DTU

DTU Aqua
National Institute of Aquatic Resources

PhD projects at DTU Aqua

February 2024

Preface

This web-publication, PhD projects at DTU Aqua, presents PhD students at DTU Aqua's PhD school as at 15 February 2024. The publication is updated twice a year.

Each PhD project is described by the PhD student. You will additionally find information on research section affiliation and supervisor. Most PhD students at DTU Aqua have co-supervisors as well. However, for the sake of simplicity we have not provided the entire list in this publication.

Our mission is to make sure that our PhD students engage in front line research, whether it is for exploring fundamental issues in aquatic sciences, utilizing new technological approaches in their data collection and processing, for statistical treatment and evaluation of data, or for mathematical modelling. Our ambition is to secure the next generation of innovative and broadly educated aquatic scientists that can face the challenges that, e.g., climate change and an increased utilization of aquatic resources present to us.

David Lusseau
Head of the PhD School at DTU Aqua

Contents

Amalia Papapostolou

Background
The structure of the marine food web plays a crucial role for fisheries and ocean biogeochemistry. Food webs consist of interconnected food chains and in the ocean a food chain typically follows the sequence: phytoplankton, herbivorous zooplankton, carnivorous zooplankton, upper trophic levels (i.e. forage fish). It can take a varying number of steps within a food chain for energy to transfer from phytoplankton to fish across different oceanic regions, depending on the planktonic community composition. The length of the food chain is tightly linked to the concept of “trophic efficiency”, namely the efficiency with which energy flows from one trophic level to the next through predation.

Project
The aim of my PhD is to make global estimates of the ‘microbial’ trophic efficiency from phytoplankton to small pelagic fish; basically how does energy flow across the food chain. This is crucial to improve our estimates and predictions for fisheries yields and carbon export. To do so, I will explore the mechanisms that govern marine food web dynamics through trait-based modeling, by implementing and further developing the “NUM” model framework, created at the Center for Ocean Life. NUM is a mechanistic size- and trait-based model along the Nutrient-Unicellular-Multicellular axis, based on individual-level processes. In NUM, the multicellular component encompasses ontogeny and describes the population dynamics of key copepod groups, characterized by their adult size and feeding mode. The composition of the plankton community is an emergent property of the model, resulting from predation and competition.

Perspective
With this PhD, we expect to identify the main mechanisms linking higher trophic levels, such as fish, to primary producers, and see how trophic efficiency correlates to fisheries yields and carbon export.

Title:
Trophic efficiency of the pelagic food chain

Principal supervisor:
Ken Haste Andersen

Section:
Centre for Ocean Life

Federica Miano

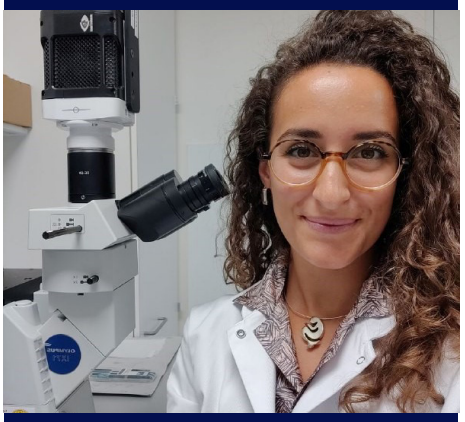
Background
Flagellates represent highly relevant species among eukaryotes both from evolutionary and ecological perspectives. They are found among all the branches of the eukaryotic tree of life, with highly diverse flagellar arrangements and resource acquisition modes. Also, they play a crucial role in the biogeochemical cycles of the global ocean. Their key position in the microbial food web is governed by their feeding on bacteria and other picoplankton, by their photosynthetic activity, and by themselves being grazed by predators. Their degree of success in eating without being eaten is the key to understand the functioning of predatory flagellates. Their feeding activity dangerously exposes them to rheotactic predators that are sensitive to flow disturbances. Therefore, flagellates have evolutionarily developed singular behaviors in terms of feeding modes and predator avoidance, to find an equilibrium between resource acquisition and predation risk. These trade-offs are still largely unexplored among flagellates.

Project
During my PhD, I will study representative flagellate species belonging to different branches of the eukaryotic tree of life to look at their behaviors both as predators and prey. Firstly, I will investigate escape responses from predators feeding currents to understand their propulsion mechanism that leads to very fast and long jumps, and characterize the fluid signals that elicit them. Secondly, I will quantitatively investigate the kinematics and 3-dimensional beat patterns of diverse flagellar arrangements and use them as input to CFD models to quantify foraging-predation risk trade-offs.

