The collapsing coastal cryosphere: Consequences from Ecology to Economics

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EU Polar Cluster

The Future of Arctic Coastal Ecosystems

Identifying Transitions in Fjord Systems and Adjacent Coastal Areas

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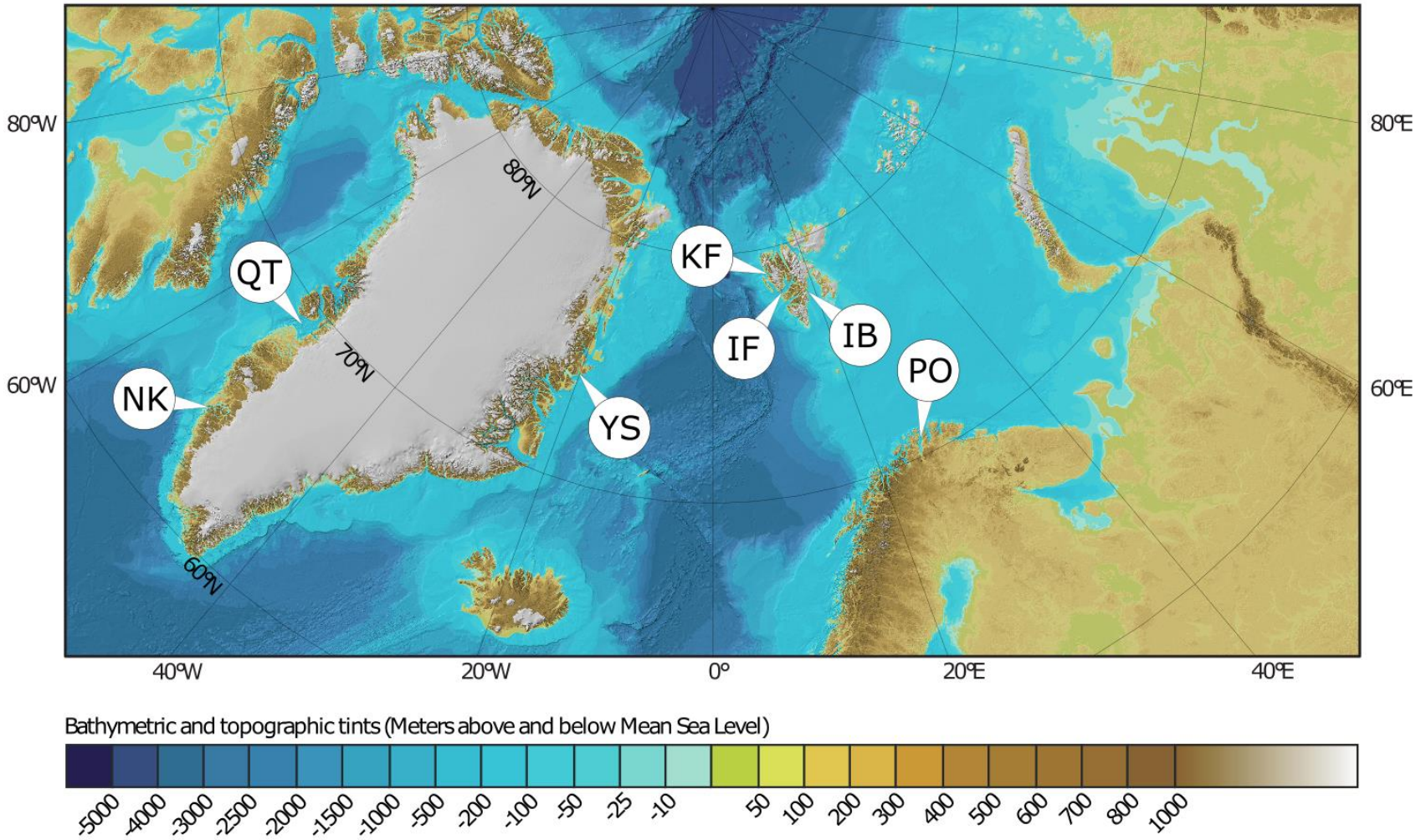
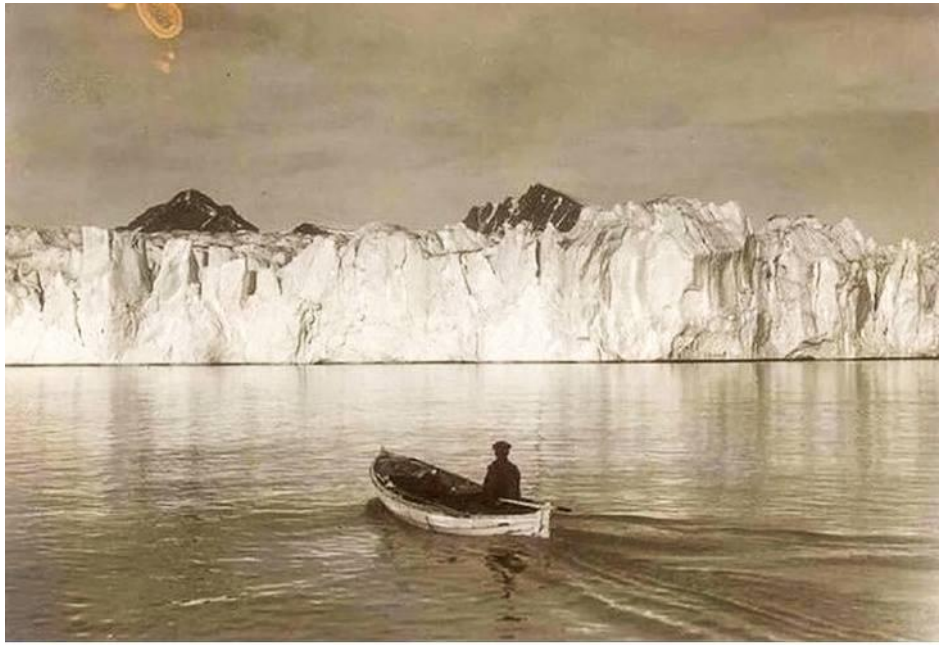
The Future of Arctic Coastal Ecosystems

Identifying Transitions in Fjord Systems and Adjacent Coastal Areas

The high Arctic
vs
The changing Arctic
vs
The future Arctic



Map based on: The International Bathymetric Chart of the Arctic Ocean IBCAO; Jakobsson et al. (2012) https://doi.org/10.1029/2012GL052219



