COASTWATCH – IEA – strategi for målrettet kystobservasjoner og assessment

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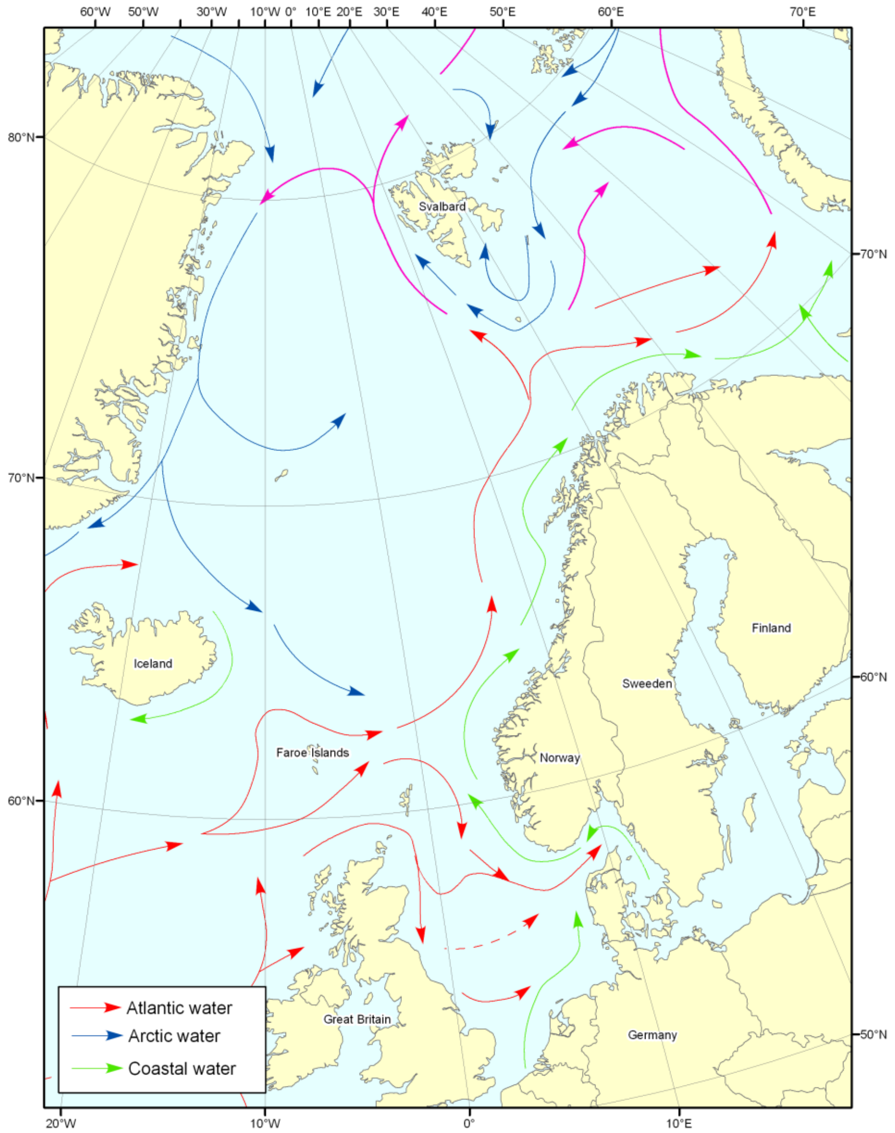
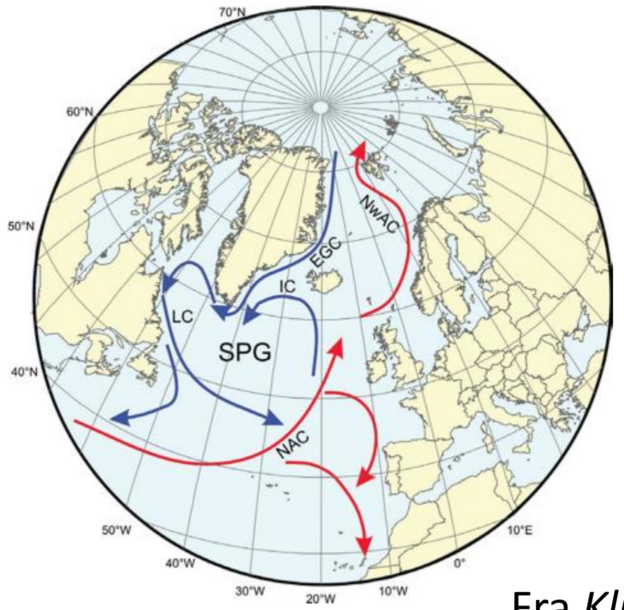
Programleder: Marine Prosesser og Menneskelig Påvirkning

Tromsø, 4. April 2019

Havstrømmer i Nordatlanteren

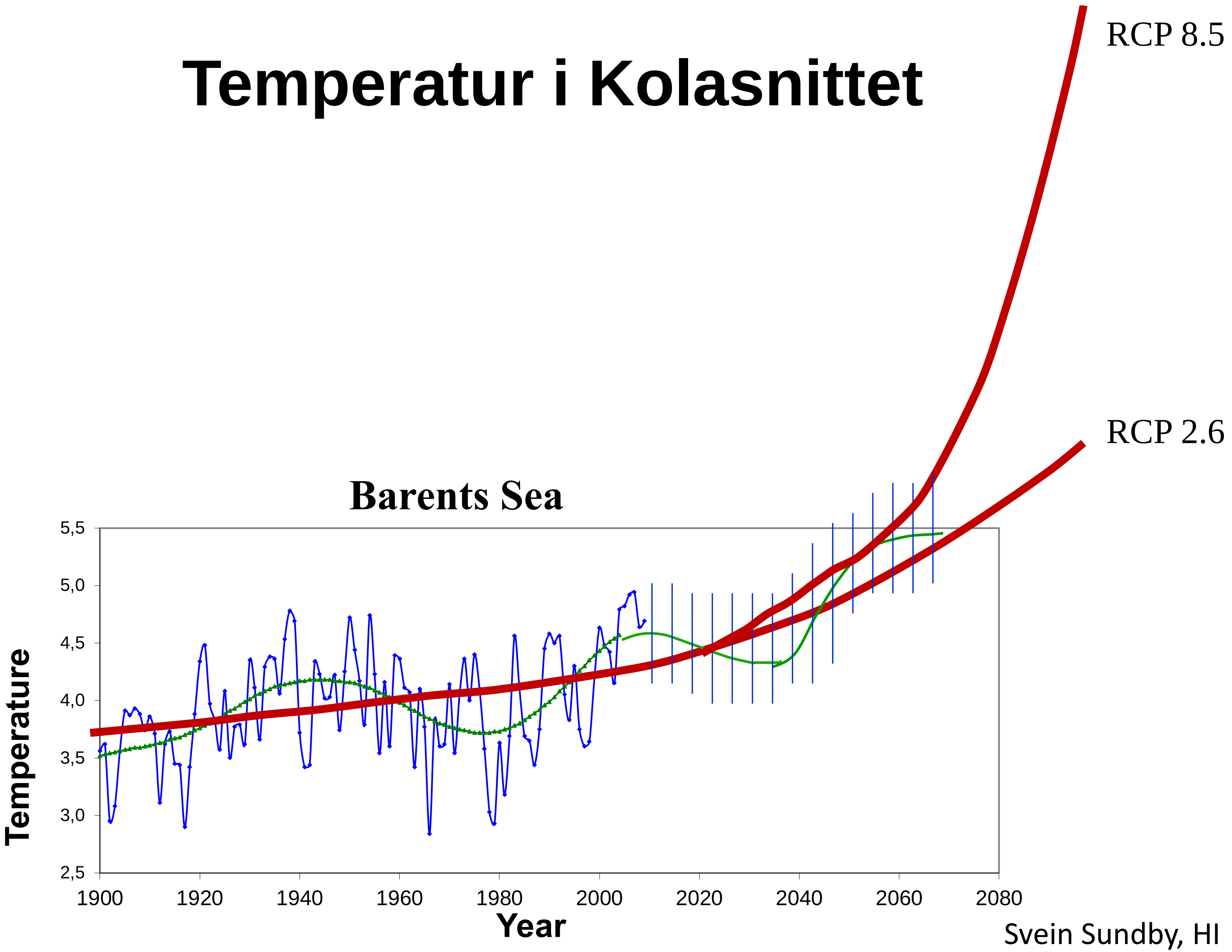


- Dominert av nordgående Atlantisk vann og sørgående Arktisk vann
- Omtrent 8 Sverdrup med Atlantisk vann som strømmer nordover langs sokkelen
- Tilfører varme til luft som temperatur rundt 10ºC over breddegradssnittet