Perspective
My PhD project aims at describing these trade-offs quantitatively and at understanding how they are differently optimized among flagellate species. This is crucial because the diversity of eukaryotic microbial communities is determined by such trade-offs in concert with environmental constraints and microbial diversity in turn governs the functionality and “services” of microbial communities and so their role in ocean biogeochemistry.

Title:
Fluid dynamics, ecology, and evolution of flagellate foraging

Principal supervisor:
Thomas Kiørboe



Section:
Centre for Ocean Life

Marcel Montanyès Solé

Background
Marine ecosystems and the services they provide are nowadays threatened by several pressures such as climate change, overexploitation of species, habitat destruction, and invasion of alien species. These pressures are likely to negatively affect taxonomic and functional diversity of marine habitats. Failing to identify future biodiversity trends and thus, to tackle the necessary management and conservation actions, will most likely lead to important biodiversity losses.

Project
This project aims to study the effects of climate change and other human activities (e.g., fishing) on the past, present and future distribution, composition, and diversity of marine fish communities throughout the North Atlantic and North-east Pacific oceans. To achieve this overall aim, we also need to better understand the underlying responses of species to drivers and to key the assembly processes that shape the taxonomic and functional structure and composition of communities at different spatio-temporal scales. We will use available data on marine fish species occurrences and traits and environmental variables to build models that will allow us to study the above-mentioned subjects.

Perspective
This project will improve our understanding on the relative importance of the assembly processes and human activities in defining the fish community. Moreover, the study of biodiversity patterns and drivers will allow us to better understand how they will be affected by climate change, so knowledge can be translated into effective management and conservation measures that seek to preserve biodiversity and hence, human well-being.

Title:
Marine fish diversity patterns, drivers and underlying processes: present status and predictions under climate change

Principal supervisor:
Martin Lindegren

Section:
Centre for Ocean Life

Toni Vivó Pons

Background
The spread of non-indigenous marine species has been increasing over the last decades, having severe effects on the functioning of recipient ecosystems as well as a socio-economic impact. Studying biological invasions from a trait-based approach is really interesting to start addressing interactions between introduced and native species from recipient communities, as the functional similarity between non-indigenous and native species coupled with the community assembly rules (environmentally or biologically filtered) play a major role on the invasion success. As a quick example, within an invasion scenario, a greater trait similarity could imply stronger competitive interactions between natives and invaders that could either difficult the invader establishment or be detrimental for native species.

Project
As a starting point the functional similarity between native and non-native organisms will be assessed, observing if the patterns of similarity are conditioned by the spatial scale, environmental or biotic conditions. This will be done by applying novel techniques for species modeling, which could allow to observe how species are associated by their traits or given certain environmental conditions. Then, the potential consequences derived from the differences in functionality between natives and non-natives will be addressed for recipient communities, e.g. the displacement or enhancing of certain native species, changes in ecosystem functionality or naturalization of the non-indigenous species.

Perspective
The main goal of this project is to propose a trait-based framework to study and better understand how native and non-indigenous species interact and which consequences these interactions could have on recipient communities. The results obtained could be really useful to expand knowledge about biological invasions in marine environments, and then transferred to policy makers to enhance the conservation efforts towards ecosystems under a biological invasion or more susceptible to be invaded in the future.

Title:
Trends and projections in invasive ecology: how susceptible to invasion are our marine ecosystems

Principal supervisor:
Martin Lindegren

Section:
Centre for Ocean Life

Magnus Heide Andreasen

Background
Gelatinous zooplankton organisms are a diverse group of soft bodied, transparent organisms that comprise members from diverse phyla in the animal tree of life. They comdynamics, partly due to their interference with human activities especially in coastal waters. It has been suggested that their abundances are on a rise due to global change induced stressors. However, the data and experimental basis to support this hypothesis remains inconclusive. monly attract large public attention partly due to their bloom and bust population

Project
The aim of this PhD project is to address the hypothesis that gelatinous zooplankton biomass is increasing due to global change induced stressors from a time series as well as experimental perspective. The project will combine statistical modelling with laboratory-controlled experiments.

