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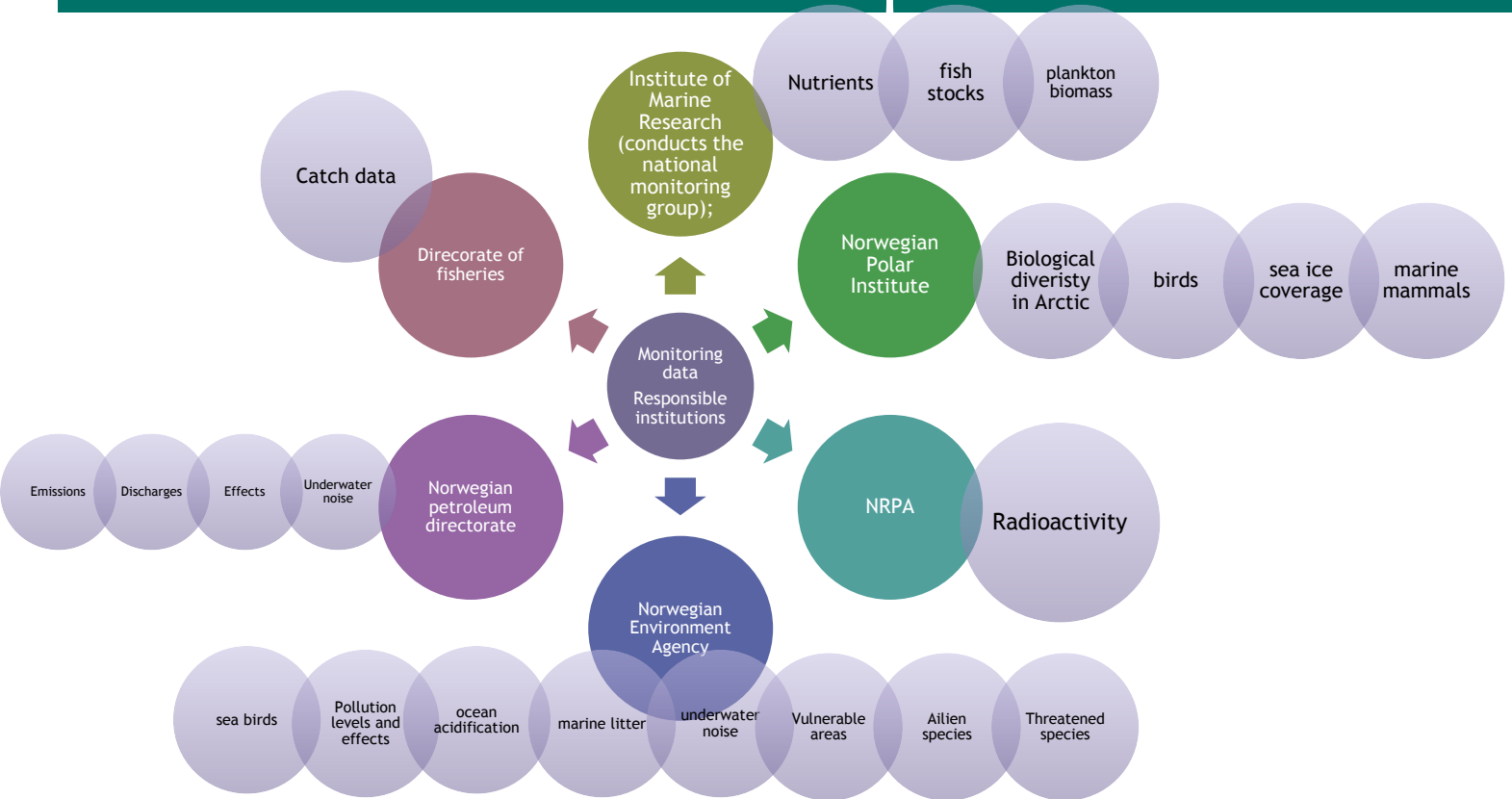
Monitoring and indicators

