



## **Masteroppgåver ved Havforskningsinstituttet V2021** **Possible master theses at the Institute of Marine Research, S2021**

**NB!** Det må etableres en kontakt med internveileder ved universitet så snart som mulig i de tilfeller det ikke allerede 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 Benthiske ressurser og prosesser – Benthic resources and processes**

Contact person: Carsten Hvingel ([carsten.hvingel@hi.no](mailto: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 bestandsvurderingsmodeller 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](mailto:guldborg.soevik@hi.no)), Fabian Zimmermann ([fabian.zimmermann@hi.no](mailto: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 analysing 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](mailto:guldborg.soevik@hi.no)), Fabian Zimmermann ([fabian.zimmermann@hi.no](mailto:fabian.zimmermann@hi.no))

#### **Bestandsvurdering av dypvannsreke i Barentshavet**

Dypvannsreke er en kommersiell og økologisk viktig bestand i Barentshavet, der bestandsvurderingen 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](mailto:carsten.hvingel@hi.no)), Fabian Zimmermann ([fabian.zimmermann@hi.no](mailto: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) analysing 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](mailto:carsten.hvingel@hi.no)), Fabian Zimmermann ([fabian.zimmermann@hi.no](mailto: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](mailto: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](mailto:fabian.zimmermann@hi.no))

### **FG Bunnfisk – Demersal fish**

Kontaktperson: Jane Godiksen ([jane.godiksen@hi.no](mailto:jane.godiksen@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.

### **Diett og vekst hos hyse (*Melanogrammus aeglefinus*) i Barentshavet**

Hyse-bestanden i Barentshavet er nå den største i verden. Pga de ekstremt sterke årsklassene 2004-2006 ble bestanden rekordstor i 2009 (individer) og 2010 (biomasse). Trolig er en ny kjempeårsklasse på vei – 2016 årsklassen ser ut til å bli veldig sterk. Mye hyse trenger mye mat – men hva spiser den egentlig? Og klarer all hysa å finne nok mat? Vi har mage-data fra toppåret 2009 og fra 2015 – da bestanden var blitt mindre igjen.

Oppgaven går ut på å se om dietten og magefylningen er forskjellige i disse to årene og om det ser ut som om veksten i det etterfølgende året har noen sammenheng med magefylningen året før.

**IMR-supervisor:** Edda Johannesen, [edda.johannesen@hi.no](mailto:edda.johannesen@hi.no).

### **FG Fangst – Fish capture**

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

**Behaviour and welfare of herring and mackerel caught in purse seines.** The objective of this MSc project will be to describe and quantify the behaviour of pelagic fish (herring and mackerel) during their capture in purse seines and relate this to potential capture related stressors (e.g. hypoxia, crowding and net contact), to assess the potential impact upon the welfare of the catch. The candidate will use archived data and video from previous research cruises and will also have the opportunity to join a research cruise on a commercial purse seine vessel and collect further data.

**IMR-supervisors:** Michael Breen, [michael.breen@hi.no](mailto:michael.breen@hi.no) / Maria Tenningen, [maria.tenningen@hi.no](mailto:maria.tenningen@hi.no).

### **Fiskestimenes reaksjon til fangst med ringnot og påvirkning på fangstsuksess**

I prosjektet skal sonardata brukes til å undersøke hvordan makrell, sild og lodde reagerer til fangst med ringnot, hva som påvirker atferden og hvilken effekt det kan ha på fangstsuksess. Dataene er allerede innsamlede, men det vil også være muligheter for å bli med på forskningstokt for å samle inn mer data.

### **Fish school reactions to capture by purse seine and implications on catch success**

In this project sonar data will be used to describe the reactions of pelagic fish schools (mackerel, herring and capelin) to capture by purse seine, identify key drivers underlying the behavioural reactions and discuss effects on catch success. Data is available from previous research cruises and there will be an opportunity to join a cruise on board a commercial fishing vessel for further data collection.