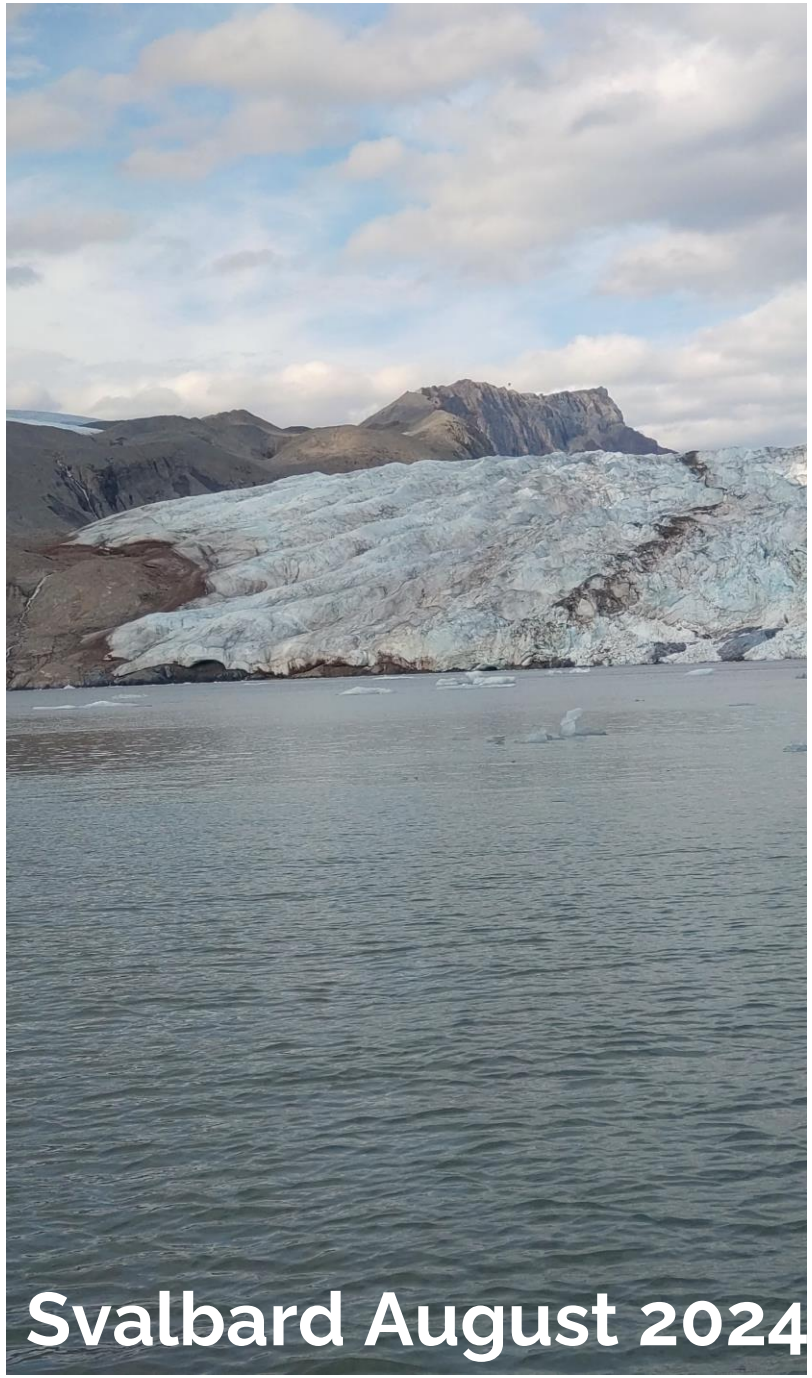
Cryosphere Reduction

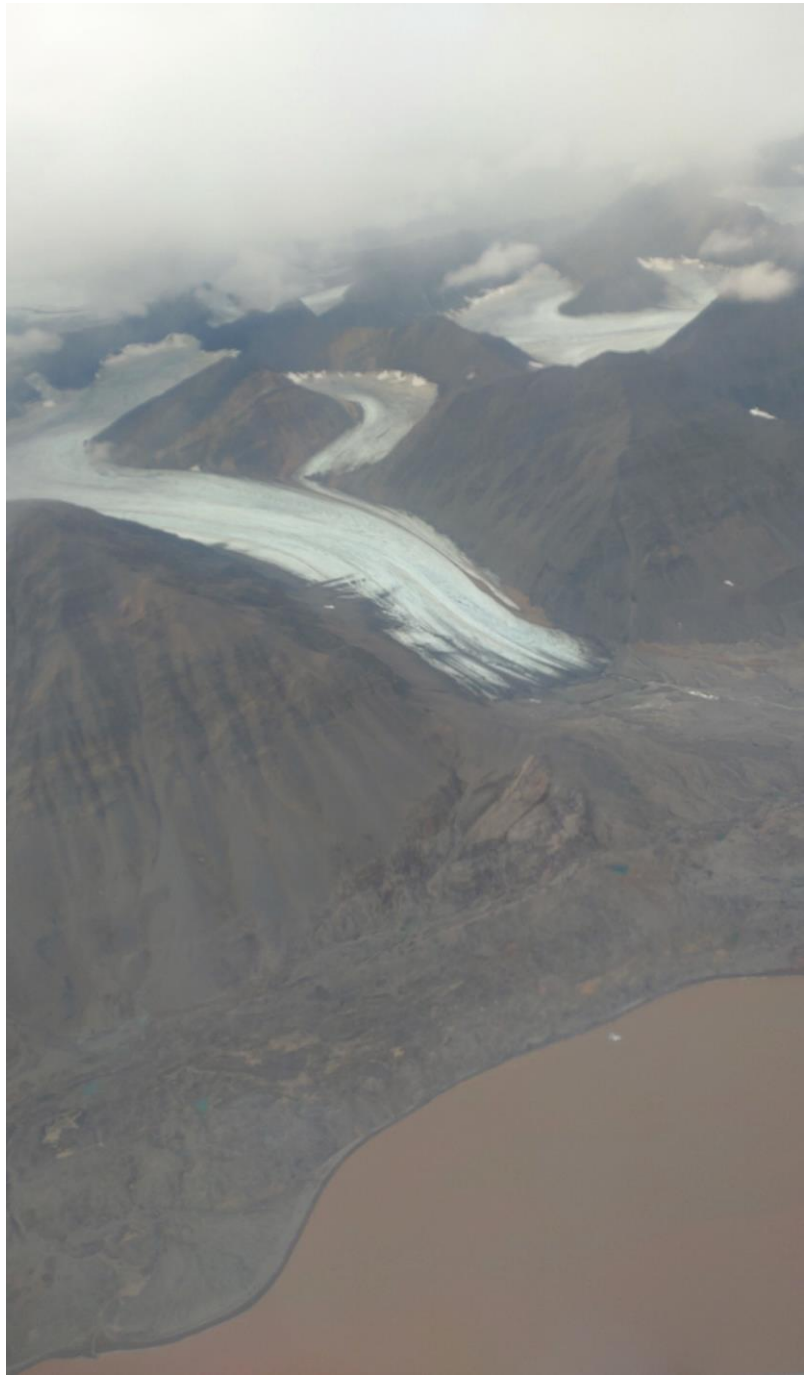
Loss of sea ice and glaciers

Retreating glacier fronts at 200 m/yr

