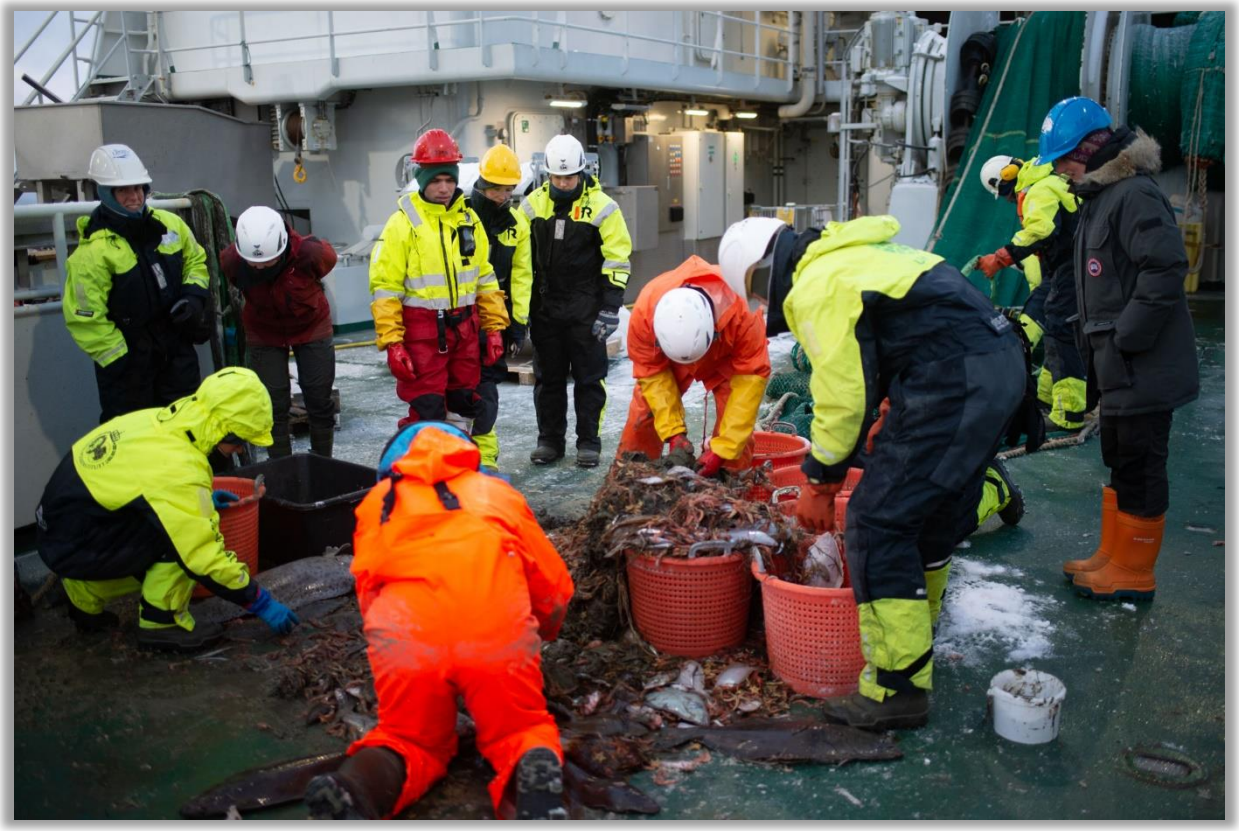
HAVFORSKERMØTET 2022
ASKER 21. – 23. NOVEMBER

ABSTRACTS



Bedriftsmedlemmar

Havforskarmøtet 2022 er arrangert med støtte frå Norges Forskningsråd.

Takk til alle våre støttespelarar!

Talk, Monday 21st Nov.

Comparing the green lens and the blue lens on global change

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The number of human beings and our habits of consumption are putting enormous pressure on planet Earth. Symptoms of unsustainable practices include the climate crisis and nature crisis, and the situation will likely get worse before it may get better. To turn the tide we need to be smart and act fast, with science and knowledge playing central roles.
But given that our planet is an interconnected system of aquatic and terrestrial habitats and expertise is increasingly compartmentalized, there is a risk that we prioritize actions that solve local or domain-specific problems while ignoring broader complications and knock-on consequences. How can we as scientists make sure good intentions have desirable impacts?
This talk adopts a planetary perspective on global change and compares the terrestrial with the marine. How are problems connected? Can impacts across land and sea be compared? What are the main challenges to healthy and sustainable oceans? Are debates and arguments about sustainability parallel across land and sea, or are there significant differences? Are these well-reasoned?
The aim is to present some facts and comparisons that stimulate critical thinking and self-reflection rather than providing answers.

Marine Protected Area myths and misunderstandings

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Myths and misunderstandings around what Marine Protected Areas (MPA) are circulate in the marine biological, fisheries and conservation communities. IUCN classify 7 kinds of MPA, only 3 of which aim to protect biodiversity (only 1 fully) and most (4) only aim to protect single species and landscapes. Entries in the World Database on Protected Areas are what countries submit, do not have to follow the IUCN classification, are not independently verified, and over rather than under-estimate protection. Most government and UN reports count all MPA as if they intend to protect biodiversity as a whole in natural state even though that is not their aim; >90% of MPA allow fishing for example and consequent trophic cascades mean the species' abundance, food webs and ecosystems are not natural. It seems dishonest to allow killing, sometimes indiscriminate, of wildlife in an area set up to protect wildlife.

At present less than 3% of the world ocean is in MPA that aim to protect biodiversity, and what % of the ocean is really protected is not known. About ¾ of coastal countries have not even one fully-protected MPA, including Norway. They thus have no baseline or reference for what a natural ecosystem would be like.

How natural resources are managed on land and in the sea shows contradictions. On land, only permitted species can be hunted, but fishery trawls, nets and long-lines kill marine life indiscriminately. On land hunting largely targets herbivores; but in the ocean top predators tend to be targeted first which leads to trophic cascades. In contrast to farming where broodstock and young animals are precious, most fishing kills the large and most productive animals first; and may dredge rather than protect juvenile habitats and food webs. Farmers pay for their broodstock, animal feed, fertiliser, land, and veterinary care, while fisheries get these public resources for free. Rather than invest in securing healthy marine biodiversity some fisheries are financially subsidised to fish more. Considering fisheries have no control over the environment, food or health of their targeted catch, and the complex ecological (predator, prey and pathogen) interactions in ecosystems, it seems a delusion to think fisheries can "manage" fish stocks. Fishery sustainability is defined based on predictions of future catches, not its environmental impact or true sustainability. It is hard to find evidence of any fishery demonstrated to be sustainable over decades.

It is not true that MPA exclude people, do not protect pelagic species, do not benefit fisheries, reduce fishery catch, that only rich countries can afford to have MPA, that MPA have to be large, have to be scientifically designed, nor that recreational fishing is less always less harmful to biodiversity than commercial fishing.

The same objections arise in proposing MPA that arise when setting aside areas for other public benefits, such as hospitals, schools, sports fields, energy production, military uses, roads, and national parks. As the ocean is already in public ownership these stakeholders: children, educators, scientists, health professionals, nature lovers, scuba divers and other recreational users, energy and tourism companies; need to have a voice as well as traditional resource users. MPA can be a win-win for biodiversity, fisheries, science, education, culture and heritage.

The effect of Marine Protected Areas on the diet of Lillesand European lobster (Homarus gammarus): DNA-based diet analysis approach

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***Introduction*:** The establishment of Marine Protected Areas (MPAs) as a conservational management strategy has been proven an effective measure for increasing size and abundance of both target and non-target species. However, past studies in Norway have tended to focus on only a few characteristics of the target species (e.g. movement, size, abundance). Community interaction effects or the trophic implications of lobster increase in local abundance and change in size structure that is apparent after MPA establishment have yet to be studied. Diet analysis of a predator can provide an understanding of community interactions based on prey species composition and diversity, while also indicating how these dynamics change in response to protection management. DNA metabarcoding is a method that provides accurate data on which species are present in a diet sample. *H. gammarus* is a valuable species that is fished both commercially and recreationally, and the decline of their populations in Norway has contributed to the establishment of MPAs protecting them specifically. The investigation of changes in lobster diet due to the establishment of MPAs will have important implications for further understanding of the community impact of such conservational management. Increased knowledge of lobster diet and its demographic variation is also important because it provides key information about benthic ecology interactions.

