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Masteroppgåver ved Havforskingsinstituttet f.o.m. V2022

Possible master theses at the Institute of Marine Research, from S2022

NB! Det må etablerast kontakt med ein internrettleiar ved universitetet så snart som mogleg i dei tilfelle det ikkje allereie er angitt.
Contact must be established with an internal supervisor at the university as soon as possible in cases where it is not already stated.

FG Bentiske ressurser og prosesser – Benthic resources and processes

Contact person: Carsten Hvingel (carsten.hvingel@hi.no)

Bestandsdynamikk av kystreke: analyse av tidsserier og utvikling av bestandsindekser

Kystpopulasjoner av dypvannsreke er viktig for kystfisket i Nord-Norge, men fiskeriet er stort sett uregulert. Bestanden er påvirket av både klimaendringer og menneskelige aktiviteter i kystsonen. Likevel vet vi veldig lite om endringer over tid og underliggende faktorer. For å forbedre kunnskapen vår om bestanden og dermed også rådgivingen og forvaltningen, vil vi på HI utforske bestående tidsserier for å 1) analysere historiske endringer i bestanden og 2) utvikle bestandsindekser som kan brukes til bestandsvurdering og forvaltning. Som masterkandidat vil du bidra til dette ved å sammenstille og analysere tilgjengelige data, produsere bestandsindekser og teste dem i bestands-vurderingsmodeller for å vurdere hvor nyttige de er for fremtidig rådgivning. Det vil være muligheter for kandidaten å delta i relevant feltarbeid.
Kontaktpersoner: Guldborg Søvik (guldborg.soevik@hi.no), Fabian Zimmermann (fabian.zimmermann@hi.no)

Dynamics of coastal shrimp: time series analysis and development of stock indices

Coastal populations of northern shrimp are important for coastal fisheries, especially in northern Norway. These stocks are impacted by climate change and anthropogenic pressures on coastal ecosystem. Yet little is known about changes over time or the underlying drivers, and the fishery is large unregulated. To improve our knowledge, advice and the management of these stocks, IMR aims to use existing time series to 1) explore historic dynamics of coastal shrimps and 2) develop stock indices that can be used for stock assessment and management purposes. The candidate will contribute to this work by compiling and analyzing all available data, producing stock indices, and testing them in assessment models to determine their value for future advice. There will be possibilities for participating in relevant fieldwork.
Contact persons: Guldborg Søvik (guldborg.soevik@hi.no), Fabian Zimmermann (fabian.zimmermann@hi.no)

Bestandsvurdering av dypvannsreke i Barentshavet

Dypvannsreke er en kommersiell og økologisk viktig bestand i Barentshavet, der bestands-vurderingen skjer gjennom Det internasjonale havforskningsrådet (ICES) og NAFO/ICES Pandalus Assessment Working Group. Selv om den nåværende bestandsmodellen antas å fungere bra og tilstanden av bestanden er god, har vi fortsatt mange spørsmål om bestandsdynamikk, data som blir brukt i bestandsmodellen, og selve bestandsmodellen. HI har som mål å forbedre den nåværende bestandsmodellen ved å 1) analysere den romlige bestandsdynamikken over tid, 2) vurdere estimeringsmetoder for de ulike bestandsindeksene (fra økosystemtokt og fangstrate fra fiskeri) og 3) utvikle en rekrutteringsindeks basert på tidsserier av lengdedata. Som masterkandidat vil du bidra til ett av disse temaområder avhengig av dine interesser og kvantitative evner. Arbeidet vil gi grunnlag for en forbedring av bestandsvurderingen av dypvannsreken og rådet fra ICES. Det vil være muligheter for kandidaten til å delta i relevant feltarbeid.
Kontaktpersoner: Carsten Hvingel (carsten.hvingel@hi.no), Fabian Zimmermann (fabian.zimmermann@hi.no)

Assessment of Barents Sea shrimp

Northern shrimp in the Barents Sea constitute a commercially and ecologically important stock that is assessed through the NAFO/ICES Pandalus Assessment Working Group. Although the current assessment model is assumed to perform well and the state of the stock is good, many questions remain around the stock dynamics, the data used as input for the stock assessment, and the assessment model itself. IMR aims to improve the current stock assessment of Barents Sea shrimp by 1) analyzing the spatial dynamics over time, 2) evaluating the estimation methods of key input indices from the commercial fleet and IMR's ecosystem survey and their effects on assessment estimates, and 3) develop a recruitment index based on time series of length composition. The candidate will contribute by working on one of these questions depending on preference and quantitative skills, providing the basis for improving the assessment of Barents Sea shrimp and our advice. There will be possibilities for participating in relevant fieldwork.
Contact persons: Carsten Hvingel (carsten.hvingel@hi.no), Fabian Zimmermann (fabian.zimmermann@hi.no)

Haneskjell i Svalbard-området: etablere et grunnlag for fremtidig forvaltning

Etter et mislykket fiskeri for nesten tretti år siden som resulterte i en bestandskollaps viser nyere forskning at haneskjellbestanden i Svalbardområdet har tatt seg opp igjen. Det gjør det mulig å overvåke den ufiskete bestanden og etablere en basis for en fremtidig forvaltning før en mulig gjenåpning av fiske på haneskjell. For tiden fokuserer HIs forskning på å undersøke toktmetoder og tilnærminger for bestandsestimering, spesielt bruk av videopptak til å bestemme skjelltetthet. Vi planlegger å forbedre robustheten og effektiviteten til metodene for å etablere rutiner for toktarbeid og et kunnskapsgrunnlag for en fremtidig bestandsovervåking. Som masterkandidat vil du bidra med å vurdere videoanalysemetoder, sammenligne video- og skrapemålinger, teste muligheter til å bestemme skjellstørrelse fra bilder, og utforske effekter av toktdesign på bestandsestimater. Det vil være muligheter for kandidaten til å delta i relevant feltarbeid.
Contact persons: Fabian Zimmermann (fabian.zimmermann@hi.no)

Iceland scallops in the Svalbard area: establishing a basis for future management

Almost thirty years after a failed fishery that resulted in the collapse of the Iceland scallop stock in the Svalbard area, recent research of IMR shows that the stock has recovered. This provides the opportunity to monitor the unfished stock and establish a basis for future management before a potential reopening of a fishery. Currently, our work focuses on testing and evaluating survey methods and methods for abundance estimation, especially the use of video recordings for determining scallop density. IMR plans to improve the robustness and efficiency of the current approaches to establish routines for surveying and a knowledge base for future stock assessment. The candidate will contribute by evaluating video analysis methods, comparing video and dredge measurements, test approaches to derive shell size from images, and explore effects of survey design on stock estimates. There will be possibilities for participating in relevant fieldwork.
Contact person: Fabian Zimmermann (fabian.zimmermann@hi.no)

Intertidal colonization and mortality of early life stages of Mytilus edulis over a salinity gradient

The blue mussel (M. edulis) has external fertilization where eggs and sperms are shed directly from the genital ducts into the water column. The fertilized egg undergoes several different larval stages before metamorphosis ends the pelagic life. The larvae growth is affected by temperature, salinity and food ration, and the duration of the pelagic phase is normally between 3 to 5 weeks. Mortality

during the larval phase is high, primarily due to predation, but extremes in temperature and salinity and food shortage also contribute.

