

Increased abundance and spatial expansion of Northeast Atlantic mackerel (*Scomber scombrus*) according to swept-area trawl surveys in the Northeast Atlantic from 2007 to 2014



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NORWAY'S MARITIME BORDERS



NORWAY - AN OCEANIC COUNTRY

Population:	5.05 millions
Land area:	323 787 km ²
Svalbard:	61 022 km ²
Jan Mayen:	377 km ²
Coastline land:	28 953 km
Total coastline (incl islands):	100 915 km
Mainland EEZ	968 700 km ²
Spitsbergen FVS:	804 000 km ²
Jan Mayen FS:	296 600 km ²

The Norwegian Sea

- The Norwegian Sea is a very productive large marine ecosystem
- Sustain some of the largest fish species on Earth
- Deep water basin (2000-4000 m) ideal for wintering zooplankton (*Calanus finmarchicus*)
- These zooplankton are exploited by highly migratory pelagic fish species

- Herring
- Blue whiting
- Mackerel

More than 15 million tonnes of pelagic fish are feeding within this ecosystem each year



The principal pelagic fish player in the Northeast Atlantic ecosystems



Northeast Atlantic mackerel (*Scomber scombrus*)

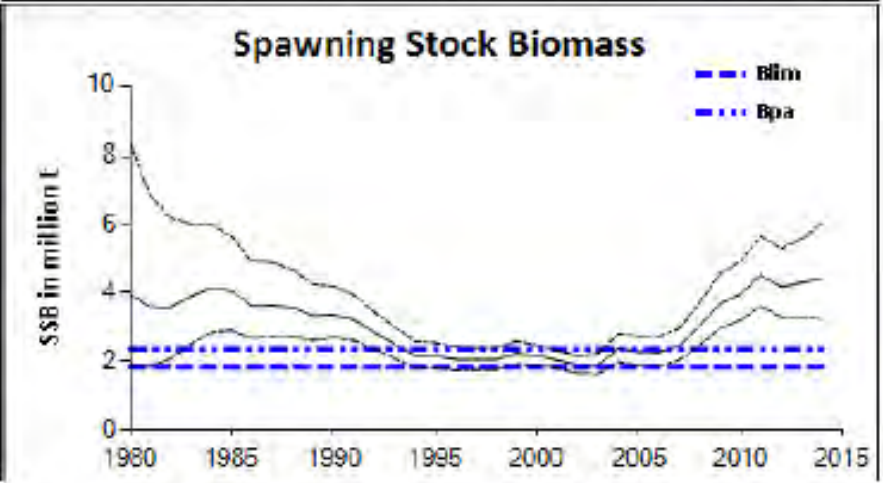
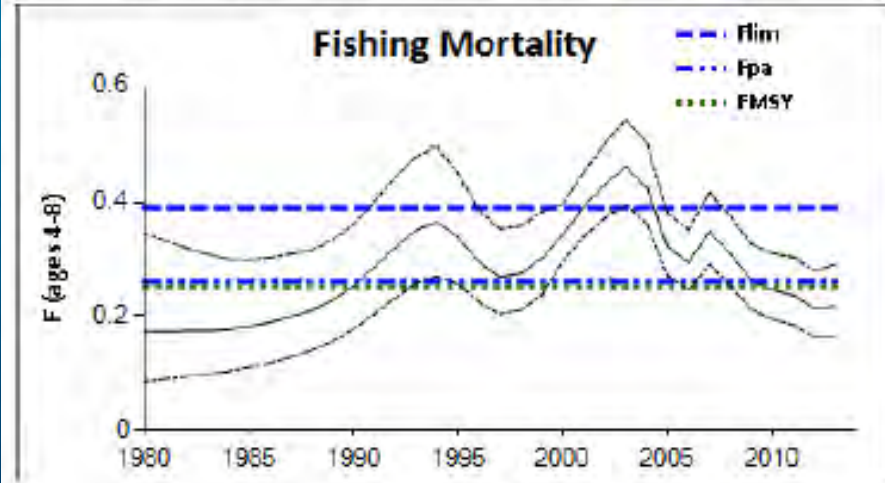
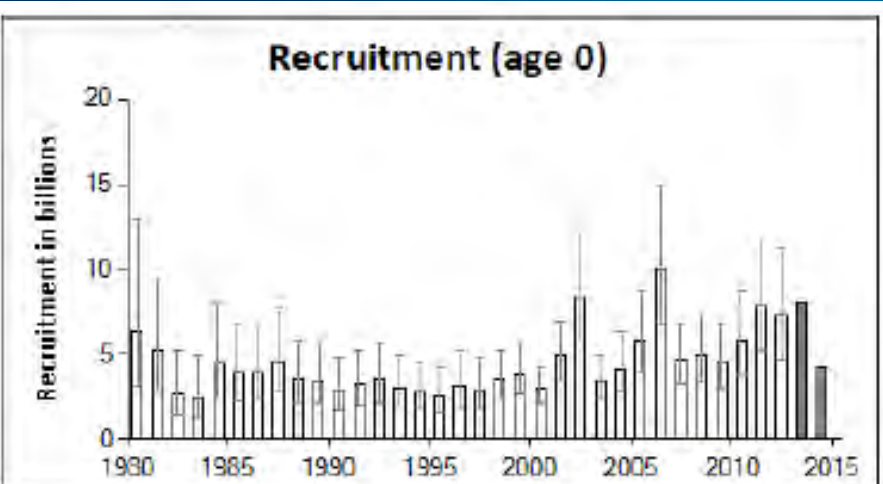
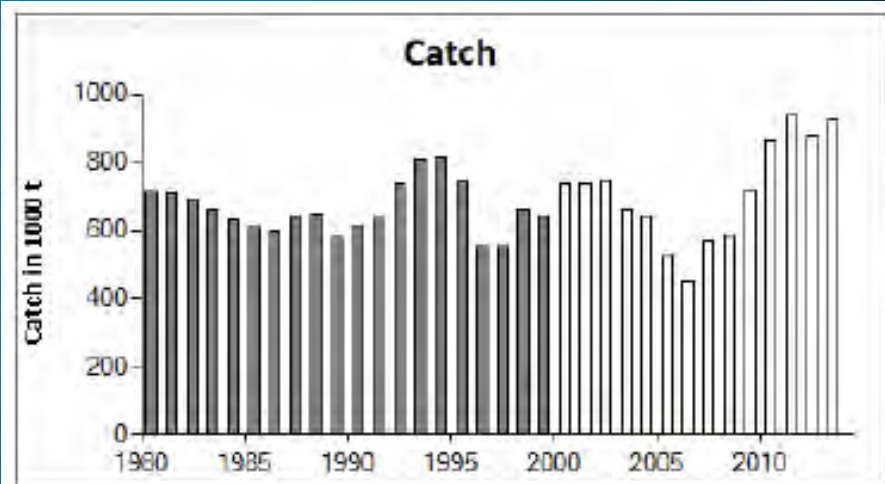
- Most valuable fish species in North Atlantic Ocean
- 1.4 million tonnes of NEA mackerel caught in 2014
- Revenue > \$ 2 billion in 2014
- Key ecological role as predator, competitor and prey in the North Sea, Norwegian Sea and massive coastal waters in the NE Atlantic
- Abundant and presently a robust fish population
- Massive distribution and annual long-distance migration patterns



