



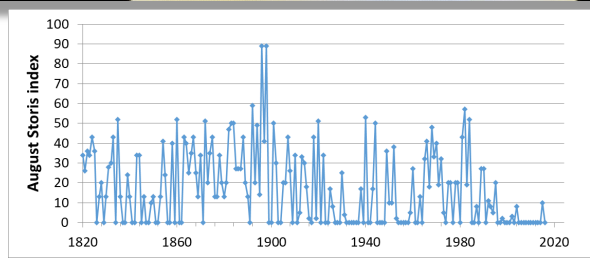
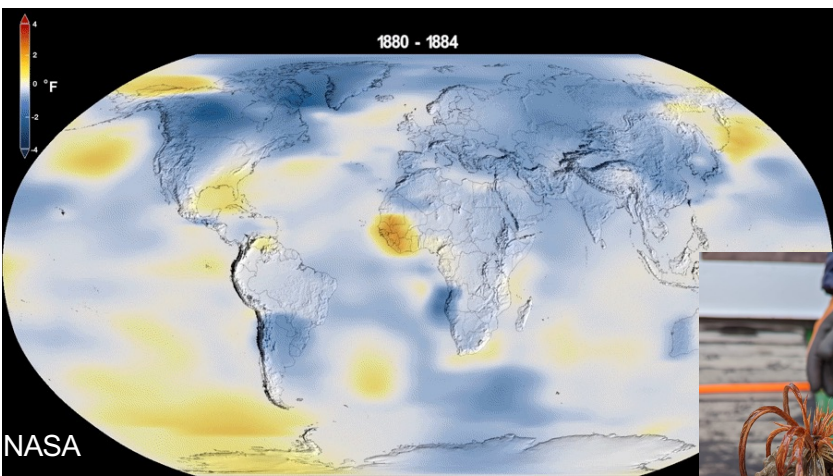
“Tipping points” in marine biodiversity — lessons from the Baltic and the Arctic

Session: Ecosystem effects in
time and space

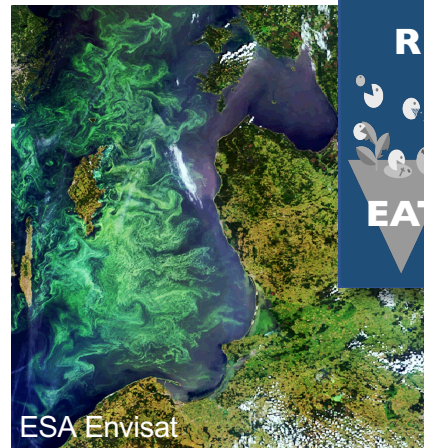
Finnish Society of Sciences and
Letters, Symposium 28.9 2023

Anna Törnroos, Åbo Akademi
University, Environmental &
Marine Biology, The Sea





Heide-Jørgensen et al., 2023



THE SEA



An interdisciplinary research
profile at Åbo Akademi Univ.
www.abo.fi

Acknowledgments



Investigating Ecological
Tipping Cascades in
the Arctic Seas
www.ecotip-arctic.eu



This project has received funding from
the European Union's Horizon 2020
Research and Innovation Programme
under grant agreement No 869383



MARBEFES has received funding from
the European Union's Horizon Europe
research and innovation programme
under Grant Agreement no 101060937



European Union's Horizon
Europe Research and
Innovation Programme
(In GA agreement phase)



The Sea



Particular thanks to:

Members of the benthos group at ÅAU: Phoebe Armitage, Marie Nordström, Erik Bonsdorff, Christian Pansch-Hattich, Christoffer Boström

ECOTIP colleagues: Marja Koski, Mats-Peter Heide-Jørgensen, Brian McKenzie, Ingrid Wiedmann, Camilla Svendsen et al.

Tipping Elements and Points – what are they?

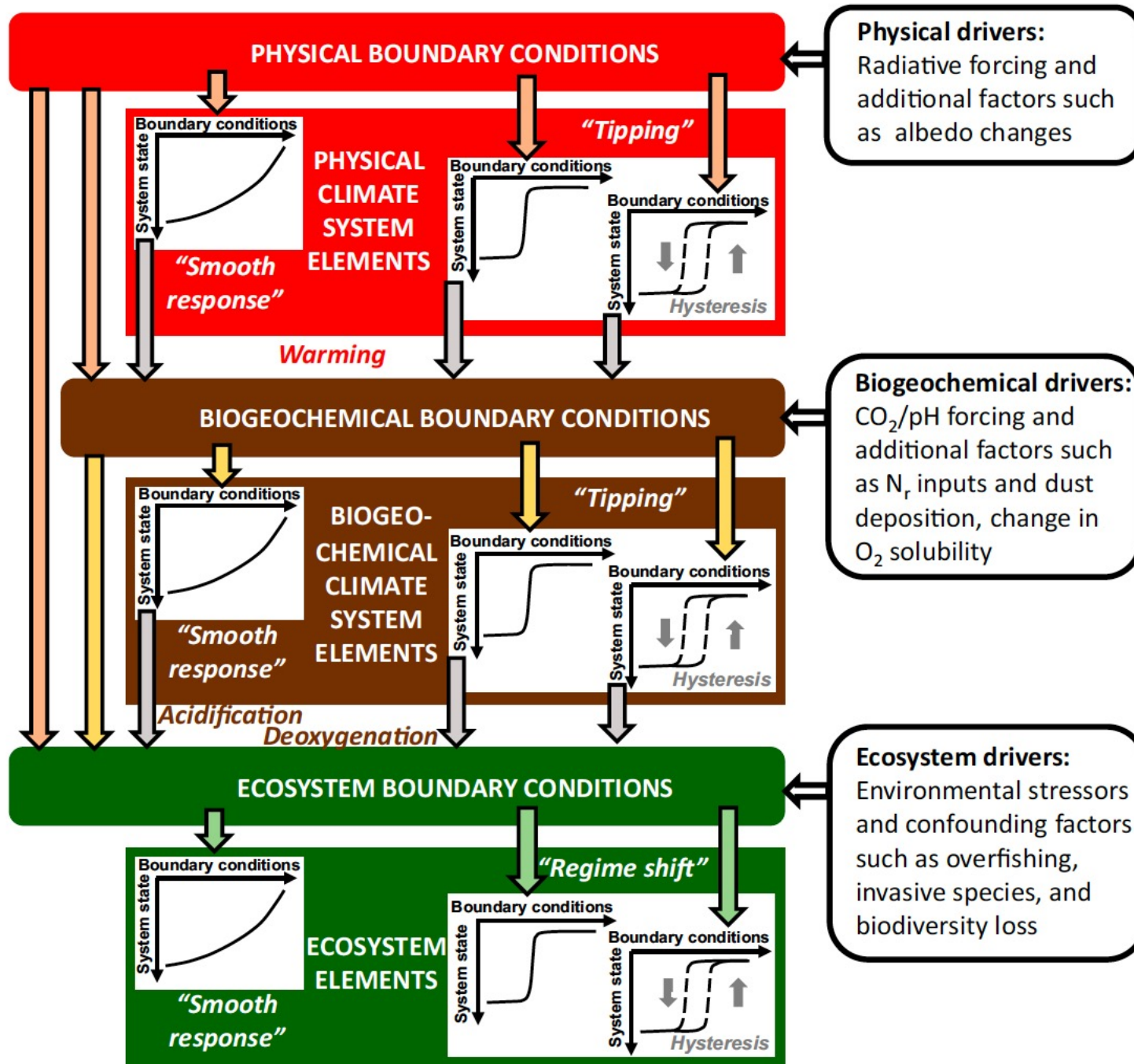
Tipping Element: “large-scale component of the Earth system that may pass a tipping point”