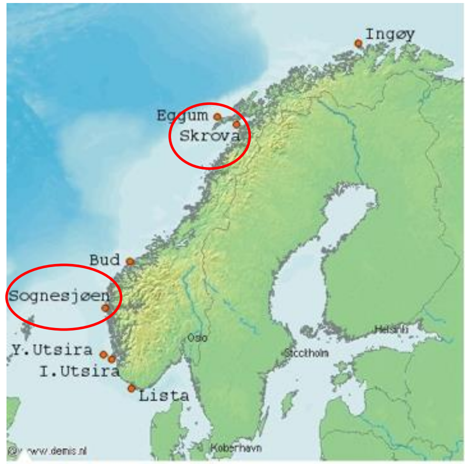
Fra *Klima i Norge 2100*

Temperatur i Kolasnittet

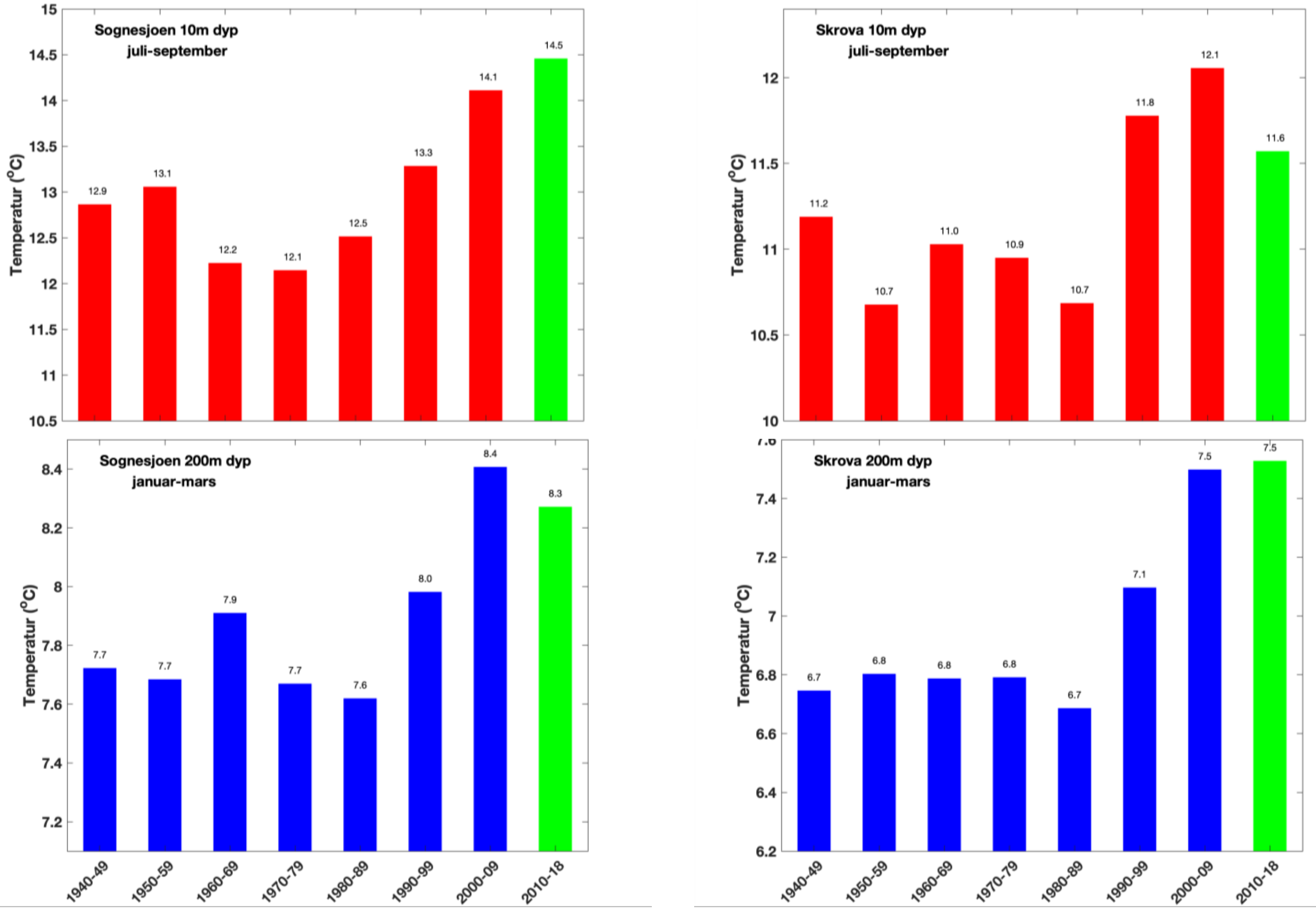


Svein Sundby, HI

Kystklima

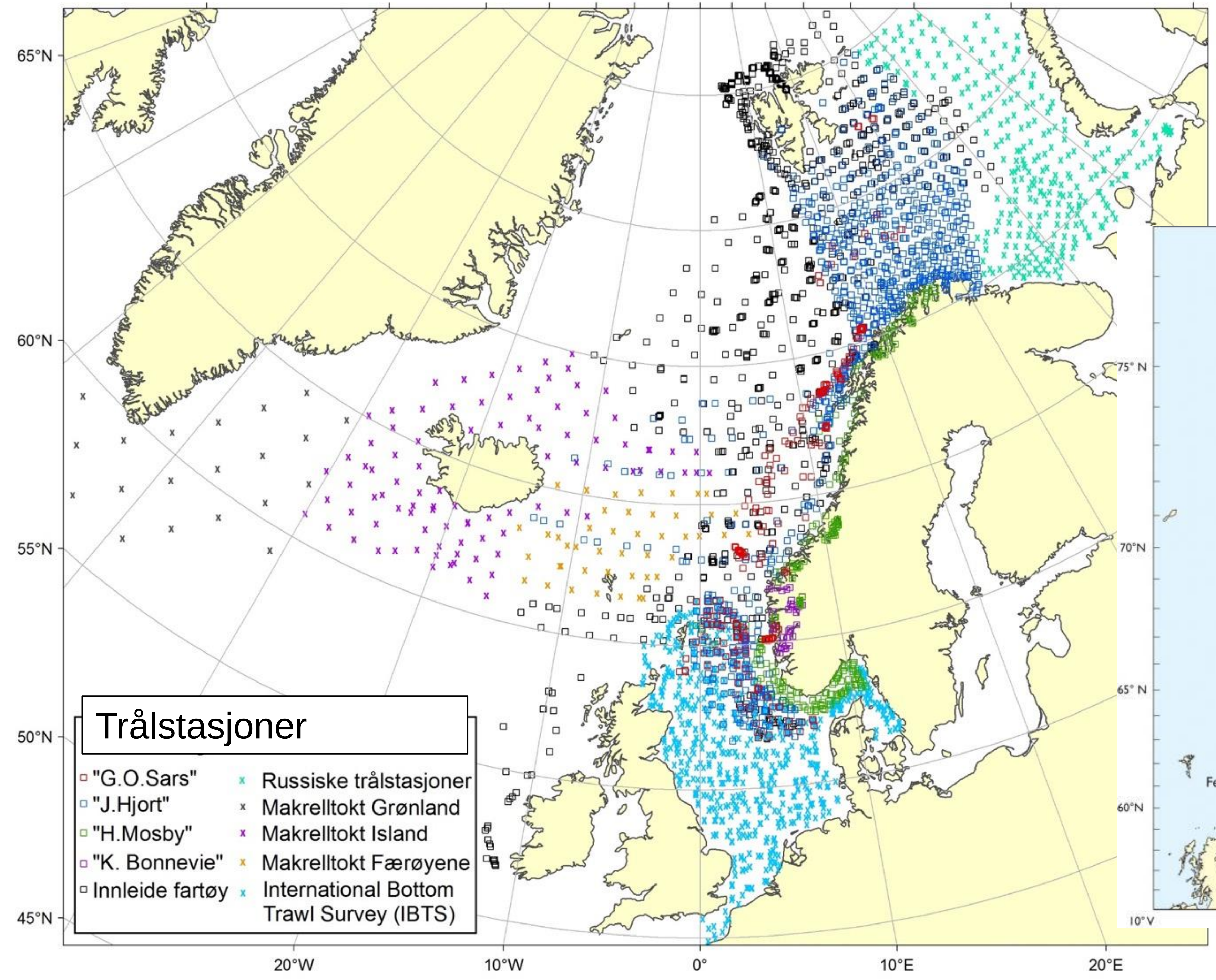


Faste hydrografiske stasjoner

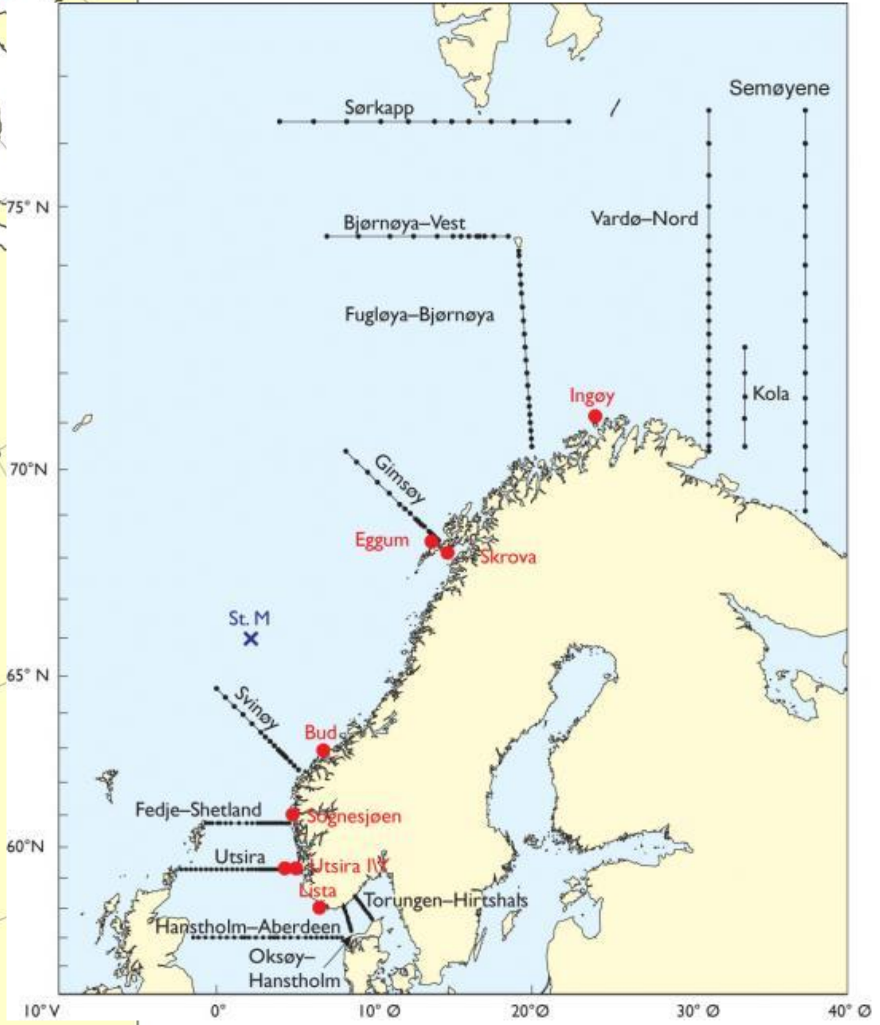


- Temperatur i øvre lag er i stor grad påvirket av lokale meteorologiske forhold, mens i 200 m er de knyttet til endringer i Atlantisk vann.
- Ca 0.5^{o}C av temperaturøkningen i 200 m dyp i siste 10-års periode skyldes observert global oppvarming, mens 0.2^{o}C skyldes naturlig variasjon.