Most bivalve larvae are able to settle when they reach 250 to 300 µm in shell length, yet final settlement may not occur until the post larva reach 2 mm. The larvae show different behavior to different substrates and are understood to be able to discriminate between habitats. Settlement is difficult to measure in the field and is normally inferred from recruitment data post settlement (days to weeks). Little is known on the mortality and growth of post settled mussel in natural habitat.

The IMR has started to monitor the abundance of mussels over a fjord to coast salinity gradient. These observations indicate recruitment of mussels to the full gradient, yet adult mussels are mainly observed in the less saline inner and mid-section of the gradient. This point to high mortality of the early life stages of mussels in coastal areas.

In this MS thesis we aim to investigate: The colonization, growth and mortality of mussel larva (on natural and artificial substrate?) over a salinity gradient in the intertidal zone, by testing the overall hypothesis:

a. There are no differences in the colonization, growth and mortality of mussel larva (on natural and artificial substrate) over a salinity gradient in the intertidal zone

The master thesis will comprise experimental design, field experiments and data analysis. The following parameters can be collected: Temperature, salinity, seston?, mussel metrics, predators and photos (abundance, size distribution and predators).

The field work will be conducted in two periods with an overall duration of approx. 12-16 weeks:

1. Spring to summer – deployment of collectors and collecting settlement mussel larva
2. Summer – monitoring colonization, growth and mortality of mussel larva

The MS requires basic marine biological and ecological knowledge.

Contact persons at the HI/IMR: Tore Strohmeier (mob 90720754; tore.strohmeier@hi.no) / Antonio Aguera (mob 94880039)

Physiological responses in mussels to natural variation in salinity

Mussels are osmoconformers and reside in salinities ranging from 4 psu to fully marine conditions. Mussel feeding rate may be similar for populations living under different salinities, but when transferred to a marked change in salinity the feeding rate drop. The time to acclimate feeding rate (and to recover respiration rate) to control values is dependent on the extent of the salinity change and may exceed several weeks. There is currently a lack of knowledge on the acclimatization of mussel feeding physiology to the natural variation in salinity encountered in estuaries and fjords.

In this MS study we aim to investigate the mussel feeding and respiration rate in a natural environment (e.g. in situ) that inhabit short term fluctuations in salinity. As this experimental approach do not control other environmental factors known to impact mussel physiology (e.g temperature and food) it requires frequent measures of physiological rates and environmental stimuli over several events of stimulus.

The master thesis will comprise experimental design, field experiments and data analysis. The following parameters can be collected: Temperature, salinity, food/seston, physiological rates and mussels.

The field work will be conducted in the inner part of the Hardangerfjord during spring and summer (approx. 10-12 weeks) using the IMR mobile physiological laboratory and instrumentation.

The MS requires statistical background and basic marine biological- and physiological knowledge.

Contact persons at the HI/IMR: Tore Strohmeier (mob 90720754; tore.strohmeier@hi.no) / Antonio Aguera (mob 94880039)

Mussel larvae physiology under natural environmental conditions

There is a raising interest in understanding the distribution of mussels along the Norwegian coast and assessing the impact of their culture in fjord ecosystems. Modelling the spatial and temporal distribution of adult mussel and their larvae is key to understand the impact of blue mussels in fjord ecosystem. To obtain realistic models we need to understand mussel larval physiology, how long the larvae stays in the water column, how are the natural low seston conditions and physicochemical temporal and spatial gradients affecting the larval development and their potential distribution and competition with other important zooplankton species.

We have some knowledge already on mussel larval development, the role of food, and other environmental conditions. However, this information is not sufficient, it is based on laboratory experiments under controlled conditions that limit our understanding of the larvae feeding physiology and development.

This experiment will aim to develop a system to successfully culture larvae in a flow through setup using natural seston as food and exposing larvae to natural variations of food and physicochemical seawater parameters (temperature, salinity and pH) during a full mussel reproductive season. Other factors such as maternal provisioning and how it changes during the reproductive season may be considered.

The master thesis will comprise the formulation of specific hypothesis related to larval development of blue mussels, experimental design, take of measurements, data processing and statistical analyses. Experiments lasts from 3-6 weeks plus analyses, several experiments to focus on different hypothesis can be run during the reproductive season between May-August.

The MS requires basic marine biological- and physiological knowledge, life history of marine invertebrates and basic statistical skills

Contact persons at HI/IMR: Tore Strohmeier (mob 90720754; tore.strohmeier@hi.no) / Antonio Aguera (mob 94880039)

Spatial distribution of blue mussels along a fjord coastal gradient.

The IMR has started to monitor the abundance of mussels over a fjord to coast gradient. These observations indicate recruitment of mussels may be happening along the whole shoreline, however stablished populations with several year classes are patchy. The monitoring effort initiated by IMR already comprises the assessment of presence/absence of mussels, cohort presence and other

qualitative metrics of abundance at randomly selected stations along the fjord shoreline. An effort that will be continued during the coming year.

Species distribution models (SDM) has proven a valuable tool to describe, predict and find drivers of species distributions. These models use of the concept of fundamental niche to assess the ranges and combinations of environmental (biotic and abiotic) that drives the observed patterns to predict the potential distribution of the species within the area of study.

In this MS, the student will analyze and develop SDMs for the blue mussels in Hardangerfjord, using the data gathered during the mussel monitoring program and diverse sources of spatial information on the Hardangerfjord environmental conditions (physical: depth, slope, temperature, salinity and biotic: primary production)

The MS requires basic GIS skills and statistical analyses of spatial data using R.