Camilla F. Pettersen, Section for environmental monitoring and mapping

Organization of marine monitoring – contributors and responsible institutions



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Monitoring conducted by the Norwegian Environment Agency that might be used

- Long range transboudary pollution and atmospheric deposition
- Ocean acidification monitoring program
- Økokyst (monitoring program of ecosystems in coastal waters)
- Riverine input program (heavy metals, nutrients)
- Monitoring program on marine hard bottom fauna (northern Norway and Svalbard)
- Puffin monitoring (population ecology)
- Seabird monitoring program
- Marine mapping
- Urban fjord monitoring (hazardous substances at different trophic levels)
- Marine litter
- Screening program

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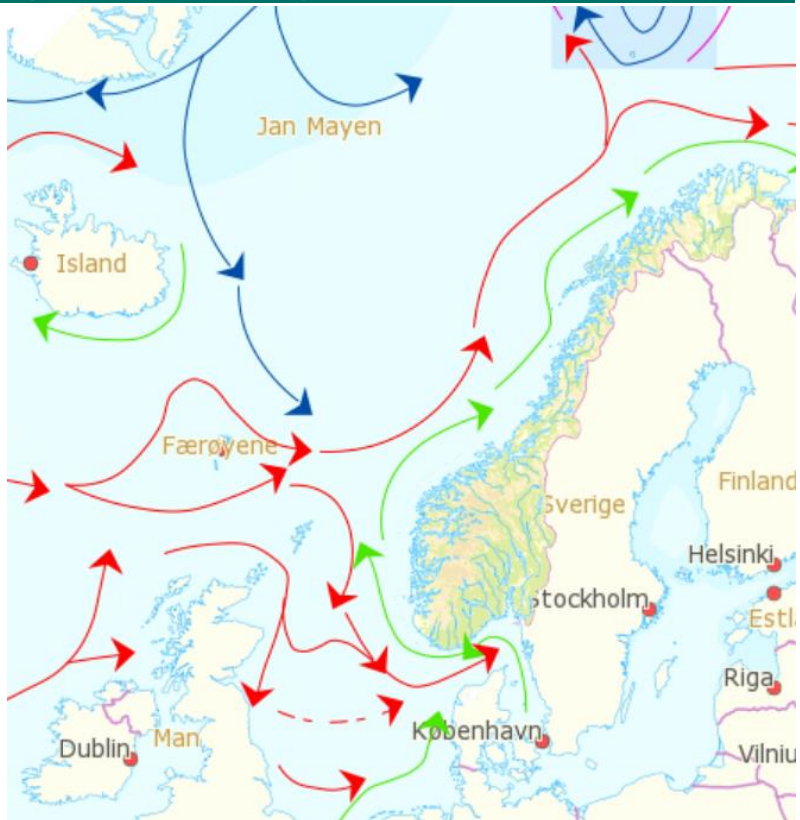
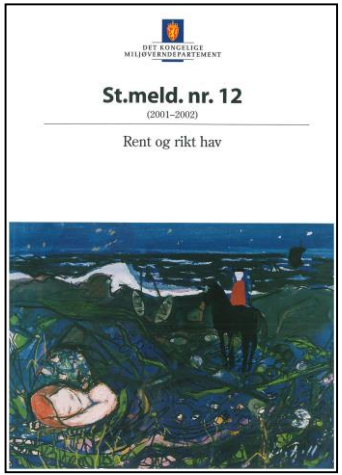
Why is it important for Norway to harmonize environemtal data with neighboring countries?

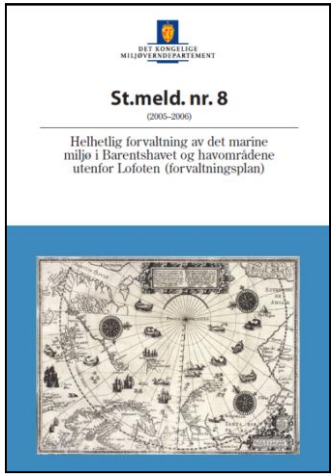
- Downstream Europe and the Baltics
- The State of marine environment depends largely on long-range pressures
- Norwegian coastline: 103 000 km
- Norwegian seas: 2 140 000 km^2 = 6x the size of our land areas
- 3 sea areas
- Different groups of users: Fishery, shipping, petroleum, tourism, recreational use, other ecosystem services