Major spawning and feeding areas



Summary of catches, recruitment (age 0), fishing mortality and spawning stock biomass



Northeast Atlantic (NEA) mackerel

Norskehavet

Foto: Lief Norström

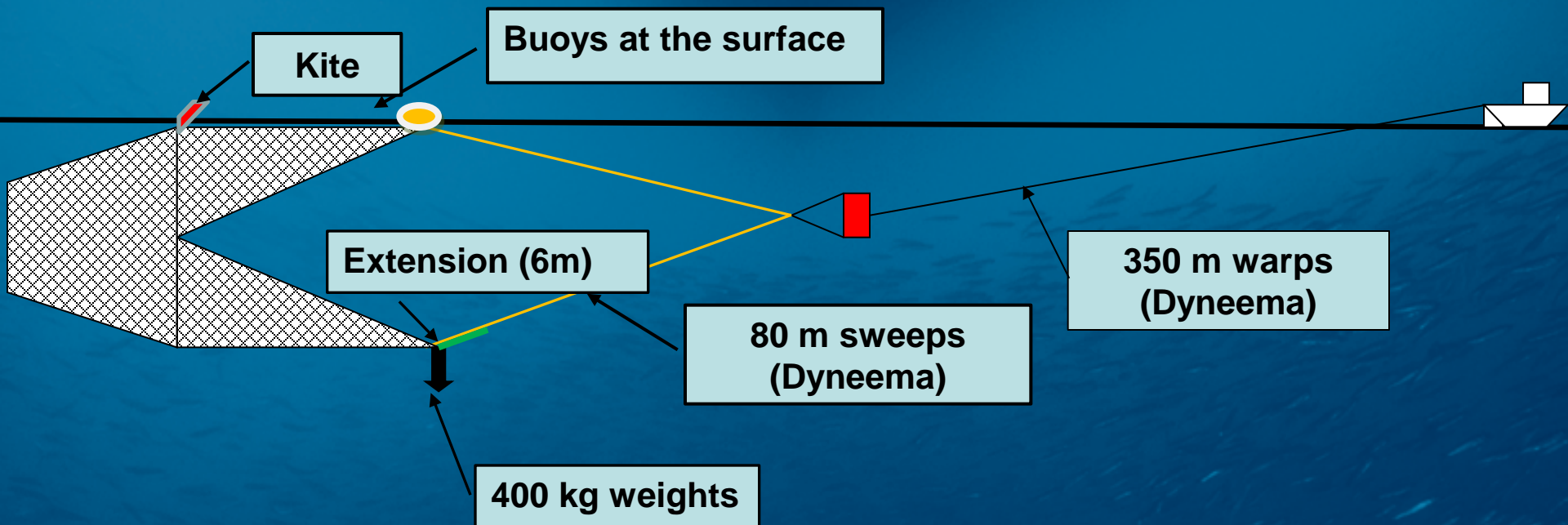
Comprehensive international effort provided new knowledge to the mackerel assessment advice



Technological development for improved mackerel science and abundance estimation



Rigging of Multipelt 832 for systematic trawling at the surface (0-35 m depth)



Large mackerel catch after 30 min trawling at surface in the Norwegian Sea in summer 2014



Research and fishing vessels hand in hand

Several international large oceanic vessels including both research vessels and chartered modern fishing vessels from Norway, Iceland and Faroe Islands performed dedicated mackerel and ecosystem research during summers 2009-2014