Contact persons at HI/IMR: Tore Strohmeier (mob 90720754; tore.strohmeier@hi.no) / Antonio Aguera (mob 94880039)

FG Bunnfisk – Demersal fish

Kontaktperson: Jane Godiksen *(*jane.godiksen@hi.no)

Sei, hyse og torsk: er det en geografisk gradient i gytetidspunkt?

Bakgrunn: Hyse, sei og torsk er de viktigste bunnfiskartene i norske havområder, og de er utbredt fra Nordsjøen i sør til Barentshavet i nord. I Nordsjøen og i Barentshavet er det egne bestander av alle tre artene, men artene finnes langs hele kysten, og kysttorsken forvaltes som en egen bestand. Alle artene gyter om våren, men når på våren gytinga skjer varierer. Gytetidspunkt kan finnes ved å registrere modningsstadiene til gonadene hos kjønnsmoden fisk. For at yngelen skal sikres nok mat, og god rekruttering sikres, må tidspunkt for gyting sammenfalle med våroppblomstringa av plankton.
Oppgavebeskrivelse: I dette masterprosjektet skal studenten analysere et stort datasett på modningsstadier fra tokt og kommersielle fartøyer samlet inn fra Nordsjøen til Barentshavet fra 2011-2021, for å finne gytetidspunkt for sei, torsk og hyse.
Mål: Undersøke om det er en nord-sør-gradient i gytetidspunkt og om gytetidspunkt varierer mellom artene.
Gjøremål: Arbeidet vil bestå av statistisk analyse av et allerede eksisterende datasett.
Ferdigheter: Dataanalyse og databehandling i R, BIO 302 anbefales.
Veiledere fra Havforskningsinstituttet: Arved Staby (hovedveileder; arved.staby@hi.no), Yves Reecht, Edda Johannesen, Johanna Fall (med-veiledere). UiB-veileder:
Eksamen: Juni 2023

Saithe, haddock and cod: is there a geographical gradient in spawning season?

Background**:** Haddock, saithe and cod are the most important demersal fish species in Norway and are widespread from the North Sea in the south to the Barents Sea in the north. There are separate stocks of all three species in the Barents and North Sea, but the species are found along the entire coast. All species spawn in the spring, but the timing of spawning varies. Spawning time can be estimated by registering the maturation stages of the gonads of mature fish. To ensure adequate food for developing fry, thereby increasing survival and the odds for successfully recruiting, spawning should coincide with the spring bloom of plankton.
Description of tasks: This MSc project involves analyzing a huge data set of maturation stages recorded during research surveys in the North Sea, Norwegian Sea and Barents Sea, and additionally on commercial vessels.
Objective: To investigate if there is a north-south gradient in the timing of spawning and if the timing varies by season.
Tasks: Statistical analyses of a large dataset that is archived at IMR.
Skills required: R programming and data analysis, BIO 302 is highly recommended
IMR personnel: Arved Staby (arved.staby@hi.no), Yves Reecht, Edda Johannesen, Johanna Fall (co-supervisors). UiB personnel:
Exam: June 2023

Gear Selectivity and fishery yield of haddock
Background: The haddock population in the Barents Sea is the largest in the world. The fishery is regulated through setting a total allowable catch, mostly of which is split between Norway and Russia. Russia catches most of the haddock using bottom trawls, whereas the Norwegian fishermen use long line, gillnet, bottom trawls and demersal seine (snurrevad). The minimum legal fishing size of haddock in the Barents Sea is 40 cm, and the fishery is regulated by area closures when the by-catch of undersized fish is too high. The fishing gear is constructed both to maximize catches and select for larger fish to reduce by-catch of undersized individuals or other species. However, a knife-edge selection is not attainable. Therefore, when using size selective gear, there is a trade-off between catching undersized fish and losing larger fish. This is the case in the demersal seine fishery for haddock. Here, some catch loss of fish above 40 cm is to be expected when the gear is optimized to reduce by-catch of undersized haddock. However, when reducing by-catch mortality of undersized haddock, more fish are surviving so they can be caught in the following years. The potential trade-off is then between high yield in the present year or a potential higher yield in coming years. Higher future yield can be obtained due to fish growth, and that the large and older haddock are better prized per kg.
Description of tasks: This is mainly a simulation modelling study. The student will apply a fish stock assessment model to simulate the effects of changing selectivity in the demersal seine fishery on the combined haddock yield.
Objective: Evaluate the effect of changing fishing selectivity on haddock yield
Tasks: The haddock stock assessment model (SAM) will be used as the operating model to simulate the "truth." Changes will be made to the selectivity function within SAM to simulate different scenarios (e.g. catching more younger fish VS more older fish) under identical fishing effort (e.g. per haul). To evaluate the effects, metrics will be calculated from the output of the model, such as average yield of all haddock fisheries combined (kg and value in NOK), average yield in demersal seine fishery (kg and value in NOK), and the amount of bycatch of other species such as cod. Plots and tables of these metrics will be created to show the trade-offs in metrics between selectivity scenarios (e.g. combined yield increases, while seine yield decreases), if they exist.
Skills required: R, programming, statistical modelling

IMR personnel: John Trochta (main supervisor; john.trochta@hi.no), Edda Johannesen, Daniel Howell and Olafur Ingolfsson (co-supervisor). UiB personnel:
Exam: June 2023

Bestemmes vekst hos hyse av dietten?

Bakgrunn**:** Hysebestanden i Barentshavet er den største i verden. Veldig sterk rekruttering av årsklassene 2004-2006 og redusert fisketrykk, førte til at bestanden nådde et rekordnivå i 2009 and 2010. Årsklassen fra 2016 er veldig sterk og vi forventer at bestanden tar seg opp igjen de kommende årene. Mye hyse trenger mye mat – men hva spiser hyse egentlig? Og finner all hysa nok mat?
Oppgavebeskrivelse: I dette masterprosjektet skal studenten jobbe med allerede opparbeidet mageinnhold fra tokt i toppåret 2009 og 2015 (når bestanden var på vei ned) for å undersøke:

- Hvordan diett og magefyllingsgrad varierer med lengde, alder, lokal tetthet og bestandsstørrelse
- Hvordan magefyllingsgrad og diett henger sammen med hysas vekst

Mål: Sammenligne diet og magefyllingsgrad i to år med ulik bestandsstørrelse og teste om veksten er henger sammen med mageinnholdet.
Gjøremål: Data er allerede samlet inn, opparbeidet i lab, og tilgjengelig elektronisk, så arbeidet består av dataanalyse.
Ferdigheter: Statistisk analyse, databehandling og visualisering i R, BIO 302 anbefales
Veiledere fra Havforskningsinstituttet: Edda Johannesen (hovedveileder, edda.johannesen@hi.no), Alfonso Perez-Rodriguez og Johanna Fall (med-veiledere). UiB-veileder:
Eksamen: Juni 2023

Is haddock growth related to diet?