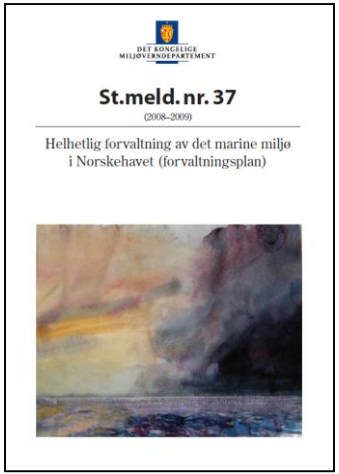


Indicators and monitoring in Norwegian marine waters

- Norwegian marine management plans
- OSPAR
- Common indicators with Russia
- Other conventions and agreements

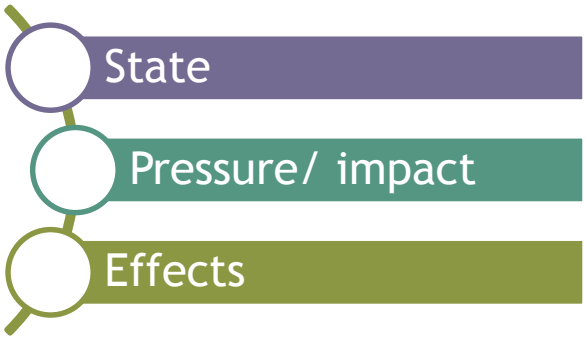






What is an indicator?

An indicator should characterize a condition, pressure or effect caused by impacts to the ecosystem. Ideally, each indicator provides information about the state of a specific part of the ecosystem at a given time.



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Building an indicator system: Physical and chemical features

- Topography and bathymetry of the seabed
- Annual and seasonal temperature regime and ice cover extent, current velocity, upwelling, wave exposure
- Mixing characteristics, turbidity, residence time
- Spatial and temporal salinity
- Spatial and temporal distribution of nutrients (DIN, Tot-N, DIP, Tot-P, TOC) and oxygen
- pH, pCO2 profiles or equivalent information used to measure marine acidification

DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 17 June 2008
Annex III

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Different habitats

- The predominant seabed and water column habitat type(s)

  - **Identification and mapping of special types of habitats**
    - identified under Community legislation (the Habitats Directive and the Birds Directive)
    - international conventions as being of special scientific or biodiversity interest

  - **Habitats in areas which by virtue of their characteristics, location or strategic importance merit a particular reference.** This may include areas subject to intense or specific pressures or areas which merit a specific protection regime

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Biological features of the ecosystem - at all trophic levels

- A description of the biological communities associated with the seabed and water column habitats which are present in the marine region or sub-region;

- phytoplankton and zooplankton communities
- angiosperms, macro-algae and bottom fauna
- fish populations
- marine mammals
- seabirds
- other species which are the subject of Community legislation or international agreements
- nonindigenous, invasive, exotic species
- genetically distinct forms of native species

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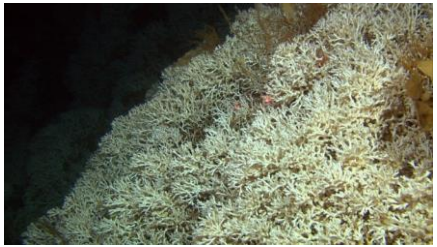
Physical loss, physical damage and physical disturbances

- smothering and sealing of the seabed
- changes in siltation
- abrasion (impact on the seabed)
- selective extraction (exploration and exploitation of living and non-living resources)
- underwater noise
- marine litter
- significant changes in thermal regime
- salinity regime



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Contamination

- introduction of synthetic compounds
  - priority substances under Directive 2000/60/EC which are relevant for the marine environment

- introduction of radio-nuclides
- introduction of non-synthetic substances and compounds (heavy metals, hydrocarbons)

