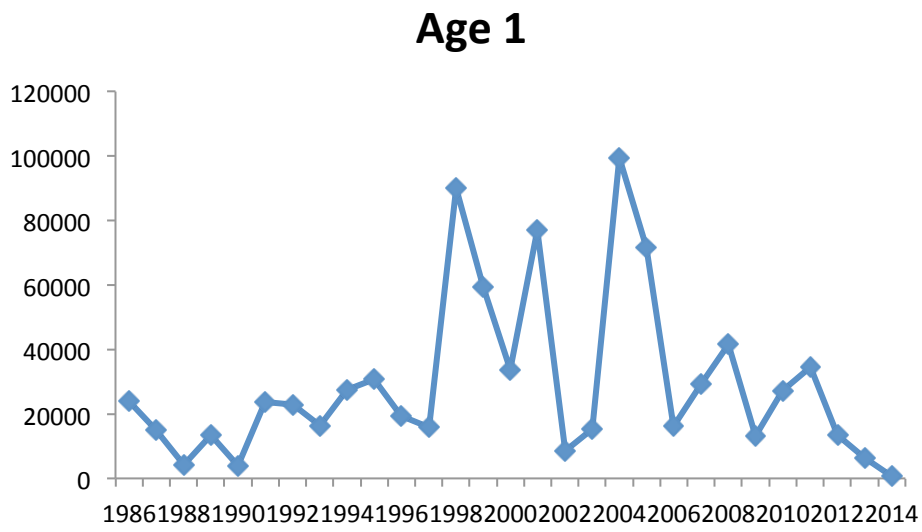
- Loss of ice = spawning habitat (position of spawning site, larvae transported into Kara Sea?)
- Increased temperature= thermal habitat
- Changes in prey: zooplankton species composition and production
- Changes in predators : cod/other predators
- fishing is currently negligible

Do you have recommendations to modeling potential future species range changes as a result of these stressors; developing knowledge of and identifying tipping points, thresholds and cumulative effects for Arctic biodiversity;
developing robust quantitative indicators for stressors through the CBMP?

Monitoring:

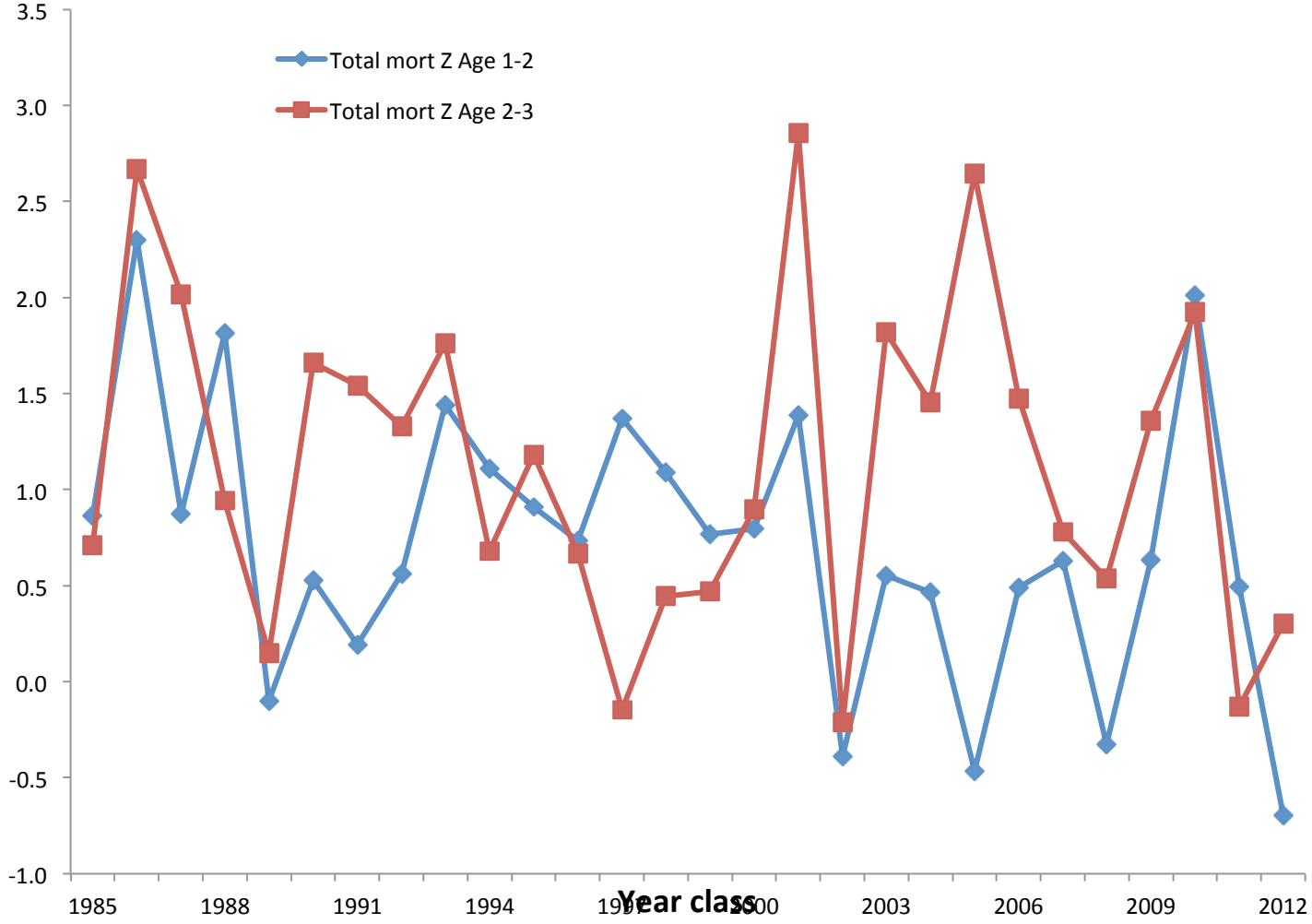
- BS polar cod distribution and abundance (to be continued)
- Predation by BS cod (to be continued)
- Monitor BS sea ice, drift model of larvae, reduced ice => drift of larvae into Kara sea?
- Pull together information on polar cod from the pan-arctic region= “indicator species”

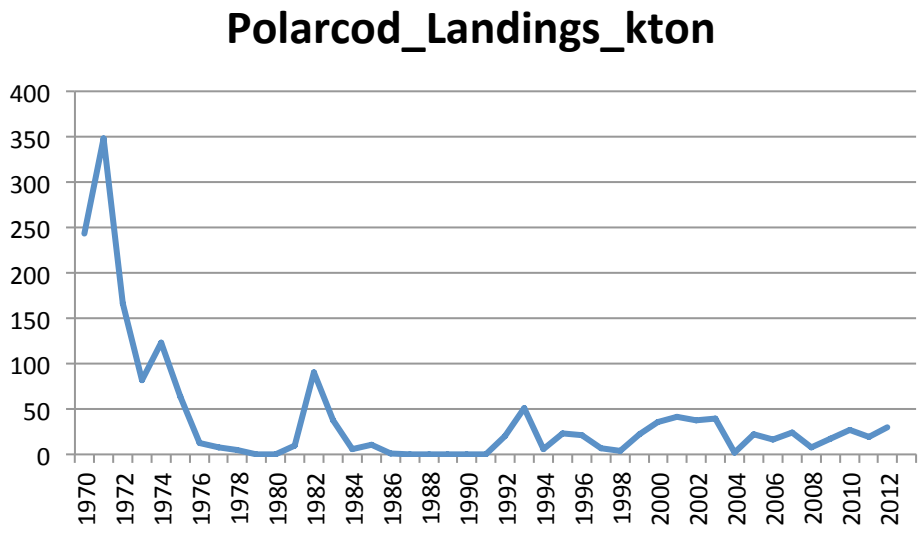
Thank you for your attention!