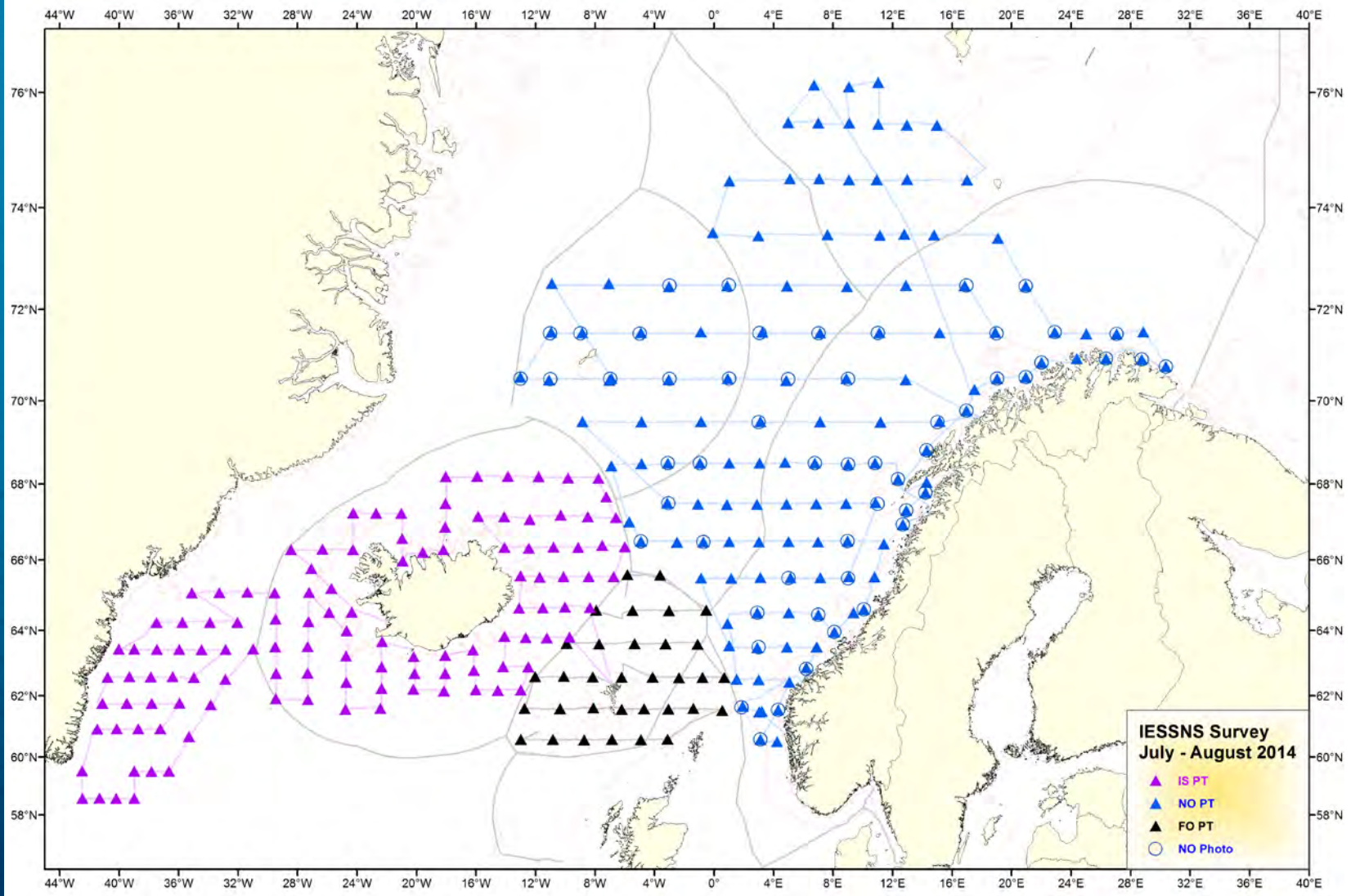


Materials and methods

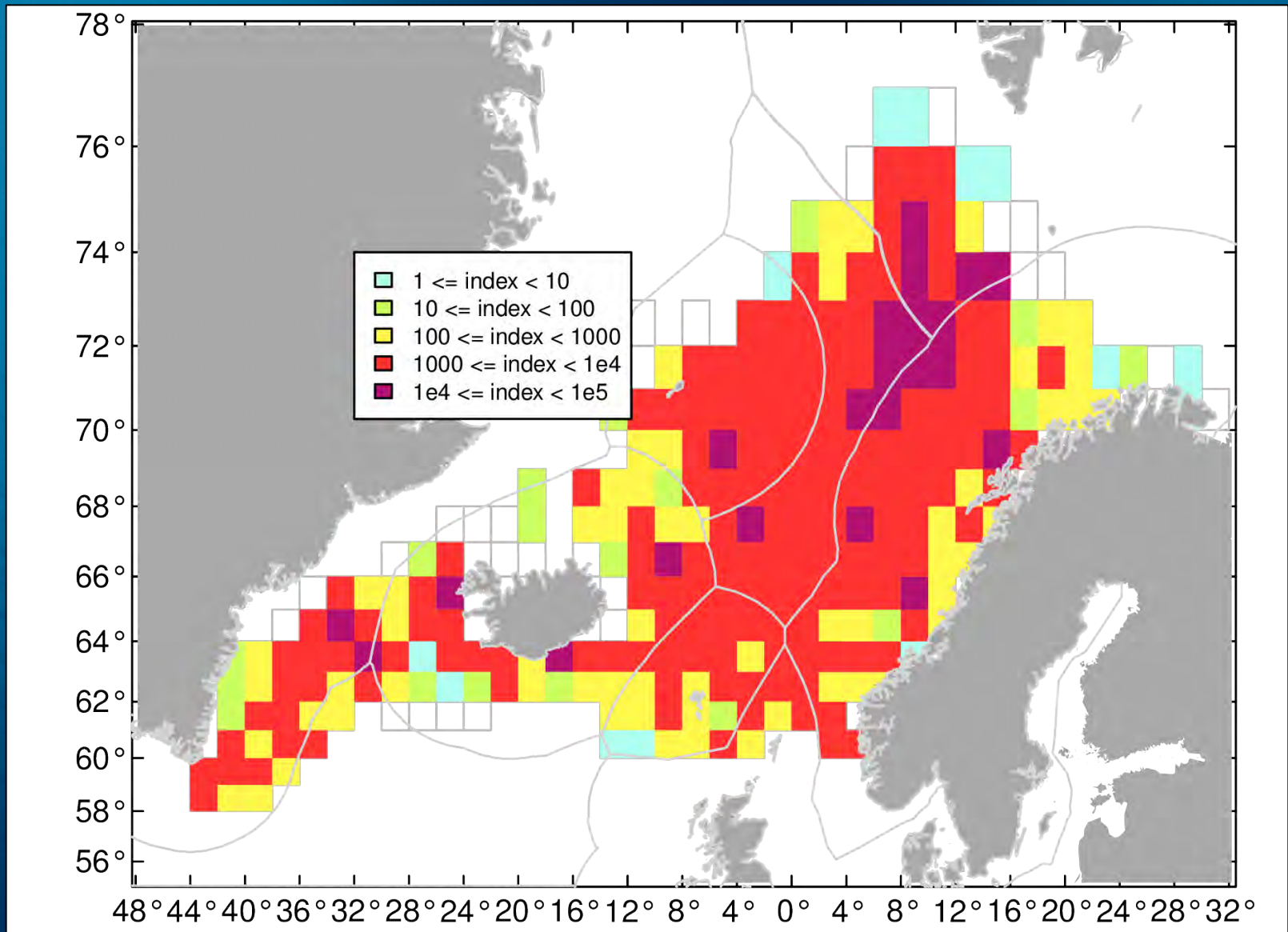
- Vessels: M/V "Brennholm" M/V "Vendla", M/V "Finnur Fridi" og R/V "Arni Fridriksson"
- Survey period: 2 July – 12 August 2014
- Area coverage: 2.45 millioner km²
- 58° N - 77° N og 26° E - 42° W
- Standardized 30 min pelagic trawling with Multpelt 832
- Multi-frequency echosounder and multibeam sonars
- Plankton sampling WP2 net 0-200 m depth
- CTD measurements 0-500 m depth
- Underwater video cameras inside the trawl
- ADCP, light measurements and weather observations
- Whale observations



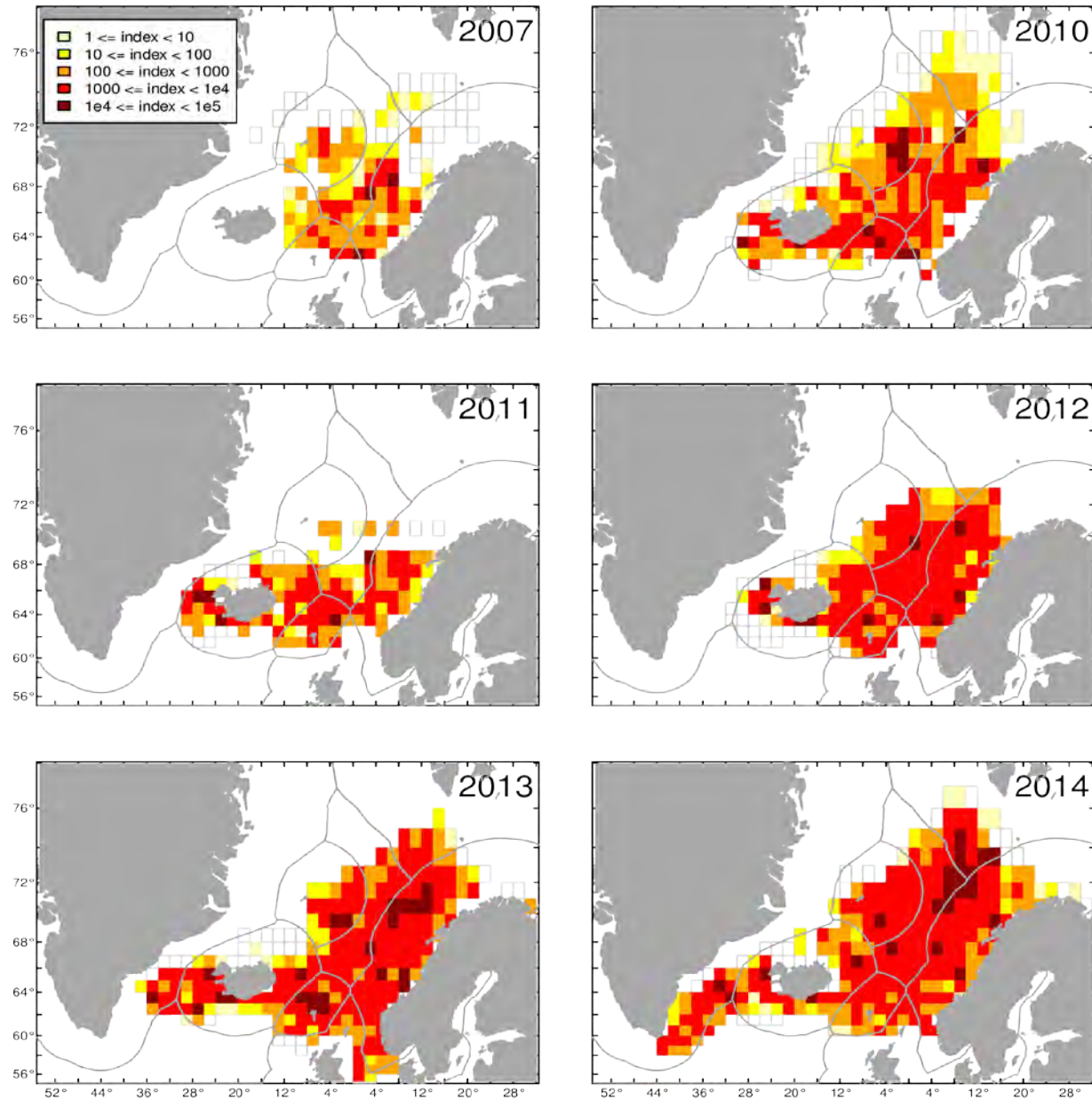
Trawl stations during the IESSNS survey 2014