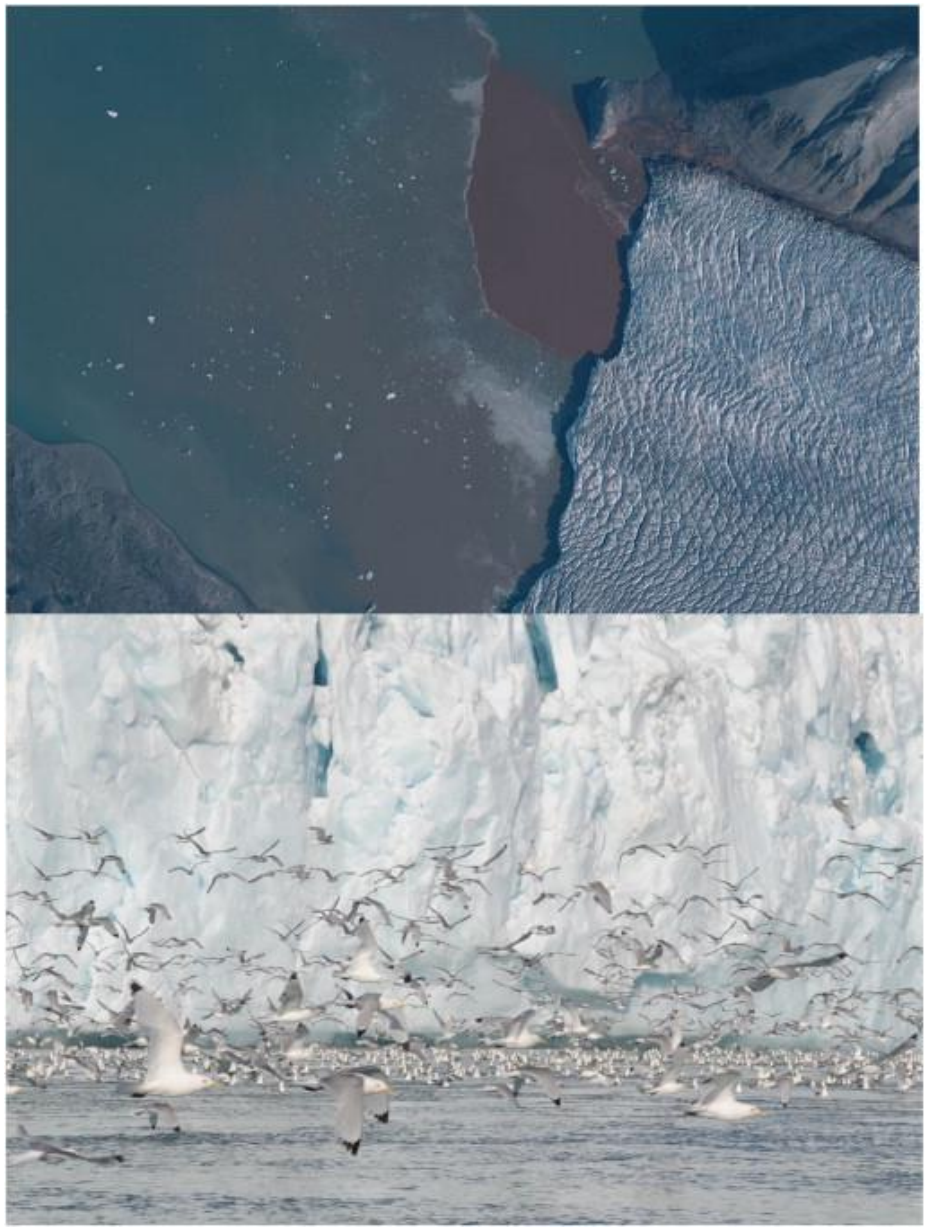
“sea vs. land terminating“

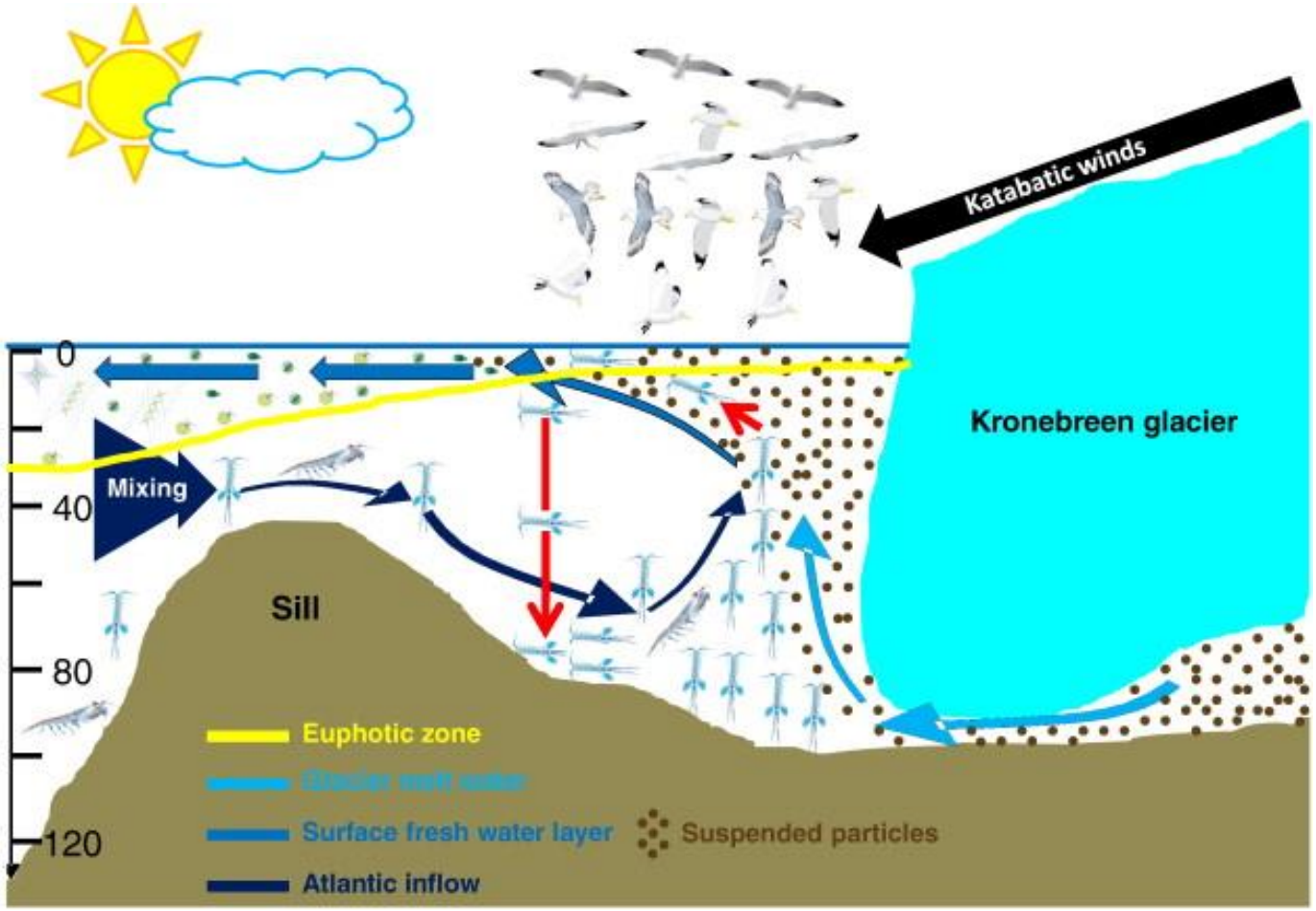
www.theguardian.com/environment/2002/aug/08/climatechange.climatechange