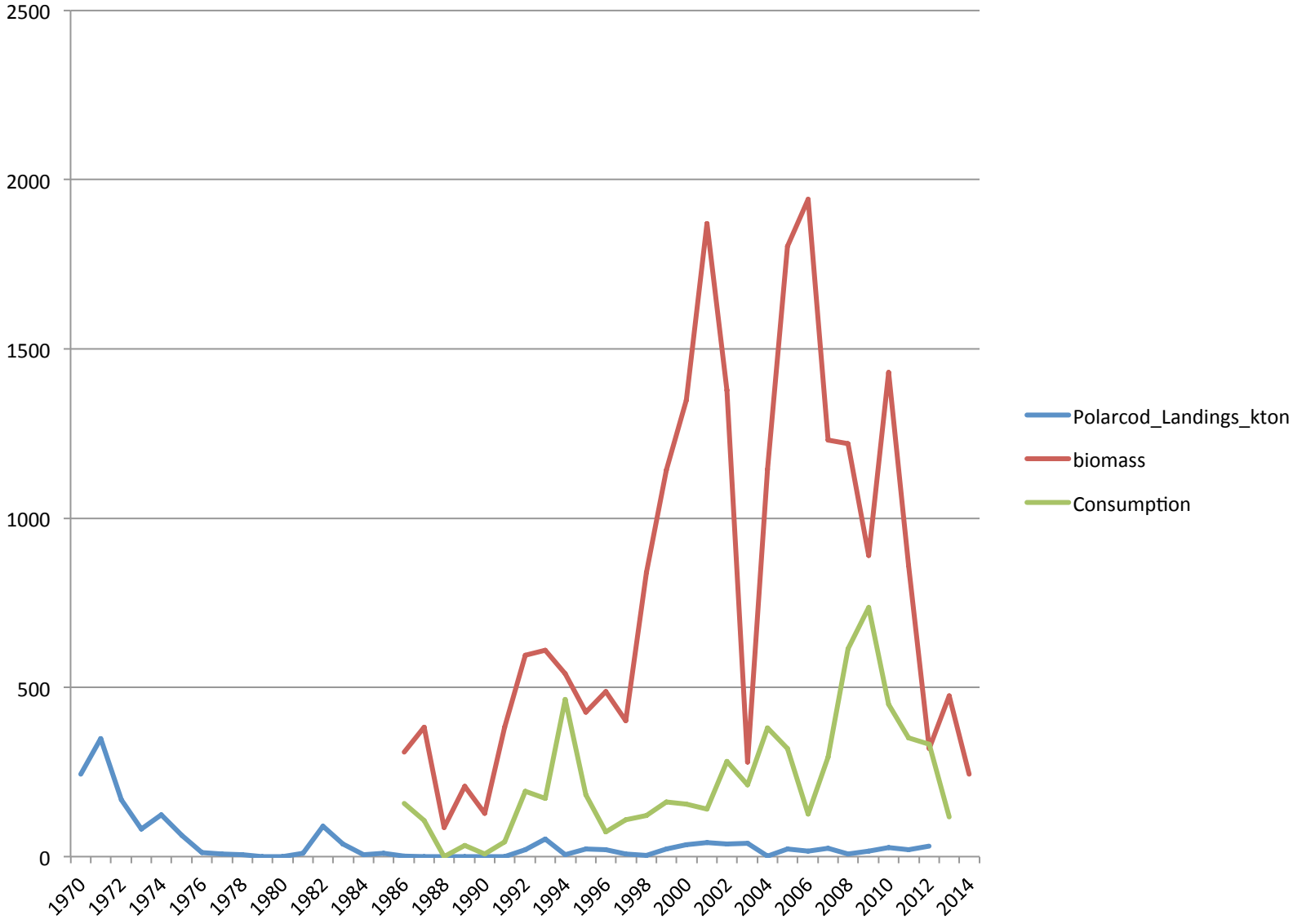


Food for thought…

Survey mortalities of the Barents Sea Polar cod




Polarcod_Landings_kton
400
350
300
250
200
150
100
50
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012


2500
2000
1500
1000
500
0
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Polarcod_Landings_kton
biomass
Consumption