Perspective
The results are expected to further our understanding about gelatinous zooplankton's long-term abundance fluctuations, their underlying population dynamics and the response of certain sub-populations to global change induced stressors.

Title:
Global change and gelatinous zooplankton: Mechanisms and responses of jellyfish population dynamics to global change induced stressors

Principal supervisor:
Torkel Gissel Nielsen

Section:
Oceans and Arctic

Aurelia Pereira Gabellini

Background
Interactions between ocean currents and life history traits can regulate fundamental processes in marine ecosystems including spatial segregation, speciation and meta-population structures. These processes can act across several temporal and spatial scales altering the response of ecosystems to multiple pressures including climate change. It is therefore relevant to develop methods to assess the marine connectivity across distant biogeographic regions to support the identification of management strategies for the sustainable exploitation of ocean resources.

Project
My PhD project aims to better understand dispersion and connectivity patterns across biogeographic regions in the Atlantic Ocean, by combining trait-based modeling description of marine organisms to high resolution ocean circulation models. General circulation models for the Atlantic Ocean will be coupled to a Lagrangian particle tracking algorithm simulating dispersion of numerical particles with properties defined by specific traits. The analyses will include a wide range of movement strategies from passive transport to more directed movements (e.g. migrations). The resulting connectivity matrices will be investigated to assess the importance of specific traits and the importance of transport across specific regions. The model will be used to assess past and present conditions as well as to provide scenarios of future connectivity patterns in the Atlantic Ocean.

Perspective
This thesis is part of Mission Atlantic project which aim is to map and assess the present and future status of Atlantic marine ecosystems. The results are expected to contribute to further our knowledge about connectivity in the Atlantic Ocean and possible consequences in the recruitment of some selected groups due to climate change.

Title:
Marine Connectivity across the Atlantic Ocean–past, present and future

Principal supervisor:
Patrizio Mariani

Section:
Oceans and Arctic

Caroline Gjelstrup

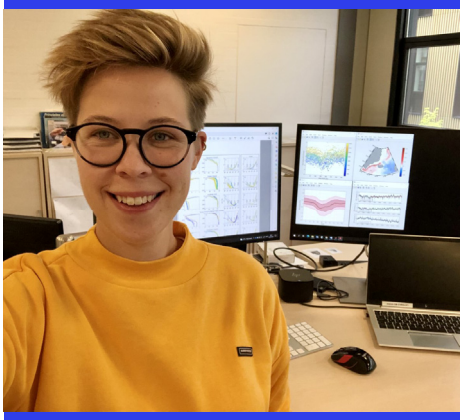
Background
Knowledge of oceanographic conditions and their variability is essential for assessment of environmental impacts on biological communities, ecosystem services and regional climate variability. East Greenland is a region of both climatic and ecological importance, providing a connection between the Arctic and Atlantic oceans as well as eco-system services such as carbon sequestration and fisheries production. The region is influenced by cold fresh waters from the Arctic and warm saline waters from the Atlantic divided by a continuous front extending along the shelf-break. Oceanographic fronts are often associated with elevated plankton production due to entrainment of nutrients enhancing phytoplankton growth and zooplankton grazing, which supports pelagic and demersal fish. Ongoing Arctic climate change, including diminishing sea-ice cover, increasing discharge from the Greenland ice sheet and anomalous warm water pulses of subtropical origin propagating through the region, alter the physical environment.

Project
This PhD project aims to improve our understanding of variability in oceanographic conditions in East Greenland, and how this relates to ecosystem change and fisheries productivity. A combination of in-situ and remotely sensed observational data will be used to characterize oceanographic conditions and resolve underlying mechanisms responsible for variability herein. Eventually, a trait-based model will be applied to understand how changes in environmental conditions influence ecosystem function.

Perspective
By gaining insights as to how the spatiotemporal distribution of water masses in the East Greenland region are changing, and what that change implies for nutrient availability and plankton dynamics we can begin to foresee how East Greenland will respond to future change.

Title:
Changing oceanographic conditions of East Greenland and its link to regional fisheries

Principal supervisor:
Colin Stedmon



Section:
Oceans and Arctic

Anshul Chauhan

Background
Understanding ocean dynamics is vital to interpreting marine ecosystems functioning and determining key processes affecting global climate and biodiversity. Changes in chemical composition, warming of the ocean, loss of biodiversity, and several climate interactions alter the dynamic equilibrium between ocean, land, atmosphere, and between biotic and abiotic components in the Earth System. Such interactions can operate across multiple temporal and spatial scales and generate extreme conditions that significantly alter ocean dynamics and ecosystem functioning. The complexity of these processes is high and many uncertainties still exist on physical, biological, and chemical mechanisms regulating them.