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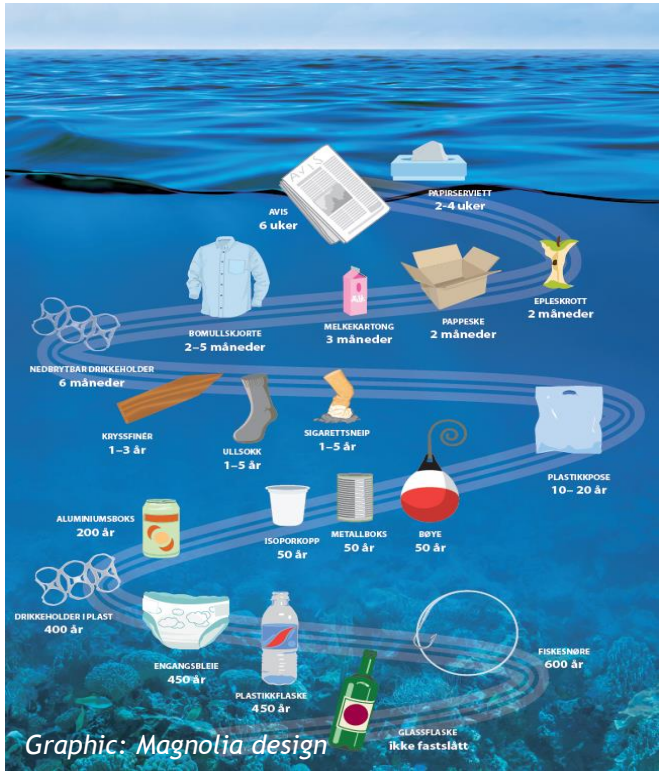
Marine litter

- Floating litter in the water column and at the surface
- Litter at the sea bottom
- Litter in sea bird stomachs
- Beach litter (different sites)

Photography: Camilla F. Pettersen, Miljødirektoratet



Graphic: Magnolia design

Photography: Camilla F. Pettersen, Miljødirektoratet

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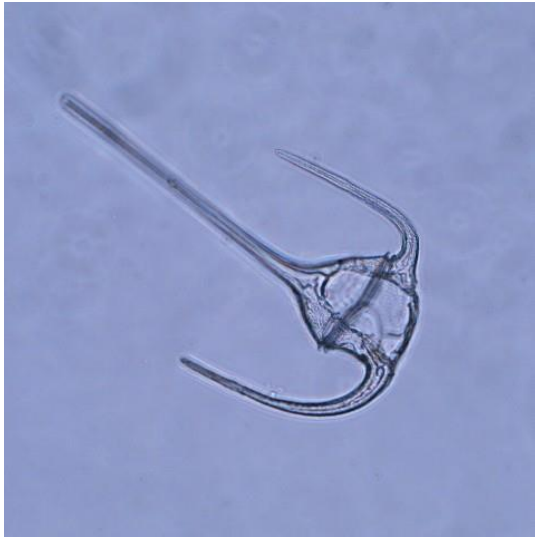
Nutrient and organic matter enrichment

- inputs of fertilisers and other nitrogen – and phosphorus-rich substances
- inputs of organic matter (sewers, mariculture, riverine inputs)



Photography: Jan Simonsen

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Biological disturbances, ailien species

- introduction of microbial pathogens
- introduction of non-indigenous species and translocations
- selective extraction of species, including incidental non-target catches (by commercial and recreational fishing)