Mackerel distribution (kg/km²) July-August 2014

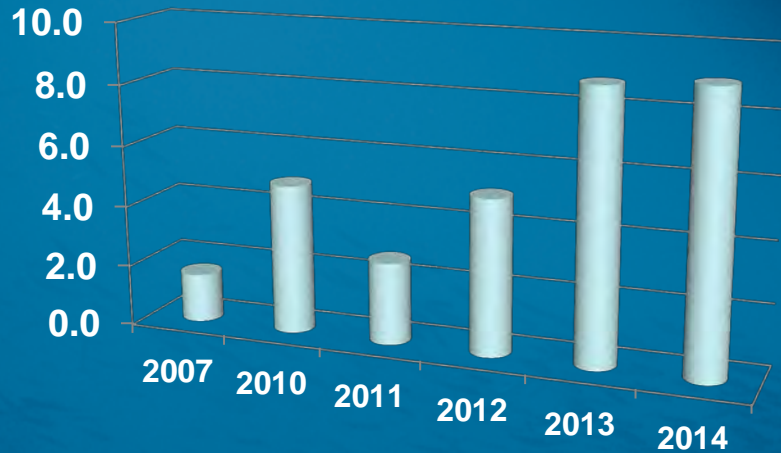


Incredible development of mackerel in the Nordic Seas

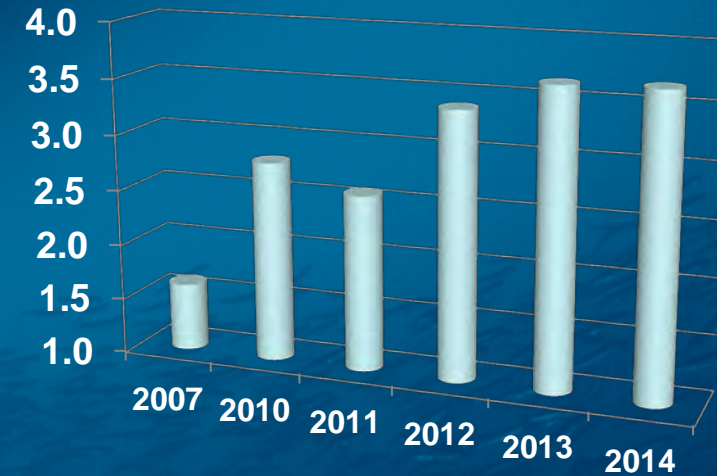


Estimated total stock biomass, habitat distribution and mean density (2007-2014)

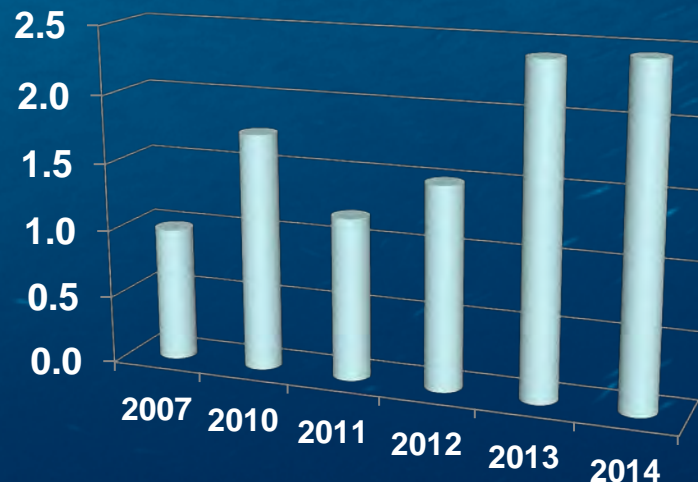
Total stock biomass (mill tonnes)



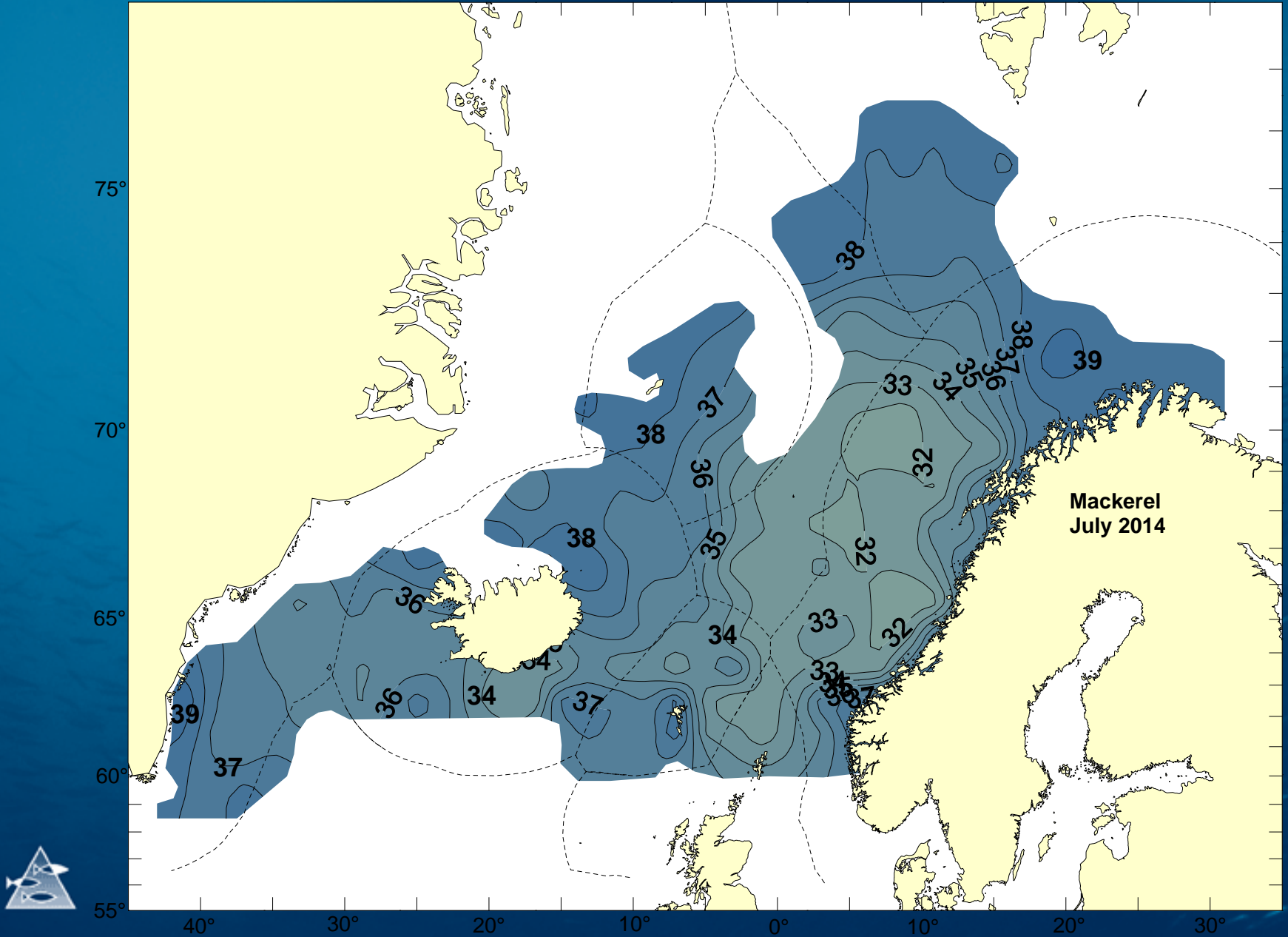
Mean density (tonnes km²)