Project
The aim of my PhD is to focus on advancing state-of-the-art processing and interpretation of big ocean data introducing deep learning methods and hybrid-modeling approaches (statistical and process based) for understanding marine ecosystems. This research project is primarily concerned with critical oceanic variables like sea surface temperature (SST), sea surface salinity (SSS), ocean currents, and phytoplankton groups as well as other ocean variables valuable in assessing present and future ecosystem states.

Perspective
With this PhD, we expect to develop indicators for ecosystem state, understand the correlation between extreme events, detect abrupt transitions in ecological states across regions, and simulate possible future outcomes in the spatio-temporal domain.

Title:
Resolving marine ecosystem dynamics in time and space with machine learning approaches

Principal supervisor:
Patrizio Mariani

Section:
Oceans and Arctic

Philip Alexander Hedlund Smith

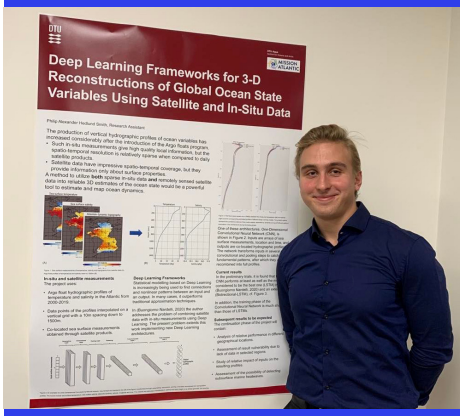
Background
Ocean dynamics are essential for the functioning of the Earth system with important effects on climate regulation and global biodiversity. Regional and global processes driving storage and transport of heat, carbon, nutrients, and marine organisms are crucial for providing many ecosystems' goods and services that enable life on Earth. These processes are driven by mechanisms interacting and operating over wide ranges of spatial and temporal scales, and inherently involve both horizontal and vertical dimensions, making them exceedingly difficult to monitor and to understand fully.

Project
The general objective is to determine and understand spatio-temporal dependencies, relations, and mutual effects in the abundant climate and biogeochemical data. The goal is to understand these relationships as well as constructing frameworks for predicting future behavior. Moreover, to establish systems where ocean and ecosystem dynamics are learned and can be emulated for different initial state values. Neural networks and deep learning approaches in particular display major advantages in exploiting spatio-temporal data and capturing nonlinear relations in data compared to classical approaches.

Perspective
Generating deep learning frameworks to combine remotely sensed and in situ observations may improve estimates and models of subsurface ocean state variables, which presently can be difficult to monitor due to the scarcity of local measurements. Furthermore, predictive data-driven models that accurately reproduce simulation data may facilitate comprehensive risk analyses and assessments, as changes in simulation data for varying driver inputs may be considerably less time consuming.

Title:
Big data analytics to support ecosystem-based risk management of marine ecosystems

Principal supervisor:
Patrizio Mariani



Section:
Oceans and Arctic

Costanza Cappelli

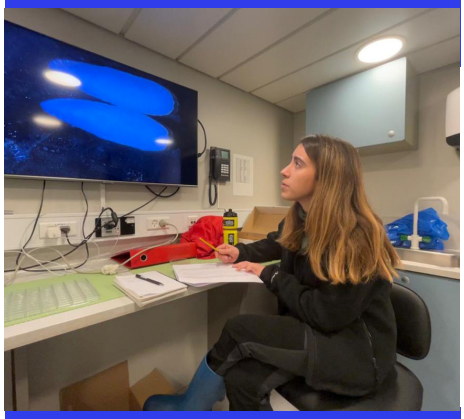
Background
Blue whiting (*Micromesistius poutassou*) is a mesopelagic gadoid species widely distributed in the northeast Atlantic Ocean, and it is commercially exploited throughout much of the region. It is both an important prey for many higher trophic level species and a zooplanktivore exerting significant top-down pressures. In the last 15 years, blue whiting has experienced considerable swings in abundance and recruitment. Despite its commercial and ecological importance, little is known about blue whiting stock dynamics in relation to atmosphere-ocean variability, constituting a major source of uncertainty for the management of this species.