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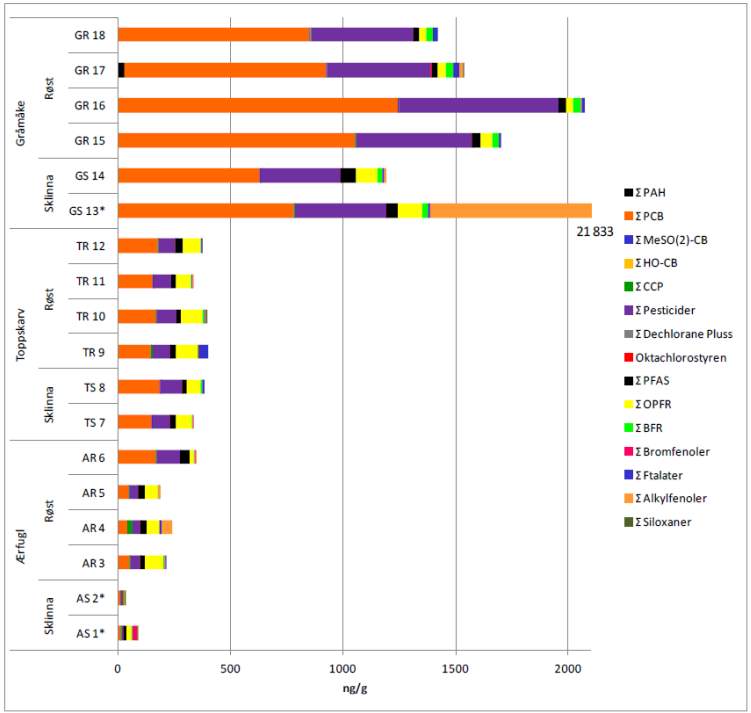
Surveys - ie hazardous substances in eggs from sea birds 2013

- Expensive analyzes
- Budget: 1 000 000 NOK
- Reporting data: 300 000 NOK
- Sampling of eggs 30 000 NOK
- 18 eggs from common european cormorants, 18 eggs herring guls, 18 eggs from common eider
- Mixing samples of 3 and 3 eggs
- 201 substances were analyzed
- Results: High levels, new substances were found at high levels
- Results are also used in international processes
- Ban of siloksanes



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Challenges

- ambitious
- expensive
- short data series
- regions differ ecologically – what is geographically adequate monitoring?
- very few effect indicators
- different monitoring methods
- expert group for underwater noise
- expert group for marine litter
- What knowledge do we need to perform management?

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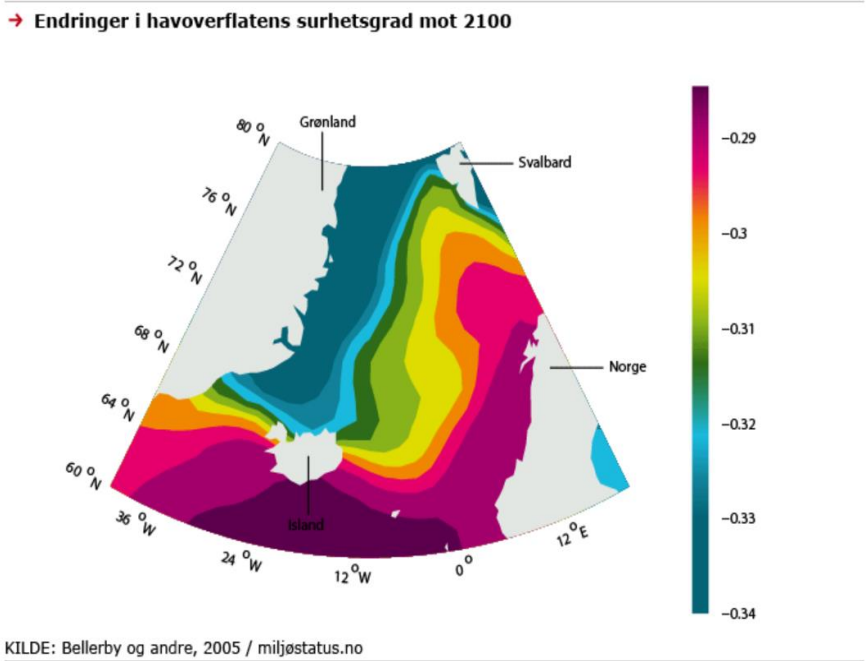
Developing indicators: Ocean acidification – a growing concern

- Emissions of CO_2 has led to acidification of the sea
- The uptake of CO_2 by sea is 25 % of the antropgene CO_2
- pH decrease -0,1 pH-units from pre-industrial time at a global level
- The surface waters of the Norwegian sea and the Barents sea has decreased -0,13 and -0,07 pH-units during the past 30 years
- Norwegians seas has become 30 times more acid
- The acidification also leads to a reduction in calsite and aragonite
- This might lead to a reduction in calsifying processes among differnt taxas
- Major structural displacements are expected in Norwegian marine ecosystems in the future
- For precaution – we should start monitoring of biological effects