Svalbard August 2024



Ecosystem Glacierfront



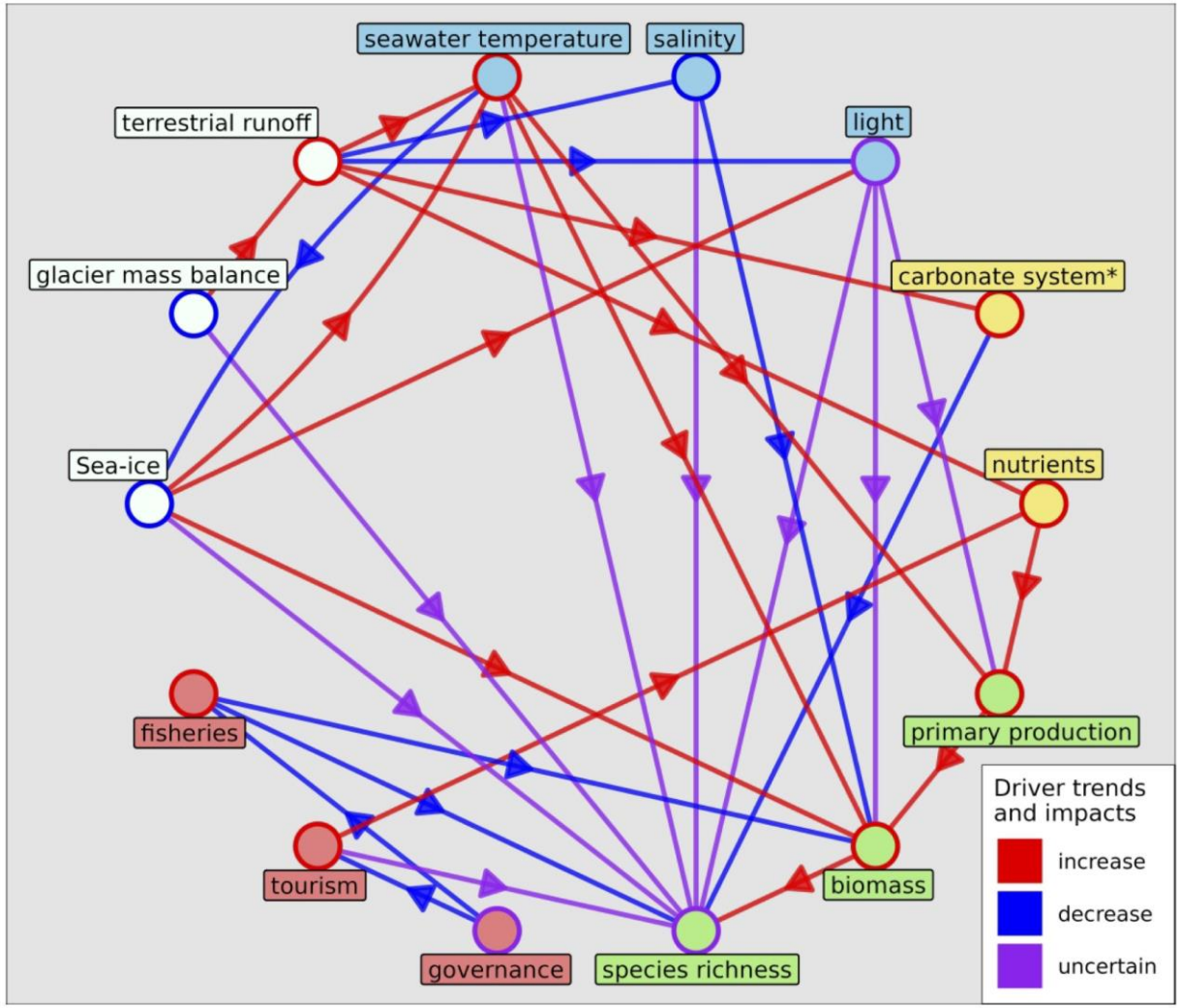


Lydersen et al. (2014)
The importance of tidewater glaciers for marine mammals and seabirds in Svalbard, Norway
Journal of Marine Systems 129, 452-471

Drivers of biodiversity changes

Synthesis for the European Arctic

Arctic biodiversity is impacted by many drivers with often uncertain consequences.



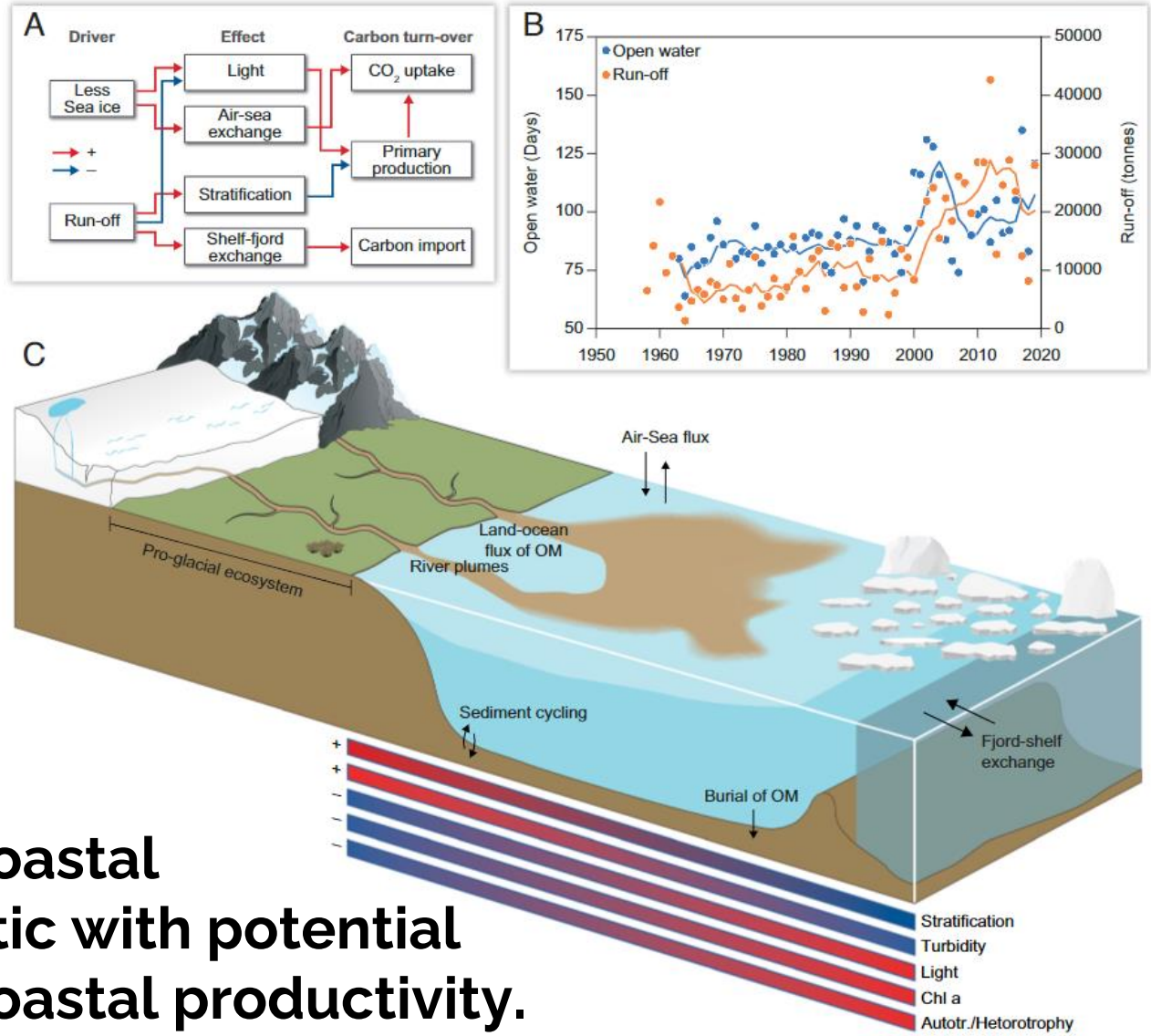
Schlegel et al. (2023) https://doi.org/10.1017/cft.2023.1

Impacts on pelagic primary production & ecosystem function

Glacial meltwater determines the balance between autotrophic and heterotrophic processes in a Greenland fjord

Sejr et al. 2022 PNAS 2022 Vol. 119 e2207024119

Melting of glaciers
-> increased supply of meltwater,
inorganic particles, nutrients,
and organic matter
-> transition from net heterotrophy in the
inner fjord to net autotrophy
in the coastal shelf waters.



-> Glacial runoff as a key driver of coastal ecosystem change in the Arctic with potential negative consequences for coastal productivity.

Fig. 7. (*A*) Conceptual diagram of the main effects of changes in runoff and sea ice cover on carbon cycling in Young Sound during summer. (*B*) Changes in days with open water (no sea ice) and runoff from land since 1960 including the 5-y running mean for each. (*C*) A schematic figure showing spatial gradients observed in Young Sound in summer.