Objectives and hypotheses: The objective of this study is to characterize demographic variation in lobster diet and assess differences that may be attributed to MPA establishment. To reach the objectives, the following two hypotheses will be explored: 1) Due to the establishment of an MPA leading to an increased size and abundance of European lobsters, there will be changes in intra-specific competition and interactions between lobsters and their prey, contributing to a difference in diets before and after MPA establishment. 2) Size and sex in European lobster determines prey preference and their ability to catch and consume prey, such that demographic differences in diet will be observed.

Methods: Feces samples from European lobster inside an MPA in Lillesand and an adjacent control area was collected in August 2020 and in August 2022 to create the basis for a Before and After Control Impact study design. DNA from these samples has been extracted and amplified by Polymerase Chain Reaction (PCR), and PCR products will be sequenced to identify species present in the lobster's diet. Data analysis includes bioinformatics and statistical tools in the R programming software.

Figure 1. *Sample collection. Photo: Silje Leiknes.*

How light from vessels influence behaviour and distribution of pelagic organisms during the polar night

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During the polar night, scientific sampling and observations of marine organisms from research vessels are conducted under little to no natural light. However, artificial lighting is commonly used during deck and sampling operations. Many pelagic organisms in the Arctic, including fish and macrozooplankton, perform diel and seasonal vertical migrations related to the light environment. Short term perturbations, such as changes in cloud cover or a solar eclipse are known to trigger changes in their vertical distribution. Knowing this, we should expect some response to the presence of artificial light. This study aims to investigate the effect of light disturbance from a vessel on pelagic organisms during the darkness of the polar night, with a special focus on what happens around the moment the lights are turned on. We use acoustic data and trawl data collected in January 2020-22 in several fjords on the west coast of Svalbard, along with an individual-based model to explore different scenarios of how pelagic organisms react to exposure of artificial light. Our preliminary results from several light experiments show that the moment the lights were turned on, organisms started moving to greater depths. The organisms continued to keep a distance to the light source while it was on, thus temporarily changing the distribution of organisms in the area. This call into question to what degree the presence of a lit vessel biases the observations collected during these surveys.

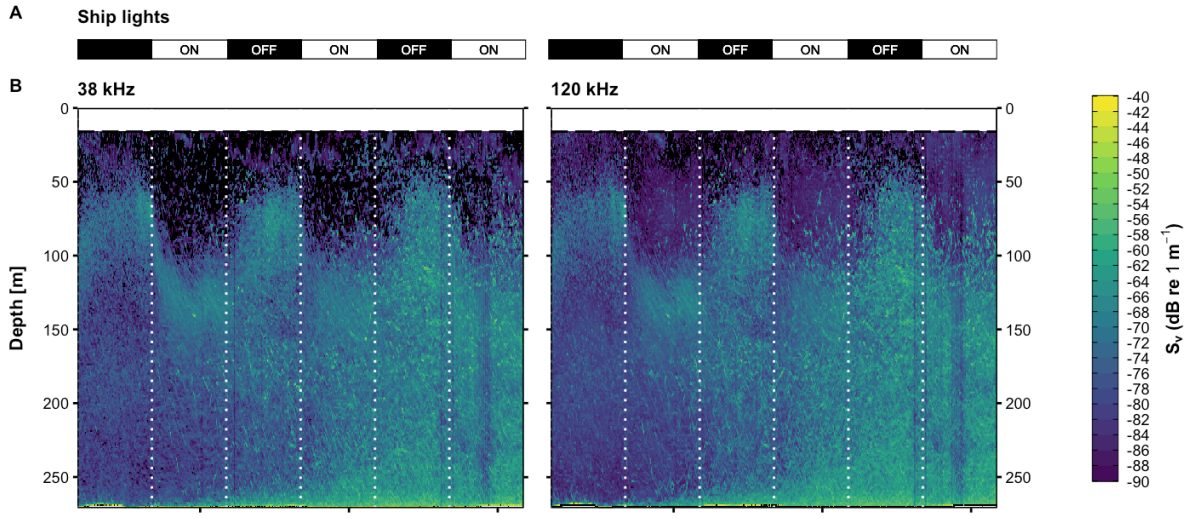

Figure 1: Echogram showing the distribution of pelagic organisms below a research vessel with the lights on and off in Isfjorden January 2022.

Talk, Tuesday 22nd Nov.

The Global Biodiversity Information Facilty (GBIF), a research infrastructure to facilitate findable, accessible, interoperable and reusable (FAIR) sharing of biodiversity data

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Availability of high-quality species occurrence data is a prerequisite for good management decisions. On average, only 20% of research data are available 20 years after a scientific paper has been published. Inaccessibility of data leads to erroneous conclusions in scientific publications and potentially poor management decisions. GBIF is a research infrastructure facilitating FAIR sharing of biodiversity data, coalescing occurrence records from multiple datasets. GBIF Norway has more than 48 million occurrence data points in 1516 datasets provided by 42 countries and 435 data publishers. Norway has a long tradition in marine research and not all marine data is shared FAIR. There is a potential for improvement to facilitate research and management of Norway's marine area of 933.028 km^2 (to the limit of the exclusive economic zone), 6375 km^2 of which have some form of protection from fishing.

Mitigation of oxygen decline in fjords by freshwater injection

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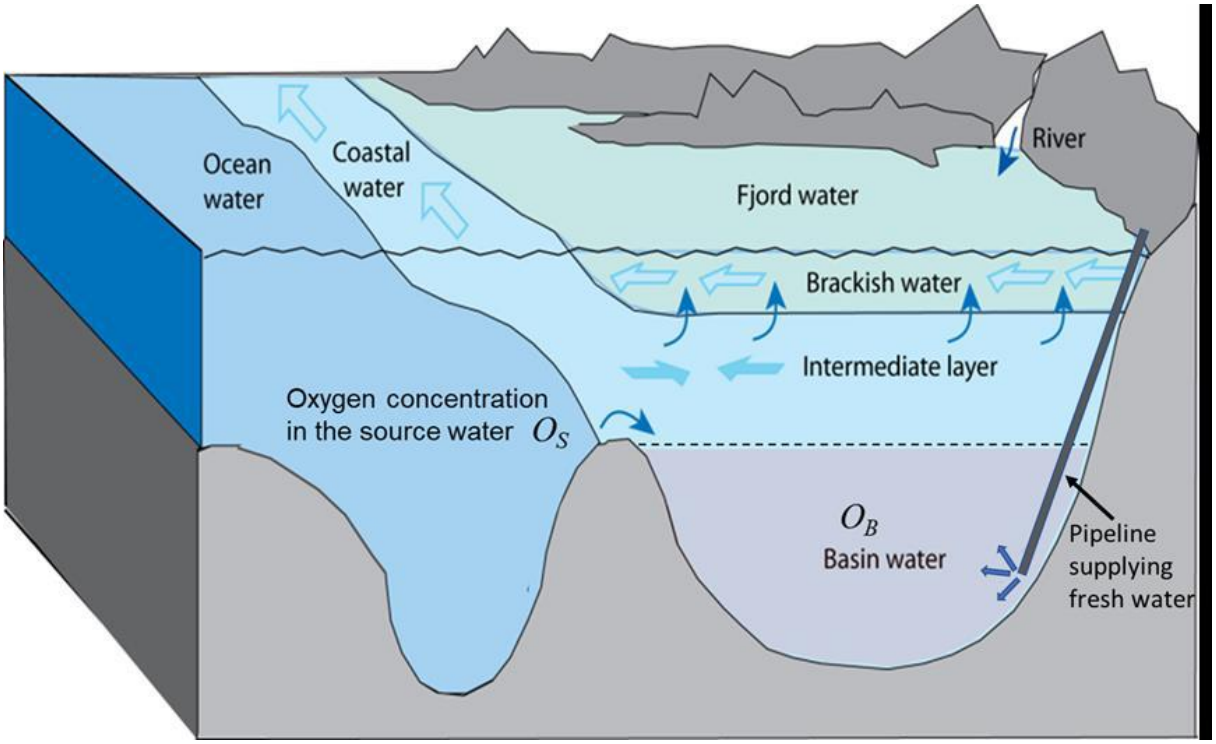
The exchange of water masses between fjords and the open ocean is commonly constrained by a topographical barrier called the sill. While fjord water located above the sill depth communicates relatively freely with oceanic water, water located below the sill depth is caught inside a volume making up the fjord basin. The water masses of this basin often become stagnant for shorter or longer periods. In these periods, the biological consumption of dissolved oxygen become larger than the supply of new oxygen and might lead to hypoxia and even anoxia and an associated darkening of the fjord basin. Such deoxygenation is natural but can be amplified by warming and human activities involving supplies of organic matter and other nutrients. Here, we use a general circulation model to explore how deoxygenation can be mitigated by injection of freshwater into the fjord basin. This causes density reduction of the basin water with subsequent water exchange and oxygenation. Our results suggest that the basin water of Masfjorden, a 480 m deep fjord with a basin volume of 4×10^9 m^3, can avoid deoxygenation with a continuous freshwater injection of 0.05 $m^3\,s^{-1}$. We conclude that injection of freshwater might serve as an efficient tool to mitigate deoxygenation of fjord basins.