Tipping Point: “a critical threshold at which a tiny perturbation can qualitatively alter the state or development of a system”

- “thresholds associated with *rapid and abrupt* changes even when the underlying forcing changes gradually”

Changes in compartments of the ocean

» Through external drivers or couplings between the compartments



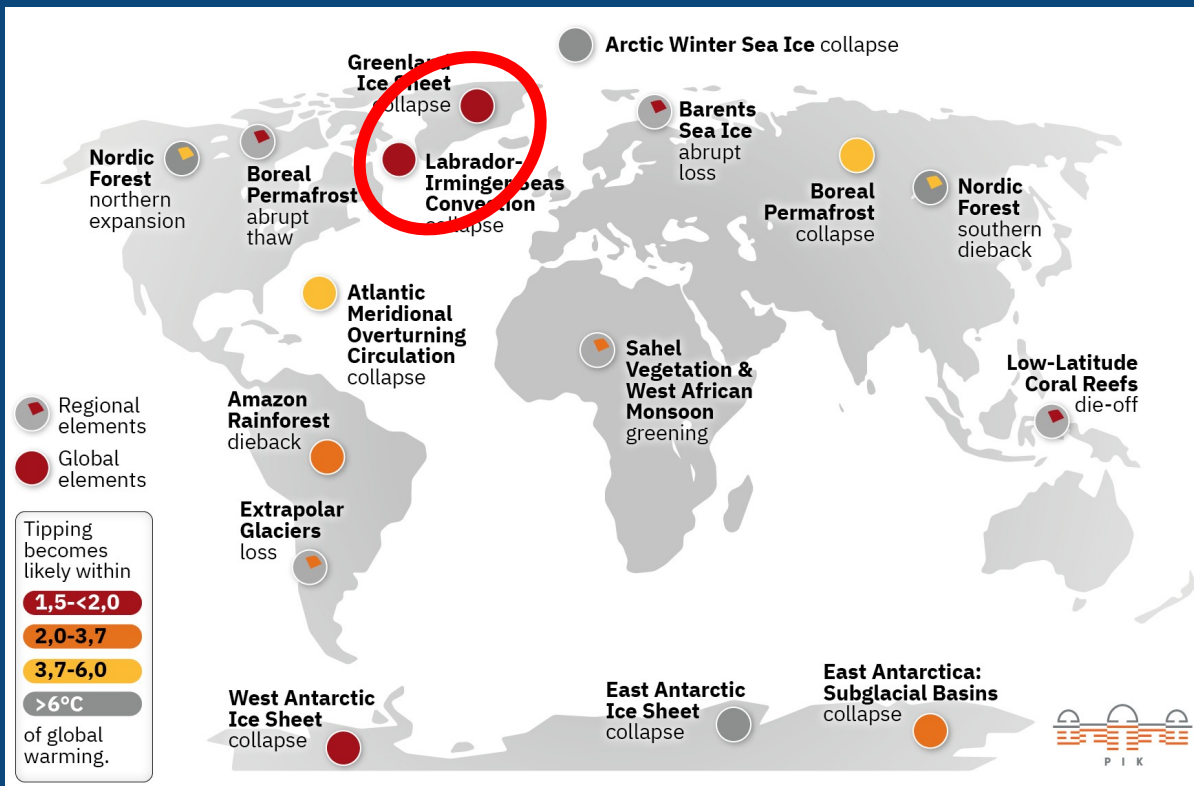
Heinze et al. 2021
PNAS

RESEARCH ARTICLE

CLIMATE CHANGE

Exceeding 1.5°C global warming could trigger multiple climate tipping points

David I. Armstrong McKay^{1,2,3,4*}, Arie Staal^{1,2,5}, Jesse F. Abrams³, Ricarda Winkelmann⁶, Boris Sakschewski⁶, Sina Loriani⁶, Ingo Fetzer^{1,2}, Sarah E. Cornell^{1,2}, Johan Rockström^{1,6}, Timothy M. Lenton^{3*}



Major Climate-Earth System Tipping Elements and Points

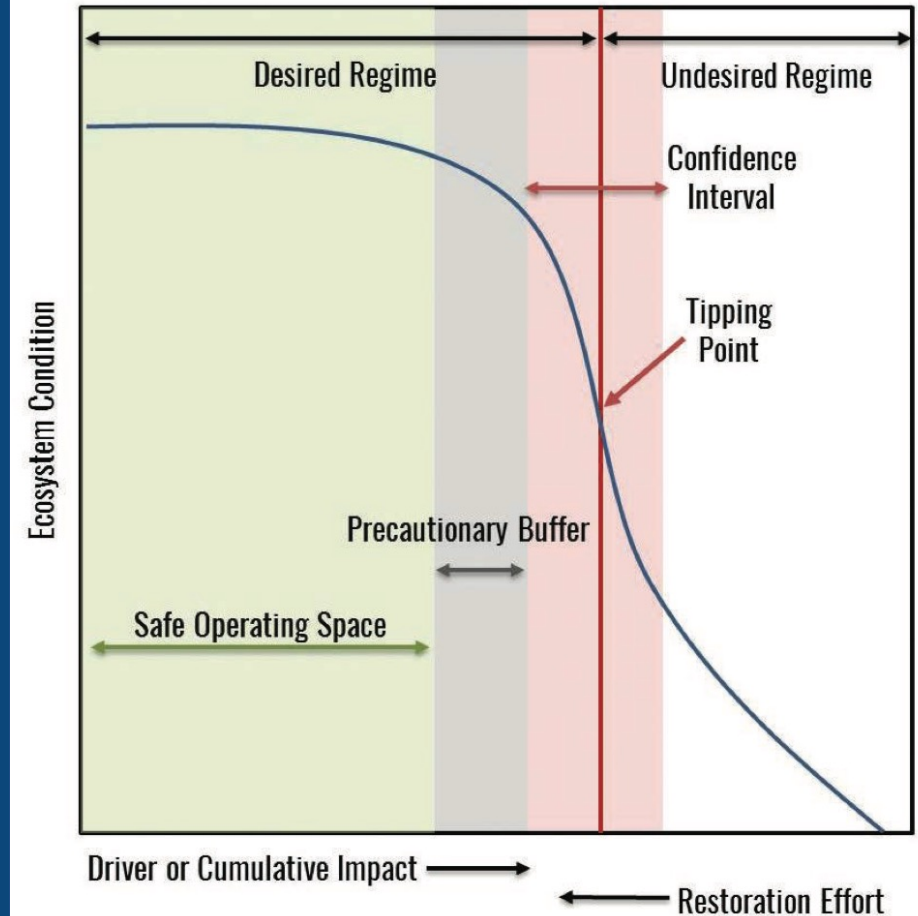
» Several tipping elements and points identified in the global climate-ocean system

Armstrong McKay et al. 2022
Science

Tipping elements, points, cascades

– measurable, identifiable, predictable?