Project
In this PhD project, I will examine how large-scale changes in the ocean-climate conditions affect blue whiting recruitment and distribution in the North Atlantic Ridge area. Using statistical tools and agent-based particle tracking modelling approaches, I will provide a quantitative analysis of the relationship between large-scale oceanographic features in the North East Atlantic (e.g., subpolar gyre dynamics, wind stress curl) and the early life history of blue whiting (larval drift patterns, growth, and survival rates).

Perspective
This project will assess factors shaping temporal and spatial dynamics of blue whiting populations in relation to variable marine climate conditions in the North East Atlantic Ocean. The purpose is to develop models to understand the reproductive variability of blue whiting, as well as to improve stock assessments and fishery-related forecasts for this species. This knowledge will contribute to new ecosystem-based approaches to the management of blue whiting, UN Sustainability Development Goals related to Life Below Water, and an increased understanding of how climate change might impact productivity and biomass of this species.

Title:
Physical processes affecting stock dynamics of blue whiting in the northeast Atlantic Ocean

Principal supervisor:
Brian MacKenzie



Section:
Oceans and Arctic

Athanasios Kandylas

Background
Oceans play a crucial role in regulating and stabilizing the Earth's climate having stored nearly 40% of the anthropogenic CO_2 emissions since the industrial revolution. However, potential tipping points might lead to abrupt changes of critical physical and biological processes affecting important marine ecosystem services, such as carbon sequestration and food production. Even though the science around the physics of climate change is robust, our understanding about the response of the marine ecosystems to these changes is still incomplete.

Project
The aim of this PhD is to develop a framework through advanced ecological modelling which will be able to give an insight into the ecological state of the majority of the marine ecosystems around the world. We expect that at the end of this process, we will have gained a better understanding of two important and interrelated phenomena: Carbon Sequestration and Oxygen Minimum Zones (OMZ) in the ocean. To accomplish this, the Nutrient – Unicellular – Multicellular (NUM) framework and the SISSOMA, a specialized aggregation model, developed in the Centre for Ocean Life will be applied.

Perspective
Overall, in a fast-changing world we need to be able to make accurate predictions about the function and structure of marine ecosystems on a global scale. The tools developed in this project work on this direction and they will hopefully help us to take critical management decisions on time.

Title:
Carbon sequestration and oxygen minimum zones

Principal supervisor:
Andre Visser

Section:
Oceans and Arctic

Thøger Engelund Knudsen

Background
Seasonal migration can serve as a strong advantage for many species across large scales of the animal kingdom. The Atlantic bluefin tuna is one such species, and travels vast distances, presumably in search for abundant prey resources. This tuna is of special interest in Denmark, as parts of its population have recently started consistently making the journey from the Mediterranean all the way to Skagerrak and Øresund.

Project
The general objective of this PhD project is to create one or more models that are able to mathematically describe the existence and evolution of migratory routes in pelagic fish populations. It is possible to mathematically show how migration and its benefits can manifest in the evolution of a species due to natural selection. An individual will to an extent remember successful journeys it has undergone during its lifetime. However, it is poorly understood how this knowledge accumulates and persist, transcending through generations, especially for species without means of explicitly communicating this information. I seek to develop a novel framework that explains the existence and creation of migratory routes in social memory so that we can understand the spatio-temporal dynamics of populations of fish like the Atlantic bluefin tuna.

Perspective
This project will help determine the key aspects for local populations of Atlantic bluefin tuna, hopefully ensuring that they have come to stay. Furthermore, the existence of a framework that describes the creation of migratory routes through collective behaviour will advance our ability to understand and predict changes in migrational patterns in a changing world.

Title:
Fish migration and ecosystem processes

Principal supervisor:
Brian MacKenzie

Section:
Oceans and Arctic

Camilla Christensen

Background
Archived specimens held in museums and other natural history collections can provide a population genetic baseline, against which to assess potential negative consequences of recent changes in the environment. Thereby, offering an opportunity to track demographic and evolutionary consequences of climate change and other human-induced pressures. The recent advances in molecular genomics has made it possible to investigate genetic changes in many individuals sampled more than a century ago. However, few retrospective genomic analyses has comprised sharks.