The role of crawling predators in the decline and distribution of blue mussels in Norwegian coastal waters

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Blue mussels (*Mytilus* spp.) are declining in coastal areas around the world. In Norway, they thrive on floating structures, while on rocky shores they have widely disappeared. Proposed and elsewhere reliable drivers such as climate change, pollution, disease, parasites, hybridization, and failed recruitment would not discriminate between floating structures and rocks. Therefore, we hypothesize that crawling predators, unable to reach floating structures, drive the Norwegian decline. A known ferocious crawling predator without pelagic stage is the dogwhelk *Nucella lapillus*. The antifouling tributyltin (TBT) made this snail sterile but is now banned and populations are recovering rapidly. We surveyed trees hanging into seawater and floating docks together with nearby rocky shores for blue mussels and dogwhelks, and conducted a predator exclusion experiment with caged blue mussels (40-80 mm). Blue mussels were present on all floating docks (65% cover), but only on 18% of rocky shores (≤5% cover). Similarly, they were found on 83% of trees without bottom contact, but only on 1% touching the seafloor. In cages, mortality due to other factors than dogwhelks was extremely low (<1%) and confirms that blue mussels continue to thrive when out of reach from predators. Additionally, we conducted pilot experiments to assess dogwhelks' feeding and crawling potential to drive a blue mussel decline of the observed magnitude and pattern. Dogwhelks drilled and fed effectively on blue mussels of any size (up to 131 mm). They more often managed to reach blue mussels on top of branches and concrete bricks than on top of ropes and chains that usually hold floating docks in place. Muddy bays are another refugium for blue mussels in Norway, and dogwhelks needed markedly more time to reach blue mussels on mud than on sand. This tentatively suggests that Norwegian blue mussel refugia, such as floating docks and muddy bays, are out of reach from dogwhelks. Shifts in community structure towards a new ecosystem state with few blue mussels might be the result of conservation success: the recovery of dogwhelks from marine pollution.

A baseline study of demersal fish assemblages around Norway's first offshore floating wind farm site

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In the coming years Norway intends to greatly develop its offshore wind power industry. This will include the development of floating wind farms, which can be used in waters too deep for bottom-mounted turbines. Floating offshore wind farms are novel, and there are currently minimal data available about their impacts on marine ecosystems. However, it is known that both structure and disturbance from the turbines, such as noise and electromagnetism, impacts marine animals. Hywind Tampen, the first floating offshore wind farm in Norwegian waters, and the first larger offshore wind farm in the world, is currently being constructed in the North Sea. This provides a unique opportunity to investigate the effects of this type of infrastructure on marine life.

Baseline data on the local demersal fish assemblage around the Hywind Tampen site were collected from a 10-day survey in March 2022, immediately before construction began. Using a chartered commercial fishing vessel, 4 replicates of 8 gillnet fleets were set at increasing distance from the wind farm site, at 0 - 20 nmi. Fish sampling from the gillnet sets provided information on abundance and species richness, and biological information including maturity stages, stomach contents, weight, and length. Echosounder transects were also conducted to map pelagic fish distribution in the area.

Results from the baseline survey indicate that abundance and distribution of fish species varied along the transect in relation to depth, as expected. The survey also confirmed the existence of spawning grounds for commercially important demersal fish species, including cod (*Gadus morhua*) and ling (*Molva molva*), close to the wind farm site. The data from this baseline survey will be considered together with multiyear time-series of data collected from the surrounding area, available from fisheries-independent surveys and fisheries-dependent sampling. These complementary datasets, which capture patterns in species distributions and abundances at different temporal and spatial scales, will contribute to a comprehensive overview of the fish assemblage in this region before the construction of the wind farm.

The baseline data collected in this study will be crucial for detecting and understanding the effects of the new floating wind farm on the local demersal fish community. Potential effects of the floating wind farm on demersal fish include attraction of cod and other predatory species to the wind farm as a novel feeding ground. Another possibility is that noise produced by the operating turbines may deter fish from the area. A follow-up study is planned to conduct the same sampling after the wind farm is constructed, so that demersal fish abundance, species composition and distribution can be compared before and after wind farm construction.

Hva vi vet og ikke vet om effekt av havvind på fiskeriressursen

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Det er stor forventning til Havvind som fremtidig energiressurs, både nasjonalt, men ikke minst internasjonalt. EU's mål er en produksjon på 450 GW i Nordsjøen innen 2050, mens Norges plan er 4.5 GW på norsk sokkel innen 2030. Olje og gass sektoren står for 25% av Norges CO_2 utslipp, Norge har derfor også et ønske om at olje- og gassplatformer skal forsyne med strøm fra havvind i fremtiden. Hywind Tampen som er under utbygging skal forsyne Snorre- og Gullfaks-feltene med strøm, mens på trappen står Trollvind og skal gi strøm til Troll og Oseberg feltet inklusiv Kollsnes. I 2010 identifiserte Oljedirektoratet 15 mulige områder for havvind utbygging. Flere av disse områdene er også godt etablerte fiskeplasser, og det er ikke godt nok kjent hvilken konsekvens havvind kan ha for fiskeriet.

I det FHF (Fiskeri- og Havbruksnæringens Forskningsfinansiering) finansierte prosjektet «Kunnskapsinnhenting for sameksistens mellom fiskeri- og havvindnæring» skal vi sammenstille eksisterende kunnskap fra vitenskapelige arbeid og rapporter på mulige effekter og konsekvenser av havvind for fiskerinæringen - samt avdekke kunnskapshull.

Studier fra eksisterende bunnmonterte havvindparker i Europa har vist at det er mye fisk i havvindparkene, og en antar at fisk tiltrekkes parkene på grunn av strukturene («rev effekt»). Norge satser i stor grad på flytende havvind. Til nå finnes det kun en operativ flytende havvindspark, Hywind Scotland, og ingen tilgjengelige effektstudier fra flytende havvindparker. En kan antar at flytende turbiner vil tiltrekke seg fisk på samme måte som bunnsatte. Dersom fisken har høyere overlevelse og reproduksjon inne i parken enn utenfor vil en kunne få en «spill over» effekt hvor en tilfører fisk til området rundt og parkene vil ha en positiv populasjonseffekt. Er det omvendte tilfelle, dvs fisken har lavere vekst eller produksjon inne i parken enn utenfor, vil vindparken kunne fungere som et «sluk» og ha negativ populasjonseffekt. Er det kun en lokal forflytning hvor fisken klarer seg like bra i vindparken som utenfor forventer en ingen populasjonseffekt. Det kan være forskjellig for ulike arter eller livsstadier hvilke scenario som gjelder For å kunne konkludere på om havvindparkene har netto positiv eller negativ effekt på fiskepopulasjonene trenger man gode førstudier. En må vite hvordan det var før utbyggingen for å kunne si noe om det har endret seg eller ikke.

Tiltrekning av fisk samt et lavere fiskepress er faktorer som er trukket frem som mulige positive effekter av havvindparker. Når det gjelder mulige negative effekter, er støy, elektromagnetisme fra kabler, endring av bunnstruktur i forbindelse med forankring, demping av vindhastighet, sprangtrinn for fremmede arter og tilførsel av mikroplast faktorer som trekkes frem og som vi enda ikke har nok kunnskap om.