- » It is about more than one point, more than one compartment and more than one context!
- » Studies of changes in multiple contexts, groups and functions have a better chance to identify & mechanistically characterise system-wide shifts



Hillebrand et al. 2023, Heinze et al. 2021

Martone et al. 2017, Selkoe et al. 2015

Arctic biodiversity change in benthic and pelagic compartments

Change in functioning - coupling between sea surface and seafloor

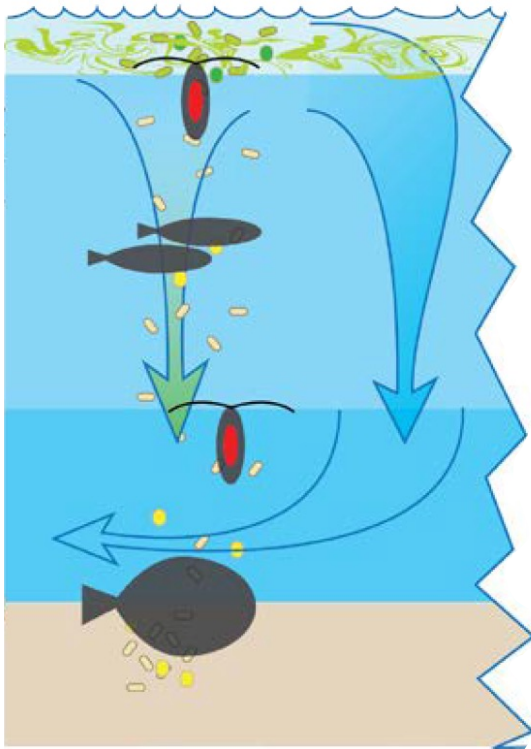
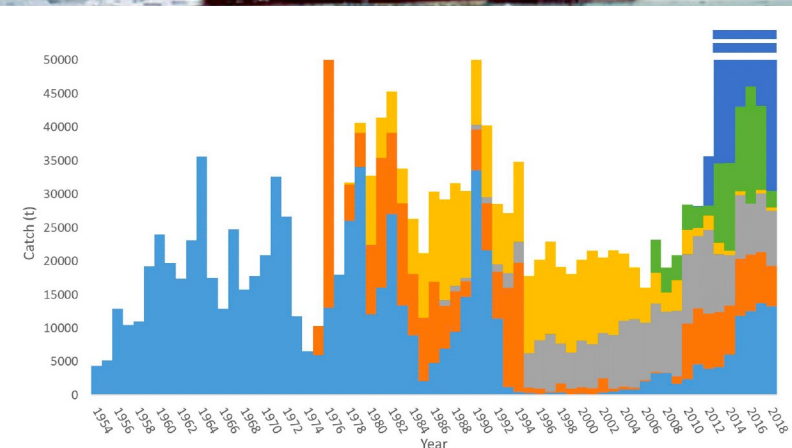
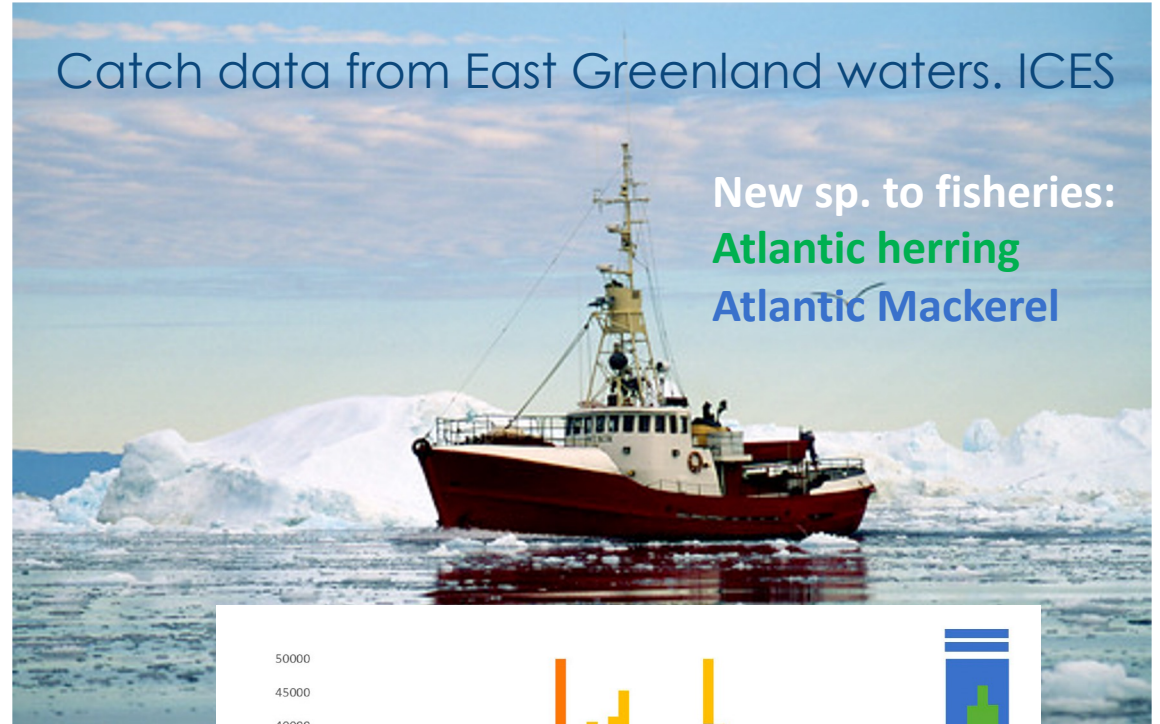


Illustration: André Visser, Ecotip

Catch data from East Greenland waters. ICES

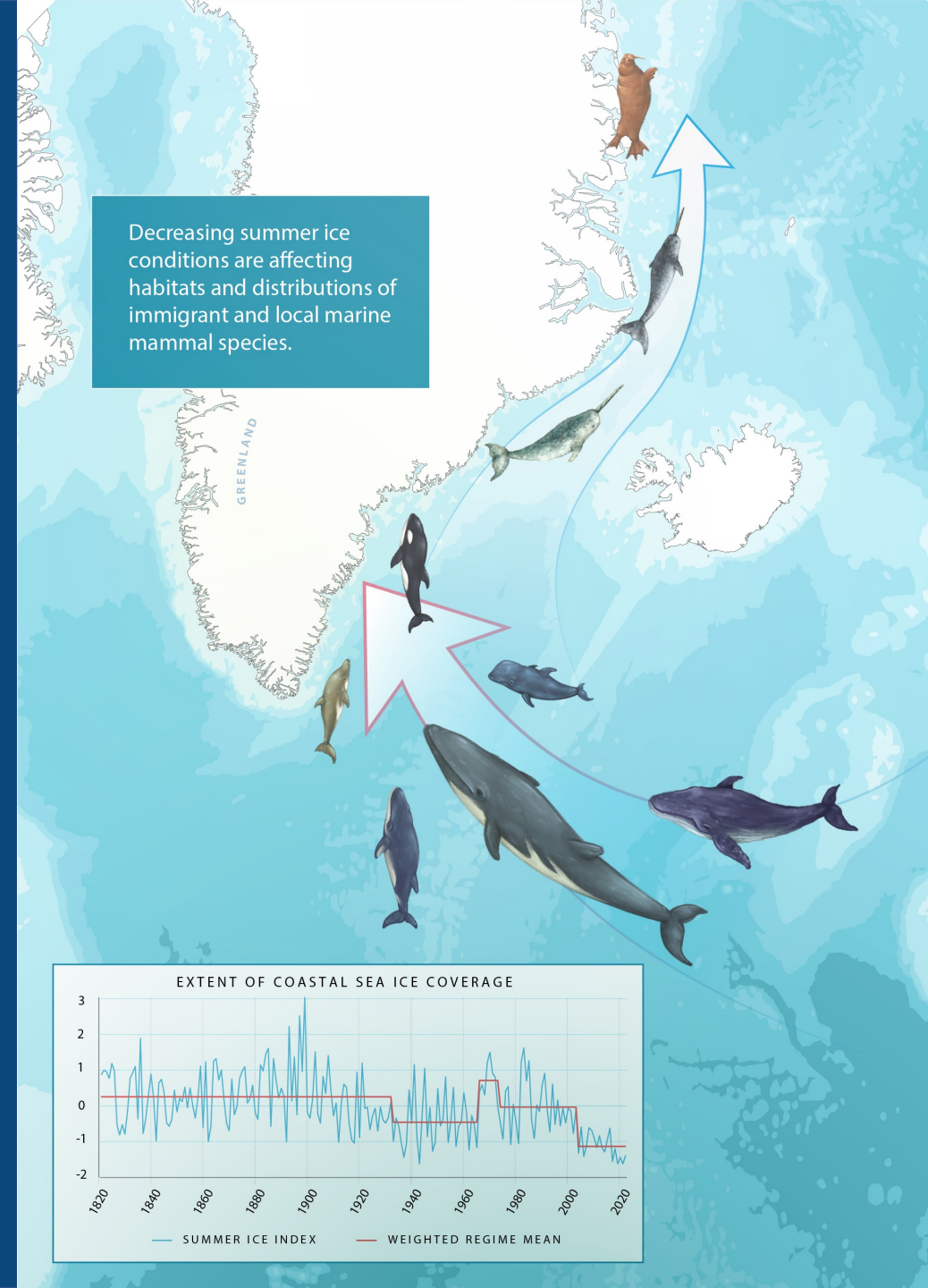
New sp. to fisheries:
Atlantic herring
Atlantic Mackerel