Background**:** The haddock population in the Barents Sea is the largest in the world. Due to the extremely strong year classes from 2004-2006, the population reached a record high level in 2009 and 2010 in terms of numbers and biomass. Another giant year class - the 2016 year class - is very strong and the stock is expected to increase. A lot of haddock needs a lot of food - but what do they really eat? And can all the haddock find enough food?
Description of tasks: This MSc project will use stomach data from the peak year in 2009 and from 2015 (when the population had become smaller again) to determine:

- How diet and stomach fullness vary by length, age, local density, and stock size
- How diet and stomach fullness vary between years
- If stomach fullness is related to growth in the next year

Objective: To compare diet composition and stomach fullness between two years with different stock size and test if growth is affected by these factors.
Tasks: Data on diet composition and stomach fullness are already available, so the work will mostly involve statistically analyzing these data.
Skills required: Statistical analysis, data management and visualization in R, BIO302 recommended
IMR personnel: Edda Johannesen (IMR supervisor, edda.johannesen@hi.no), Alfonso Perez-Rodriguez (co-supervisor), Johanna Fall (co-supervisor). UiB personnel:
Exam: June 2023

Når klekker hyselarvene?

Bakgrunn: Hyse har veldig variabel rekruttering, og rekrutteringen hos nordøstarktisk (NØA) hyse er spesielt variabel. Forskere i USA har sammenlignet data på hyseegg med dagsoner fra ørestein hos hyseyngel, og funnet ut at en større andel av egg gytt tidlig på våren vil overleve til høsten. Dette varierer imidlertid mellom år, og i år med mye yngel vil også egg klekket seint ha hatt en høy overlevelse og bidra til rekrutteringen. Vi har ikke egg-data på NØA hyse, men vi har data på 0-gruppe om høsten. For å forstå mer av rekrutteringsmekanismene av hyse vi undersøke om klekkedato for 0-gruppe hyse varierer mellom områder og mellom år med god og dårlig rekruttering. Er det forskjell mellom juvenile som ender opp vest av Svalbard og dem som ender opp i det sørvestlige Barentshavet? Er det flere egg gytt seinere i sesongen som overlever til 0-gruppestadiet hos sterke årsklasser?
Oppgavebeskrivelse: I dette masterprosjektet skal studenten jobbe med dagsoner i øresteiner til 0-gruppehyse samlet inn på økosystemtoktet i Barentshavet for å finne klekketidspunkt for hyseyngel som har overlevd til 0-gruppestadiet.
Mål: Finne klekketidspunkt for hyse-yngel og teste om klekketidspunkt varierer mellom svake og sterke årsklasser.
Gjøremål: Arbeidet vil bestå av preparering av øresteiner og telling av dagsoner, i samarbeid med Åse Husebø (tekniker ved bunnfiskavdelingen), samt statistisk analyse av materialet. Det blir sannsynligvis mulighet til å delta på økosystemtoktet i Barentshavet.
Ferdigheter: Praktiske ferdigheter, dataanalyse i R
Veiledere fra Havforskningsinstituttet: Edda Johannesen (hovedveileder, edda.johannesen@hi.no) og Jane Godiksen (med-veileder). UiB-veileder:
Eksamen: Juni 2023

When are the haddock larvae hatched?

Background**:** Haddock has very variable recruitment, and the recruitment of Northeast Arctic (NEA) haddock is particularly variable. At Georges Bank (USA), researchers have compared hatching data from egg surveys with day zones from otoliths and found that a larger proportion of juvenile hatched early in the spawning season will survive until the autumn. However, in years when strong year-classes are formed, even those that hatch late have a high survival rate and will contribute to the recruitment. We do not have egg data on NØA haddock, but we have data on group 0 in the autumn. To understand more of the recruitment mechanisms of haddock, we want to investigate whether the hatching date for 0-group haddock varies between areas and between strong and weak year-classes. Is there a difference between juveniles that end up west of Svalbard and those that end up in the southwestern Barents? Are a higher proportion of juveniles spawned late found in years when strong year-classes are formed compared to years with weak year-classes?
Description of tasks: This MSc project involves investigating day-zones in otoliths from 0-group fish sampled in the Barents Sea to find out when they have hatched.
Objective: To test if hatching time varies between strong and weak year-classes.
Tasks: Preparing otoliths and count day zones, in collaboration with Åse Husebø (technician at IMR) and statistical analysis. Participation at the ecosystem survey fall 2022, if possible.
Skills required: Practical skills, R-programming for data analysis
IMR personnel: Edda Johannesen (IMR supervisor, edda.johannesen@hi.no), Jane Godiksen (co-supervisor). UiB personnel:
Exam: June 2023

Bycatch of coastal cod (*Gadus morhua*) and golden redfish (*Sebastes norvegicus*) in the North Sea and Norwegian Sea saithe fishery

Background: Saithe (*Pollachius virens*) is a commercially important fish species caught in the North Sea and along the Norwegian coast north of Stadt (620N). In the Norwegian and Barents Sea total annual catches of saithe are around 150 000 tonnes, and in the North Sea around 90 000 tonnes. The main gear types that catch saithe are bottom trawls, Danish seine, purse seine, set nets and longlines. Its I common knowledge that for most of these gear types deployed, cod and golden redfish are bycatch species, meaning that they are caught in saithe targeted fishing operations. However, little is known regarding the seasonal and temporal variation in quantities of cod and golden redfish bycatches, and differences in bycatch related to gear type. With the exception of fishing vessels < 15 m, catch data are recorded in logbooks, which is made available to IMR by the Fisheries Directorate. Management recommendations for saithe require knowledge on bycatch species, thus results from this study will a) aid in improving management advice of NEA saithe and North Sea saithe, and b) will contribute to improved management recommendations for golden redfish, cod and coastal cod.