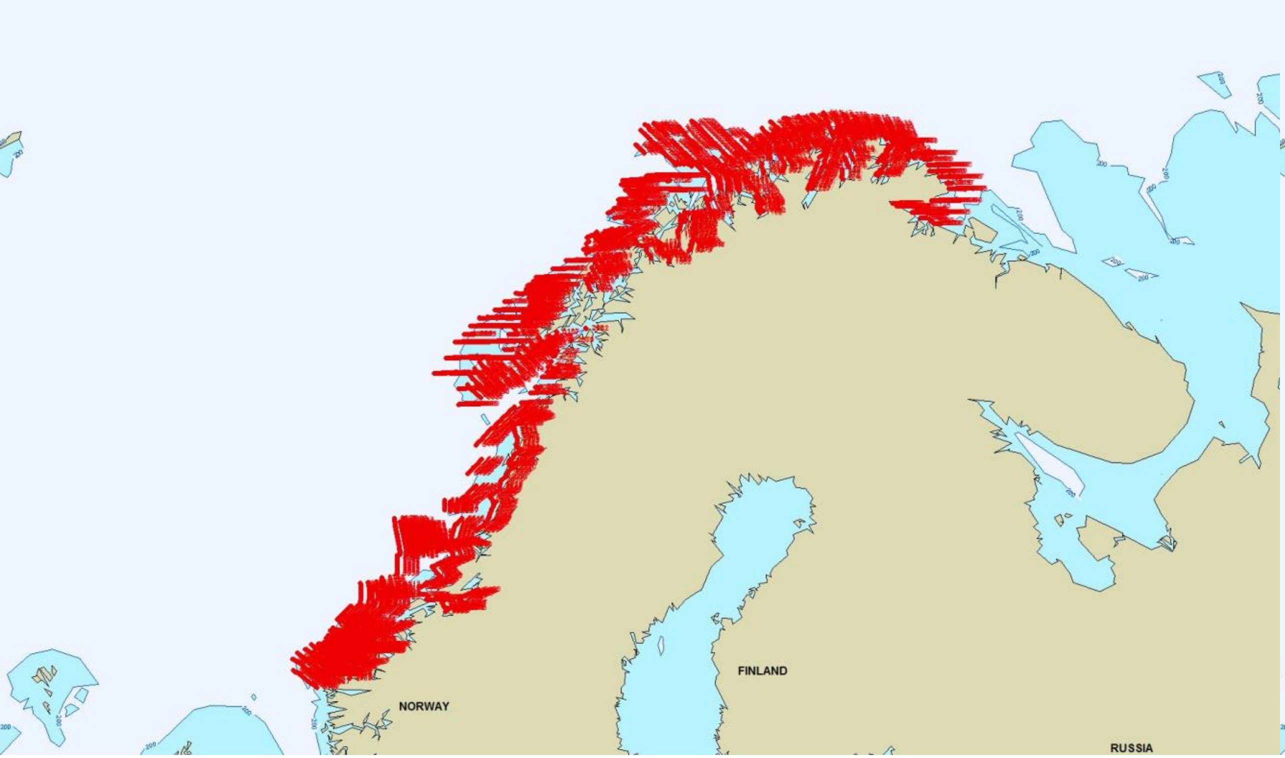
Fra Jon Albretsen, HI

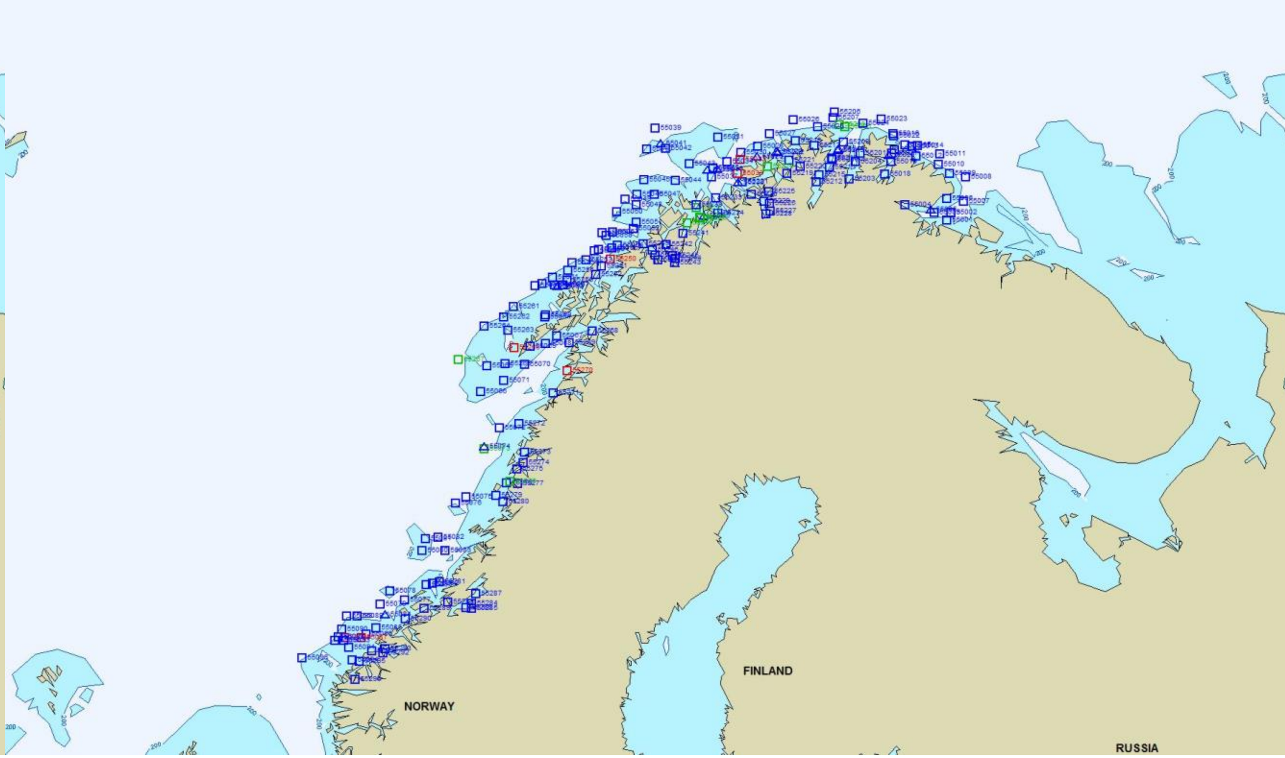


Snitt og stasjoner



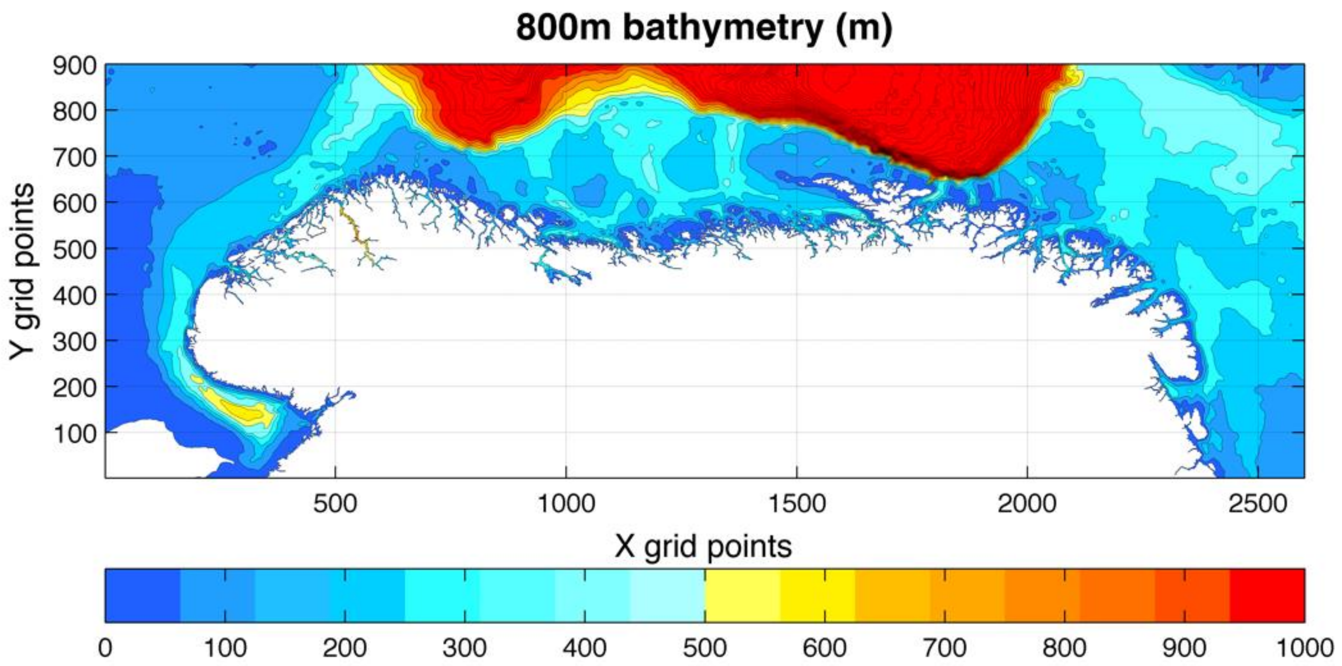
Kystøkotoktet hver høst
- Transekt akustisk mengdeberegning og tråltokt





Kyst-arkiver med ROMS

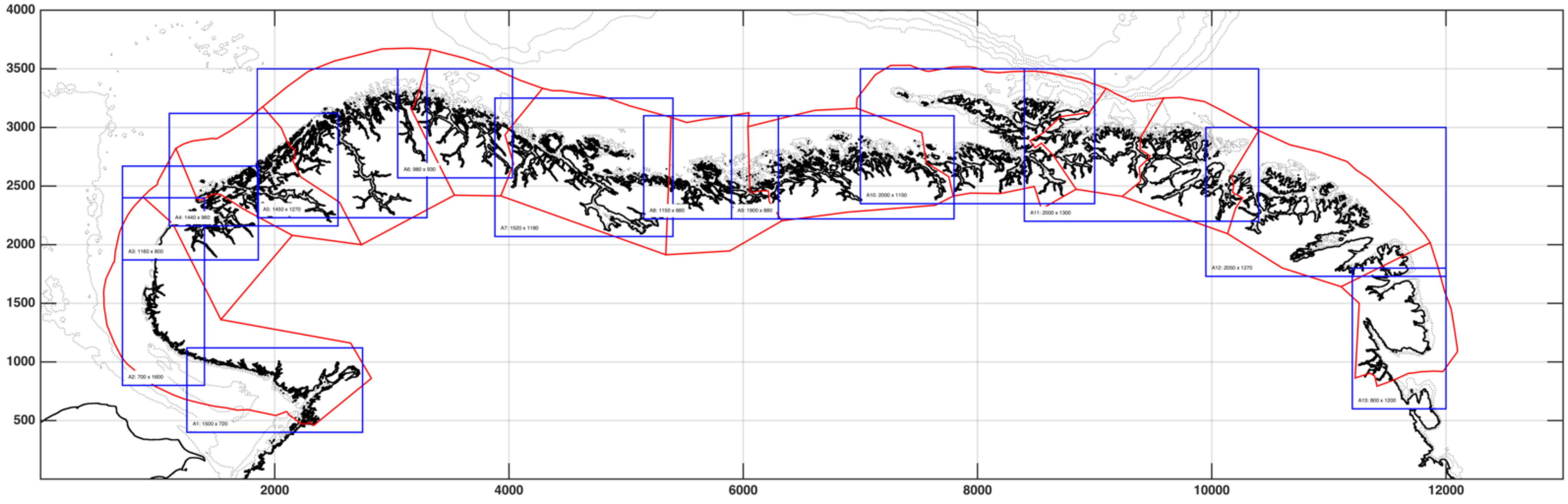
- NorKyst800 er kjørt opp fra 1995-sep 2017.
- NorKyst800 2017-> planlegges oppdatert hver 3. måned med input fra Nordic4km, AROME2.5km og oppdatert elveavrenning fra NVE



Courtesy by Jon Albretsen, IMR

Fjord-arkiver med ROMS

- En rekke korte kjøringer med 160 m oppløsning er utført i forbindelse med ulike prosjekter
- 13 NorFjords160-områder (mars 2017->) planlegges oppdatert hver 3. måned med input fra NorKyst800, AROME2.5km og oppdatert elveavrenning fra NVE



Courtesy by Jon Albretsen, IMR

COASTWATCH

- Søknad sendt forskningsrådet om infrastrukturstøtte på 87 mill totalbudsjett 104 mill.
- Inkluderer 11 norske partnere og SAC med internasjonale eksperter
- 2 fokusområder i første runde – erfaringer fra disse vil hjelpe i den videre utvikling

COASTWATCH – the Norwegian coastal observing system of systems

Project owner: Geir Lasse Taranger (IMR), **Scientific project manager** Frode B. Vikebø
Host Institution for the research infrastructure: Institute of Marine Research (IMR)
Partners: Institute of Marine Research (IMR), Norwegian Meteorological Institute (MET Norway), University of Bergen-Geophysical Institute (UIB-GFI), Norwegian Research Centre (NORCE), Norwegian Institute for Water Research (NIVA), Akvaplan-Niva (APN), Nansen Environmental and Remote Sensing Center (NERSC), Runde Environmental Centre (RMS), University of Oslo-Centre for Ecological and Evolutionary Synthesis (UIO-CEES), the Norwegian Water Resources and Energy Directorate (NVE), Norwegian Institute for Nature Research (NINA).
This proposal is based on the outlines NCOSS outline nr. 289747 and COASTWATCH outline nr. 289728

Summary: We propose to implement the first building block of the Norwegian integrated coastal observing system - COASTWATCH, contributing to the European Ocean Observing System vision, through its direct integration into the European coastal observing system – JERICO. COASTWATCH is building upon the concept of Supersite supporting a comprehensive ecosystem approach of the Norwegian coastal environment. The components are;

- HF radars for continuously updated surface currents,
- Coastal gliders for subsurface observations of essential coastal variables,
- Flagship stations performing multi-disciplinary observations of the physical, biogeochemical and biological compartments, by moorings, FerryBox and Sailbuoy,
- A framework for citizen science and the utilization of user observations.

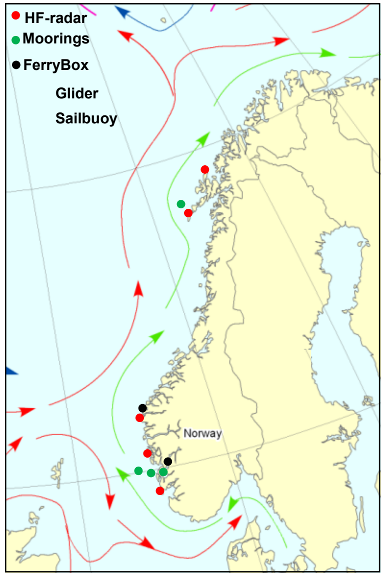


Figure 1. Locations of the various coastal observation infrastructure components.