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Ongoing monitoring on ocean acidification: Physical and chemical parameters

- Carbon chemistry parameters:
  - total alkalinity (AT)
  - total inorganic carbon (CT)
  - pH
  - partial pressure of CO (pCO2)
  - [CaCO3] (both types: aragonite and calsite)
  - nitrate og phosphate
- Calculated values:
  - saturation levels of aragonite (ΩAr)
  - saturationlevels of calsite (ΩCa)
- No monitoring on biological effects yet

Snitt	Prøvetakings-måned	Type	Målte parametere	Utførende institusjon	Finansiering
Torungen-Hirtshals	februar	vannsøyle	A_T, C_T	IMR	Miljødir
Svinøy-NW	januar	vannsøyle	A_T, C_T	IMR	Miljødir
Fugløya-Bjørnøya	mars	vannsøyle	A_T, C_T	IMR	Miljødir
Bjørnøya-Sørkapp	august	vannsøyle	A_T, C_T	IMR	Miljødir
NØ Barentshav	september	vannsøyle	A_T, C_T	IMR	Miljødir
Langs 75° N	juli	vannsøyle	A_T, C_T	UNI	EU Carbochange
Tromsø- Longyearbyen/ Ny-Ålesund	februar, juni, september, november	overflate	A_T,C_T, pH,	NIVA	Miljødir /Fram
Oslo-Kiel	januar, juli, september, november	overflate	A_T,C_T, pH,	NIVA	Miljødir
Bergen-Kirkenes	februar	overflate	A_T,C_T, pH,	NIVA	Miljødir

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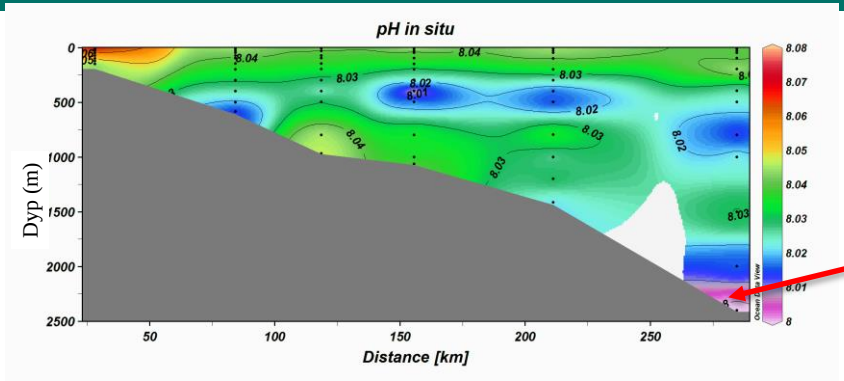
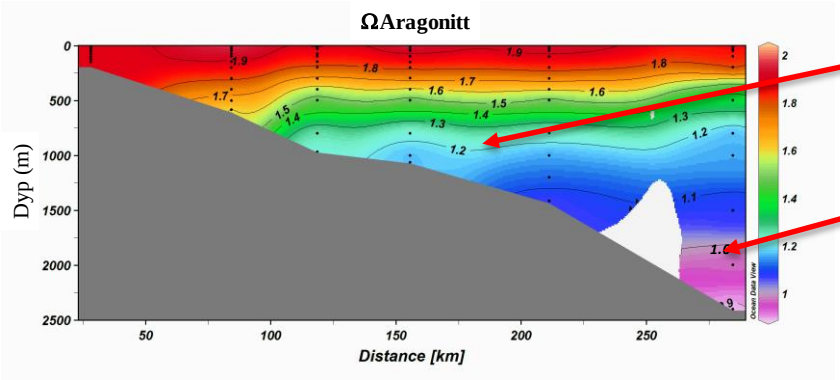
Results from the OA-monitoring in the Norwegian sea, (transect between Svinøy-NV) from januar 2013



pH in january 2013



Low saturation levels

The saturation horizon was found at 2000 meters depths in 2013, compared to 1800 meters depths in 2014
The rapid increase might be explained by inflow of Arctic water