Description of tasks: This MSc project will analyse available logbook data collected over a 6 year period. In addition biological data from the reference fleet will be analysed to describe the size of cod and golden redfish in the bycatch.

Objective: Describe and analyse temporal and spatial variation in bycatch quantities and size of cod and golden redfish by gear type in the North Sea and north of Stadt (620N).

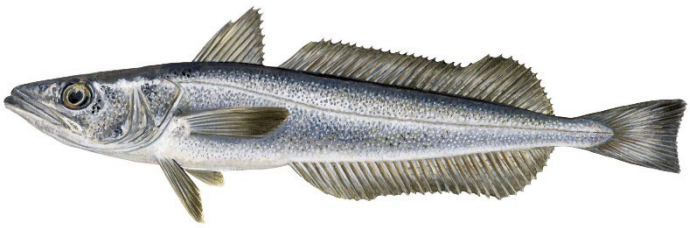
Tasks: Extract logbook data for the period 2015-2021. Data will be for fishing operations where saithe was the target species. Produce annual overview of bycatch quantities by location (statistical main areas), season, and gear type. Maps showing the distribution of bycatch will be helpful in identifying areas with high bycatch quantities of the two species. Extract relevant reference fleet data (length data) to produce length frequency distributions by year, season, gear, and statistical area.

Skills required: R

IMR personnel: Yves Reecht, Arved Staby (arved.staby@hi.no), Kjell Nedreaas (others?)

UiB personnel: Anne Gro Salvanes ? other UiB contacts ?

Reproductive biology of the European hake North of 62˚N



Background: European hake (*Merluccius merluccius*) is a common fish species in the North Sea and along the Norwegian coast up to the Lofoten Islands. The species is caught mainly as a bycatch species in the setnet and trawl fishery. Since the beginning of the 21 century the abundance of this species has increased greatly in the North Sea. Though extensive knowledge has been gathered pertaining to this species reproductive cycle in the more southern areas of its distribution, little is known about this species' reproductive biology east of the Shetland Islands.
Description of tasks: This MSc project will analyse available data on European hake, which includes monthly collected data from North of 62°N on gonad development (weight and macroscopic maturity stage) and liver weight, in addition to gonad samples from the North Sea. These samples have already been screened for histological stage, further ascertaining the reproductive state of the fish. The study will aim to describe the onset of female gonad maturation, the start and duration of spawning, as well the correspondence between macroscopic staging and histological descriptors which will be used to validate the macroscopic gonad staging.

Data overview: data on hake gonad maturity, histological analysis – Master thesis

- Gonad weight and gonad sample (filename 'Lysing gonad data IBTS Q3')
  IBTS Q3 2013: station 24111-24190, 60 samples analyzed for histology
  IBTS Q3 2014: 140 samples analyzed for histology
- Gonad weight, liver weight etc., pictures, collected by the Reference fleet 2015/2016 vessel Tramsegg. In total 483 samples were worked up over a 12 month period. For this biological data there is corresponding catch data of hake, catch location, and limited length distribution data.

Objective: Describe the reproductive biology (spawning season and duration, gonad development, possibly fecundity) of European hake North of 62˚N.
Tasks: Analyse gonad data in conjunction with simultaneously collected commercial catch data over a 12 month period. Prepare maps of catch distribution and possible migration patterns. Participate in the coastal ecosystem survey of IBTSq3 survey to possibly collect additional (see page 2 for data overview).
Skills required: R
IMR personnel: **Arved Staby, Jon Egil Skjæraasen -** Others?
UiB personnel:

FG Fangst – Fish capture

Contact person: Svein Løkkeborg (svein.loekkeborg@hi.no)

Skin injuries and mackerel welfare following crowding in purse seines

Fish welfare in wild capture fishing is an understudied topic in animal welfare science. During purse seine fishing, fish are exposed to various sources of stress that can compromise their welfare and result in unacceptably high mortality rates if catches are subsequently released. Atlantic mackerel support important fisheries in northern European waters but are known to be particularly vulnerable to mortality following release. This is likely related to, at least in part, their vulnerability to abrasive skin injuries arising from contact with gear and other fish when the catch is densely crowded in the

final stages of capture. This MSc thesis therefore aims to increase the understanding of how such skin injuries impact upon the welfare of mackerel and contribute to developing welfare conscious fishing practices.

The Fish Capture group at IMR conducted crowding and survival experiments on large groups of captive mackerel in 2019. These experiments generated a photographic archive of skin injuries. The primary task of this MSc thesis will be to quantify these skin injuries (incidence rate, location, severity, extent etc.) and to investigate their relationship with crowding density and mortality. Injuries will also be related to physiological status for a subset of fish. There may be the opportunity to undertake a histological description of mackerel skin / injuries using archival or newly gathered material as well as the chance to join a research cruise onboard a commercial purse seiner to gather data related to injuries from the field.

Specific competences required: Fish biology, statistical analysis and programming (e.g. R). Experience with image analysis (e.g. ImageJ) would be an advantage.
Language requirements: English
The work will be conducted at the Institute of Marine Research, Fish Capture Group, Bergen, Norway.
Responsible scientists and supervisors: Neil Anders (Post-doctoral researcher, IMR – neil.anders@hi.no), Mike Breen (Senior researcher, IMR – michael.breen@hi.no)

Spatio-temporal variation in the growth and size distributions of lesser sandeel investigated using biological samples from fishery and fishery independent surveys – a step toward fully autonomous sandeel surveillance

Unmanned surface vehicles (USVs) are increasingly used for fish stock monitoring and may in the future replace many of the traditional research vessel based acoustic surveys. USVs are expected to provide high quality data with a low environmental impact. The Institute of Marine Research (IMR) has recently invested in two USVs that will be used in fish stock monitoring surveys. However, acoustic surveys require biological samples for validating acoustic data and obtaining length and age distributions needed for stock assessment. Biological samples are traditionally obtained by trawl and there is a need to find alternative sampling methods for USV based surveys. The aim of this MSc project is to investigate whether commercial catch data can replace biological samples obtained by trawl samples in traditional research vessel-based surveys. Sandeel (*Ammodytes marinus)* will be used as a case study. Sandeel has a key role in the North Sea ecosystem and supports important fisheries. The student will compare length and weight distributions obtained by research vessel with data from commercial catches in time and space for the years 2007-2021. Key challenges are that the commercial catches may focus on specific age and length groups, and that there may be regions that are not sufficiently covered by the commercial catches. The expected outcome of the project is a practical suggestion for how to implement catch data in a future autonomous sandeel survey. This will be an important step in implementing USVs to stock monitoring at IMR. The project is part of CRIMAC, a Center for Research-based Innovation in Marine Acoustic Abundance Estimation and Backscatter Classification, https://crimac.no/.