Zooplankton & Seabirds

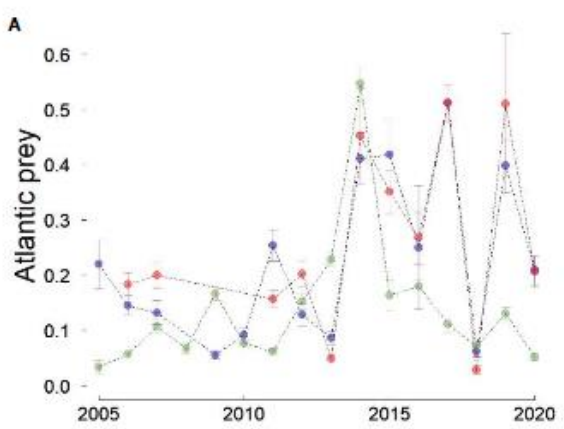
Consequences of Atlantification on a Zooplanktivorous Arctic Seabird

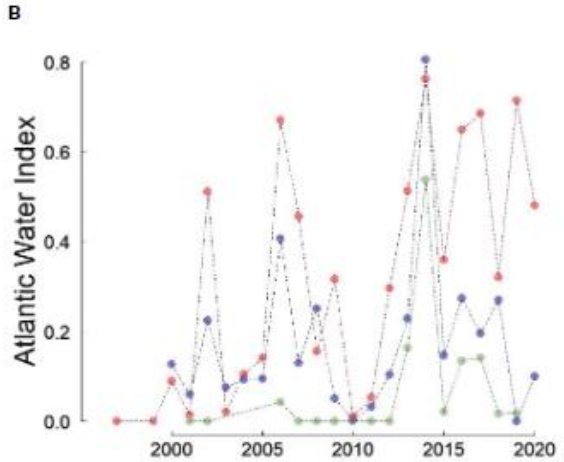
Descamps et al. (2022) Front Mar Sci 9: 878746

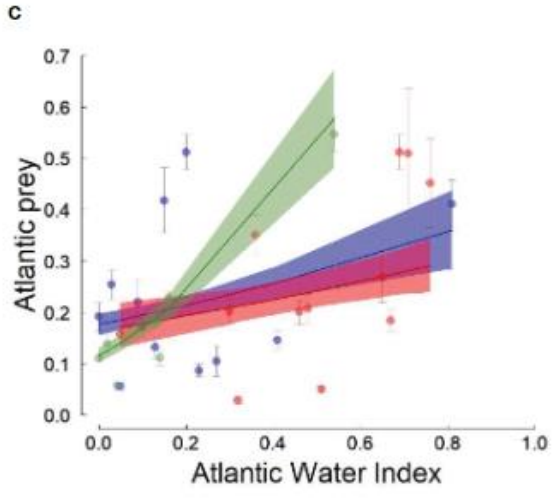
Long-term data (2005-2020) from a high Arctic zooplanktivorous seabird, the little auk

-> Positive relationship between the inflow of Atlantic Waters and the Atlantic prey, i.e. the copepod *Calanus finmarchicus*

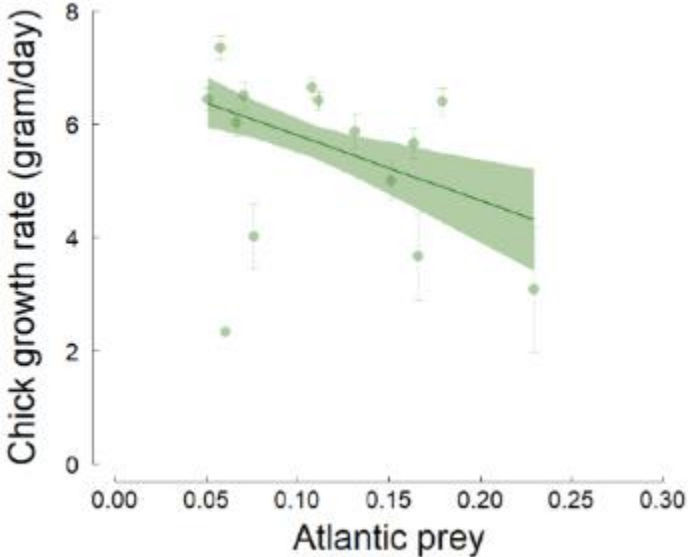
-> A high proportion of Atlantic prey is negatively associated with adult body mass and chick survival







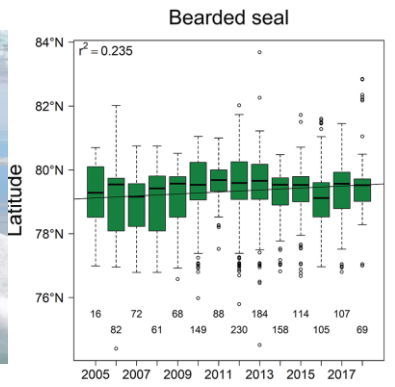
https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/little-auk/

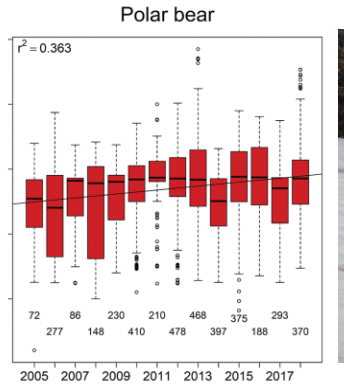


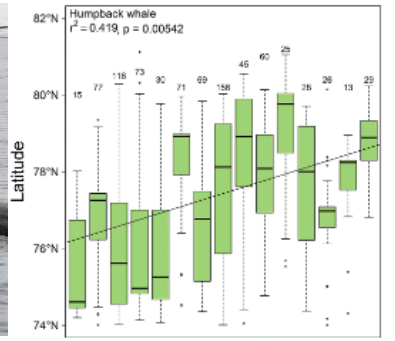
Marine mammals

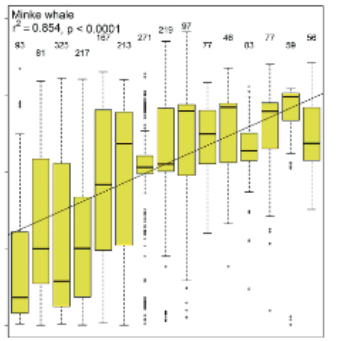
Whales, dolphins, seals, polar bears

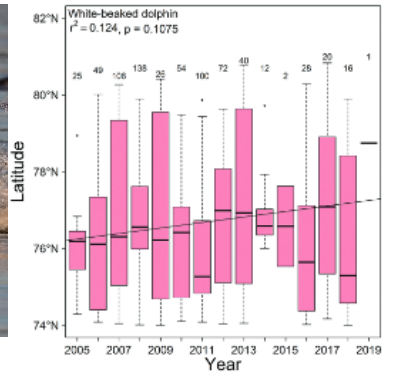
Almost all marine mammals around Svalbard are shifting their distribution towards the north.