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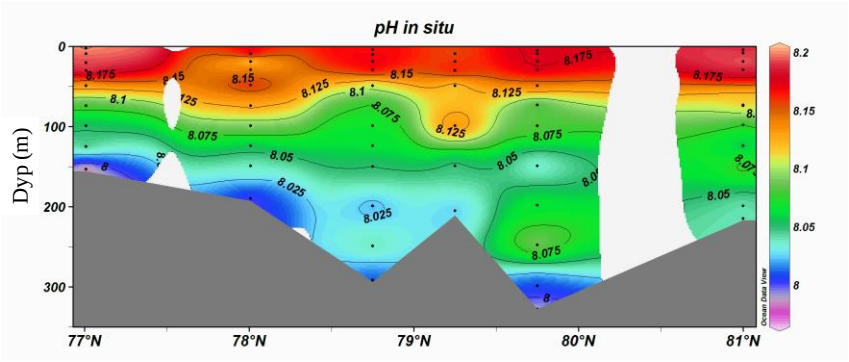
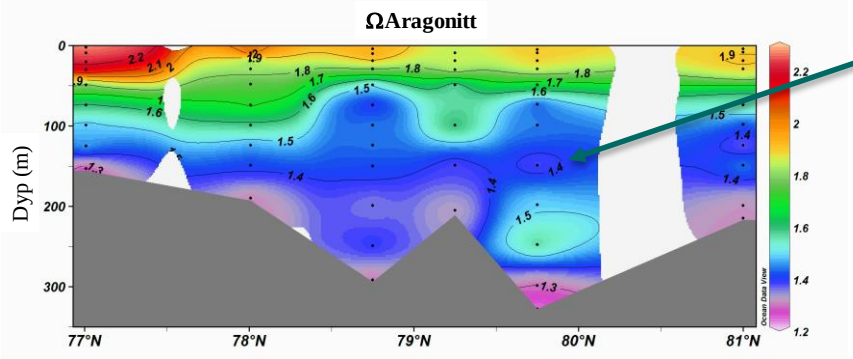
Results from the Barents sea (NE) from september 2013





Low saturation levels of aragonite

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Assignment from the Ministry of Climate and environment
Proposal for monitoring of biological effects from ocean acidification

From the letter of allocation:

- «*Forslag til biologiske effektindikatorer for havforsuring i hav og kyst i samarbeid med Norsk Polarinstitutt. Miljødirektoratet skal lede arbeidet. Arbeidet skal sees i sammenheng med relevant internasjonalt arbeid på feltet, spesielt i OSPAR.*»
- Frist for levering er utsatt til 1. ~~oktober~~ desember 2015.
- Oppdraget er også omtalt som en av føringene (føring nr 9) i kapittel 3 i tildelingsbrevet som omhandler resultatkrav i henhold til arbeidet med oppnåelse av nasjonalt miljømål 1.1:
- «*I forvaltningen av marine områder skal direktoratet styrke kunnskapen om effekter av klimaendringer og havforsuring og miljøkonsekvenser av ny og framtidig næringsvirksomhet i havområdene, slik som mineralutvinning på havbunnen.*»
-

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Workshop September 17th 2015, on biological effects from ocean acidification. We gathered 30 scientists to discuss biological effects. Draft workshop report. Proposals will be developed in near future.