Kunnskapsinnhenting for sameksistens mellom fiskeri- og havvindnæring - Kva er relevant kunnskap frå fiskarar?

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Det er stor forventning til Havvind som framtidig energiressurs, både nasjonalt, men ikkje minst internasjonalt (EU), med ein forventa produksjon på 450 GW i Nordsjøen innan 2050. Havvind blir peikt på som ein moglegheit for Norge. I juni 2020 vart det åpna opp for at det kan søkast om konsesjon for bygging av havvind på områda Utsira Nord og Sørlege Nordsjø II. Hywind Tampen, den første flytande vindpark i Norge er under bygging på austsida av fiskebanken Tampen i Nordsjøen. Fleire område som peiker seg ut som eigna område for havvind er også godt etablerte fiskeplassar, og det er ikkje godt nok kjent kva for konsekvens havvind kan ha for fiskeria i desse områda.

Havforskningsinstituttet gjennomfører saman med Fiskeridirektoratet, Sintef, UIB og Runde Miljøsenter eit prosjekt som har som mål å kartlegge eksisterande kunnskap og erfaringar om effektar og konsekvensar av etablering av havvind for norsk fiskerinæring. Prosjektet er finansiert av FHF – (Fiskeri- og havbruksnæringens forskningsfinansiering), Fiskeridirektoratet og Havforskingsinstituttet. Aktiviteten til den norske fiskefartøy med lengde over 15 meter er godt kartlagt ved hjelp av satellitt-sporing, elektroniske fangstdagbøker og landingsdata frå fiskesalgslaga. Dette er data som Fiskeridirektorat lagrar og systematiserer slik at ein kan få god oversikt over kvar fiskeria blir drivne og kor mykje som blir fiska av ulike artar.

Desse datene gir god oversikt over dei områda der det foregårkommersielt fiske. Denne informasjonne vil gi eit godt grunnlag for å definere område der det kan bli konflikt mellom fiskeriaktivitet og vindkraftutbygging. Havforskingsinstituttet har samtal mykje informasjon om gyte og leveområde til dei fleste av fiskeartane i norske farvatn. Til tross for dette er der ein del artar som ikkje er godt beskrivne. Fiskerane har ein del informasjon som kan belyse dette. Dette gjeld til dømes lange og brosme og ein del artar som ikkje er av dei mest kommersielt viktige. Leveområda og gyteområda til ein del artar som er særleg viktig i næringskjeda og dermed økosystemet i havet er lite kjendt. Eit døme på ein desse artane er havsil (tobis) (*Ammodytes marinus*). Den er sterkt knytt til sandholdig sediment. Slike område er det svært mange av i norskefarvatn, men dei er lite kartlagd. Ved hjelp av detaljerte sedimentkart (marine grunnkart), kart frå Mareano prosjektet og informasjon frå fiskarar er ein i stand til å kartlegge leveområde og gyteområde for denne viktige «nøkkelarten».I intervju med fiskarane er det fokus på å samle inn den erfaringsbaserte informasjonen som fiskarane har opparbeidd seg.

- Fiskemønster
- Målart
- Fangstsamansetning på ulike felt og djupner
- Leveområde og gyteområde for ulike fiskeslag
- Botntilhøve, sand, korall,
- Vrak, stein og andre hindringar
- Straum
- Erfaringar med fiske rundt faststående installasjonar, slik som oljeplattformer etc.
- Data frå skipperane sine eigne plotterar
- Innspel om korleis vindanlegga kan best mogleg tilpassast til fiskeriaktiviteten i eit område.

Resultat frå undersøkingane har vist at mange skipperar har svært god og detaljert informasjon om fiskeoperasjonane sine. Denne informasjonen er eit viktig tilskot til kunnskapsgrunnlaget som er under utvikling for sameksistens mellom fiskeri- og havvindnæring.

Towards a separate management regime for coastal shrimp (*Pandalus borealis*) in Northern Norway

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Coastal fisheries for northern shrimp (Pandalus borealis) include commercially important inshore populations north of 62°N in Norway that are considered part of the Barents Sea management unit (NAFO & ICES, 2020). Inshore shrimp populations face distinct anthropogenic disturbances (Bechmann et al., 2020) and populations apart from Finnmark are genetically closely linked to the Skagerrak-Norwegian deep stock. Clear genetic differences between coastal shrimp in Northern Norway and the Barents Sea stock suggest the importance of separate management. Fjord environments differ in bottom temperature and topography which could influence population structure. Managing shrimp populations of different dynamics in the same management unit may risk overfishing or fishing below sustainable yield in less productive and more productive fjords respectively. A detailed assessment on northern shrimp in coastal Norway north of 62°N have not been previously done and the lack of knowledge lead to unprecise management. This thesis describes the effectiveness of scientific surveys to be used for stock assessment and give an overview of the management potential for northern shrimp in fjords in Northern Norway. To differentiate potential management units, by population structure and estimated survey indices, time series from electronic logbooks (ERS) and scientific surveys was used. In addition to fisheries data, there are four datasets from scientific surveys available that include relevant data on shrimps in Northern Norway. All of the datasets intersect in the Kvænangen/Reisafjorden area, which was therefore selected as focus area to compare trends and evaluate their usefulness as stock indices. For Kvænangen/Reisafjorden, data from all scientific surveys were integrated to estimate density- and length-based stock indices, comparing different mixed effect modelling approaches. The main results showed that the Coastal survey had a disruptive effect on abundance and length indices and may not be sufficient to be used in management of coastal shrimp. Length indices varied significantly between the Coastal survey and the other surveys, while the other surveys had non-significant differences. Populations in Northern Norway should be managed by four main units: Altafjorden, Balsfjorden, Malangen and Porsangerfjorden; Kvænangen, Reisafjorden, Lyngen and Ullsfjorden; Laksefjorden and Tanafjorden; Varangerfjorden.