Tipping cascades in East Greenland



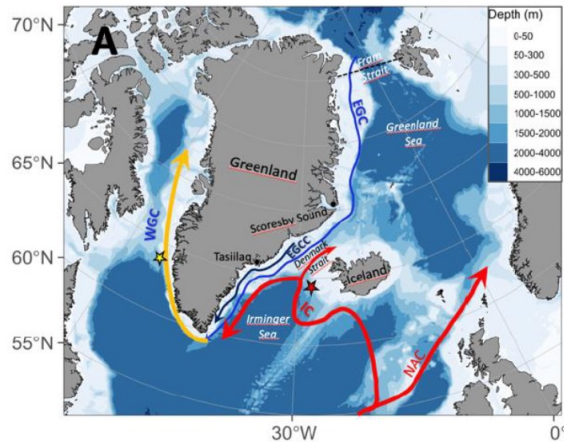
Heide-Jørgensen et al. Global Change Biology 2022



Tipping cascades in East Greenland



Drivers of change



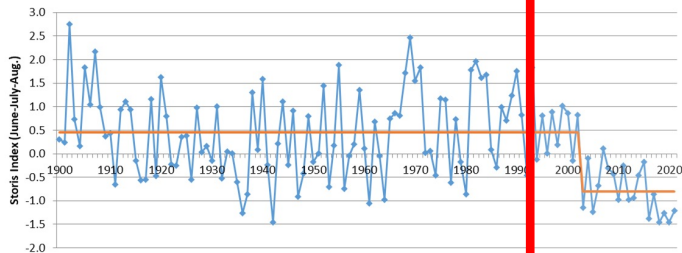
Reduced ice export
from north

+

Warmer sea
temperatures

+

Faster ice
melting



More access to
coastal & shelf
habitats for warm
adapted spp.

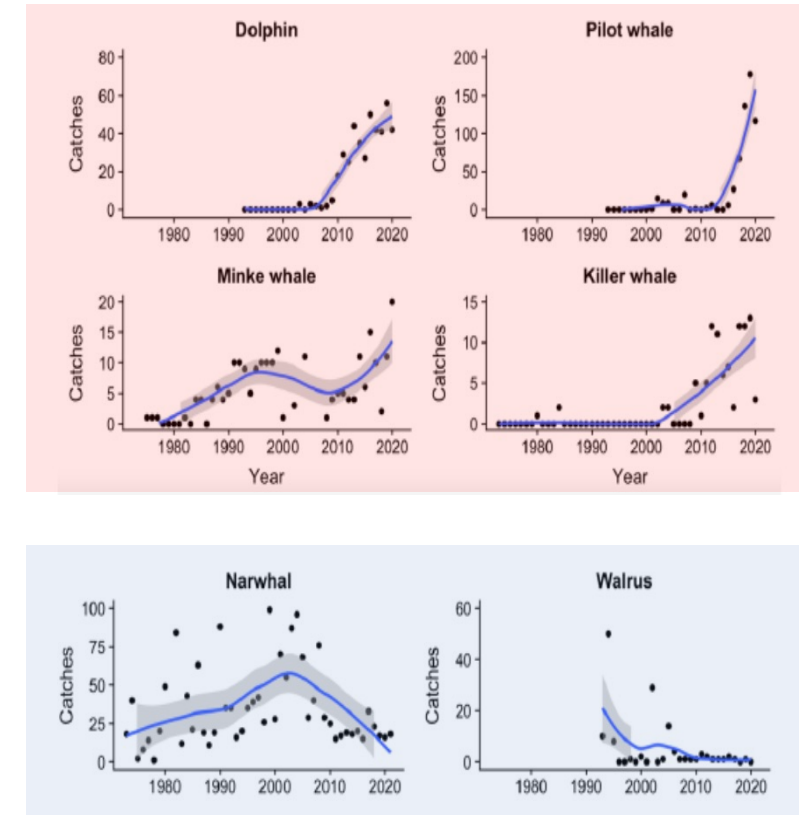
+

Altered sp.
distributions

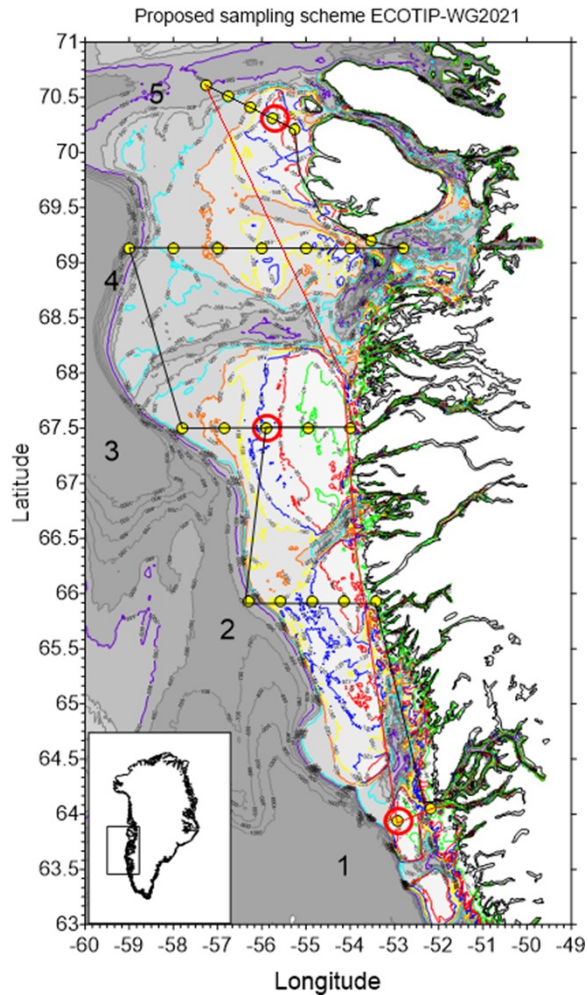
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New food web
links and flows