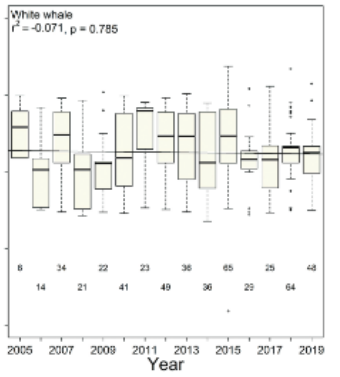










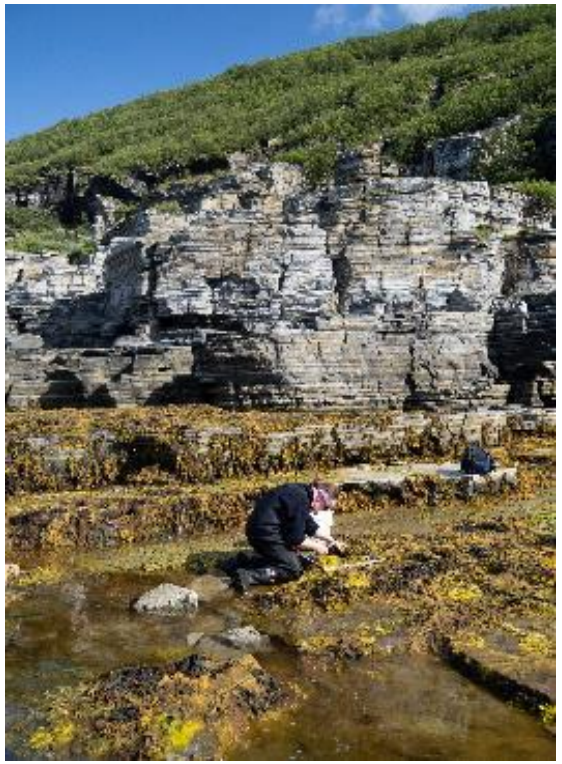


Photos: Sébastien Descamps & Geir Wing Gabrielsen
Data: Bengtsson et al. (2021, 2022) https://doi.org/10.33265/polar.v40.5326, https://doi.org/10.33265/polar.v41.7773

Seaweed

Introduction of new intertidal species

Retreating ice provides space for the formation of novel ecosystems in Arctic intertidal areas.



Porsangerfjord
Finmark, Northern Norway

High intertidal

Mid intertidal

Low intertidal

Kongsfjord
Svalbard

Photos: Luisa Düsedau

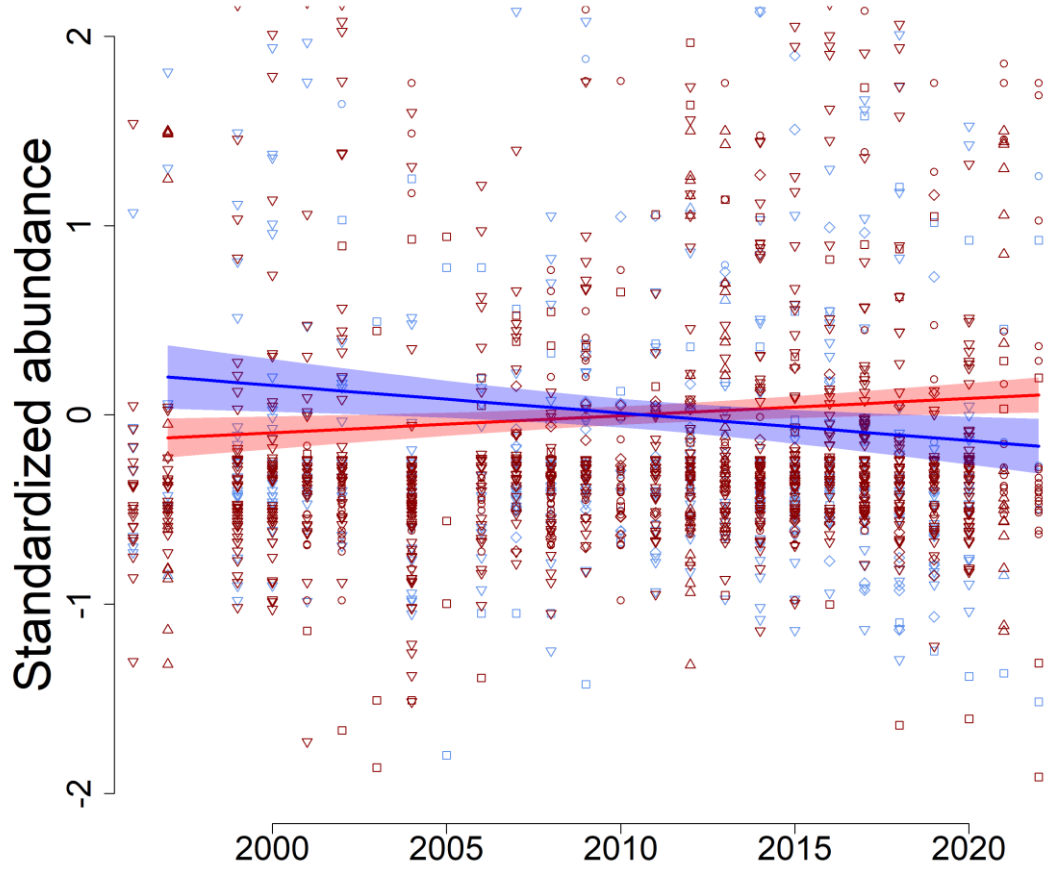
Overall assessment of biodiversity changes

Synthesis of time series data

The abundance of boreal species is increasing, while Arctic species are decreasing.