The first building block sets priority on two locations presenting specific challenges and high interest for both research and environmental management needs:

Priority area 1: The western mid-Norwegian counties face several environmental challenges related to multiple anthropogenic and natural impacts, e.g. climate change, communal discharges, risk of accidental oil spill and notably an intense aquaculture industry. The region corresponds to the new salmon Production Areas number 3 and 4 in the so-called "traffic light" combined monitoring and modelling system, which supports management decisions on salmon farming production growth. Areas 3 and 4 are the only ones currently flagged red in the traffic light system, which indicates that production must be reduced in the region if still red during the 2019 assessment. Other environmental key challenges in the region (e.g. main spawning grounds of Norwegian Spring Spawning herring, areas of petroleum activities, and a highly dynamical spring bloom system) implies a great need to advance integrative multidisciplinary knowledge on coastal environments and the capabilities of simulation and forecasting coastal processes.

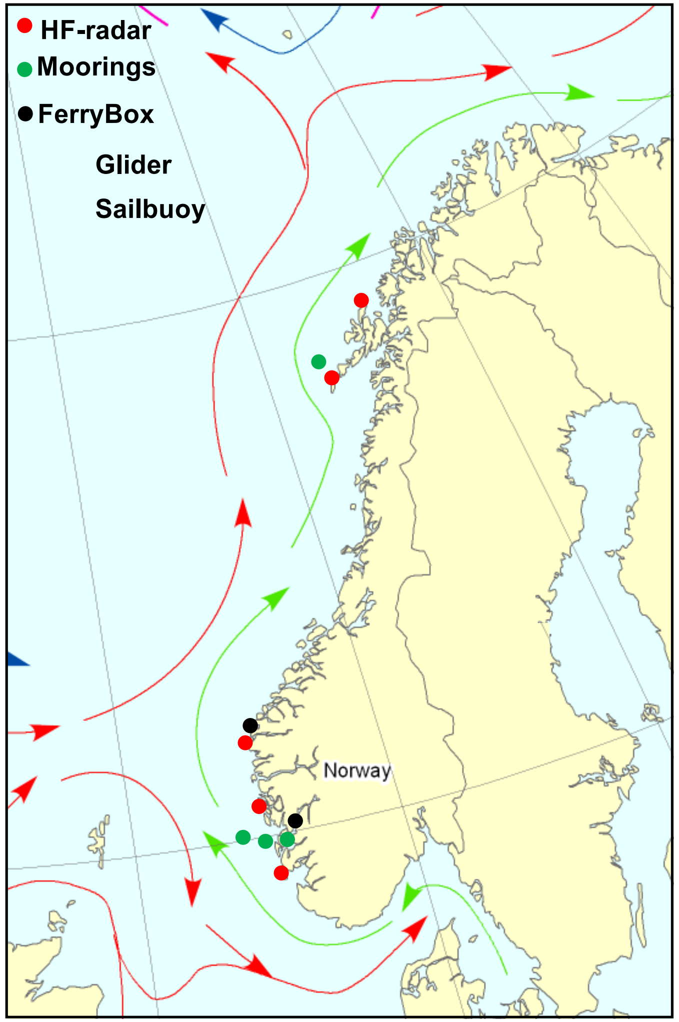
Priority area 2: Lofoten/Vesterålen is recognized as a very productive and sensitive environment to external stressors, where about 70 % of all commercially caught fish in the Norwegian Sea and the Barents Sea have early vulnerable life stages drifting through during planktonic stages. It is a region with complex dynamics where the Norwegian Coastal Current and the Norwegian Atlantic Slope Current meet and mix. A better understanding of structure, functioning and change in the local ecosystem is a pre-requisite for ecosystem-based management and sustainable use of marine resources.

The only way of tackling these challenges is to drastically improve the present capability to dynamically observe the coastal environment, as proposed in COASTWATCH. A key component of COASTWATCH is the improvement in ocean modelling capabilities through advanced data assimilation, hence the observing systems will also be adapted to such a purpose.

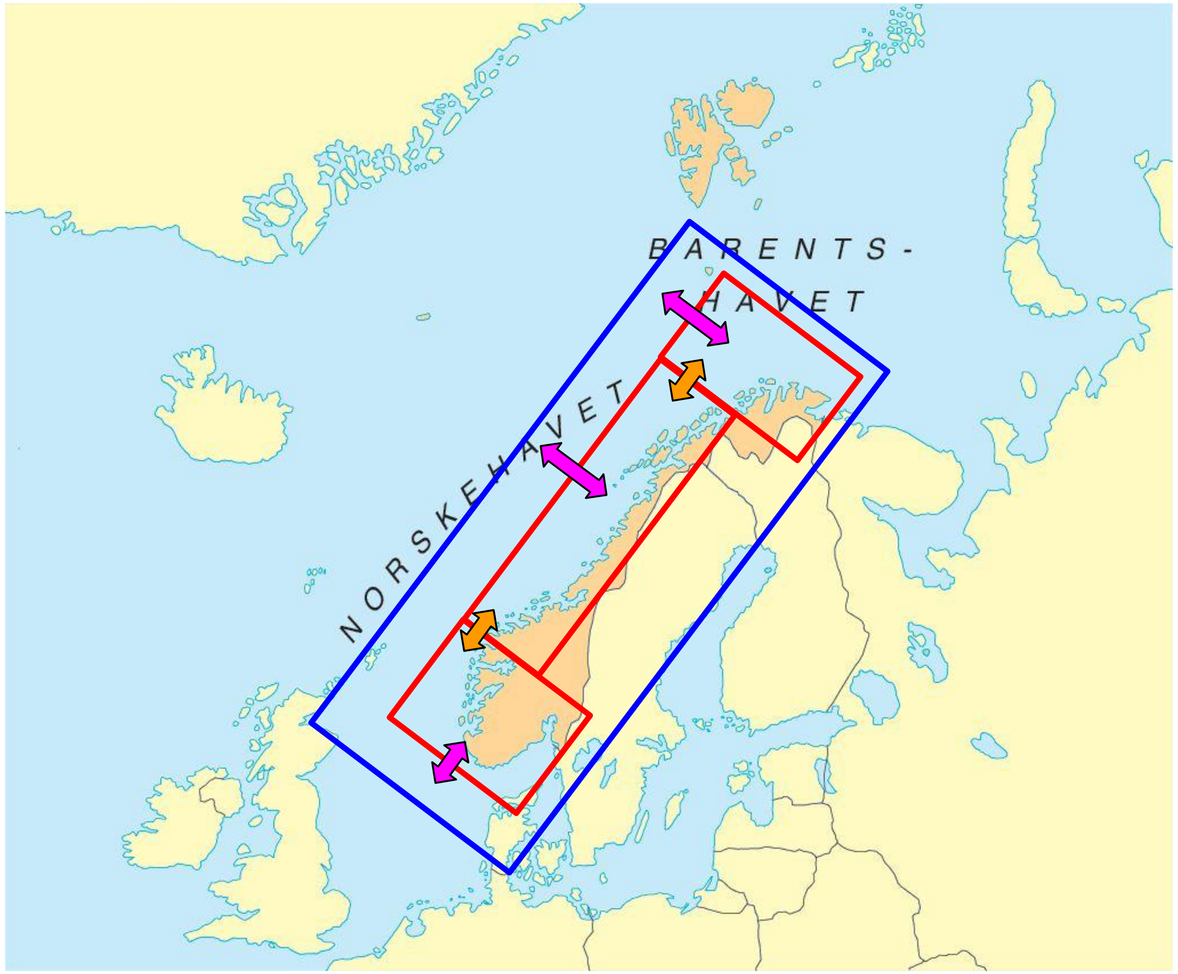
Kontinuerlige overvåkning langs kyst og modell - COASTWATCH

Ulike plattformer og sensorer
Hele kysten, men først to nøkkelområder

- Kontinuerlige observasjoner gir nødvendige data for prosessforståelse
- Kan brukes til data-assimilering i havmodeller
- Gir både havvarsler og historiske arkiver
- Kan brukes av trafikklyssystemet, risikomodeller for petroleumseffekter, rekrutteringsmekanismer hos fisk etc
- Nøyaktige og kontinuerlige beskrivelser av det fysiske miljø er en nødvendig komponent i integrerte økosystemvurderinger



Modellutviklingsplaner HI + MET



Norkyst-800m
med 4DVAR

Norfjord-266m (1:3)

Toveisnøsting mellom grov- og finskalamodeller

Toveisnøsting mellom finskala-modellene.

Courtesy by Jon Albretsen, IMR

Strategic initiative – Assessing cumulative impacts on the Norwegian coastal ecosystem and its services (Coast-Risk)

- Project lead: Mette Skern-Mauritzen (IEA) and co-lead Frode Vikebø (case studies)
- Project period: 2019-2023
- Annual budget: 12 mill. + in kind ship time of 6 mill. per year in 2020 and 2021
- Styrke kunnskapsgrunnlaget om ulike påvirkningsfaktorers betydning for kystøkosystemenes tilstand, funksjon og utvikling, og gjennomføre en **Integrert Økosystemvurdering** som også inkluderer en risikovurdering av samlet påvirkning

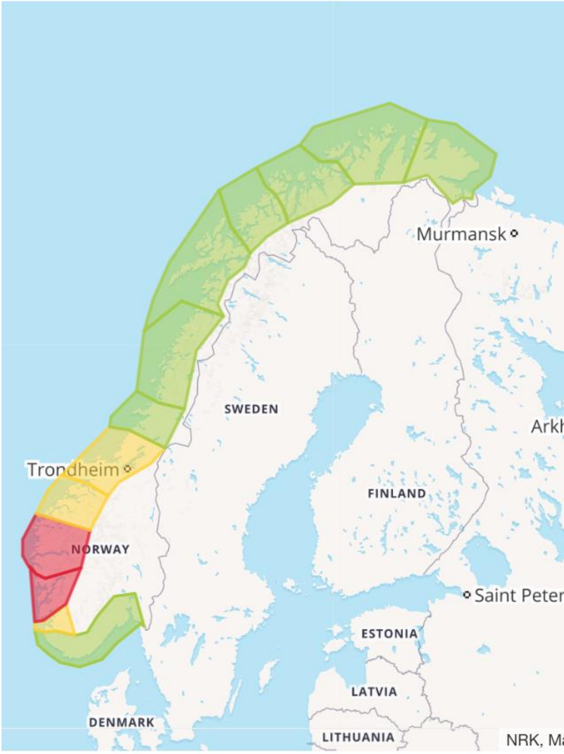
Strategic initiative – Assessing cumulative impacts on the Norwegian coastal ecosystem and its services (Coast-Risk)

Secondary Objectives:

- Identify the key present and future pressures to the three NC ecosystems (see Box 1)
- Provide relevant ecosystem assessment data by i) identifying and compiling existing data on ecosystem components and pressures, ii) initiating complementing ecosystem surveys and additional observational platforms and sensors, iii) developing existing numerical models providing coastal ecosystem data and iv) conducting experiments
- Identify the species, habitats, communities and ecosystems vulnerable to single or cumulatively impacting pressures through direct and/or indirect food-web mediated impacts
- Quantify risks to species, communities and ecosystems of cumulative pressures using statistical and numerical models, and experiments
- Explore management options and trade-offs to reduce risks and ensure sustainable use
- Translate IEA output into scientific publications and tailored products that can be implemented and used by stakeholders, and guide future NC ecosystem monitoring and research

Strategic initiative – Assessing cumulative impacts on the Norwegian coastal ecosystem and its services (Coast-Risk)

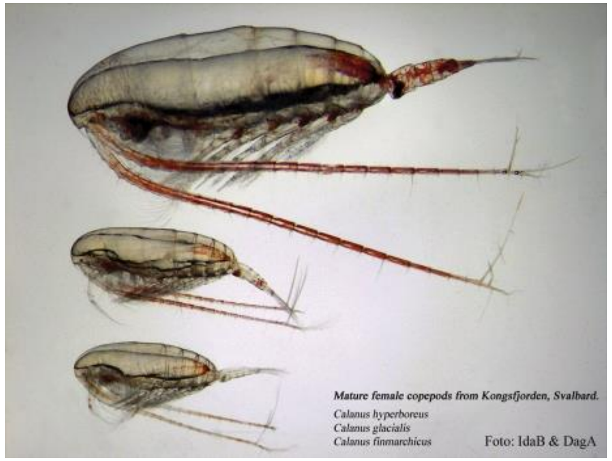
- **Priority area 1:** PA 3+4, Western Norway, face environmental challenges related to multiple anthropogenic and natural impacts but most notably an intense aquaculture industry. PA 3 and 4 are currently flagged red in the traffic light system, indicating that aquaculture production must be reduced if still red during the 2019 assessment.
- **Priority area 2:** PA 9, Lofoten/Vesterålen, is a very productive and sensitive environment to external stressors, as about 70 % of all commercially caught fish in the Norwegian Sea and the Barents Sea have early vulnerable life stages drifting through during planktonic stages, and now considered for future petroleum activities.
- **Priority area 3:** PA 12, Finnmark west, is a region far north with a complex coastline including several fjords with and without sills with a potential for a significant increase in aquaculture and mining, while natural resources are declining due to a combination of anthropogenic and natural causes.