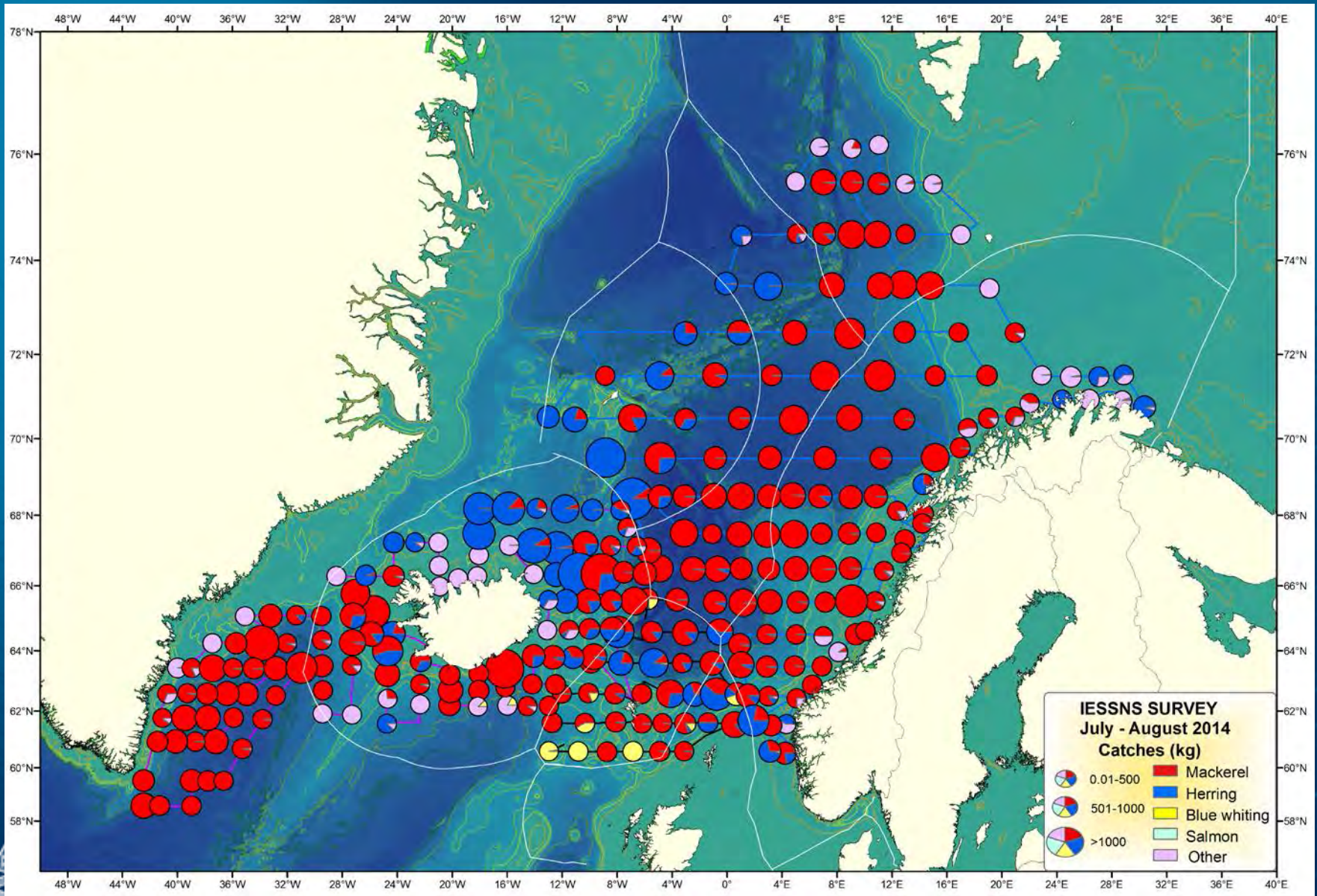
Habitat distribution (mill km²)