**IMR-supervisor:** Maria Tenningen, [maria.tenningen@hi.no](mailto:maria.tenningen@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, Fish Capture research group, IMR – [neil.anders@hi.no](mailto:neil.anders@hi.no) )

Mike Breen (Senior researcher, Fish Capture research group, IMR – [michael.breen@hi.no](mailto:michael.breen@hi.no) )

### **FG Fiskeernæring – Research program Fish Nutrition**

Contact person: Rune Waagbø ([Rune.Waagbo@hi.no](mailto: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](mailto:oystein.saele@hi.no))

**Investigating the requirements for micronutrients in Ballan wrasse (*Labrus berggylta*).**

IMR-supervisor: Øystein Sæle ([oystein.saele@hi.no](mailto: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](mailto:oystein.saele@hi.no))

## **FG Fiskeridynamikk – Fisheries dynamics**

Contact person: Jon Helge Vølstad ([jon.helge.voelstad@hi.no](mailto: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 robustness 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](mailto: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](mailto: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 prioritisation of which of the collected material to analyse, 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 analyse 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](mailto: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](mailto:jon.helge.voelstad@hi.no))

### **Biologisk potensiale 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 pt 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](mailto:kjelln@hi.no), Tom Williams, [tom.williams@hi.no](mailto:tom.williams@hi.no) og Tom Clegg, [tom.clegg@hi.no](mailto:tom.clegg@hi.no).

### **FG Marin økosystemakustikk – Ecosystem acoustics**

Contact person: Rolf Korneliussen ([rolf.korneliussen@hi.no](mailto:rolf.korneliussen@hi.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](mailto: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](mailto:nilsolav@hi.no)).

## **FG Oseanografi og klima – Oceanography and climate**

Contact person: Jan Erik Stiansen ([jan.erik.stiansen@hi.no](mailto: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](mailto: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](mailto: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](mailto:mari.myksvoll@hi.no))

Arbeidssted: Bergen

**Spredning av lakselus langs norskekysten:** Kjøre partikkelspredningsmodell for lakselus langs hele norskekysten med det eksisterende modellarkivet NorKyst800 (1995-2020) for å kartlegge innstrømningsepisoder i ulike fjordsystemer, og diskuterer hvordan det fysiske miljøet påvirker bæreevnen for akvakultur i produksjonsområdene.

**Kontaktperson: Mari Myksvoll** ([mari.myksvoll@hi.no](mailto:mari.myksvoll@hi.no))

Arbeidssted: Bergen

## **FG Pelagisk fisk – Pelagic fish**

Contact person: Aril Slotte ([aril.slotte@hi.no](mailto: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.

### **Otolith growth of small pelagic fish in Norwegian fjord**

Small pelagic fish are an important ecological and economical source in the north-eastern Atlantic. Along the Norwegian coast with its numerous fjords, the most common pelagic species are Atlantic herring (*Clupea harengus*) and European sprat (*Sprattus sprattus*). Recent genetic papers have shown differentiation between populations inside the fjords



compared to offshore individuals (Han et al., 2020; Quintela et al., 2020). However, the connectivity between fjords is still debated. In addition, offshore migrating herring utilize fjords as nursery ground. By conducting otolith microstructure analysis, we can investigate daily growth rates that can be linked to environmental parameters. The aim of this project is to compare otolith growth for both species within and between Norwegian fjords. Further, different spawning types of herring, mainly spring and autumn (Berg et al., 2020), should be identified.

During this project, you will learn how to apply otolith microstructure analysis. This includes both technical methods, like grinding and photographing of otoliths, as well as statistical analysis. You will have the possibility to sample your own material during an ecosystem survey along the Norwegian coast during summer.

**Keywords:** small pelagic fish, otolith microstructure, growth, population identification

**Supervisor:** Florian Berg, Institute of Marine Research (IMR), Bergen, Norway; telephone: +47 94209887; e-mail: [florian.berg@hi.no](mailto:florian.berg@hi.no)

**Co-supervisor:** Arild Folkvord, Department of Biological Sciences, University Bergen, Norway; e-mail: [arild.folkvord@uib.no](mailto:arild.folkvord@uib.no)

## References

- Berg, F., Østgaard, H. D., Slotte, A., Andersson, L., and Folkvord, A. 2020. A combination of genetic and phenotypic characterization of spring- and autumn-spawning herring suggests gene flow between populations. ICES Journal of Marine Science. doi: 10.1093/icesjms/fsaa046
- Han, F., Jamsandekar, M., Pettersson, M. E., Su, L., Fuentes-Pardo, A., Davis, B. W., Bekkevold, D., et al. 2020. The genetic architecture underlying ecological adaptation in Atlantic herring is not consistent with the infinitesimal model. bioRxiv: 2020.2007.2015.204214.
- Quintela, M., Kvamme, C., Bekkevold, D., Nash, R. D. M., Jansson, E., Sørvik, A. G., Taggart, J. B., et al. 2020. Genetic analysis redraws the management boundaries for the European sprat. Evolutionary Applications. doi: 10.1111/eva.12942