Are you interested - contact: Maria Tenningen (maria.tenningen@hi.no) or Espen Johnsen (espen.johnsen@hi.no)

FG Fiskeernæring – Research program Fish Nutrition

Contact person: Rune Waagbø (Rune.Waagbo@hi.no)

In principle, all our running research projects in the research program can be available for master student studies.

Investigating the requirements for micronutrients in Lump sucker (*Cyclopterus lumpus*). *IMR-supervisor: Øystein Sæle* (oystein.saele@hi.no)

Investigating the requirements for micronutrients in Ballan wrasse (*Labrus berggylta*). IMR-s*upervisor: Øystein Sæle* (oystein.saele@hi.no)

Applying a gut sac model (from salmon) to investigate the impact of undesirables in feed, such as pesticides, on intestinal integrity. *IMR-supervisor: Øystein Sæle* (oystein.saele@hi.no)

FG Fiskeridynamikk – Fisheries dynamics

Contact person: Jon Helge Vølstad (jon.helge.voelstad@hi.no)

Robustness-analysis of fishery dependent estimates

The IMR run several sampling programs to collect data from commercial fisheries, and provide estimates using a Bayesian modelling framework dependent on several use choices, such as categorization of fishing gears and post-stratification of spatial and temporal covariates. We wish to analyse the roboustness of estimates to user choices and sampling variation. The candidate will analyse results from different model configurations and assess the robustness of estimates and implications for interpretation. Some familiarity with Bayesian statistics and R will be required.
IMR-supervisor: Edvin Fuglebakk (edvin.fuglebakk@hi.no).

Comparative study of estimators for non-probabilistic samples

Practical constraints commonly lead to deviation from probabilistic approaches in sampling. This can be addressed with explicit modelling approaches, or with post-stratification and assumptive applications of traditional design-based estimators. These approaches come with different formulations of assumptions and different technical implications for estimation support systems. We would be interested in do a comparative study of such estimators for evaluating their practical utility and interpretability for non-probabilistic sampling of biological parameters from commercial fisheries.
IMR-supervisor: Edvin Fuglebakk (edvin.fuglebakk@hi.no).

Development of tools for post-collection subsampling of aging structures

Different biological variables very different time-cost and monetary cost. Length-measurements are for example very cheap and can be done in field, while age-determination and genetic analysis require the logistics, expertise and material cost associated with post-fieldwork analyses. When estimates are to be delivered on a deadline, time-cost may prohibit complete analysis of the collected data. In these cases, it is a challenge to do post-collection prioritization of which of the collected material to analyze, and ad-hoc solutions may introduce bias in estimates. An ideal procedure would preserve or improve upon the statistical properties of the original sampling while at

the same time be implemented within practical logistical constraints. The candidate would analyze sampling designs, workflows and proxy indicators of fishing activity in order to propose a solution for rigorous post-collection subsampling of age-materials.
IMR-supervisor: Edvin Fuglebakk (edvin.fuglebakk@hi.no).

Time series analysis of survey estimates

The survey estimates are traditionally used as input to assessment models, but there could be simpler models serving as alternatives to the assessment models, which are worth pursuing.
Suggested contact: Jon Helge Vølstad (jon.helge.voelstad@hi.no)

Biologisk potensial for utnyttelse av bifangstarter i norske fiskerier

Norske fiskerier er hovedsakelig basert på ca. 40 arter, eller ca. 80 arter dersom vi tar med arter som blir landet delvis og uregelmessig. Totalt sett så vet vi at norske fiskere fisker ca. 140 arter. Det vil si at flere arter av ulike grunner p.t. ikke har noen markedsverdi. Havforskningsinstituttets referanseflåte gir oss representative data for hele artsmangfoldet i forbindelse med fiskeriene, og basert på disse data vil oppgaven forsøke å estimere det uutnyttede kommersielle potensiale, inkl. sesongmessige variasjoner. I samarbeid med Norges Sjømatråd vil oppgaven også studere i hvilken grad de uutnyttede norske artene allerede finnes på det internasjonale marked.
HI-veiledere: Kjell Nedreaas, kjelln@hi.no, Tom Williams, tom.williams@hi.no og Tom Clegg, tom.clegg@hi.no.

FG Fremmed- og smittestoff– Contaminants and biohazards

Kontaktperson: FG-leder Monica Sanden (Monica.Sanden@hi.no)

Want to do your **master's thesis on antibiotic resistance?** In collaboration between Institute of Marine Research (IMR) and University of Bergen (UiB).

We have a master's project in microbiology connected to the Res-Marine project funded by the Norwegian Research Council (NRC) funded (https://www.tv2.no/a/11567134/; https://prosjektbanken.forskningsradet.no/project/FORISS/315266?Kilde=FORISS&distribution=Ar&chart=bar&calcType=funding&Sprak=no&sortBy=date&sortOrder=desc&resultCount=30&offset=0&Fritekst=Res-Marine), that aims at understanding the role of the marine environment in dissemination and emergence of antimicrobial resistance (AMR). The student will carry out isolation of bacterial pathogens from waste water, marine sediments and water samples, and carry out antibiotic susceptibility testing. The tasks would also include learning DNA sequencing and analysis of whole genome sequences (bioinformatic analysis). If interested contact Nachiket Marathe (nachiket.marathe@hi.no).

Master's opportunity on **Microplastic and antibiotic resistance**.
Plastic pollution is a global environmental problem that is projected to increase in upcoming decades because of the upward trend in global production and consumption. MPs provide surficial substrates for the microorganisms to attach and form biofilms. Fish pathogens such as *Aeromonas* spp., *Vibrio* spp. and opportunistic human pathogens like *E. coli* are present in biofilms from marine plastics. Recently, previous master student on the project has characterized multidrug resistant pathogens and environmental bacteria present on marine plastics from western Norway, using whole genome sequencing. This work has led to 2 publications (Radisic et al., 2020; Radisic et al., 2021). The master's project will focus on the role of microplastics in dissemination of antibiotic resistance genes and resistant pathogens in the marine environment. The student will carry out isolation of pathogens, DNA extraction and Whole genome sequence analysis. If interested contact Nachiket Marathe (nachiket.marathe@hi.no).