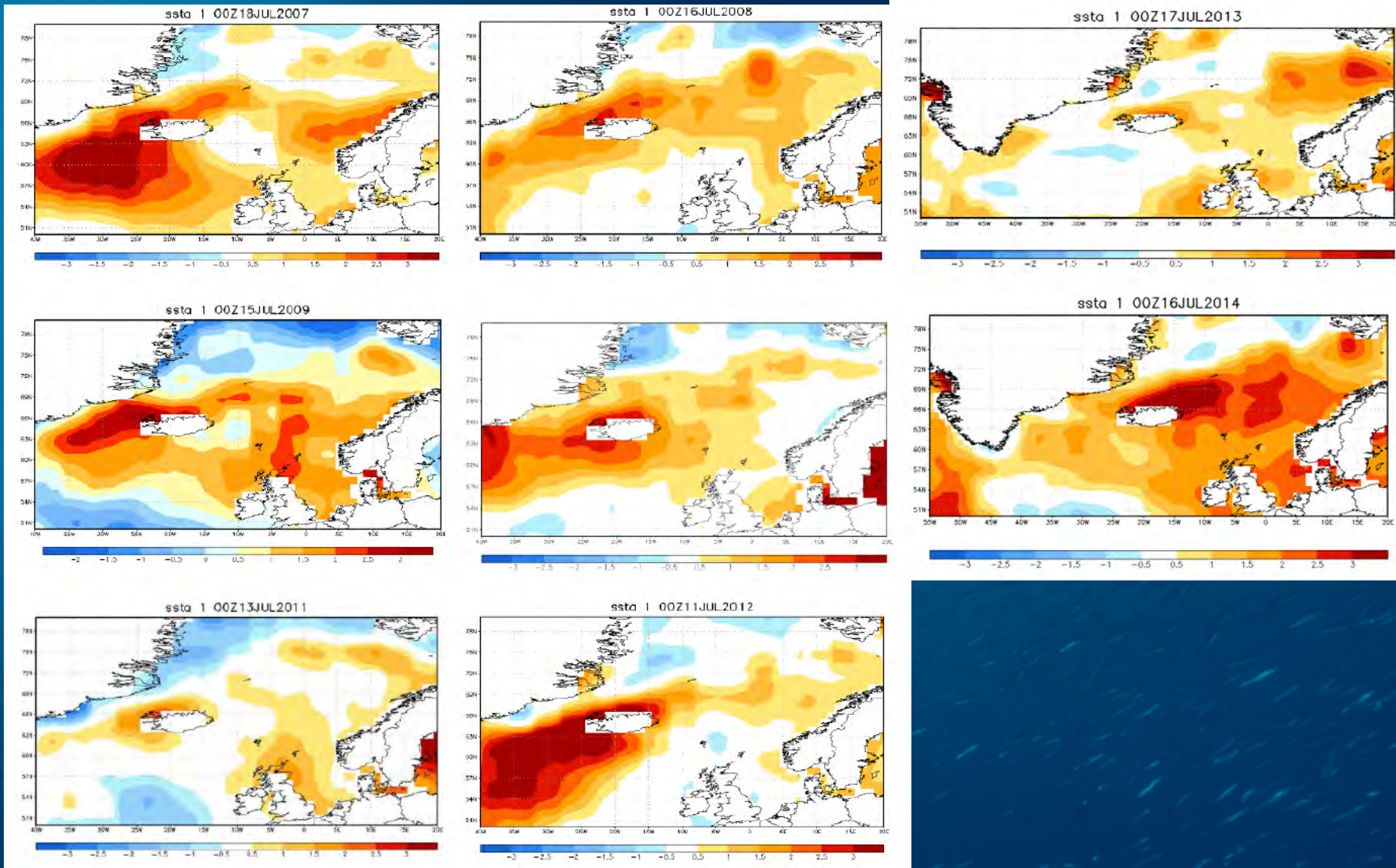
Average length (cm) for NEA mackerel



Distribution and overlap of mackerel and herring



SST anomalies mid-July 2007-2014

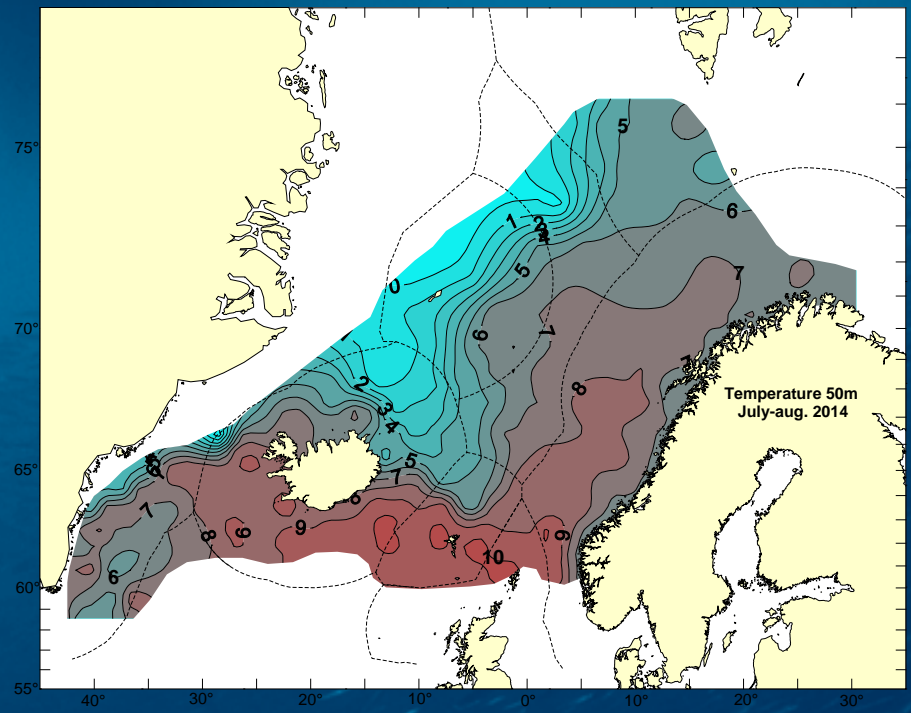
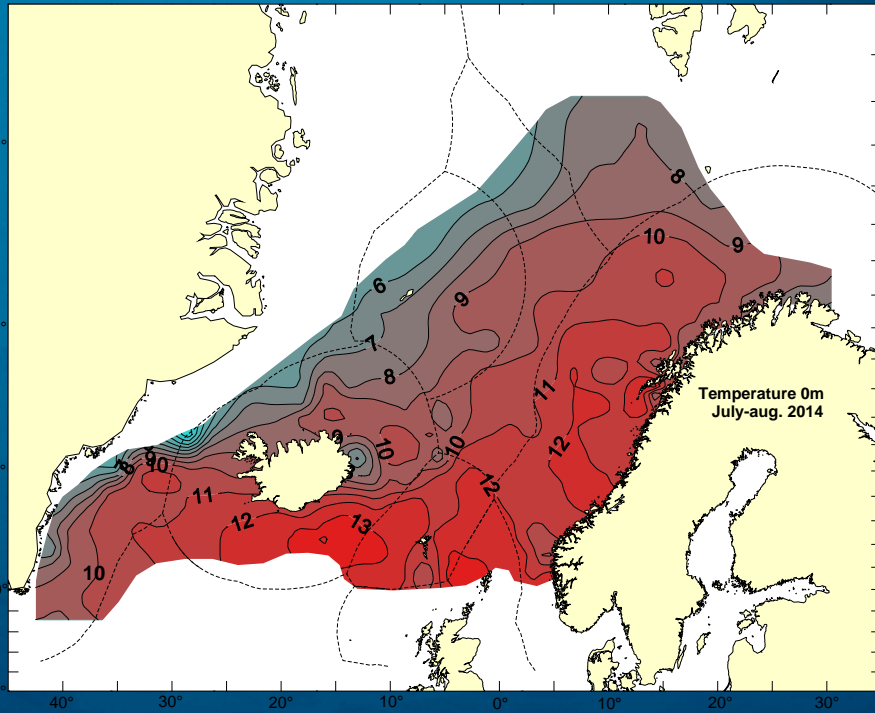


Substantially higher SST anomalies in recent years compared to the long-term average (20-years period)