Kartlegging av sårbar natur ved hjelp av Marine Grunnkart og en lavkostnads ROV

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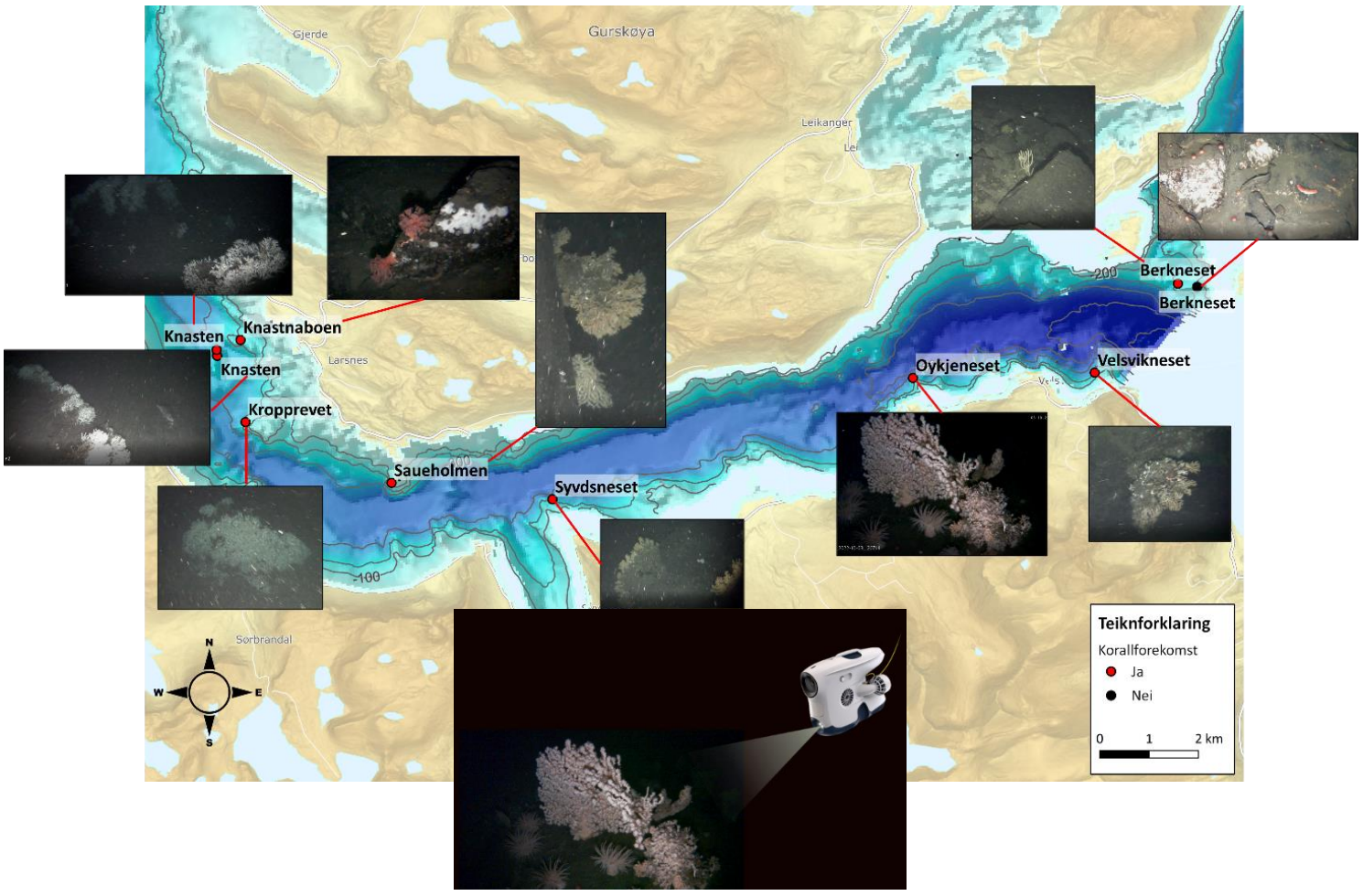
Næringen i Møre og Romsdal er sentrert rundt marine industrier som fiskeri, akvakultur og skipsfart. Økt satsing på marine industrier fører til konkurranse om ledig havareal og mer press på naturmangfoldet i disse områdene. En bærekraftig forvaltning av de marine økosystemene er avhengig av et godt kunnskapsgrunnlag for å kunne opprettholde god tilstand i fjordene. Derfor er første steg å finne ut hvilket naturmangfold somfinnes i fjordene, og hvor det befinner seg. Koraller danner naturtyper som er hotspots for biodiversitet og er viktige leveområder blant annet ungfisk og evertebrater. Møre og Romsdal har mange korallregistreringer, men i Søre Sunnmøre var det få registrerte funn. Var dette på grunn av mangel på undersøkelser, eller var området uegnet for korall? Ved hjelp av detaljerte Marine Grunnkart og en innleid BluEye ROV gjorde vi ti stikkprøver på åtte lokaliteter som stakk seg ut som områder som egnet seg for koraller basert på batymetri- og sedimentkart. Korallforekomster ble observert på alle lokalitetene, og på ni av ti transekter. Dette funnet understreker viktigheten av kartlegging av våre fjorder, og gir forvaltningen viktig informasjon for framtidig beslutningstaking slik at en på best mulig måte kan forvalte ressursene i fjordene på en bærekraftig måte.



Behavior of Ballan wrasse (*Labrus bergylta*), and Corkwing wrasse (*Symphodus melops*) in a restored urban ecosystem

Catharina Olsen

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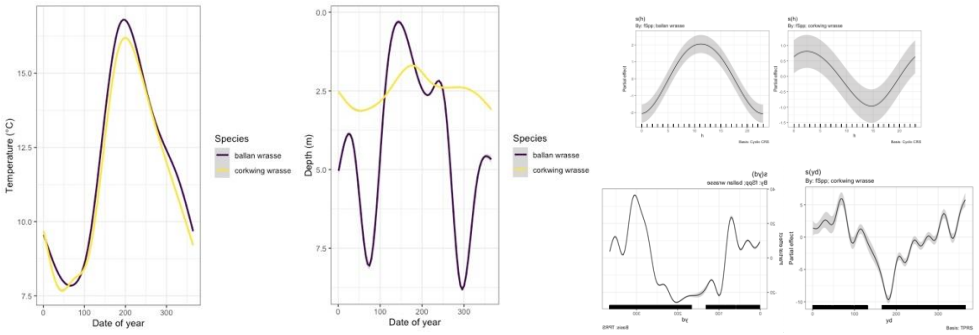
With a rising connection between humans and the ocean, an increase in urban ecosystems follows. One of the problems regarding urban habitats in contrast to natural, is the number of pollutions introduced. The Bergen city centre fjord is an urban ecosystem, extremely influences by human activities. Here the seabed is highly polluted by heavy metals (PCB7 and PAH16) and organic pollutants, which is considered threatening with negative influences on both the marine ecosystem and human health. Consequently, the city centre fjord has undergone a habitat restoration where a proportion of the seafloor has been covered by masses to reduce the effect of polluted marine substrate, in addition to a restoration planned for Store Lungegårdsvannet in 2023. This study aims to understand how the two species of wrasse (*Labrus bergylta* and *Symphodus melops*) use the habitat in both the restored and unrestored urban ocean and review the effect of the ongoing restoration process. This is done by looking at the species vertical behaviour using acoustic telemetry. The results will be actively used by the local municipality to plan future restoration activity that is planned in the remaining unrestored areas, by providing information on when wrasse is most sensitive to disturbance by sea floor covering. Acoustic tracking data were collected in May 2022 and analysed to investigate questions about the movement ecology of the wrasse species. Generalized additive models was used to understand the depth and temperature use of the two species over the course of nearly one year of tracking. The results showed that Ballan wrasse and Corkwing wrasse use the habitat in the Bergen city centre fjord differently. *L. bergylta* has a higher temperature range than *S. melops*, and their depth range differ considerably ($P < 2e\text{-}16$), where *S. melops* is located at shallower depths. A possible explanation for this phenomenon is that with small differences in their niche, it is possible for coexistence of two similar species. Time of hibernation is still a research question to be revealed in this study, but it is clear that it exists.



Is the Invasive Round Goby Introduced to the Oslo Fjord?

Lars Martin Myhre
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Over the last 150 years, various human activities have altered or weakened ecological barriers. In marine environments the most damaging activity is the ever-increasing, global commercial fleet. By passively transporting species through ballast water or biofouling, the commercial fleet has created pathways across ecological barriers. A species that has dispersed far from its natural range in the Black and Caspian seas through the commercial fleet, is the round goby (*Neogobius melanostomus* Pallas, 1814). As it has been present in Gothenburg, Sweden since 2010, it is expected to arrive in Norwegian ecosystems soon. Although the ecological impact from round gobies is difficult to predict, there are species native to Norway with overlapping niches, and benthic invertebrate taxa that potentially will be negatively impacted by the increased predation pressure. It is therefore of interest to detect the round goby early to limit its dispersal, and to early on map out ecological impacts. This study aimed to investigate a potential introduction of the round goby in the Oslo Fjord. Through fishing campaigns in September 2021 and August 2022, we attempted to verify its presence by catching round gobies. As newly introduced species tend to be of low abundance and patchy distributed, we also implemented eDNA-sampling to further build upon the notion that the method is an asset for detection and monitoring of invasive species. As a positive control both methods were tested in Gothenburg, where populations of round goby are well-established.

As expected from other literature we proved that both methods can be implemented to detect round gobies. We found however that eDNA-sampling was more efficient at detecting round gobies than fishing methods, as we only caught the fish at three out of five stations in Gothenburg. More importantly our eDNA results showed weak positive signals in four out of eight stations in the Oslo Fjord. This suggests that the round goby is introduced to the Oslo Fjord, but with significantly lower abundance than in Gothenburg. We did not manage to visually detect the invasive species, even during our second fishing campaign where fishing efforts around two of the positive stations were tremendously increased.

We hope that our findings can be applied to other investigative attempts in the Oslo Fjord to focus more fishing efforts at the positive tested stations. More eDNA-sampling should however be collected to help locating the alleged round goby populations.

Macroalgal biodiversity and biomass of Kongsfjorden through time and space.

L. Düsedau, **S. Fredriksen,** M. Brand, A. Savoie, S. Jungblut, M. Molis, J. Niklass, C. Buschbaum, K. Bischof, I. Bartsch.