Ecological consequences

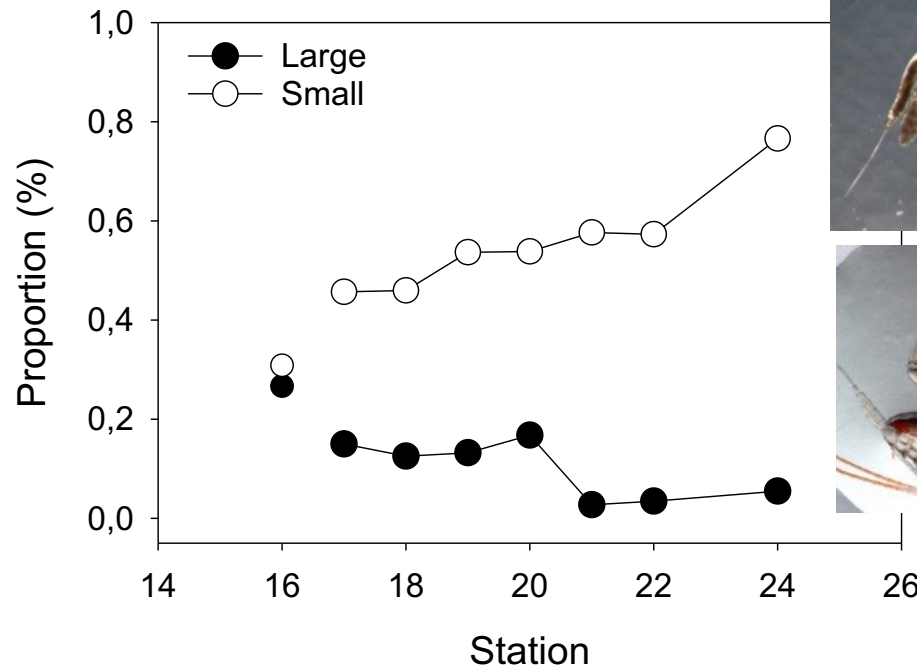


Space-for-time can inform of a likelihood of a “tipping point” /regime shift:

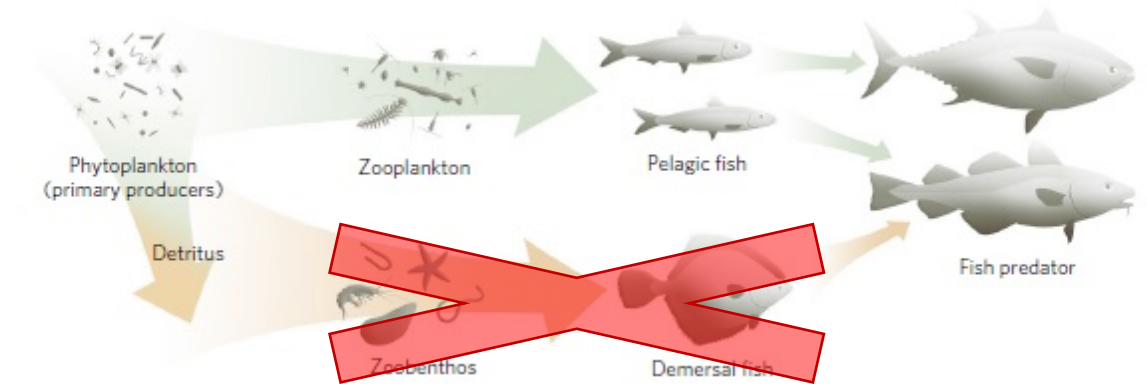
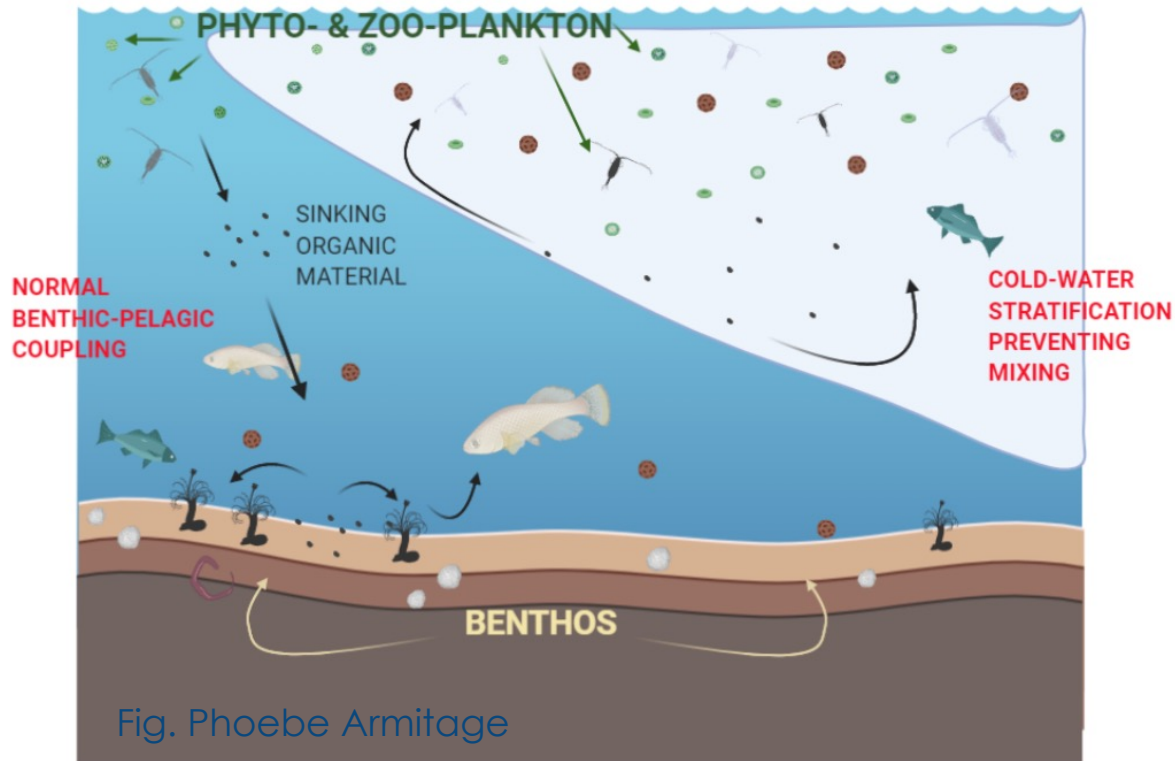


Koski et al. in prep.