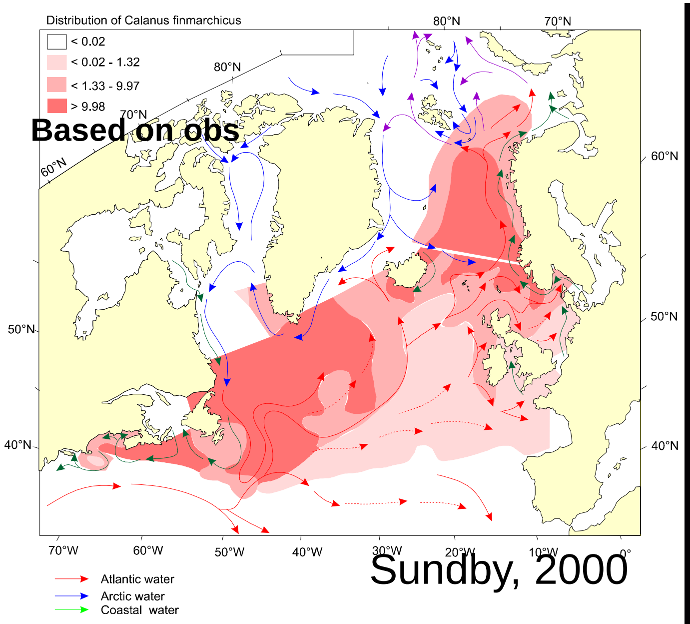
Strategic initiative – Assessing cumulative impacts on the Norwegian coastal ecosystem and its services (Coast-Risk)

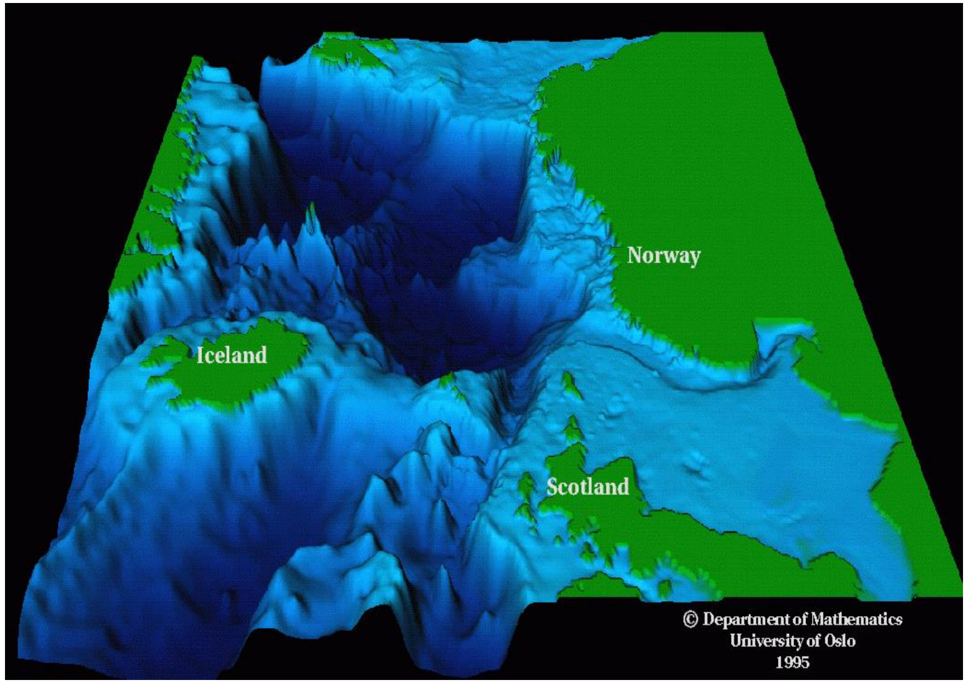
CS	Knowledge gaps and CS-specific objectives.
i)	Coastal warming reduces the frequencies of deep water renewal of sill fjords and results in deoxygenation. In combination with upper ocean fjord circulation often modified by river regulation, this influences a wide range of biological and ecological processes in the fjords. Furthermore, with increasing aquaculture, the organic enrichment and oxygen consumption at the seabed has increased, affecting the carrying capacity. We propose to quantify the various stressors and exchange processes in sill fjords and evaluate the importance for i) vertical nutrient flux, ii) reoxygenation, iii) turbidity, iv) mobilization of pollutants v) and impact on dispersal (connectivity) through egg and other planktonic stages in conjunction with CS iii-iv.
ii)	The combination of increased nutrient availability in the surface waters through winter mixing, increasing water column irradiance and stratification trigger the annual phytoplankton spring bloom. The fate of the spring bloom is determined by the nutrient supply, presence of potential grazers and the degree of sedimentation. In this CS we will investigate the food web dynamics during the spring bloom covering chemical aspects (nutrient dynamics), abundance and composition of phytoplankton, protozooplankton and mesozooplankton to quantify impacting processes as a function of natural and anthropogenic changes.
iii)	Recruitment in key commercial fish species spawning at the NC depends on the availability of lipid-rich calanoid copepod species Calanus finmarchicus (C.fin.) for their newly-hatched larvae. Inter-annual variation in the nauplii stages at the time where larval fish search for food may be caused by e.g. climate-induced bottom-up processes through onset of phytoplankton spring bloom. Recent studies inform of a dramatic reduction in C.fin. at the shelf of more than 50 % during the 2000s. We will investigate sources (deep oceans and fjords), dispersal processes and stressors that may explain the observed changes of C.fin. in key areas of coastal and fjord species using both empirical and modelling approaches.
iv)	Key commercial and ecological species, such as coastal cod, shrimp and sprat are declining. Due to unknown population structure of the coastal species, and lack of knowledge on interactions with oceanic populations or neighbouring coastal populations, management advice on harvest levels and impacts of other stressors become uncertain and potentially wrong. A recent genetic study demonstrated that coastal cod from 62^{o}N and north probably contains multiple sub-populations through genetic isolation by distance. Here we will compile region-specific abundance data combined with genetics and biophysical models to determine appropriate management units whereby cumulative natural and anthropogenic pressures act.

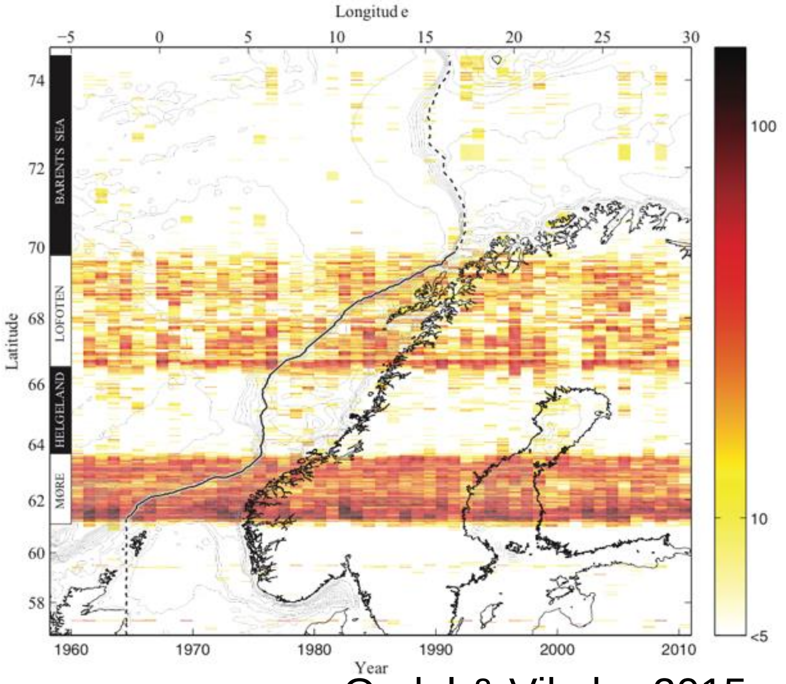
“Raudåte” transporteres av havstrømmer fra dyphav til sokkel og er en nøkkelart for fiskelarver



- *C. finmarchicus* overvintrer på 500 – 2500 m dyp i Norskehavet
- Går til overflaten sent på vinteren og gyter med våroppblomstring
- Numeriske modelelr indikerer jevn strøm mellom år opp på sokkelen på hovedgytefeltene for sild og torsk