Macroalgae are major primary producers along the rocky shores of the Arctic. With Svalbard being a hot spot of global warming, the overall retreat of the yearly ice cover and change of associated environmental drivers alter the light availability for the macroalgae. In a study comparing results from Hansneset in Kongsfjorden from 1996/98, 2012/2013 and 2021 we found that the depth distribution of kelp species decreased over time. *Alaria esculenta* is now more common in shallow waters and *Saccharina latissima* has moved upward and are now totally missing at greater depths. Digitate kelp (*Laminaria digitata* and *Hedophyllum nigripes*) show the same reduction in maximal depth distribution. At the same time macroalgal biomass is reduced in greater depths. The sediment plumes from melt water runoff, increasing the turbidity of the water, are the most obvious explanation for the observed changes in the depth distribution. In the intertidal zone benthic algae have become more abundant due to the reduction in ice scouring and elongation of open water periods.

Use of stereo baited remote underwater video (stereo-BRUVs) systems to assess the occurrence and abundance of wild benthic fish species and macroinvertebrates at aquaculture sites

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Several studies have shown that sea-based aquaculture sites attract a range of wild marine species (Barrett et al. 2019). These species can either be attracted to the shelter provided by the marine infrastructure, or to wastes coming out of the fish farm (feed or excrements). If an artificial habitat (such as a fish farm), that is brought into a natural environment, attracts animals, it might disrupt these species natural behavior. For instance, the animals may prefer the artificial habitat over the natural one, even if this means that it leads to impaired reproduction, altered body conditions and reduced survival (Dempster et al. 2011, Tanner & Williams 2015a). The existence of such ecological traps has been well documented in terrestrial systems, however, the studies on ecological traps in the marine environment is limited.

Previous studies on the interaction between intensive aquaculture and wild fish have been very much focused on pelagic species occurring in immediate proximity to the net pens (Dempster et al. 2009,). Less is known regarding the influence of aquaculture on the occurrence of benthic fish and other motile organism, living on and shortly above the benthos in such locations. The results presented is part of a PhD-project that aims to study the effect of aquaculture demersal fish and motile macroinvertebrates living in deeper waters beneath fish farms.

In the study stereo baited remote underwater videos systems (stereo-BRUV) were used, which consisted of a metal frame with two cameras, lights and a bait container. A total of 40 BRUV deployments were conducted, covering 10 aquaculture locations in Storfjorden and Romsdalsfjorden in Møre and Romsdal county. The videos were taken both at farms with ongoing production and farms that had had a fallow period of minimum 2 months (empty sea cages). For all aquaculture locations control recordings were taken in nearby areas uninfluenced by fish farm activities. BRUVs were lowered onto the seabed (max. 200 m) and recorded for 60 minutes.

Data was collected from all sites starting in November 2021 and over the course of the year 2022. This intended to provide an overview of the differences between sites, changes within the seasons (summer/winter), and the effect of production vs. no production. The video recordings from the field studies, were analyzed to describe the occurrence and species composition, as well as to quantify the abundance of fish. As a measure of presence of fish, the parameter “time to the first appearance of finfish” was used. Preliminary results will be edited and presented on the poster during the Havforskarmøte.

Keywords: Aquaculture environment interaction, BRUV, demersal fish, macroinvertebrates

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Tau og tare

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Eg skal stille ut ein poster (på engelsk) om masteroppgåva mi. Oppgåva er basert på praksisplass hos Lerøy si avdeling Ocean Forest. Eg skal gjennom praksis, og i oppgåva sjå på korleis ein kan gjere produksjonen meir berekraftig med å bytte ut tauet dei brukar i dagens produksjon.

Oppgåva kjem til å ha tre hovuddelar:

1. Eg skal måle vekst på ulike typar tau, med å bruke utvikling av dekningsgrad i prosent. Dersom taren ikkje veks på eit tau er det ikkje vits å bruke i produksjonen.
2. Eg skal måle brotstyrken på dei ulike tua, for å finne kva tau som går i oppløysing i passeleg tid med tanke på hausting.
3. Det skal bli gjort ei berekraftsanalyse av dei ulike taua. Det vil ikkje bli gjort ein full LCA, men ønske er å dra inn nokre tankar og metodar frå LCA.

The Biological Potential of Bycatch Species in Norwegian Fisheries

Biologisk potensiale for utnyttelse av bifangstarter i norske fiskerier

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For my masters project, I am looking at bycatch species in Norwegian fisheries and investigating their biological potential. I am using data from the Norwegian Reference Fleet, a joint project between the Norwegian fishing fleet and the Institute of Marine Research. The Norwegian Reference Fleet provides information about catches and general fishing activity to the Institute of Marine Research to support stock assessments with additional biological data including fishing effort, catch composition and bycatches.

My analysis focuses on four species that are regularly caught as bycatch but do not currently have much market value and are not commercially exploited: the American plaice (*Hippoglossoides platessoides*), the Norway redfish (*Sebastes viviparus*), the Grey gurnard (*Eutrigla gurnardus*) and the Megrim sole (*Lepidorhombus whiffiagonis*). I will describe the trends seen in the catch data from the Norwegian Reference Fleet and also try and estimate the abundance of these bycatch species. Further I will examine the market value of the species and whether they have commercial value internationally.

In addition, I am hoping to conduct a qualitative study interviewing Norwegian fishers who are part of the Norwegian Reference Fleet to get a better understanding of the bycatch species and their behaviour towards fishing gear, as well as the fisher's views on the Norwegian market and the potential of bycatch species.

A comparison of microparasite surveillance approaches among Norwegian aquacultural sites

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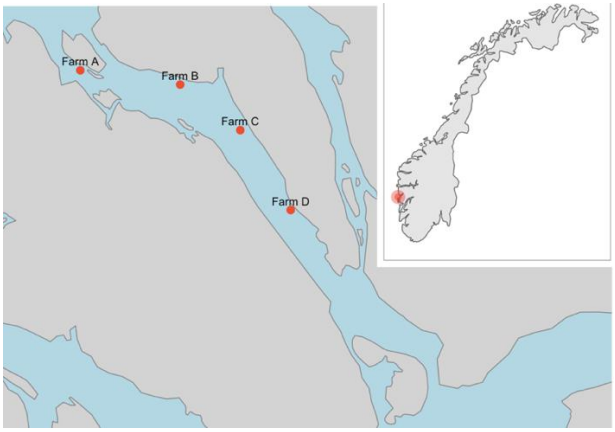
Open aquaculture production in Norway is a multi-billion kroner industry and grows bigger and more advanced every year. Infectious diseases are a well-known challenge in salmon aquaculture, accounting for substantial costs to the industry and rising concerns regarding the impact on wild fish populations, which can also become infected. The surveillance of fish diseases is currently done periodically of farmed fish and in occurrence of high mortality, which could cause the pathogens to spread before even detected. An early detection could be a solution to reduce disease spread and the protection of wild fish.
Environmental DNA/RNA, genetic material sampled from the environment, is emerging as an effective tool for the surveillance of pathogenic bacteria, virus and protists.
In collaboration with members of the PATHDNA project, I aim to investigate the effectiveness of eDNA monitoring for a diversity of important pathogen species on seawater and tissue samples from four rainbow trout farms in Vestland, Norway. I collected a total of 144 5L filtered seawater samples and 44 gill tissue samples in respectively May and September, representing multiple levels of spatial, temporal, and technical replication. After extracting total nucleic acids from all gill and filter samples, I will test the samples for a diverse group of 40 pathogen species using qPCR. I will utilize site occupancy models with measured environmental covariates to model the detection probability and spatial distribution for each pathogen species that is detected. This work will help to shed light on the influence of natural and production-specific habitat variation on the distribution and probability of detection for a diverse group of economically and ecologically important pathogen species as well as how best to allocate sampling effort to account for imperfect detection of different pathogen species.