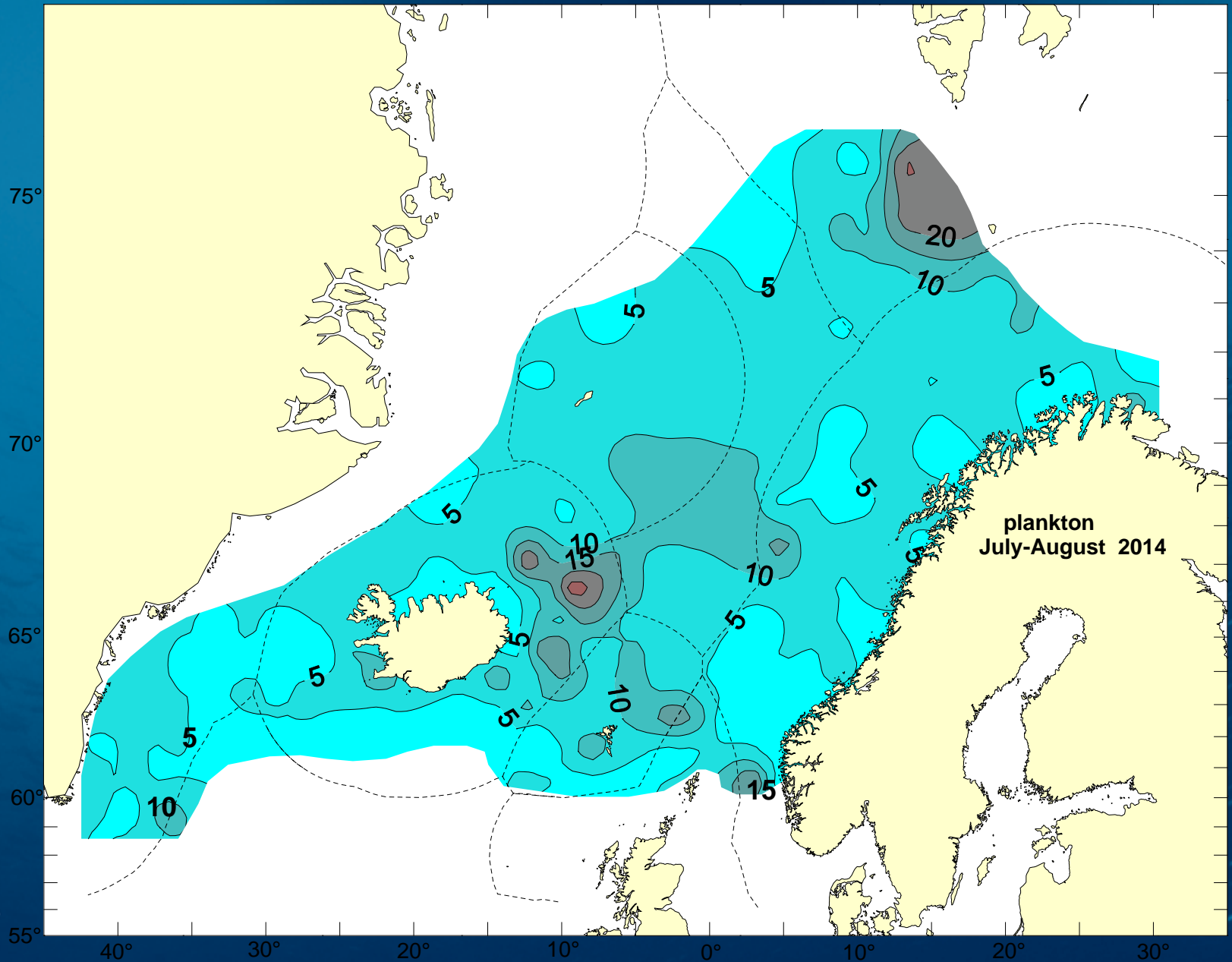
Mackerel prefer temperatures $>6-7^{\circ}\text{C}$

Temperature at 10 m depth

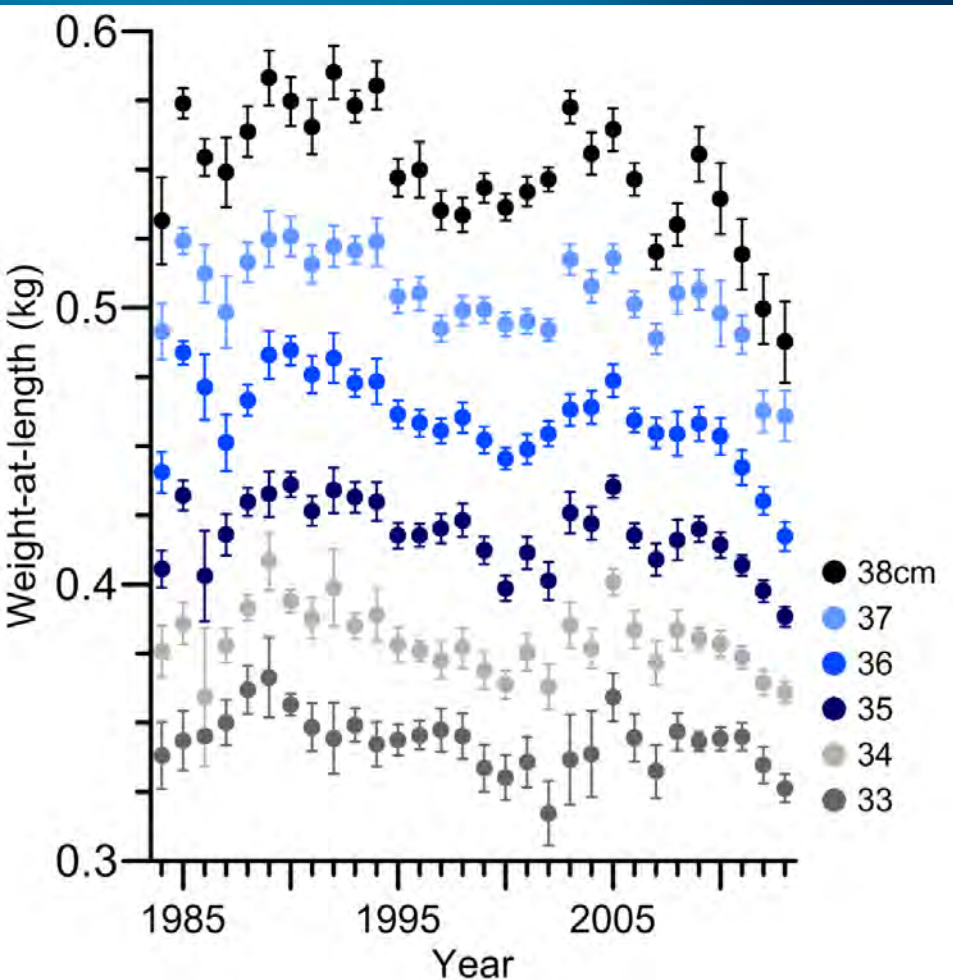
Temperature at 50 m depth



Plankton distribution and concentrations



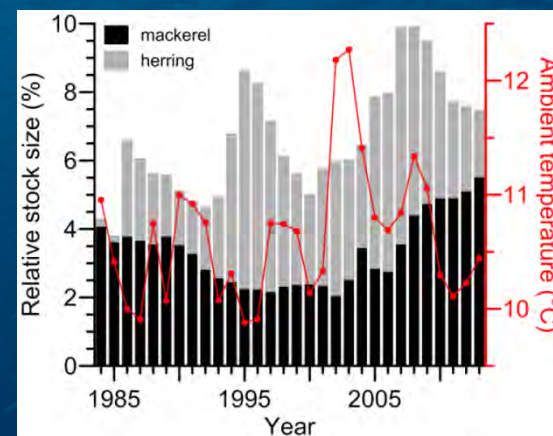
Mackerel condition, in fall, declined from 2009 to 2013 and decline was greater for longer individuals