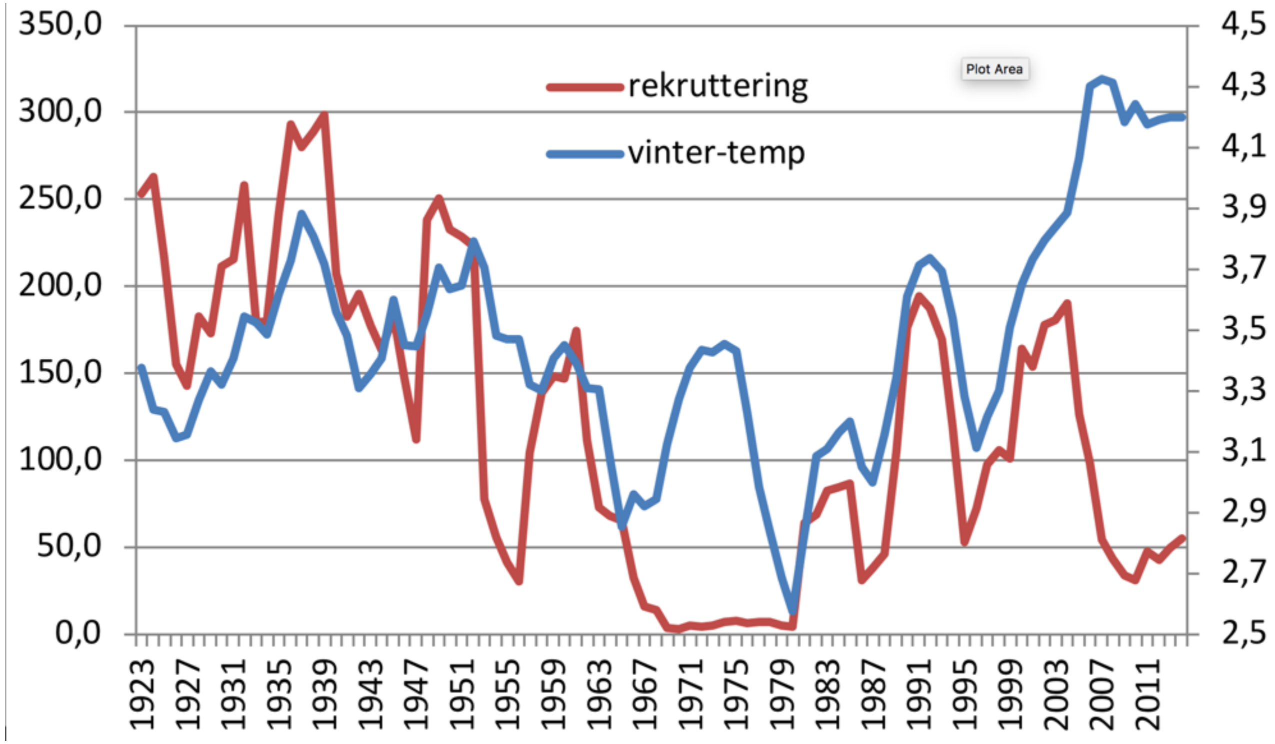


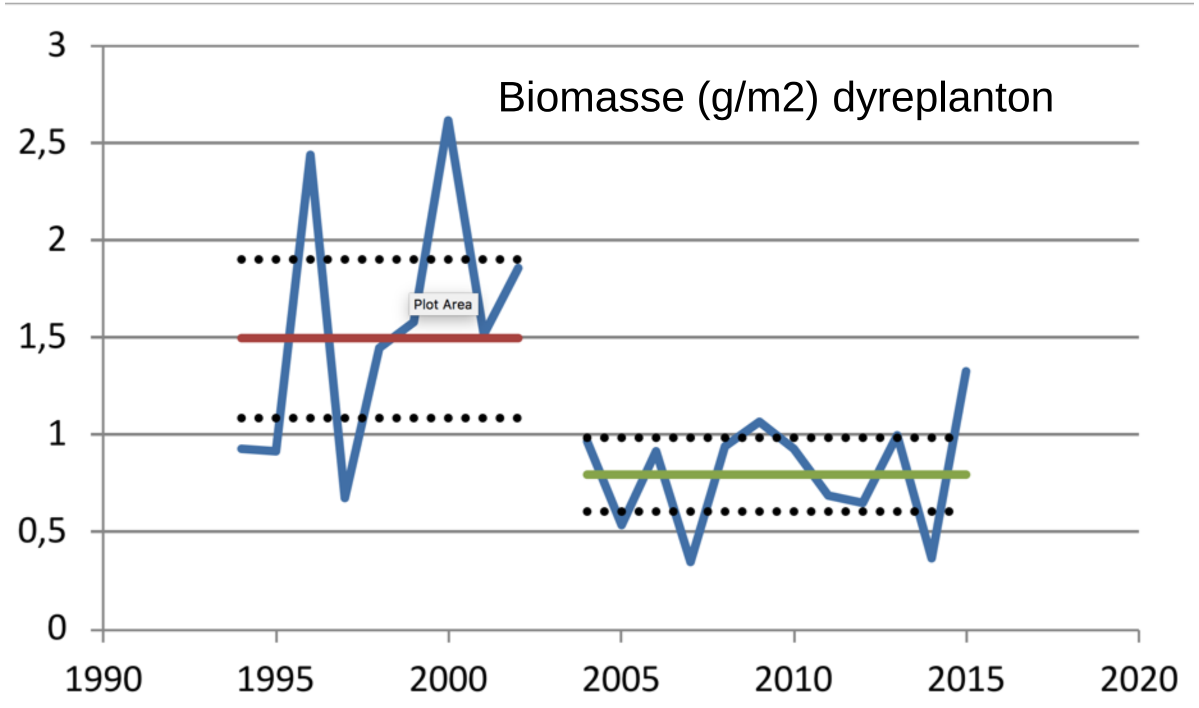




Opdal & Vikebø 2015

Rekruttering vs temperatur for Norsk vårgytende sild





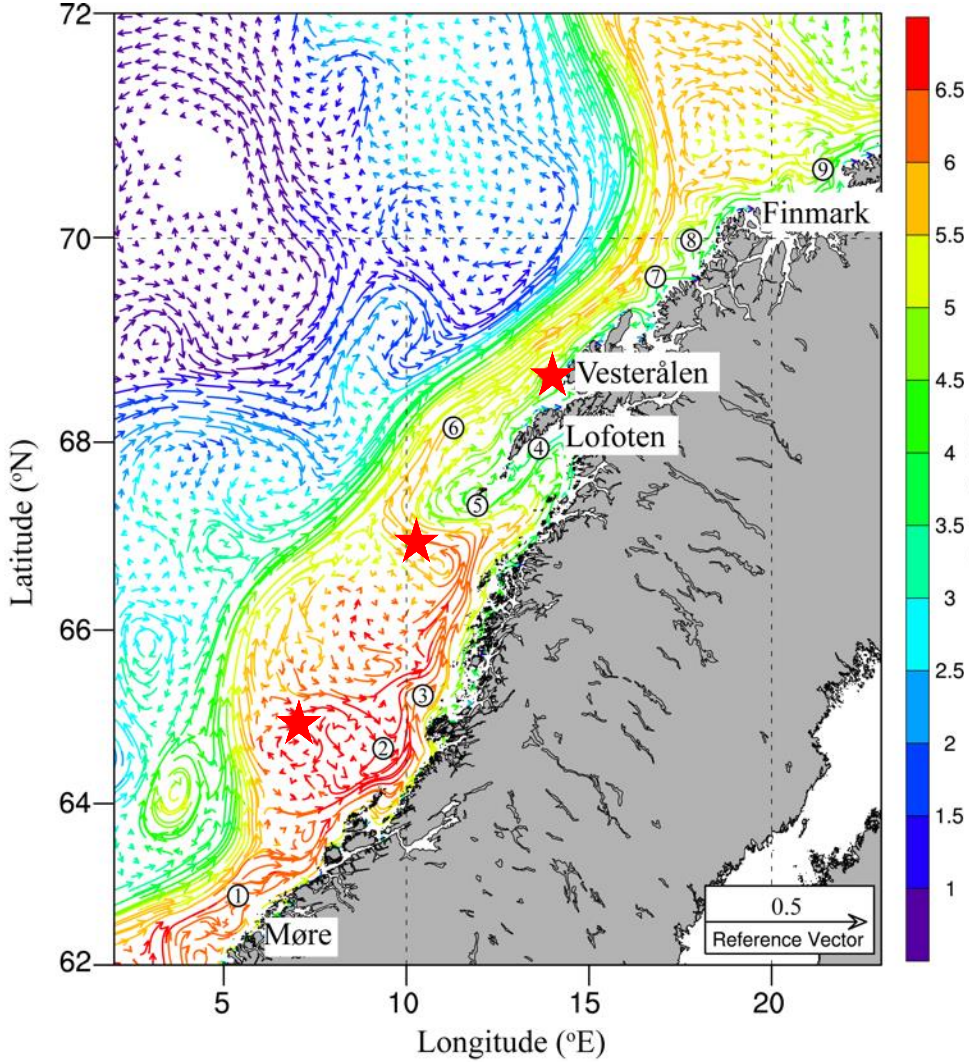
- Historiske samvariasjoner mellom rekruttering og omgivelsestempratur bryter sammen på 2000-tallet
- Sammenfallende reduksjon i raudåtebiomasse på sokkelen

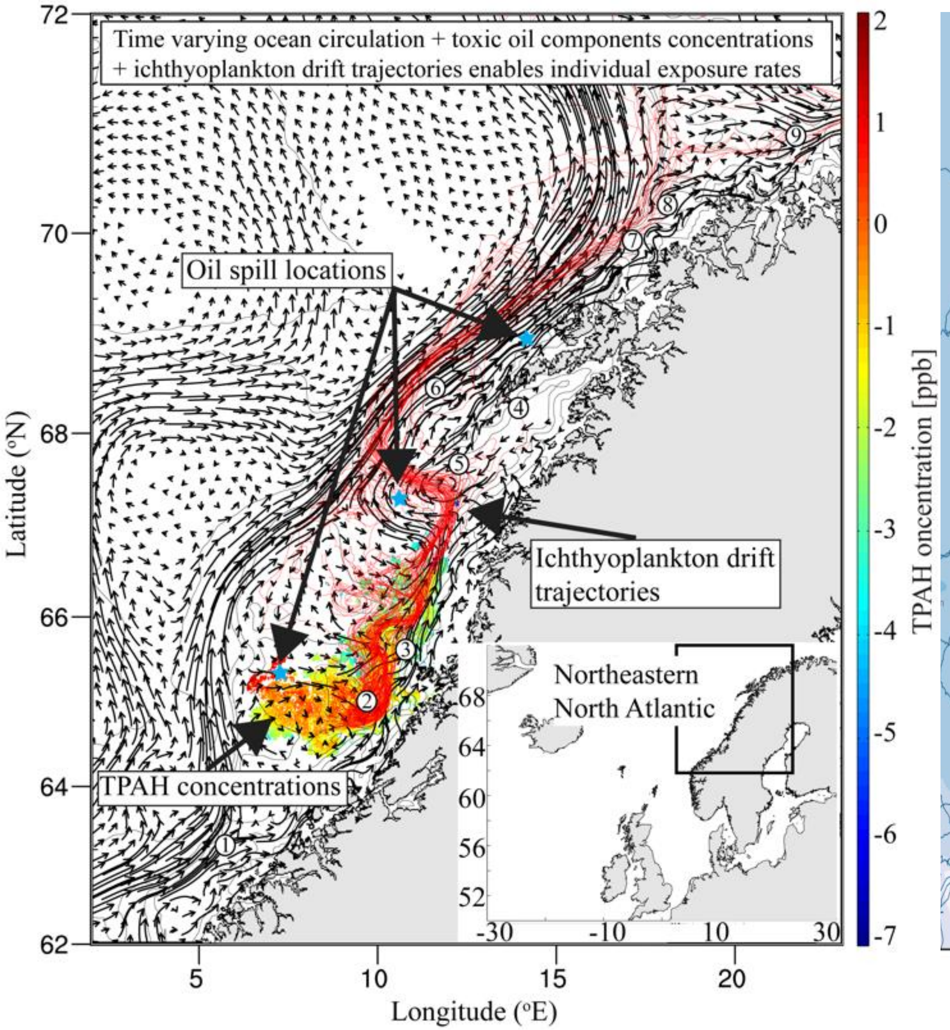
Toresen et al. (Fish and Fisheries, 2019)

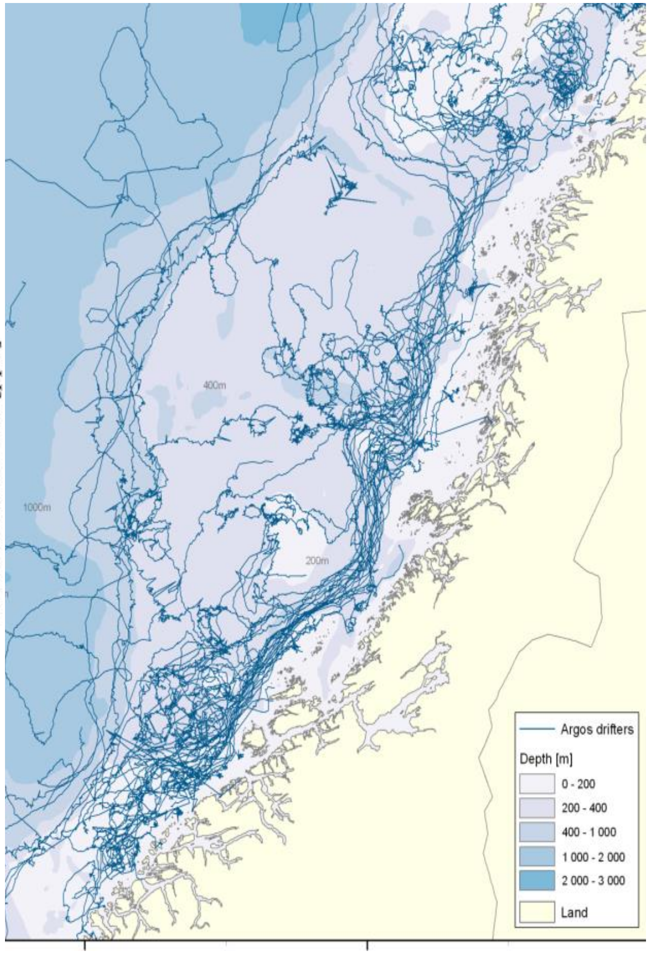
Sammendrag

- Forstå prosesser og mekanismer som regulerer struktur og funksjon
- Utvikle nødvendig overvåkning som gjør oss i stand til å vurdere variabilitet og endring for utvalgte deler av miljø og ressurser
- Koble eksperimenter, data fra felt og numeriske modeller for å vurdere samlet belastning samt skille mellom menneskeskapte effekter og naturlig variasjon på individer, populasjoner og økosystem