How to succeed in habitat restoration – linking restoration success to habitat characteristics, environmental conditions, pressures and restoration method

Trine Bekkby[1*] T, Guri Sogn Andersen[1], Hazel Thornton[2], Sara Pruckner[2], Chris McOwen[2], Nadia Papadopoulou[3]
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[2] UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), UK
[3] Hellenic Centre for Marine Research (HCMR), Greece

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Global change and anthropogenic impacts (such as farming, fisheries, coastal development and industrial exploitation of marine resources) have a major impact on the global biosphere. Human pressures on marine ecosystems are expected to increase considerably in the next decades, leading to loss of marine biodiversity and degradation of ecosystem functioning and service provision. In an attempt to slow down or stop the degradation within European seas, the EU Biodiversity Strategy 2020 aimed to restore degraded ecosystems, in accordance with the 2010 Aichi targets and the UN 2030 Agenda for Sustainable Development (A/RES/70/1). It has been demonstrated that optimal conservation outcomes can be achieved through the restoration of degraded habitats, as habitat loss and degradation are important causes of populations' collapse, species decline and extinction in marine ecosystems. However, the degree of success in habitat restoration is highly variable. This variation is linked to an uncertainty in the relationship between habitat characteristics, the level and type of pressures, the restoration methods used and the restoration success. This again hampers the progress towards important aims and targets. If we are to reverse the trend of habitat loss and degradation, European countries need to develop a better understanding of the consequences of interactions between ecosystem attributes and multiple pressures. The EU (Horizon 2020) funded MERCES project (Marine Ecosystem in Changing European Seas) therefore focused on the restoration of different degraded marine habitats across Europe, with the aim to support informed decision making for future restoration efforts. A set of experts discussed biological and ecological features (such as life-history traits, population connectivity, spatial distribution, structural complexity and the potential for regime shifts) and their contribution to the successful accomplishment of habitat restoration. The aim of this presentation is to show the results from this discussion and show the results from a more empirical and numerical approach to identify factors that enhance the likelihood for habitat restoration success. The project includes restoration of different marine habitats at 128 sites distributed across 12 European countries. Data from each restoration case study site can be downloaded from the MERCES Story Map site. Our focus was on seagrass meadows, macroalgae beds, seamounts, coralligenous assemblages and kelp forests.

Talk, Wednesday 23rd Nov.

Eelgrass restoration in the inner Oslo Fjord – a pilot project for Oslo municipality

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Eelgrass beds are an important marine nature type that host high biodiversity, store carbon, and function as a nature-based solution for climate adaptation. There has been a reduction in the distribution and condition of eelgrass meadows in the inner Oslofjord in recent years, probably due to increased sea temperature, eutrophication, overfishing, coastal darkening, and coastal zone development. There are no known occurrences of eelgrass within the boundaries of Oslo municipality today.
In this talk, I will present an ongoing pilot project to test if eelgrass beds can be restored in coastal areas within Oslo municipality. In June 2022, we transplanted eelgrass from a large eelgrass bed in Bærum to three test sites in Oslo. During the past months, we have monitored the growth and condition of the eelgrass and the environmental conditions in the areas (light, temperature, sediment type). The preliminary results indicate that the plants are surviving and growing in some of the test sites, but survival during the winter months will be critical to assess whether the sites are favorable for large-scale restoration efforts. Restoration of eelgrass beds would have potential positive effects for marine ecosystems, carbon storage and climate adaptation in the inner Oslo fjord, but would require long-term monitoring of the eelgrass and management of boating and other human activities.

Restaurering av tare sammenliknet med naturlig tilbakekomst av tareskog; økologiske og arealmessige perspektiver.

Kelp restoration compared to naturally kelp recovery; ecological and spatial perspectives.

Hartvig Christie[1], Camilla W Fagerli[1], Eli Rinde[1], Hans Kristian Strand[2]
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Siden 1988 har vi gjort flere forsøk med restaurering av nedbeitet tare i Midt- og Nord-Norge ved å ekskludere kråkeboller. Tareskogen kommer raskt tilbake av seg selv når beitetrykket fra kråkebollene blir tilstrekkelig lavt. Slike tiltak har foregått i liten skala både i rom og i tid, og suksessen har vært kortvarig siden kråkebollene har kommet tilbake uten oppfølgende tiltak. Kråkebolleørkenen i Porsanger representerer imidlertid et unntak. Der ble kråkebollene fjernet med brent kalk på et 70 hektar stort område. Økt predasjonstrykk fra kongekrabbe har sammen med kalkbehandlingen bidratt til å holde beitetrykket fra kråkebollene nede og sørget for varig gjenvekst av tareskog. Langs kysten fra Trøndelag og nordover til Harstad-området har tareskogen (stortare og sukkertare) gradvis kommet tilbake uten aktiv restaurering, ettersom en økt forekomst av taskekrabber har redusert kråkebolle-populasjonene. Arealene med naturlig tilbakekomst av tareskog er anslått til mange hundre kvadratkilometer og tilbakekomsten synes å være varig. Tilsvarende tilbakekomst av tareskog skjer også naturlig på stor romlig (rundt 100 km^2) og tidsmessig skala (foreløpig 10 år) i noen fjorder i Øst-Finnmark knyttet til en økning av populasjonen av kongekrabbe som predator. I Sør-Norge har det siden tidlig på 2000-tallet vært utført småskala eksperimenter for å restaurere sukkertare, uten langvarig suksess. Langtids (13 år) overvåking på 12 stasjoner viser at sukkertaren også her har evne til å komme tilbake, sannsynligvis når forholdene har vært gunstige. For å få tilbake tareskog er det viktig at vi tar lærdom av de erfarte kunnskaper om økologiske forutsetninger for at tareskog skal kunne restitueres i større omfang. Denne kunnskapen bør også brukes til å veilede småskala initiativer.

Hanging gardens - do floating kelp farm communities resemble natural kelp forests?

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The interest in seaweed cultivation is increasing globally, which requires knowledge of the potential effect of seaweed production on the marine environment, both negative and positive. We therefore wanted to study the fauna communities found in a kelp farm and compare these with what is found in natural kelp forests with the aim of finding out if a kelp farm ecosystem resembles that of natural kelp forests. The field work was conducted in north-western Norway, just before the kelp was harvested in the spring. Fauna traps were deployed and kelp plants scraped in the kelp farm (both in the sugar kelp, *Saccharina latissima*, and the winged kelp, *Alaria esculenta*, part), in natural sugar kelp, winged kelp and tangle kelp (*Laminaria hyperborea*) forests and in the water masses. The potential effect of the duration of the growth period of the farmed sugar kelp on the associated community was also analysed. The study shows that a kelp farm has lower taxa richness and fewer individuals than natural kelp forests, but indicates that the farm still has an ecological function as a habitat. However, the communities in the farm are more similar to the natural kelp forest surrounding the farm than with the natural kelp forest of similar species. In the autumn, after the kelp was harvested, the communities changed, and the alien Japanese skeleton shrimp *Caprella mutica* appeared in high abundance. The result from this study contributes with important knowledge of kelp farms ecological role in the marine environment, which is important both for today's management and for the planned growth of the industry.

BOATS - Tracking cod, wrasse and lobsters in Bergen city center

Knut Wiik Vollset[1], **Saron Berhe**[1], Elena Rusetskaya[1], Cecilie Nilsen[1], Lotte Svengård Dahlmo[1], Robert Lennox[1,3]

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Acoustic telemetry is a tool that is used to track aquatic animals around the world. It involves physically capturing and operating a battery driven transmitter into the fish, and then tracking its behavior by a network of hydrophones (i.e. receivers) that can decode the information sent from the transmitter. As part of our infrastructure with over 120 receivers in and around Bergen tracking different aquatic species, we have established the BOATS telemetry array (short for Bergen Ocean Acoustic Tracking System), a network of around twenty receivers around Store Lungegårsvann, Vågen and Puddefjorden in collaboration with Bergen kommune. The goal is to use this local array to track the behavior of cod, wrasse and lobsters during a period of 3 years to study how these species are impacted by the ongoing marine sea floor restoration, river restoration in Møllendal and the sea front restoration in Store Lungegårdsvatn.Or aim for this project is to document how they are impacted before, during, and after the process of restoring the urban fjord areas, and give concrete advice on how to best conserve and further develop the ecosystem services these species provide. This involves taking samples of aquatic species to measure mercury levels and tagging and tracking the species to inform Bergen kommune about how to minimize impact on aquatic organisms and their habitat and facilitate the succession of thriving urban ecosystems in the years to come.

80 years of changes: insights from a long-term time series of Norwegian eelgrass

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Seagrass meadows provide numerous ecosystem services (carbon storage, coastal protection, habitat provisioning) and support high associated biodiversity. Globally, seagrass meadows have experienced a general decline over the last century. However, there is high variability in seagrass status and health between regions and between meadows, and recent positive trends towards recovery have been observed in several areas. Understanding the environmental and anthropogenic factors that drive both decline and recovery can inform more effective management and conservation efforts for these critical ecosystems.