FG Marin økosystemakustikk – Ecosystem acoustics

Contact person: Rolf Korneliussen (rolf.korneliussen@hi.no)

Effect of anthropogenic noise on vocalization in spawning cod (*Gadus morhua*)

Background:
Anthropogenic noise in the sea is increasing and has been recognized as a pollutant of the sea e.g. under the European Marine Strategy Framework Directive (MSFD). Among the most widespread and long-range sources of underwater sound are seismic air guns, routinely used in the search for, and during exportation of oil and gas reserves. The intense sound exposure at very close range of the air gun can lead to physical injury and death. Beyond such close range, but within hearing range, it can mask important biological sounds such as communication between individuals or sound from an approaching predator or prey. Continuous noise, such as noise from boat engines and oil and windfarm industry may be even more harmful, because it leaves fewer silent periods that could be used for communication. Cod, like other gadoids, produce sounds and use them in a variety of behaviours. They use the sounds for communication, including mating and territorial behaviors. Cod make sounds using striated drumming muscles that attach to the swim bladder. The sound /grunts are made singly, or in a short series, and are produced over the year by females and males, but during spawning mainly by males. In ongoing project at IMR, SpawnSeis, we are looking at the effect of seismic on spawning cod. We additionally have ongoing and planed projects looking at effects of anthropogenic noise from vessels and windfarm industry.

This MSc project will look at data from the SpawnSeis project, where we have recorded the behaviour (sound and video) of spawning cod in a fish-net-pan when exposed to a seismic airgun. In this setup the cod was also periodically exposed to boat noise between more silent periods. A recent study hypothesis that cod prolong their grunts when exposed to boat noise.

Task:
1. This master study will investigate the hypothesis that cod increases the length (time) of the grunts when they are exposed to boat noise

2. Further, the thesis will compare the effect of boat noise with the effect of seismic noise on spawning noise (and behaviour) in cod

Method:
Analysing vocalisation and behaviour of cod from audio and video recordings, during their exposure to seismic air gun, boat noise and silent periods.

Are you interested contact: Karen de Jong (karen.de.jong@hi.no), Anne Christine Utne Palm (annecu@hi.no) or Lise Doksæter Sivle (lise.doksaeter.sivle@hi.no), UiB supervisor Beatriz Diaz Pauli (Beatriz.Diaz-Pauli@uib.no)

Bootstrapping of acoustic-trawl surveys. Variance estimation of acoustic-trawl and swept-area survey estimates has received increasing attention with the on-going REDUS project (Reduced Uncertainty in Stock Assessment) at the IMR. Using the StoX software, the variance of the survey estimates can be estimated by bootstrapping echosounder and trawl data. This routine has however not been intensively tested with regards to number of bootstrap replicates, number of data points

available and the stochastic nature of the data. Evaluating these bootstrap routines and suggesting alternatives would be a valuable contribution to the assessment of fish stocks.
Suggested contact: Espen Johnsen (espen.johnsen@hi.no).

Image analysis of echosounder and sonar data. Machine learning initiatives have been initiated at the IMR for categorizing images of fish, seals and other organisms, and similar approaches are intended for acoustic data. Alternatively, traditional image analysis can be applied.
Suggested contact: Nils Olav Handegard (nilsolav@hi.no).

Detecting internal waves in echosounder data
Waves in the ocean does not only occur at the surface. They are also commonly observed in the ocean interior as internal waves and are considered important features for vertical mixing of water masses.

For internal waves to exist, the ocean must be stratified. As such, the density must change with depth due to changes in temperature and/or salinity. If the density changes over a small vertical distance (as in the case of the thermocline) the waves propagate horizontally like surface waves, although at slower speeds due to the density difference across the thermocline interface. If the density changes continuously, the waves can also propagate vertically as well as horizontally through the ocean.

Uniformly scattered organisms and particles in the water column can be observed using scientific echosounders. If these scatters are located where internal waves occur, the wave patterns become visible on the echograms. Conversely, if no waves are present, the scatterers will be evenly distributed. The scatterers can then be used to detect internal waves in the water column.

The objective of the project is to develop a data mining algorithm that automatically locate the presence of internal waves from acoustic data.

The One Ocean expedition are collecting acoustic data around the world, and this data set will be used as test case. IMR has also a large database of historical acoustic data that also can be mined for these features and can be used as a complementary option.

The project is associated with the One Ocean expedition (https://oneoceanexpedition.com/), the Center for Research-based Innovation in Marine Acoustic Abundance Estimation and Backscatter Classification (https://crimac.no/) and the Nansen Environmental and Remote Sensing Center.

Are you interested - contact: Nils Olav Handegard (nilsolav@hi.no) and/or Johnny A. Johannessen (johnny.johannessen@nersc.no).

Spatio-temporal variation in the growth and size distributions of lesser sandeel investigated using biological samples from fishery and fishery independent surveys – a step toward fully autonomous sandeel surveillance

For more information, see FG Fangst – Fish capture. Are you interested - contact: Maria Tenningen (maria.tenningen@hi.no) or Espen Johnsen (espen.johnsen@hi.no)

FG Oseanografi og klima – Oceanography and climate

Contact person: Jan Erik Stiansen (jan.erik.stiansen@hi.no)

Conditions in the surface layer of the Scotia Sea in summer 2019
As part of the international Antarctic krill survey, krill trawls were carried out across the entire Scotia Sea. Sensor mounted on the krill trawls collected temperature and salinity data. Combined with regular CTD casts from research vessels involved in the survey, analysis of this dataset will provide valuable information of the hydrographic conditions during the krill survey, and an update to a similar survey conducted in 2000
Contact person: Angelika Renner (angelika.renner@hi.no)
Working place: Tromsø

Currents in Bransfield Strait: During January-February 2019, several combined current profilers/echosounders were deployed for ~1 month in Bransfield Strait. Analysis of this unique dataset will provide insight into dynamic processes contributing to water mass exchange and krill swarming mechanisms in this hotspot for Antarctic krill fisheries.
Contact person: Angelika Renner (angelika.renner@hi.no)
Working place: Tromsø