Eksponering av arter og stadier for ulike stressorer

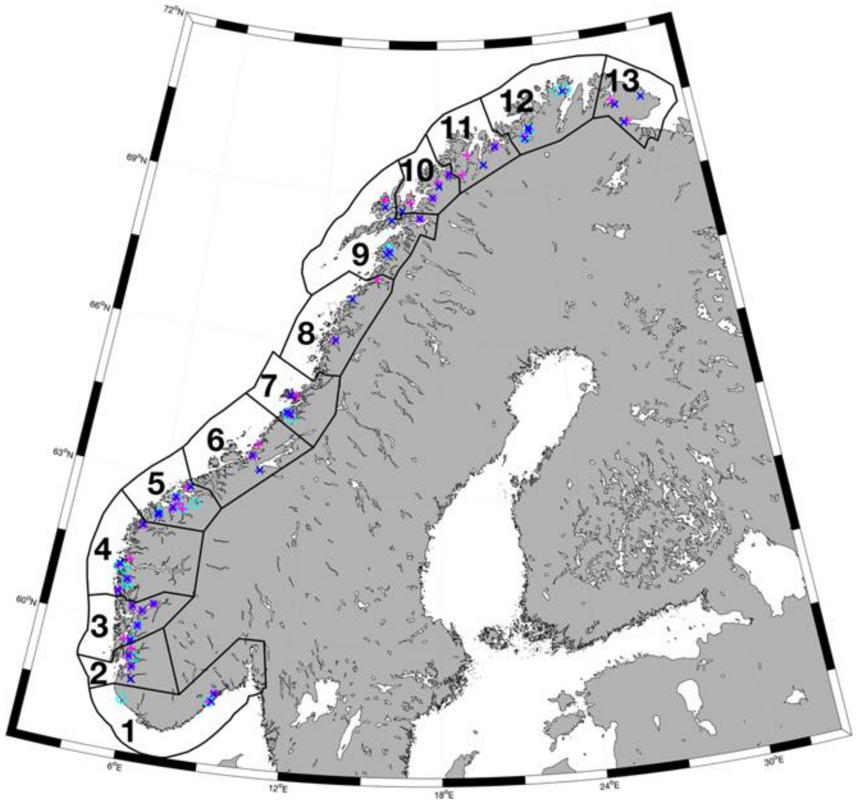


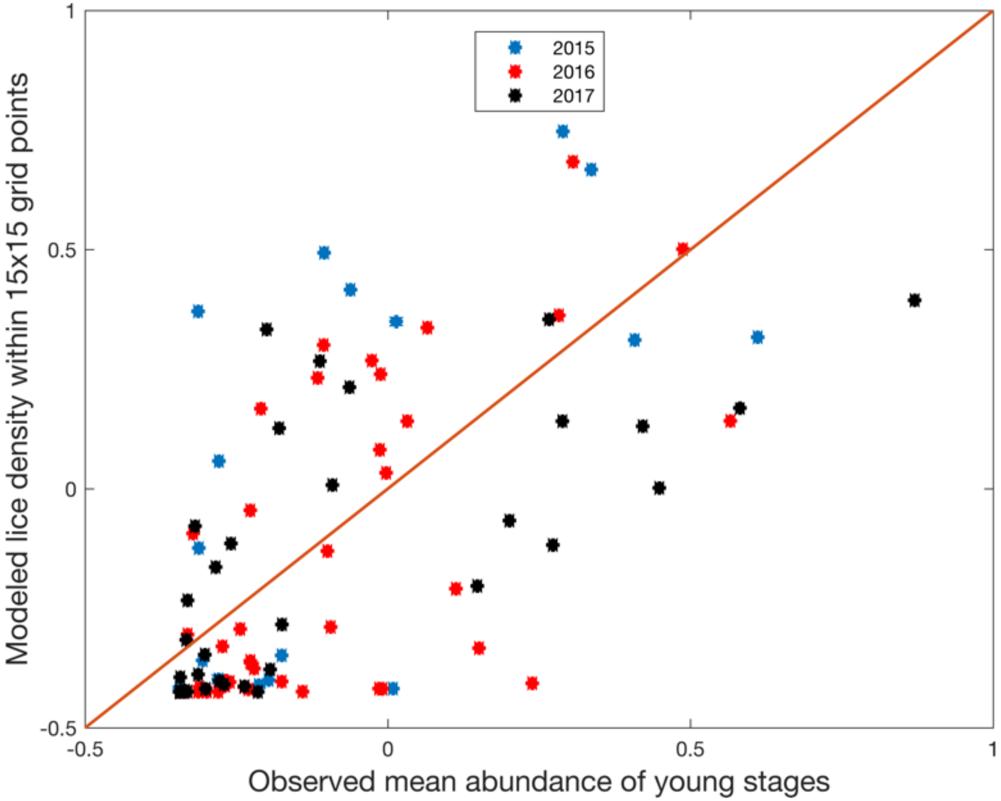




(Vikebø et al. 2014, 2015)

Lakseproduksjonsområder

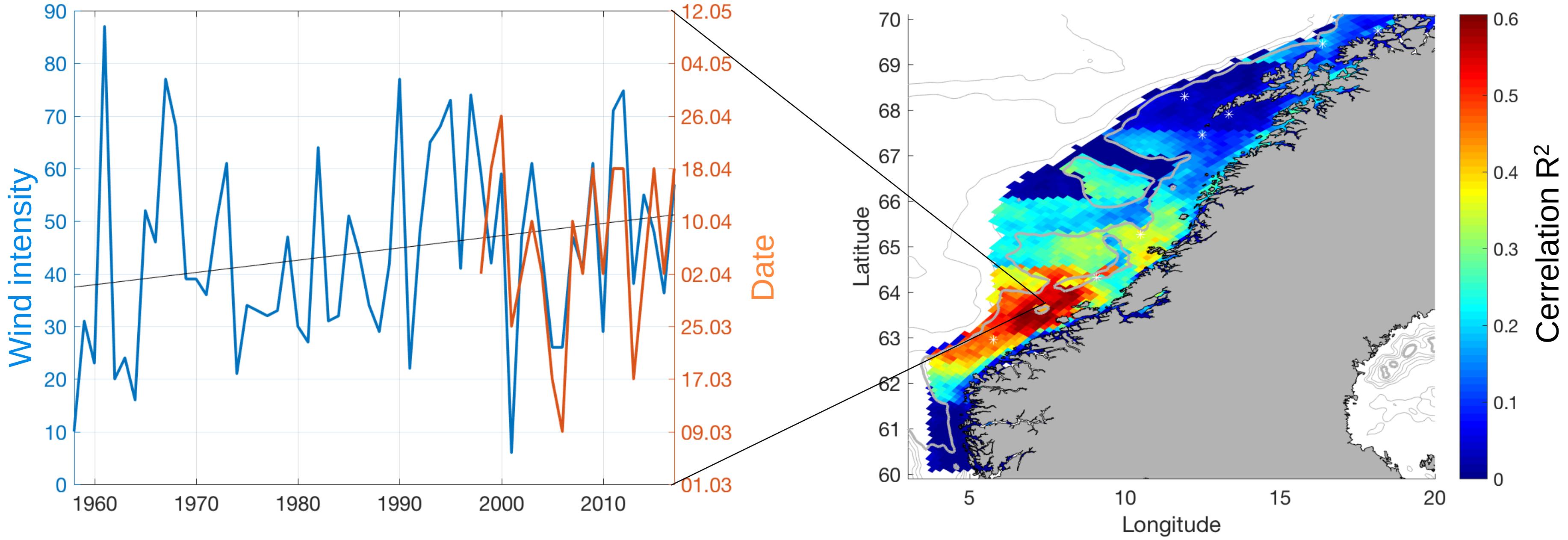




Bjørn Ådlandsvik, Havforskningsinstituttet

Myksvoll et al. 2018

Vind og våroppblomstring



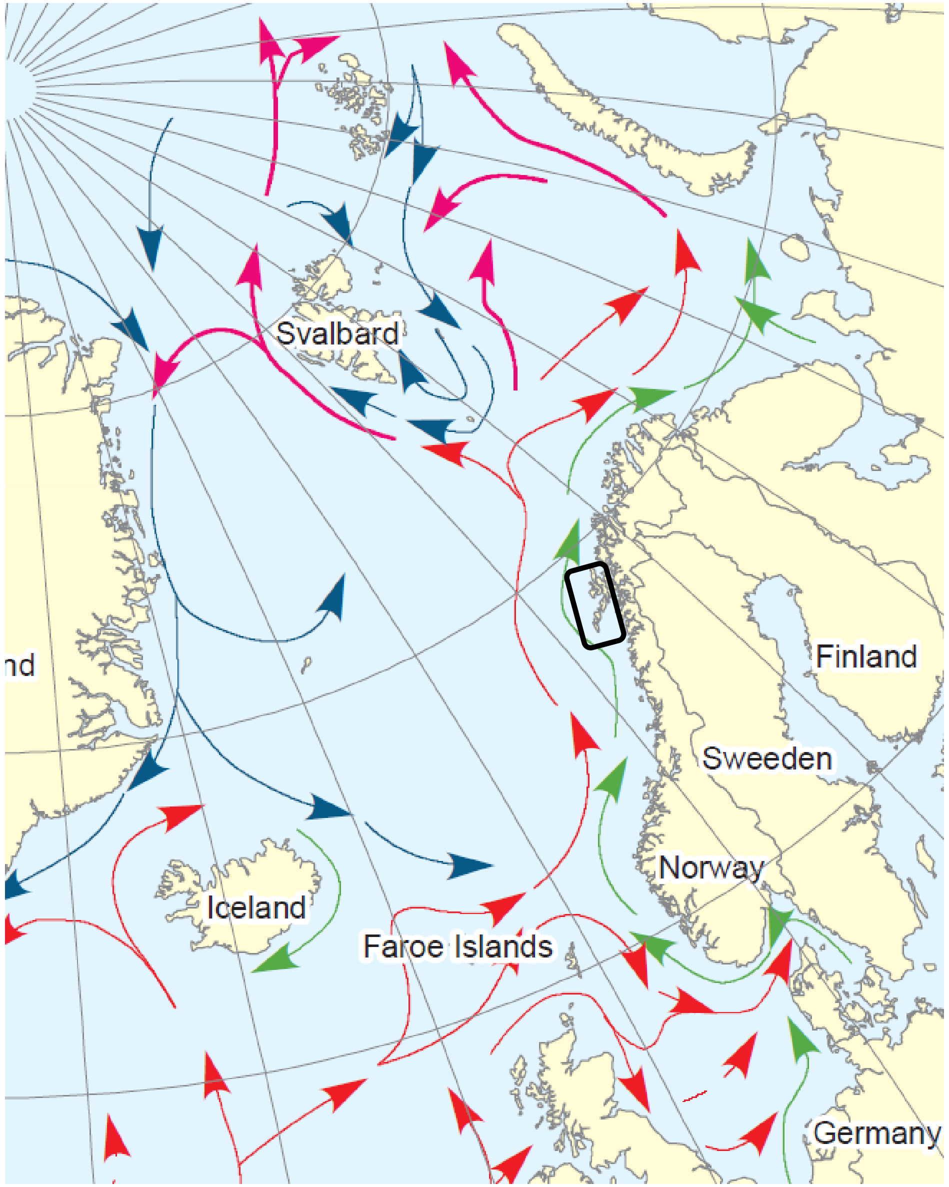
Lat (ºN)	60.0-61.5	61.5-63.0	63.0-64.5	64.5-66.0	66.0-67.5	67.5-69.0	69.0-70.5
OSB (<300 m)	08.03	14.03	23.03	14.04	14.04	12.04	29.04
Std.	12.0	12.1	15.4	9.7	5.7	7.0	19.7
OSB (>300 m)	20.03	05.04	11.04	17.04	29.04	19.04	15.04
Std.	14.3	12.3	12.8	11.3	12.9	10.9	12.1