«Boreal» species

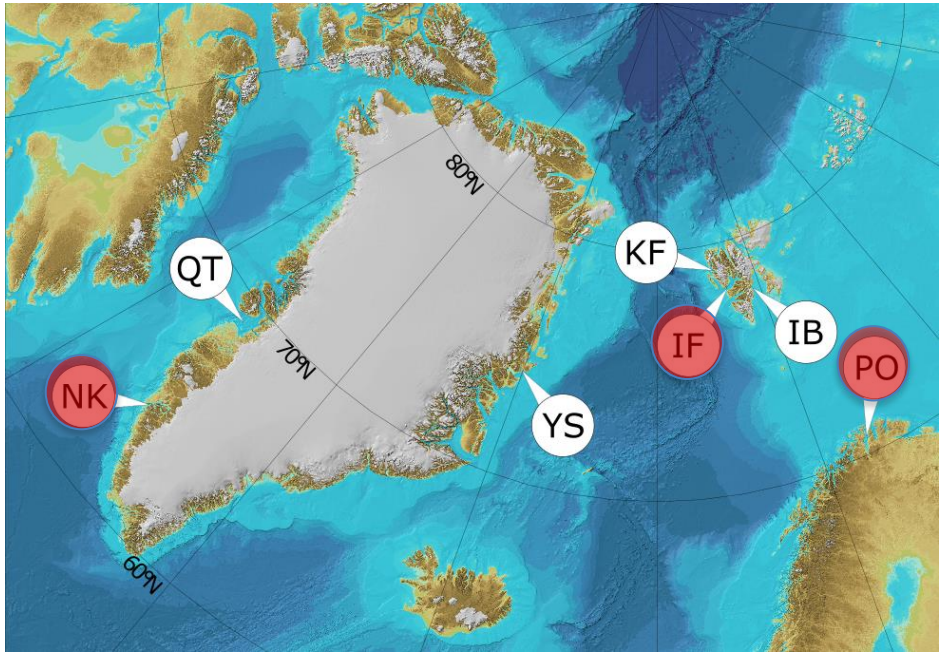
Arctic species



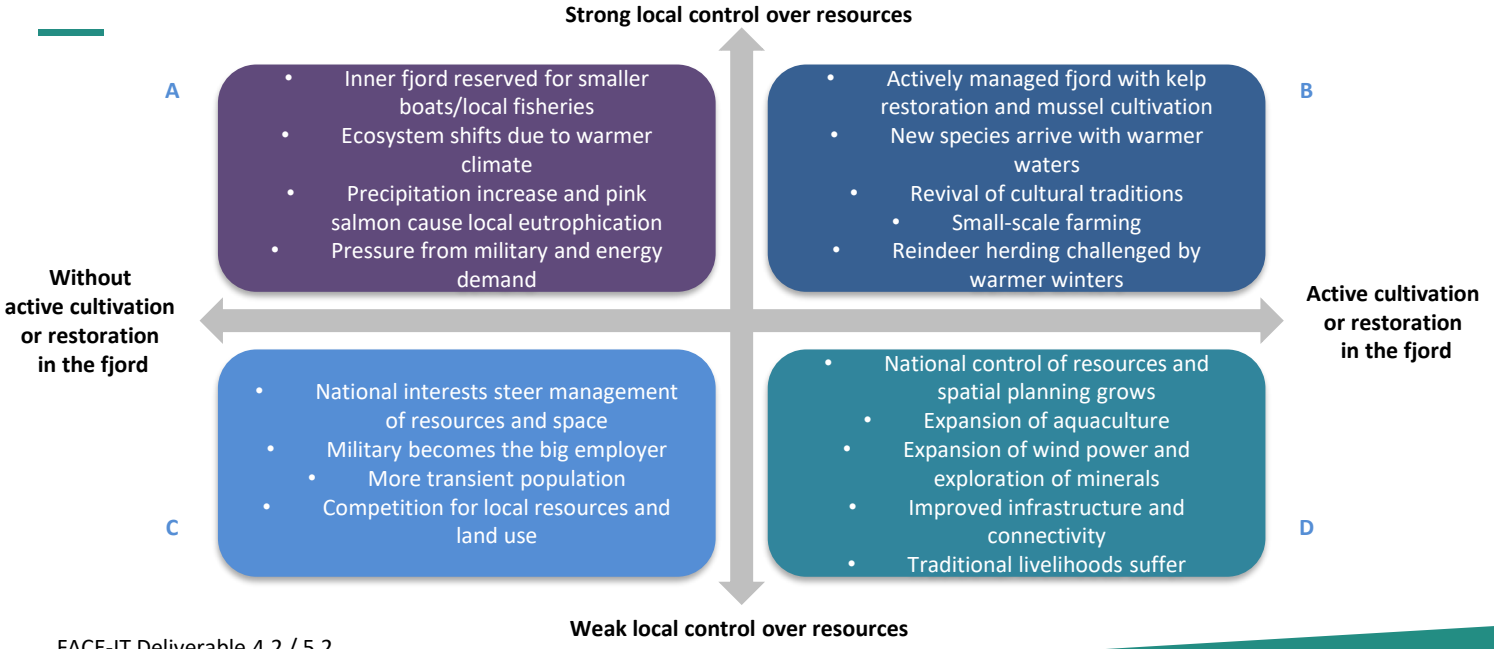
Data: Sébastien Descamps

Interaction of
cryosphere reduction, biodiversity change, societal and economic impacts

-> findings from stakeholder workshops



K Bischof



Commercial fish and invertebrates

Ecosystem Modelling of Porsangerfjord

Climate change, fisheries, and esp. their combination are affecting commercial species.

Management of resources?

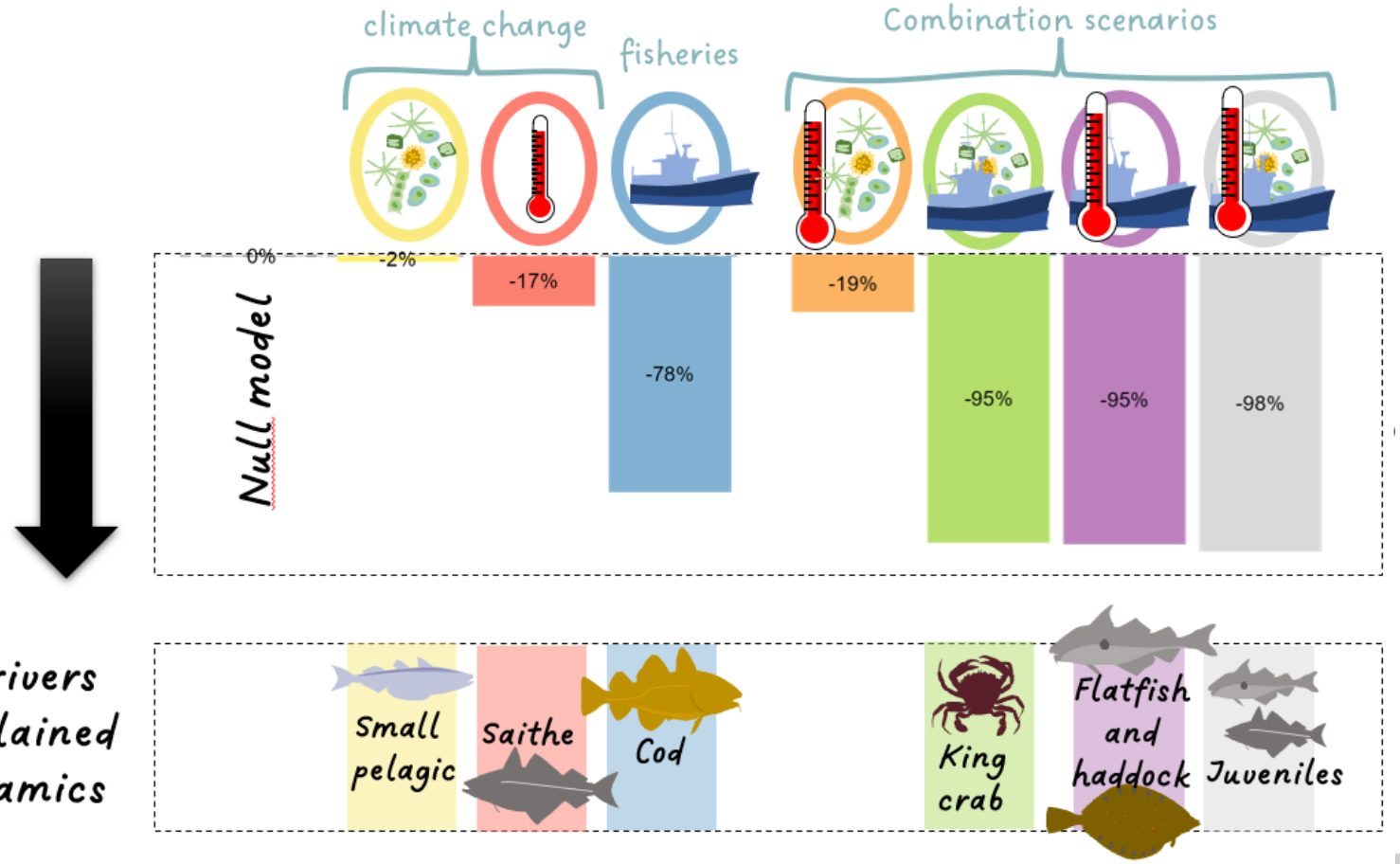
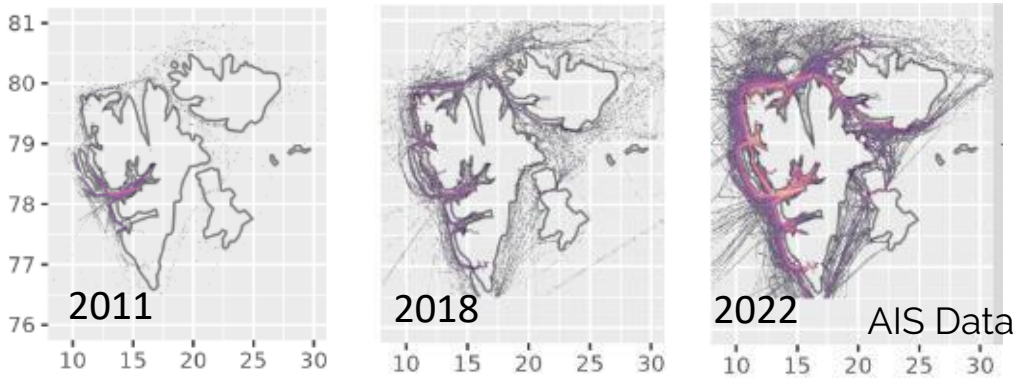
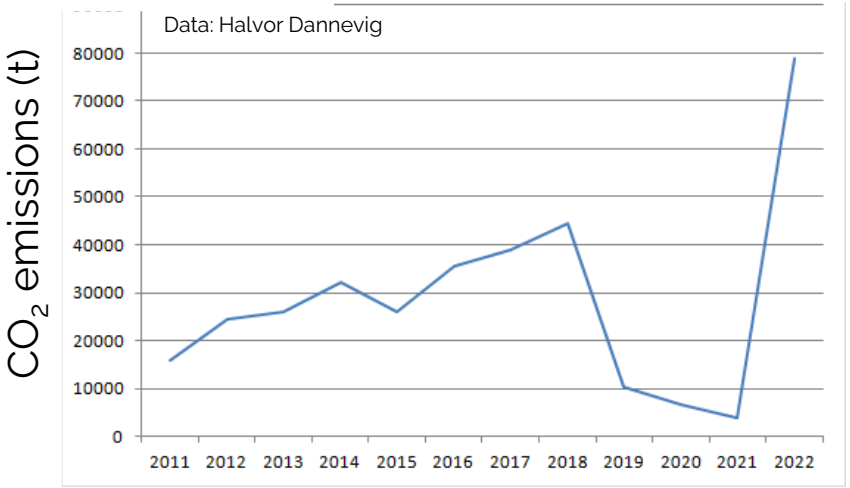