Klimatrender i kyst og fjordstrøk: Kombinere målinger fra Hardangerfjorden og faste overvåkningsstasjoner på kysten med NorKyst800, modellarkiv med 800m oppløsning langs hele norskekysten 1995-2020, for å identifisere endringer i det fysiske miljøet og mulige konsekvenser for fjordøkosystemene.
Kontaktperson: Mari Myksvoll (mari.myksvoll@hi.no)
Arbeidssted: Bergen

Utslipp fra rør til det marine miljø: Lage en matematisk modell for spredning av utslipp fra renseanlegg og industri til det marine miljø, basert på kjente empiriske formler. Modellen kan testes mot profiler i det eksisterende modellarkivet NorKyst800 for å diskutere konsekvenser av f.eks. storskala utbygging av landbaserte oppdrettsanlegg.
Kontaktperson: Pål Næverlid Sævik (paal.naeverlid.saevik@hi.no)
Arbeidssted: Bergen

FG Pelagisk fisk – Pelagic fish

Contact person: Aril Slotte (aril.slotte@hi.no)

Vi arbeider p.t. med tilrettelegging av flere masteroppgaver i Bergen. We are currently working with the facilitation of several master's theses in Bergen.

FG Plankton

Kontaktperson: FG-leder Kjell Gundersen (kjell.gundersen@hi.no)

***Calanus finmarchicus* fraction in zooplankton biomasse data from the Norwegian Sea**
Zooplankton data finnes ofte bare oppgitt som fordelt på størrelsesfraksjon 180-1000um, 1000-2000 um og >2000um, og ikke fordelt på art og evt stadie. Om vi feks ønsker å estimere *C. finmarchicus* biomasse i et datasett, er vi avhengige av mer eller mindre velbegrunnede antagelser om at *C. finmarchicus* utgjør en gitt fraksjon av zooplankton biomassen i hver størrelsesfraksjon, f.eks. 50, 70 og 0 % i de tre nevnte klassene. Gitt den viktige rollen *C. finmarchicus* har i økosystemet, og behovet

vi modellører har for et estimat av *C. finmarchicus* biomasse til modellvalidering, har vi et ønske om å forbedre den estimerte *C. finmarchicus* fraksjonen i hver klasse.

Dette tenkte vi kunne gjøres slik:

- fokusområde: Norskehavet. Svinøy-data ca. 6 ganger årlig, også noen data med fordeling lenger mot vest
- benytte allerede opparbeidede data: tørrvekt biomasse per art og totalt i de 3 fraksjonene
- innhente noen nye data på tokt, telle antall i hvert stadie. Student kan ved hjelp av tekniker gjøre dette, bør være et relativt kort tokt da.
- benytte kjente stadievekter fra litteratur og beregne biomasse i hver fraksjon, bestemme usikkerhet i estimat etc.
- publisere resultatet i en form som det kan refereres til

Contact: Solfrid Sætre Hjøllo (solfrid.hjollo@hi.no) og Cecilie Thorsen Broms (cecilie.thorsen.broms@hi.no).

FG Reproduksjon og utviklingsbiologi – Reproduction and developmental biology

Kontaktperson: FG-leder Anna Troedsson Wargelius (annaw@hi.no).

I satsningsområdet **Bærekraftig oppdrett av marin fisk** kan vi tilby oppgaver innen reproduksjon og tidlige livsstadier på kveite og andre marine fiskearter som kan være aktuelle som kandidater for oppdrett. Within the focus area «Sustainable aquaculture of marine fish», we have MSc thesis projects on reproductive physiology and early development of Atlantic halibut and other species that may be candidates for aquaculture.
HI-veileder: Birgitta Norberg (birgittan@hi.no)

Influence of light on signaling pathways and metamorphosis behaviour of halibut (*Hippoglossus hippoglossus*). The aim of this MSc project is to understand the signaling pathways that will lead to flatfish swimming behaviour prior eye migration and pigmentation formation under influence of light. The student will use imaging and video analyses for recording fish behaviour and morphological defects (eye and pigmentation) under light regime. He/she will also examine molecular markers involved in eye migration modulation.
Contact: Torstein Harboe (torsteinh@hi.no); Prescilla Perrichon (prescilla perrichon@hi.no); Birgitta Norberg (birgittan@hi.no)

The role of multiple vitellogenins and cathepsins in acquisition of egg buoyancy in Atlantic halibut (*Hippoglossus hippoglossus*)
Atlantic halibut oocytes undergo extraordinary hydration during maturation, and halibut eggs exhibit highly variable buoyancy. Egg buoyancy is an important parameter representing egg quality in most marine fishes. The objective of this MSc project is to 1) investigate the involvement of multiple vitellogenins (Vtgs) and the functionality of certain cathepsins (CTS) in the process of maturational yolk proteolysis and oocyte hydration in the Atlantic halibut, and 2) relate them to egg quality. The candidate will utilize molecular, biochemical and immunochemical tools for detection of multiple Vtgs in prehydrated and mature oocytes leading to eggs of different buoyancy grades.
Contact: Birgitta Norberg (birgittan@hi.no); Özlem Yilmaz (ozlem.yilmaz@hi.no)

FG Sjøpattedyr – Marine mammals

Contact person: Tore Haug (tore.haug@hi.no)

Analyser av allerede innsamlede data av hvalarter. *Kontaktperson: Nils Øien (nils.oien@hi.no).*

FG Økosystemprosesser – Ecosystem processes

Contact person: Mette Mauritzen (mette.mauritzen@hi.no).

Diettanalyser 0-gruppe torsk gjennom kritisk fase Skagerrak. *Innsamlet materiale, men studenten kan bli med på tokt. To oppgaver.* ***HI-veileder:*** *Tore Johannessen (tore.johannessen@hi.no).*

Eksperimentelt oppsett for å teste konkurranse mellom stillehavøsters fucus-arter ift. kolonisering av hardbunn. *HI-veileder: Anders Jelmert (anders.jelmert@hi.no).*

Økosystembasert høsting av rekefjorder inkl. modelleringsverktøyet ECOPATH. *I dette prosjektet kan det bli aktuelt med masterstudenter i flere arbeidspakker.* ***HI-veiledere****: Guldborg Søvik, guldborg.soevik@hi.no, Kjell Nedreaas, kjelln@hi.no; Bérengère Husson, brengere.husson@hi.no og Lis Lindal Jørgensen (lislin@hi.no).*

See also https://www.hi.no/hi/forskning/student-som-vil-bli-havforsker