Zooplankton community composition



The hypothesised changes for Arctic benthic systems:



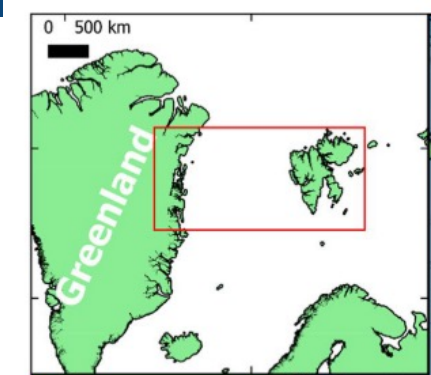
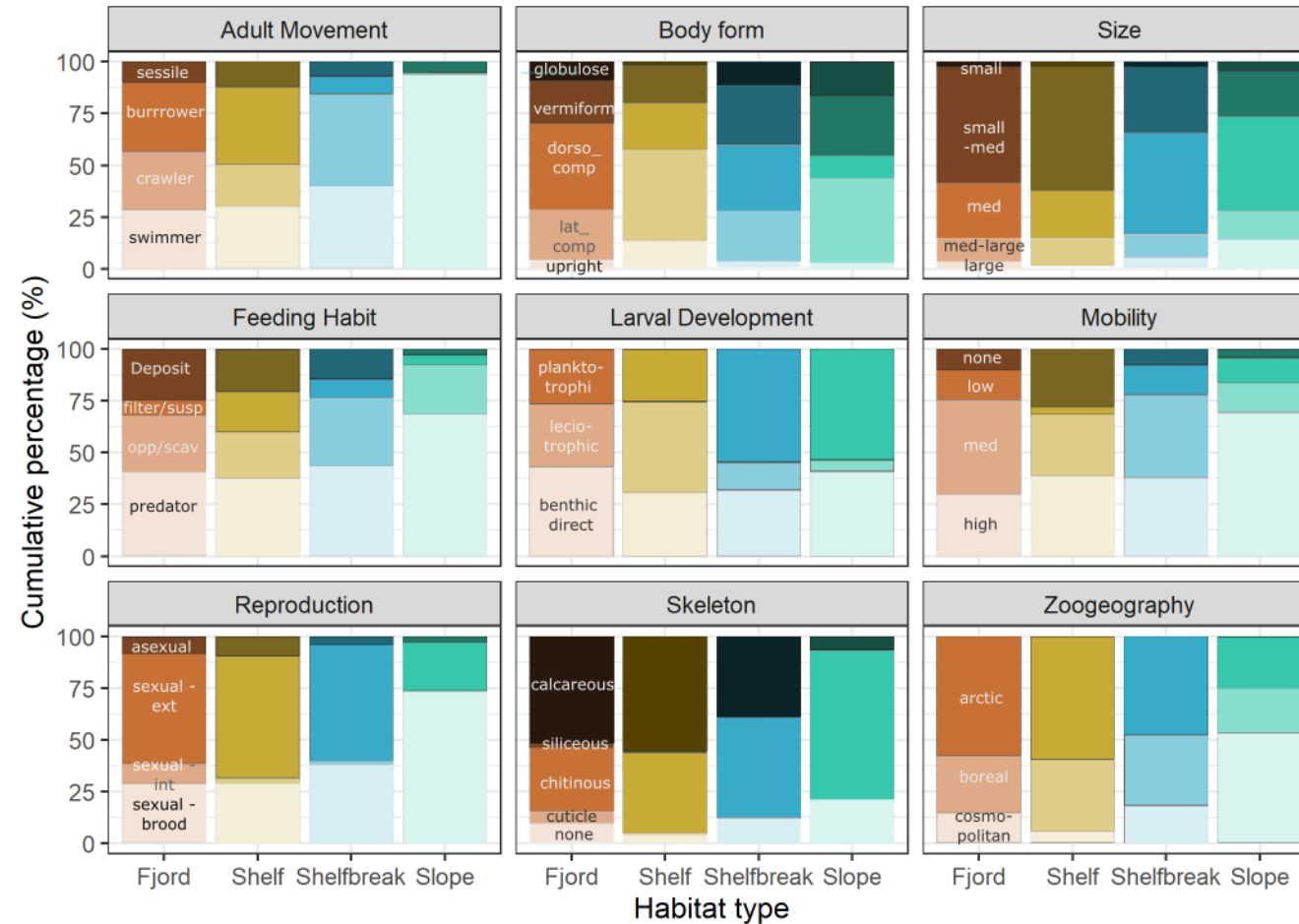
Expect fish production to become more pelagic as climate changes: pelagic fish pathways which are favored in more stratified systems

Benthos: disruptions in benthic-pelagic coupling

Spatial distribution of traits

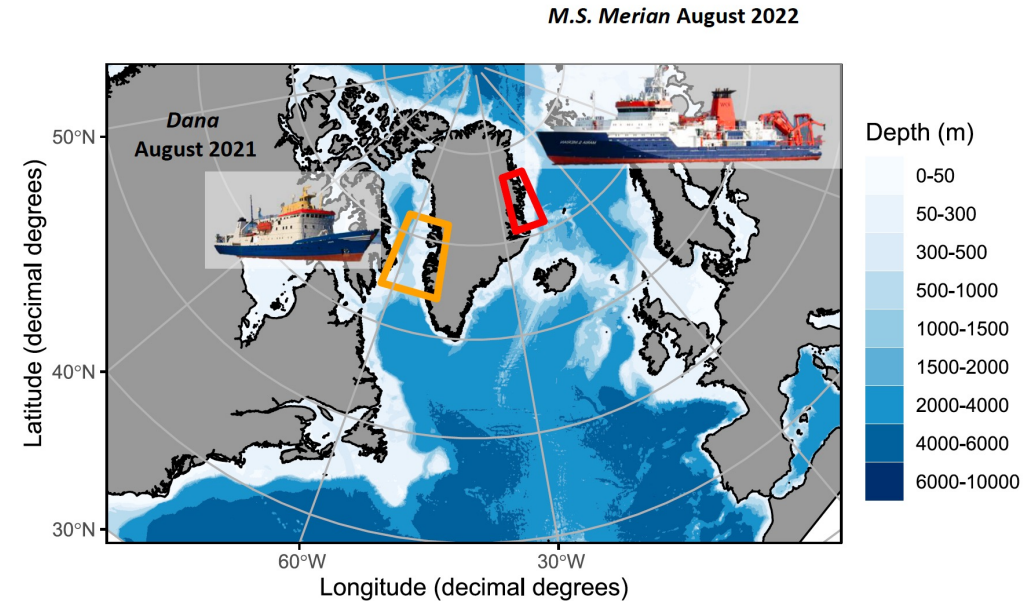
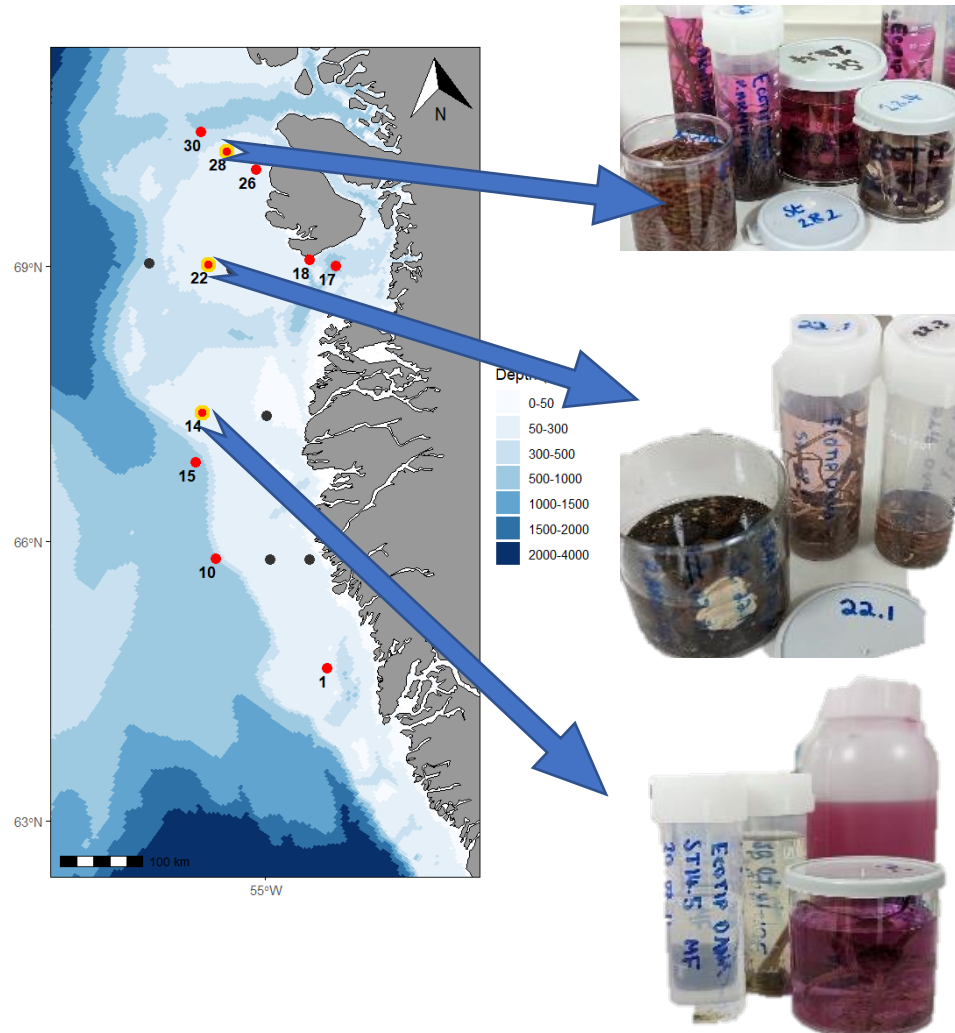