Project
This PhD project is part of an international collaborative project, GenoJaws, involving the University of Queensland, Technical University of Denmark and Flinders University. The ambition of the project is to gain knowledge about population genetic parameters of the vulnerable sand tiger shark (*Carcharias taurus*) on a spatial and temporal scale. Performing genomic analysis on contemporary and historical samples will allow us to test for changes in abundance, effective population size, distribution and connectivity and ultimately make us capable of evaluating adaptive responses to environmental change and exploitation.

Perspective
By tracking changes in genetic composition on a temporal scale, it is possible to find evidence of both distributional shifts and responses to selection. Ultimately, analysis of such records, taken over several years, can help us understand micro evolutionary processes. In addition, retrospective analysis can help making informed decisions for the protection and management of the current populations of sand tiger sharks.

Title:
Population genomics of archived shark samples

Principal supervisor:
Einar Eg Nielsen

Section:
Marine Living Resources

Paulina Urban

Background
Environmental DNA (eDNA) describes all DNA molecules found in an environmental sample, e.g. water, soil or air, that originated from organisms present in that environment. Consequently, analysis of eDNA can be used for monitoring of species or species assemblages. This would likely save time, costs, and workload for such procedures. So far, eDNA implementations for large scale monitoring projects conducted by management institutions, such as fisheries institutes, are limited. This includes both single species monitoring, of e.g. invasive species, and monitoring of species assemblages, e.g. for bycatch estimations. One of the reasons for this might be the need for quantitative estimates for such applications. In order to use eDNA for quantitative estimates, eDNA behavior needs to be better understood, and the molecular methods applied need to be calibrated and validated.

Project
My PhD project aims at facilitating practical implementations of eDNA based methods for monitoring of single species and species assemblages in management and industry. To archive this, on the one hand I will develop methods for eDNA-based quantitative assessment of species assemblages that could be used for by-catch estimations in fisheries. On the other, I will assess and advance methods for monitoring single species, e.g. invasive species that would enable fast monitoring of their spread in ecosystems.

Perspective
Results gained from this PhD project will improve the understanding of eDNA ecology and behavior, and improve the molecular methods applied on eDNA for different monitoring goals. If successful, the methods developed throughout the PhD will come at hand to applied areas such as management, and industry, which need frequent species monitoring.

Title:
Analysis of environmental DNA, "eDNA" from marine organisms

Principal supervisor:
Einar Eg Nielsen

Section:
Marine Living Resources

Paco Rodriguez-Tress

Background
Schooling and swarming are dominant features in marine ecosystems and are observed in over 25% of bony fish species throughout their life. Despite being present through most of the commercial fish species, the fundamentals of schooling mechanisms, as for example triggers, are still not well understood to date. Thus, the distribution and the spatial structure of pelagic schools remains elusive, potentially controlled by a range of factors, that still remains to be elucidated. These small- and large-scale aggregation dynamics can lead to a mismatch between traditional surveys and fish distribution, and to predictable variability in occurrence and density of schools, which are important elements of the commercial cruise planning, fuel optimization and target decision.

Project
Using direct commercial fishing data and underwater acoustic observations, this industrial PhD project will provide insight into the spatial distribution and schooling mechanisms of pelagic fishes. Going further in-depth with understanding causes of uncertainty in biomass estimates, it investigates the behavioural mechanisms of schooling fish during school-formation and -deformation at dusk and dawn. This way, spatial structure is understood as an emerging and predictable property of individual behavior and can be separated from measurement uncertainty.

Perspective
Small pelagic schooling fish are a sustainable and healthy protein source, which plays a key role in food security. They also have a significant potential for the green transition, as they are a CO2-friendly protein source. Conversely, the challenge when mobilizing fish in the green transition is to ensure sustainability and to maintain a low CO2 emission in the catching process. Thus, this project will provide mechanistic knowledge about spatial distribution of fish, so that stock assessments can be improved, and fishing optimized.

Title:
Optimizing important small pelagic fish resources by using data from scientific & commercial vessels

Principal supervisor:
Stefan Neuenfeldt

Section:
Marine Living Resources

Alexander Rosén

Background
Metabolic rate scales with body size, but usually out of proportion, meaning that for a given increase in body mass, metabolic rate usually increases less. This means that larger animals are more efficient, and 1 kg of mouse thus uses magnitudes more energy than 1 kg elephant. This scaling is not constant and there is substantial variation among taxa and taxonomic level. Precisely why it is so, and particularly why there is variation in this metabolic scaling relationship between individual, species and groups of species are some of the biggest unanswered questions in biology.