Here, we explored a unique dataset following eelgrass (*Zostera marina*) cover over 80 years in 67 sites along the Norwegian Skagerrak coast. We found that, following losses due to eelgrass wasting disease in the 1930s, eelgrass populations recovered and stabilised until the 1980s, when there was a general decline. Like in many other parts of northern Europe, this decline was likely due to high nutrient loads. However, following this, trends diverged in different areas. Eelgrass populations in the coastal Skagerrak recovered and are continuing to increase, while populations in the inner and outer Oslofjord continue to decline. We link these differing trends to natural and anthropogenic environmental conditions, such as temperature, salinity, exposure, human population, fisheries, and nutrients. Understanding the factors that allow for natural recovery of degraded eelgrass meadows have important implications for management and restoration efforts, as well as furthering our understanding of the drivers that promote the resilience of seagrass communities to environmental change.

Mapping and monitoring of seagrass meadows in a small, defined area

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Eelgrass and other seagrass meadows are important habitats due to their high primary production and because they provide several different ecosystem functions, like foraging areas, spawning surfaces and shelter for numerous marine animals (including commercially important fish species). In addition the nature type improves water quality, oxygenates the seabed and binds bottom sediments. In Norway the eelgrass meadow is considered viable but still needs protecting due to its value for the ecosystem. There is international agreement on the importance of, and it is on OSPARs list of threatened nature types. Even though eelgrass seems to be doing quite well in most parts of Norway it is vulnerable to human intervention, climate change and eutrophication, among other things.
This year we have reviewed literature, tested methods, and started the mapping of seagrass meadows in a small, defined area. The work will continue next year and we hope to help cover some of the knowledge gaps in the field, while also increasing local knowledge. We found seagrass meadows both where a national mapping of eelgrass reported a meadow, and in an area where no meadow was previously found. We also found a meadow most likely consisting of another species than the most common, *Zostera marina*. In the continuation of the project we plan to more precisely measure size and other ecological parameters and to also have the tools to investigate the maximum growth depth. In addition we aim to increase knowledge on seasonal and annual variability by monitoring some selected meadows over time, and increase knowledge on less investigated species of sea grass.

Bit for bit - tap for tap. Om fysiske påvirkninger i Oslofjorden.

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Oslofjorden – En terskelfjord som har alle muligheter til å by på stor artsdiversitet og rike økosystemer. Når vi ser riktig langt tilbake i tid var det et myldrende og rikt liv i fjorden uten så stor påvirkning fra oss mennesker.

Hverdagen for artene i Oslofjorden i dag er en helt annen. Det går ikke en eneste dag uten at en bit av Oslofjorden påvirkes, enten det er byggesaker i strandsonen eller større prosjekter som utfyllinger av overskuddsmasser fra tunneler til molo, større landareal eller spenstige planer om friluftsøyer, eksempelvis Lysakerfjorden. Videre er det utbygging av marinaer, behov for mudring, utvidelse av havner- dypere og bredere – som fører til deponering av forurensede masser et annet sted, eks Borg havn. Godt kjent er også planene om ny farled og ønske om å fjerne deler av sjeteen ved Drøbak.

Artene i fjorden taper hver dag – Det er tap av leveområder, tap av beskyttelse, tap av robuste økosystem – tap av artsrikdom og tap av enkeltarter. Bit for bit taper biomangfoldet.
Store deler av hverdagen i Oslofjordens Friluftsråd er å skrive høringsuttalelser til kommuneplaner, reguleringsplaner, innspill og protester på fysiske inngrep i Oslofjorden. OF savner det regionale perspektivet og at helheten av alle bit for bit forstyrrelsene oppdages av politikere, byggesaksbehandlere og planleggere. Dispensasjoner fra Plan og bygningsloven kan ikke fortsette å være regelen, men heller de få unntak for at Oslofjorden ikke skal fortsette å tape.

Positive skritt i riktig retning er Helhetlig plan for Oslofjorden og etablering av arealvern som for eksempel våre marine nasjonalparker, sjøfugl- og hummerreservater!

Oslofjordens Friluftsråd og Citizens Science for Oslofjorden

Henning Røed

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Oslofjordens Friluftsråd (OF) har i snart 90 år arbeidet for å sikre allmennhetens adgang til bruk av Oslofjorden, samt arbeidet aktivt for at fjorden skal bevares som en ren og rik fjord for kommende generasjoner.

Som en del av dette arbeidet har OF sammen med paraplyorganisasjonen Norsk Friluftsliv tatt initiativ til å samle frilufts- og miljøorganisasjoner i noe vi vil kalle et Nettverk for Oslofjorden. Som en del av dette har vi i OF en ide om å engasjere de som bryr seg om Oslofjorden og nærmeste områder i et Citizens Science prosjekt.

For at dette også skal kunne være interessant for forskere har vi tanker om en rekke arter/ting som folk langs fjorden kan være med på å registrere. Vi ønsker selvfølgelig også hvis mulig å gjør dette i samarbeid med Hi og andre forskningsinstitusjoner.

Vi vil lansere noen av de elementene vi kan tenke oss å mobilisere folk til å være med på. Dette for blant annet å kunne få tanker, forslag og kommentarer fra deltagerne på møtet. Hvilke arter er interessante, og hva er ellers mulig å gjøre, som kan bidra til en levende fjord og god forskning.

Phytoplankton community dynamics and possible changes in the spring bloom due to climate changes. A study based on a century long time series from the Oslofjorden.

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The environmental status of the pelagic waters of inner Oslofjorden has improved significantly during the last 50 years after the implementation of sewage cleaning technology. A long time series of phytoplankton data with related environmental data was compiled in this project and made it possible to study the long-term effects of the increase and subsequently the reduction in nutrient supply. We found that phytoplankton abundances increased with eutrophication during the first part of the time series. Then a decrease in phytoplankton abundance followed the decline in nutrient releases. Despite the changes in nutrient input, the phytoplankton community's phenology and composition have remained rather constant over the last century. However, the blooms' levels and timing have changed, especially the spring blooms. We find that increased SST during winter and spring may be one important driver for this change. In the outer Oslofjorden, there is a similar reduction in the spring bloom amplitude, despite minor changes in the levels of nutrients. With global warming, it is predicted by IPCC that the net primary productivity of phytoplankton will “very likely” decline in the future due to increased temperature and stratification, changes in light and nutrient availability, and increased predation.

Towards scalable benthic characterization using bottom-following imaging drifters

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Collecting high-quality georeferenced optical imagery of the seafloor plays a key role in interpreting and ground-truthing broadscale remote sensing data. Traditional techniques to collect such imagery offer combinations of quality, coverage rate and cost that often lead to undersampling and/or highly correlated observations. With initiatives like Seabed 2030, we are likely to acoustically map most of the world's seafloor in the coming years. However, our current approaches to optical imaging to characterize benthic cover will not scale to such extents.

We present an approach to collecting georeferenced seafloor imagery that has the potential to address large scale mapping challenges in a cost-effective manner. This approach hinges on using multiple small, simple bottom-following (i.e. constant altitude) imaging drifters on many short deployments. Their design restricts mission profiles to specifying a desired imaging altitude and bottom time, which significantly simplifies operations and training of operators. These drifters can be operated from smaller vessels or while multibeam mapping, which increases ship utilization. The relatively low platform cost allows for using several simultaneously which provides a degree of robustness to the loss of one or more of these assets. Future iterations of this approach will be deployable by uncrewed surface vessels, further reducing operating costs and enabling systematic visual sampling of large extents of seafloor.

These minimal platforms represent the observations-gathering component of an automated system running on the surface vessel. Starting with remote sensing data it adaptively selects target locations to deploy the imaging drifters. The observations from the drifters are fed into a predictive habitat model with uncertainty estimates that provide areas of high-value for further sampling. The drift of the platforms is also used by the system to estimate the local current field and improve the targeting ability of the following dives.

We present the components of this system and results from adaptive sampling deployments around a temperate rocky reef near Port Hacking, NSW, Australia. We also present preliminary results from a deployment on Tautra reef in Trondheim Fjord, Norway, where the ability to operate in strong currents present in fjords can complement other forms of benthic imaging.