SG	1	2	3	4	5	6	7	8
R^2	0.45	0.50	0.38	0.04	0.12	0.03	0.21	0.19
P	0.00	0.00	0.00	0.38	0.13	0.44	0.05	0.07

- Forsinket våroppblomstring med økende breddegrad
- Forsinket våroppblomstring med økende avstand fra kyst
- Vind og våroppblomstring samsvarer godt på Møre

Vikebø et al. Accepted

Fisheries in the Barents Sea and the Norwegian Sea dependent on spawning grounds



Lofoten-Vesterålen

Norsk-arktisk torsk	846
Norsk vårgytende sild	726
Norsk-arktisk hyse	278
Norsk arktisk sei	164
Snabeluer	28
Nordnorsk kysttorsk	21
Steinbit fangst	17
Brosme 50 %	10
Lange	8
Øyepål	6
Vanlig uer	0
SUM 1000 tonn	2103
Prosent andel	**70**

70 % of fish eggs and larvae drift through the Lofoten

Britiske øyer og Nordsjøen

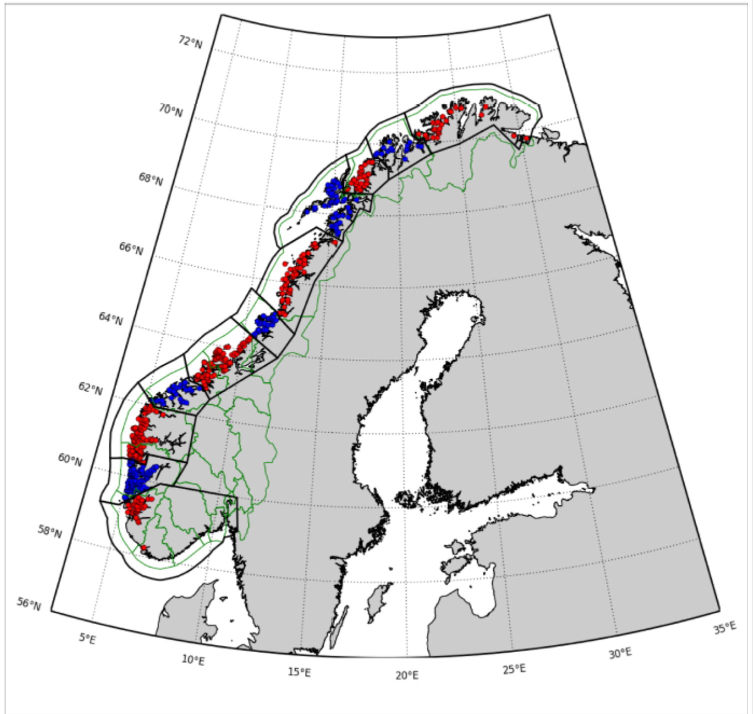
Makrell 50 %	280
Kolmule 50 %	260
Brosme 50%	10
SUM 1000 tonn	550
Prosent andel	**18**

Barentshavet

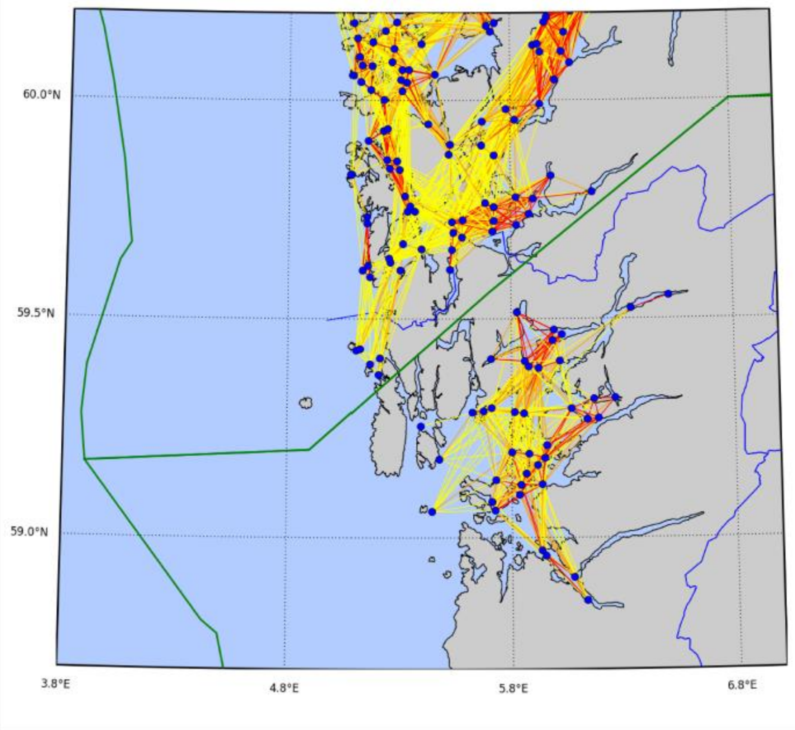
Lodde Barentshavet	320
Polartorsk	20
Blåkveite	15
SUM 1000 tonn	355
Prosent andel	**12**

KILO (2013)

Lakseproduksjonsområder

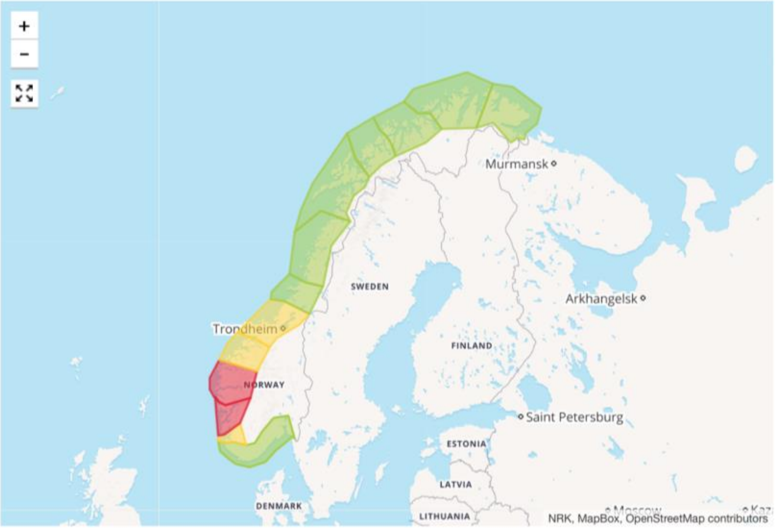


Figur 3.1: Havforskningsinstituttets forslag til områdeinndeling. Grensene til områdene er tegnet i svart. Grønne kurver viser fylkesgrensene. Kartet viser også posisjonene til de 591 lokalitetene som er brukt i analysen. Fargene på anleggene alternerer mellom rødt og blått for de ulike områdene.



Dette er kartet som avgjer vekst og kutt i oppdrettsnæringa

Dersom dei ikkje får kontroll på lakselusproblemet innan to år, må alle fiskeoppdrett frå Karmøy til Stadtlandet kutta i produksjonen.



Det er berre fiskeoppdrett som ligg i grøne soner på regjeringa sitt nye kart over miljøproblem knytt til fiskeoppdrett, som skal få lov til å vekse.

Anders Ekanger
@ekanders
Journalist

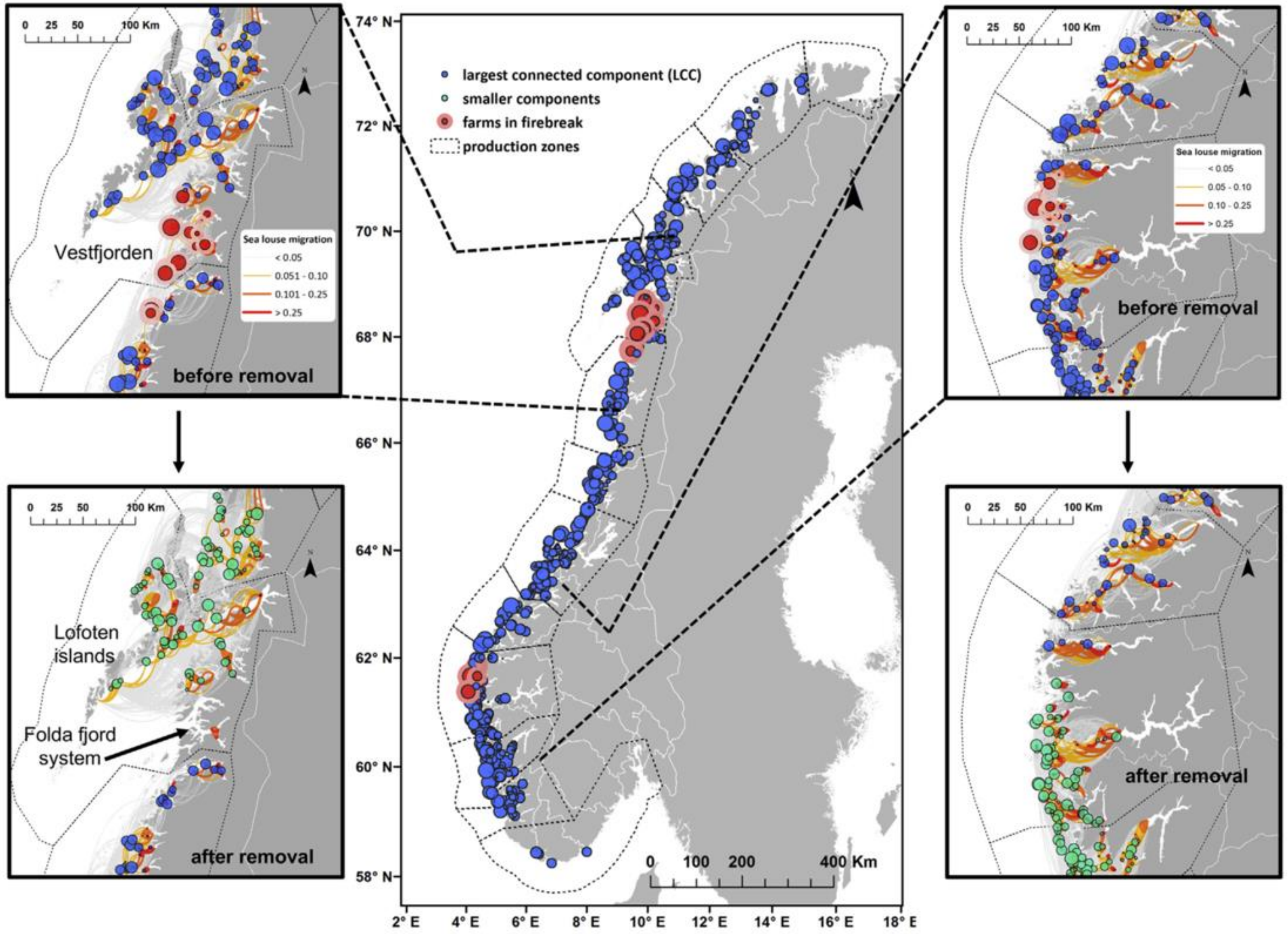
Even Norheim Johansen
@evennor
Journalist

Publisert 31. okt. 2017 kl. 17:49

Artikkelen er mer enn ett år gammel.

Bjørn Ådlandsvik, Havforskningsinstituttet

Finnes det naturlige «branngater» for å redusere lakselusspredning?



- Lakselus transportert fra anlegg som partikler med egenskaper.
- Tallfester smittesammenhenger mellom anlegg.
- Finner anlegg som er nøkkelområder for smitte på tvers av delområder.

Samsing et al. 2019