Possible suggestion: Pteropods; *Limacina helicina*

- Cost effective monitoring
- Show the dissolution of shell among pteropods as a respons to increasing levels of pCO_2

www.miljostatus.no

http://www.imr.no/overvakingsgruppen/miljotilstanden_i_norske_havomrader/nb-no

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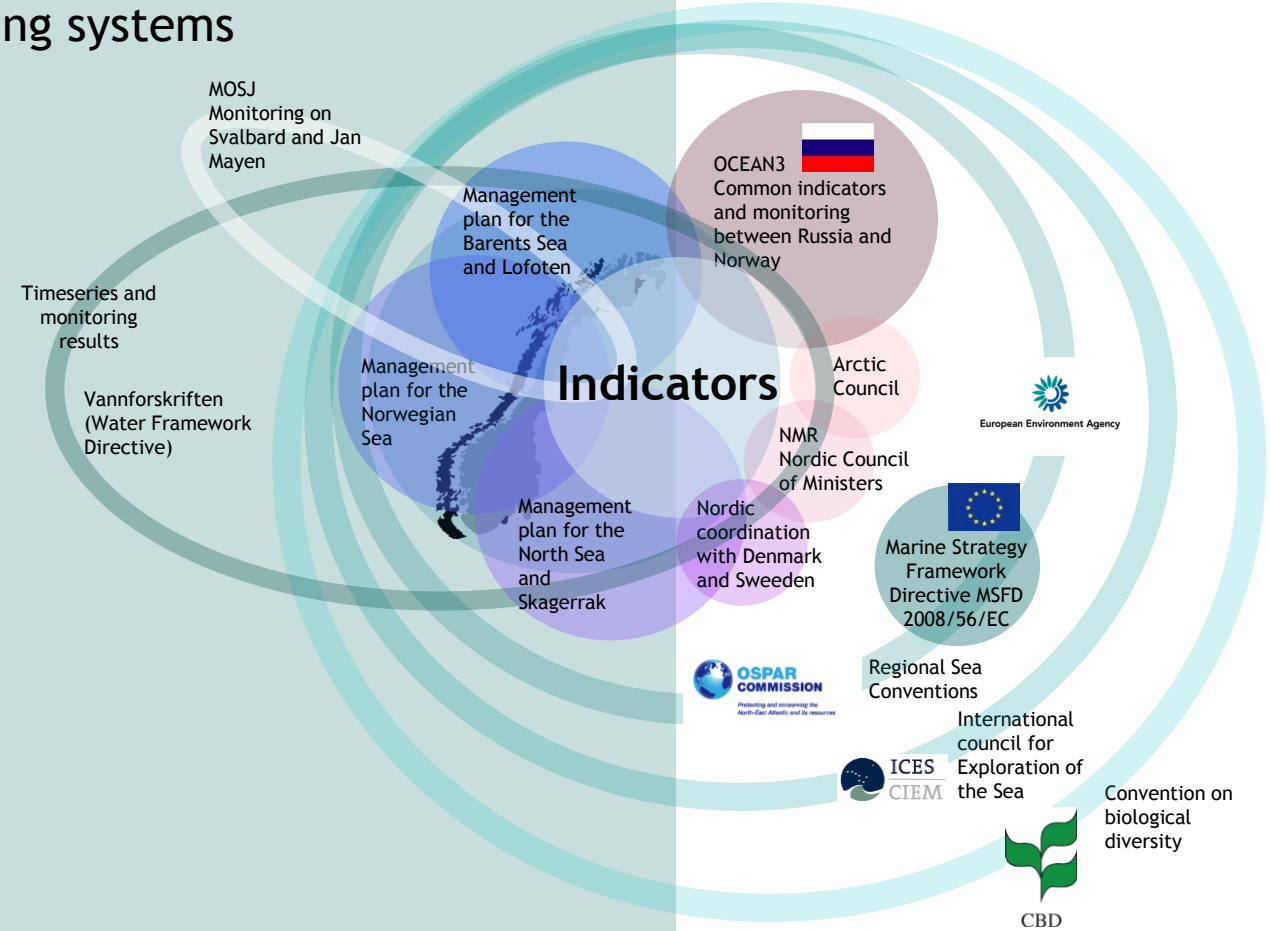
Reporting systems



Directive on Conservation of Wild Birds 2009/147/EC

EUs Habitats-direktiv 92/43/EEC og Natura 2000

(EUs Vannramme-direktiv 2000/60/EC)

(EUs kjemikalie-direktiv REACH EC 1907/2006)

National level

International level

Thank you, for your attention!

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www.miljødirektoratet.no