There are **clear spatial patterns** in functioning (traits) across fjord to slope habitats.

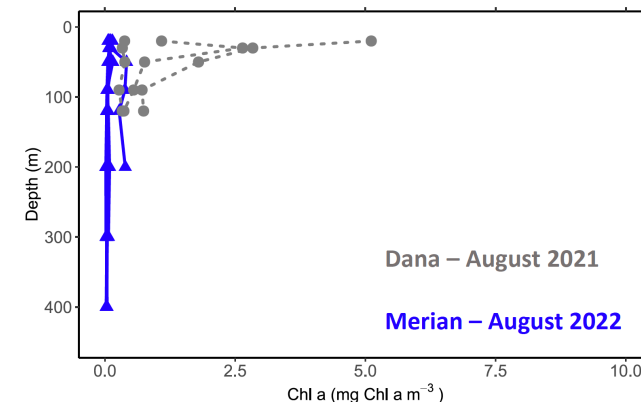


Benthic-pelagic coupling in a system with little/no historical (baseline) data

Prelim. analysis!



Downward Chl a flux in sediment traps (Merian, Dana)



Lessons from the most studied system in the world

NEWS






Where now for Baltic Sea stocks?

With many fish stocks declining, ICES plans to gain further insight into the dynamics of this ecoregion.

Published: 1 June 2023

ICES advice for [fishing opportunities in the Baltic Sea in 2024](#) has been published.

For a number of large commercial stocks, the advice does not make for positive reading. Many of the herring stocks are in trouble. Western Baltic herring has zero-catch advice. The advice for Central Baltic herring recommends a 50% cut in catch as the stock is below Blim (the biological reference point below which recruitment). Herring stock sizes in the Gulf of Bothnia are also low. While eelgrass beds – a valuable nursery habitat for cod – have large numbers of juvenile cod, these fish are not progressing to

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scientific reports

News

 Share  Tweet  in Share

Scientific Advice states that Baltic Sea herring stocks are below safe levels. NGOs: “stop while there is still time”

Published on June 3, 2023



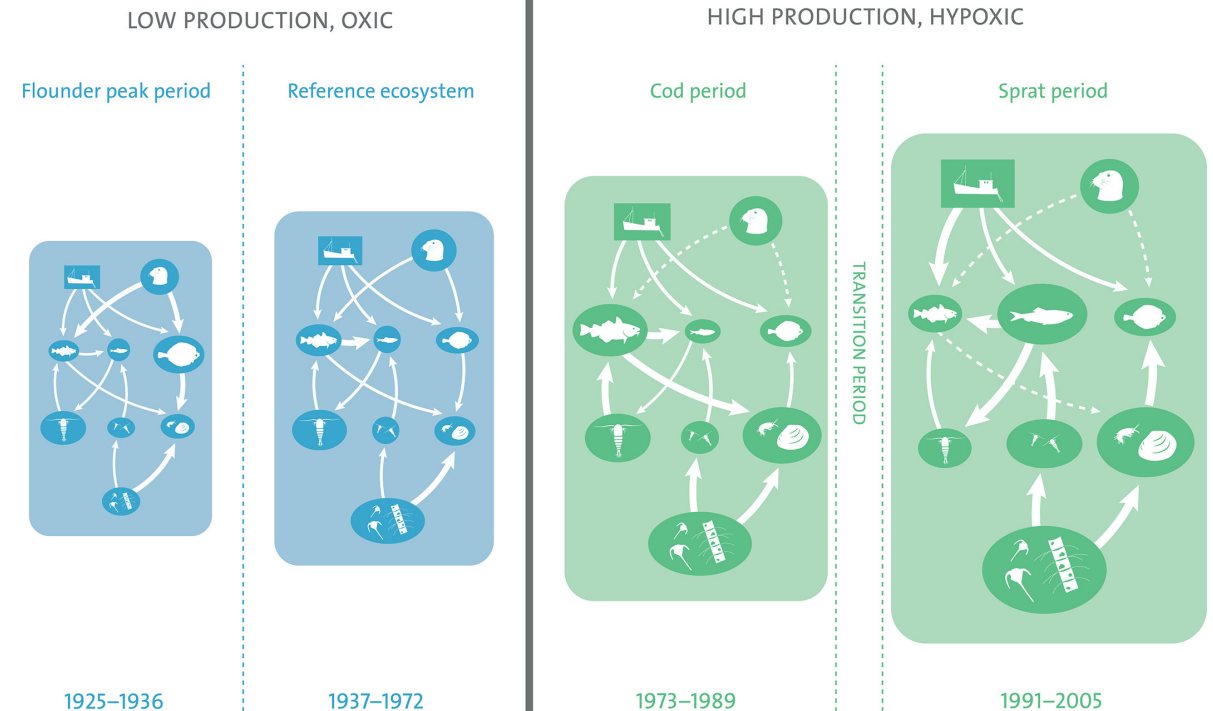
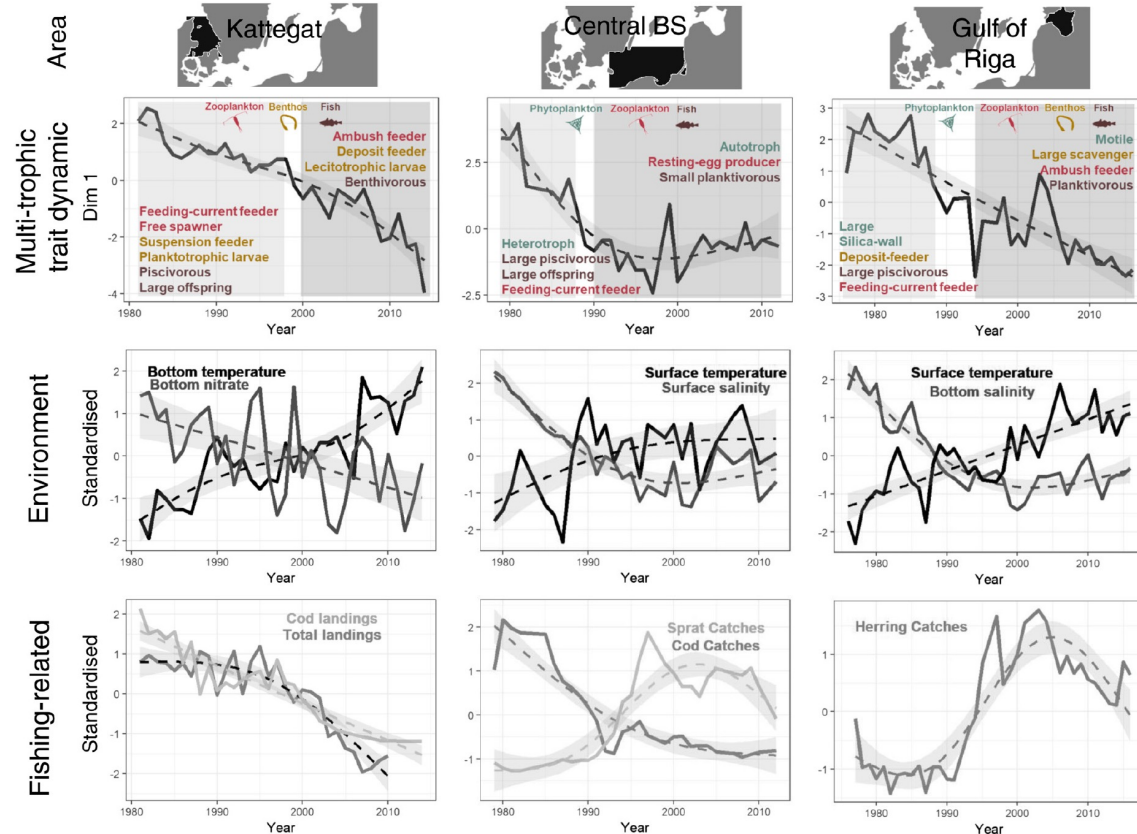
 Check for updates