Figure: Berengere Husson

The “Svalbard case”

Boost in tourism after the pandemic





Smaller boats, but in total carrying more tourists, can access locations previously blocked by ice

The “Greenland case”

Climate Change is only ONE aspect of societal change

Photo: Simon Jungblut

Chances for development?
Gaining independence?
Natural resources & mining (“green mining” & glacier flour)?
Agriculture & aquaculture?

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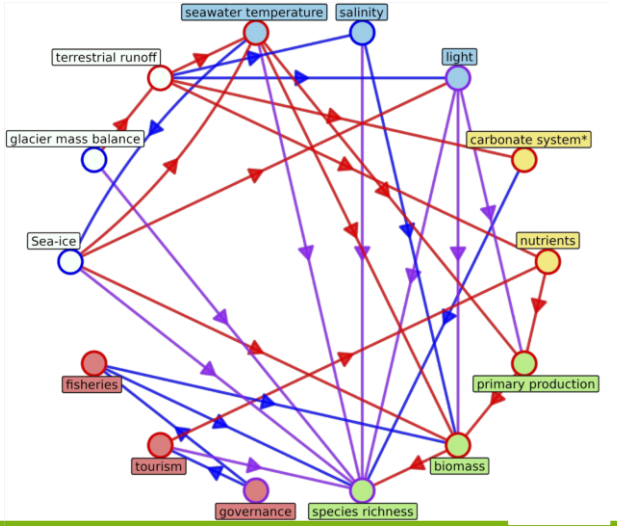
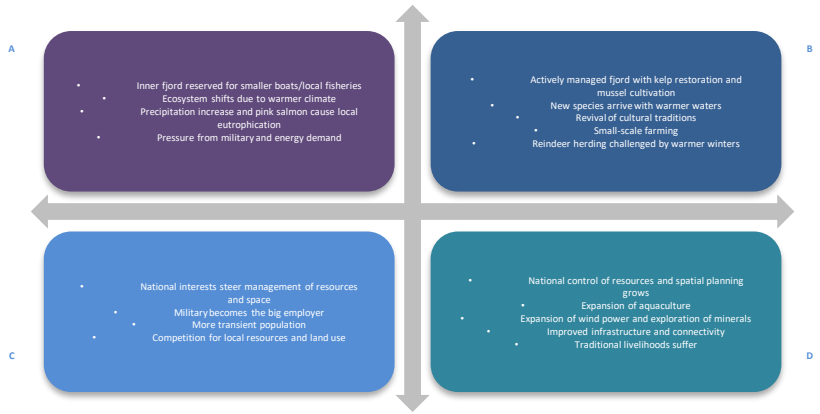
FACE-IT Arctic Biodiversity & Livelihoods

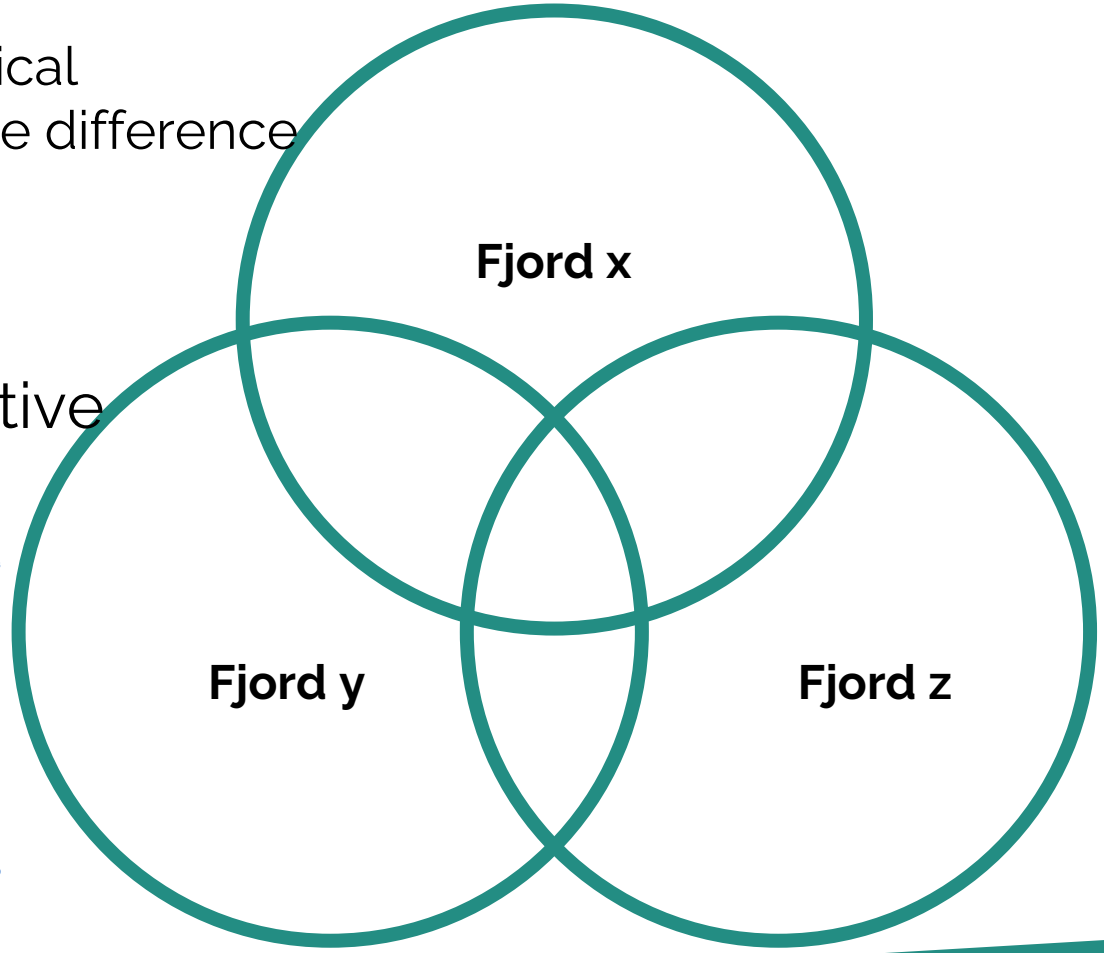
Biodiversity & socio-economy are tightly linked.

Every fjord is unique!
Despite some commonalities in physical drivers & ecological consequences, the social-ecological dimension makes the difference for designing co-adaptive management approaches.

No overarching Arctic policy fitting for all fjords
Locally tailored governance needed to be effective







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