In 2013 the average mackerel was 4 cm shorter and weighted 175 g less than the average individual in 2002

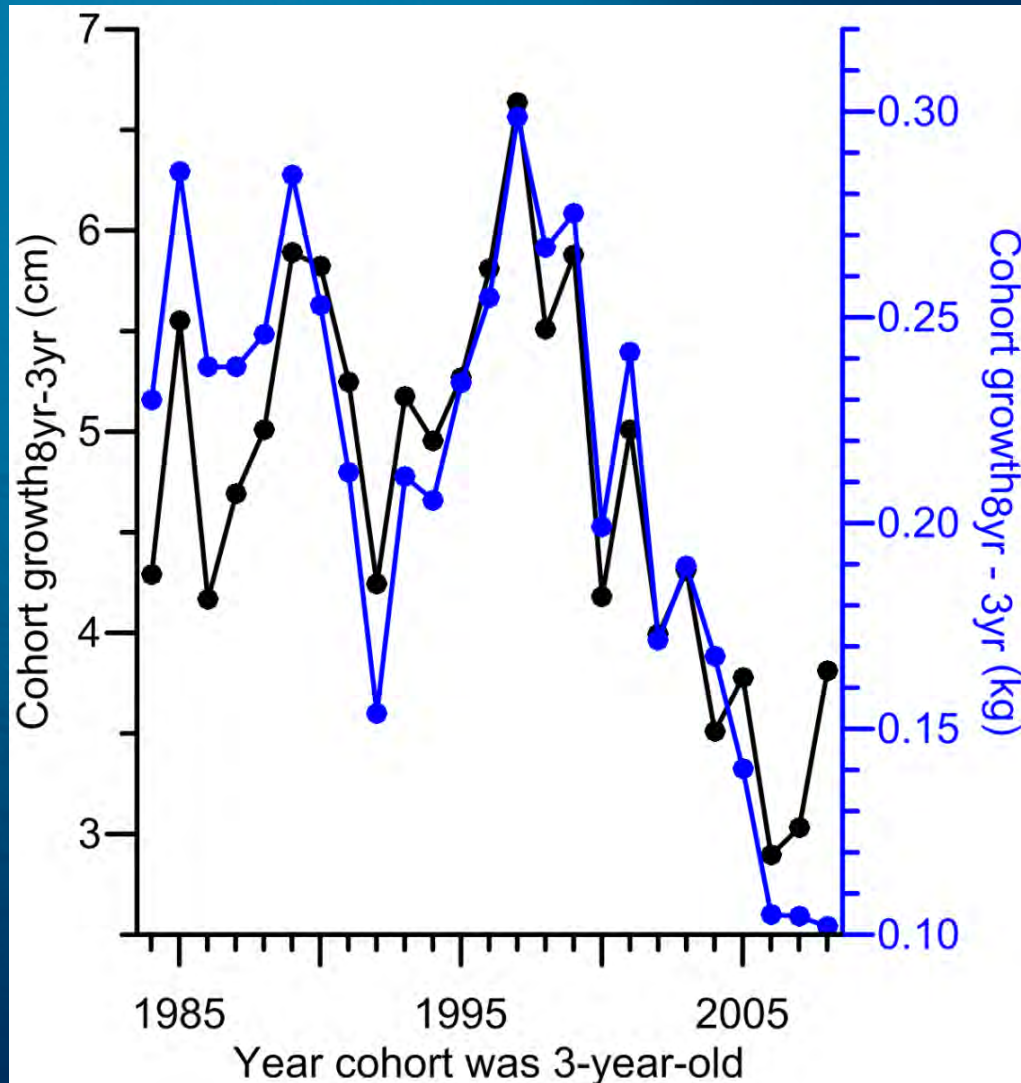
Factors effecting condition:

- 1) density dependence
- 2) negative influence of herring stock size
- 3) positive influenced of feeding ground temperature



Anna H. Olafsdottir, Aril Slotte, Jan Arge Jacobsen, Guðmundur Oskarsson, Kjell Utne, and Leif Nøttestad
Changes in body condition and somatic growth rate of mature mackerel from 1984 to 2013: effects of mackerel stock size, herring stock size, and temperature (*manuscript submitted to ICES J. Mar. Sci*)

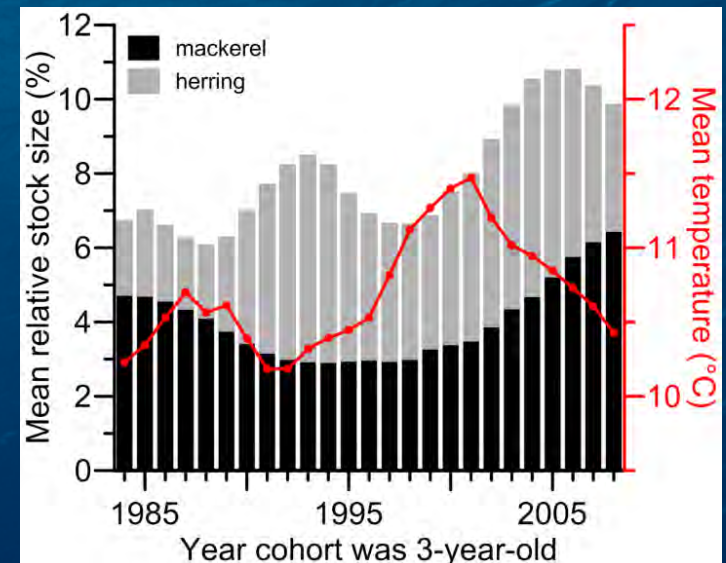
Somatic growth, per cohort, declined 66 % from 1997 to 2008 and was density dependent



Factors effecting growth:

- 1) density dependence
- 2) negative influence of herring stock size

Temperature did not have any significant effect on cohort growth



Holy mackerel: why is this happening?

Possible combined reasons and drivers for mackerel constantly swimming into brand new territories

- 1. Increased population size of NEA mackerel in recent years. Very strong recruitment from the 2002, 2005, 2006 and 2010 year classes and also strong 2007, 2008 and 2011 year classes!**
- 2. Significantly warmer waters compared to 10-20 years ago**
- 3. Lower and more dispersed plankton abundance and distributions at present compared to 10-20 years ago**
- 4. Significantly increased intra-specific competition and possibly inter-specific competition between the large planktivorous fish species in the Northeast Atlantic**



Investing in marine science is rewarding

The landings of Northeast Atlantic mackerel (*Scomber scombrus*) have an export value > \$ 2.0 billion per year. Norway exported mackerel worth a record \$ 700 million in 2014.

New and innovative methodology developed by the Institute of Marine Research in Norway has lead to improved abundance estimation and consequently increased quotas and revenue from the mackerel fishery.

Expect high spawning stock biomass in the years to come due to very large year classes coming into the fishery in the next 2-3 years.

Good news for the international fishing fleet on mackerel!





Thanks for your attention!