OPEN

Tipping point realized in cod fishery

Christian Möllmann¹, Xochitl Cormon¹, Steffen Funk¹, Saskia A. Otto¹, Jörn O. Schmidt^{2,3}, Heike Schwermer^{1,2}, Camilla Sguotti¹, Rudi Voss^{2,4} & Martin Quaas⁴

Piecing together the puzzle: From a benthic to a pelagic state in 80 yrs.



Pecuchet et al. 2019 Ecography

Törnroos et al. 2019 Global Change Biology

Tomczak et al. 2022 Limnol. Oceanogr.

Can we learn from our sea & mistakes?



MARBEFES has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement no 10106093

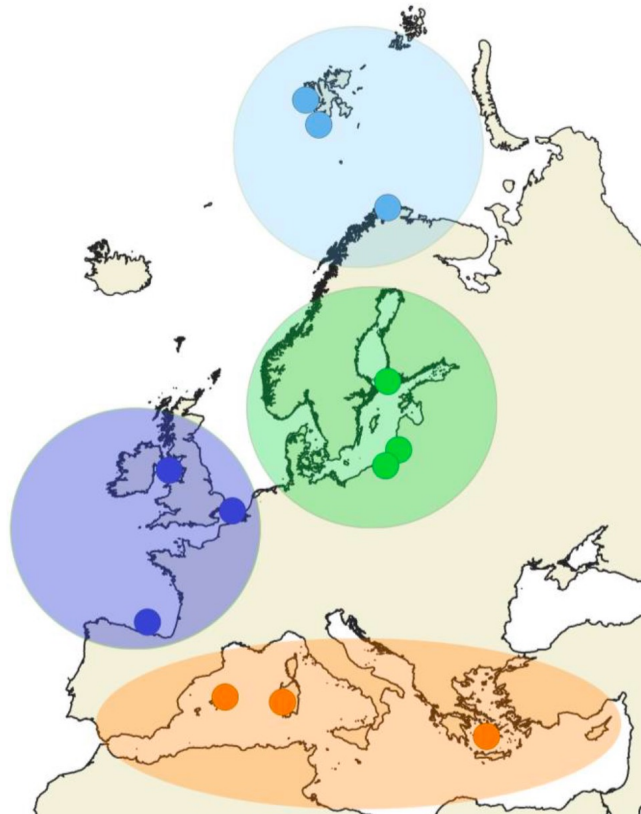
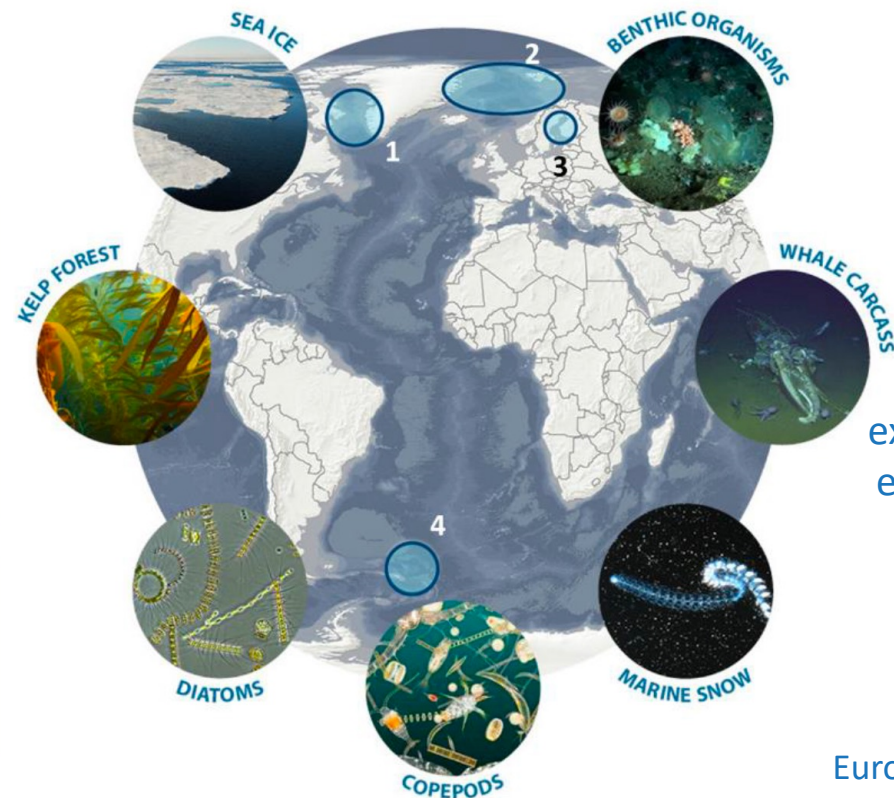


Figure 4.4 The MARBEFES broad belt transects (BBTs) in the Arctic, Baltic, Atlantic and Mediterranean



Blue Carbon production, export, and sequestration in emerging polar ecosystems



European Union's Horizon Europe Research and Innovation Programme
(In GA agreement phase)

Summary

System-wide changes in the Arctic:

- Biological changes from microbes to whales identified.
- Hypothesised changes are already happening with drivers being both abiotic, biogeochemical (e.g. temperature, salinity) and biotic (food-web), all interlinked.
- These changes already now affect local communities and will need management adaptations and policy decisions.

System-wide changes in the Baltic Sea:

- At a stage where biodiversity changes really hit home (fisheries)
- How to learn from this? Could holistic approach to identifying changes have helped (multiple taxon groups, multiple functions)? Can “tipping point” discussion be helpful to prevent it? → requires multidisciplinary collaborations.

Tack, Kiitos Thank you for listening!



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 869383



MARBEFES has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement no 101060937



European Union's Horizon Europe Research and Innovation Programme (In GA agreement phase)

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