## Life history traits of coastal sprat in Norwegian fjords

The Norwegian coast, with its numerous fjords is an important ecosystem. The fjords are nursery grounds for many species, but also inhabit local populations. One of these species is European sprat (*Sprattus sprattus*) which can be found in most fjords between Oslofjorden up to Trondheimsfjorden. However, a recent genetic study showed no differentiation between populations from different fjords (Quintela et al., 2020) and their connectivity is still debated. Each fjord has its own characteristics and environment which could influence life history traits of sprat. Historical data has been sampled for many years during scientific surveys. These data can be used to analyse life history traits of sprat from different fjords. Further, acoustic data can be used to study biomass dynamics of several fjords. Linking the changes in life history traits and dynamics of fjords with environmental data could give us an idea about the productivity of each fjord. The aim of this project is to investigate the life history traits for sprat and their productivity from several fjords. Further, the results could be used to evaluate the connectivity of sprat between fjords.

During this project, you will learn how to analyse and compare life history traits of fish. This includes both, technical methods like measuring different traits as well as statistical analysis.



You will have the possibility to sample your own material during a survey along the Norwegian coast during summer.

**Keywords:** connectivity, life history traits, sprat, population dynamics

**Supervisor:** Florian Berg, Institute of Marine Research (IMR), Bergen, Norway; telephone: +47 94209887; e-mail: [florian.berg@hi.no](mailto:florian.berg@hi.no)

**Co-supervisor:** Arild Folkvord, Department of Biological Sciences, University Bergen, Norway; e-mail: [arild.folkvord@uib.no](mailto:arild.folkvord@uib.no)

## References

- Quintela, M., Kvamme, C., Bekkevold, D., Nash, R. D. M., Jansson, E., Sørvik, A. G., Taggart, J. B., et al. 2020. Genetic analysis redraws the management boundaries for the European sprat. *Evolutionary Applications*. doi: 10.1111/eva.12942

## Temporal stability of Atlantic herring (*Clupea harengus*) otolith shape

The assignment of individual fish to its stock of origin is important for reliable stock assessment and fisheries advice. Otolith shape is commonly used as the marker of distinct stocks in discrimination studies. In Atlantic herring (*Clupea harengus*), otolith shape analysis can be applied to identify and separate different stocks (Smoliński et al., 2020). For the assignment of unknown fish, a good reference baseline with known origin of individuals is necessary. However, there has been little research to examine within-stock temporal stability of herring, and whether such a baseline need to be rebuilt annually or can be used over several years. Herring otoliths has been sampled routinely for otolith shape analysis during an annual acoustic survey in the North Sea since 2014. These otoliths will be used as a reference to investigate temporal stability of otolith shape in Atlantic herring. Further, the effect of temporal stability or instability on baseline for assignment purposes can be evaluated.

During this project, you will learn how to apply otolith shape analysis. This includes both, technical methods like photographing and extraction of the otolith shape outlines as well as statistical analysis. You will have the possibility to sample your own material during a survey in the North Sea during summer.

**Keywords:** North Sea, otolith shape, herring, temporal stability

**Supervisor:** Florian Berg, Institute of Marine Research (IMR), Bergen, Norway; telephone: +47 94209887; e-mail: [florian.berg@hi.no](mailto:florian.berg@hi.no)

**Co-supervisor:** Arild Folkvord, Department of biological science, University Bergen, Norway; e-mail: [arild.folkvord@uib.no](mailto:arild.folkvord@uib.no)

## References

- Smoliński, S., Schade, F. M., and Berg, F. 2020. Assessing the performance of statistical classifiers to discriminate fish stocks using Fourier analysis of otolith shape. *Canadian Journal of Fisheries and Aquatic Sciences*, 77: 674-683.

## FG Plankton

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

No master thesis proposals for the moment.

## **FG Reproduksjon og utviklingsbiologi – Reproduction and developmental biology**

Kontaktperson: FG-leder Anna Troedsson Wargelius ([annaw@hi.no](mailto: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](mailto: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.

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### **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.

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