Project
The goal of the project is to test a novel hypothesis that metabolic scaling is governed by growth and that variation in selection pressures on fast early-life growth courses the variation in metabolic scaling. This will be tested using both a multigenerational selection study where zebrafish will be breed for high or low growth rates and during a comparative study examining different fish species with varying levels of early growth rates. Metabolic rate will be measured with respirometry.

Perspective
This project is expected to produce new and fundamental knowledge about metabolic scaling and why it varies both in individuals, between individual, between species and species groups. These findings would translate into a better understanding of the energetics of animals and low evolution affects this. In addition, it can help predict how animals will be respond to new selection pressures such as climate change and over-harvesting.

Title:
Growth and metabolic scaling of fish: unravelling how variation in growth affects metabolic scaling

Principal supervisor:
Tommy Norin

Section:
Marine Living Resources

Berthe Vastenhoud

Background
The mesopelagic zone of the ocean is located in pelagic water masses from 200m to 1000m depth, between the euphotic zone, where light is available, and the bathy-pelagic zone, where no light is visible. Global survey estimates of the mesopelagic fish biomass are large but remain uncertain, with estimates ranging between 1 and 20 Gt. There is increased interest from commercial fisheries to exploit these species for the use for fishmeal, fish oil and nutraceuticals, but the question is whether such potential exploitation is sustainable or not.

Project
This project evaluates the sustainability of potential exploitation of two key meso-pelagic fish species, *Maurolicus muelleri* and *Benthosema glaciale*, in the North-East Atlantic Ocean, both in terms of ecological sustainability and economic viability. Length-based statistical methods for data-limited stock assessments are used to estimate demographic parameters related to growth, mortality, stock size and production of the stocks according to Maximum Sustainable Yield. The economic sustain-
ability of a mesopelagic fishery and different management strategies will be evaluated using the DISPLACE individual vessel based bio-economic model for Danish large scale pelagic fisheries.

Perspective
Alongside with the global human population growth, the demand for food, including marine products, continues to increase. The sustainable exploitation of new marine resources such as mesopelagic species could complement and potentially partially relieve the fishing pressure on existing marine resources while meeting the increasing demands. It is important already in an early stage to make assessments of the long-term ecological and economic sustainability of potential exploitation, and to develop suitable management measures. This project is part of the H2020 MEESO project, which aims at filling knowledge gaps related to mesopelagic species, to assess their role in the ecosystem and the sustainability of potential mesopelagic exploitation.

Title:
Fish stock assessment and fisheries dynamic modelling - Investigating the sustainability of potential mesopelagic resource exploitation

Principal supervisor:
J. Rasmus Nielsen

Section:
Ecosystem based Marine Management

Anne Cathrine Linder

Background
One of the grand challenges of sustainability science is understanding principal trade-offs between human well-being and the natural environment. Such trade-offs are dependent on how well-being benefits emerge from spending time in nature and how such use of nature may in turn threaten biodiversity. Thus, it is relevant to determine the overlap between species and habitats sensitive to tourism and recreation and ecosystem features underpinning cultural ecosystem services (CES). CES are generally defined as non-material benefits people obtain from nature and have been suggested to be important contributors to human well-being. However, we have a poor understanding of how CES are derived from human-nature interactions, with one of the key hurdles being data access.

Project
The objective of my PhD project is to utilize data from social media to understand cultural ecosystem services associated with human-nature interactions and assess trade-offs arising from these interactions. Social media sampling and text mining approaches will be used to sample the intensity of nature use and retrieve the context of human-nature interactions to identify key ecosystem features providing CES. This project will also estimate sentiment and emotions expressed in social media posts, which along with a series of controlled experiments will enable me to understand well-being emerging from CES exposure as facilitated by human-nature activities.

Perspective
This project will advance sustainability science by providing a global understanding of CES. Moreover, this project will identify nature features important for eliciting well-being benefits and determine the overlap between these key features and species and habitats sensitive to tourism and recreation. Thus, providing a framework for assessing trade-offs arising from human-nature interactions.

Title:
Using computational human ecology approaches to understand the role of cultural ecosystem services to trade-offs between human well-being and biodiversity conservation

Principal supervisor:
David Lusseau

Section:
Ecosystem based Marine Management

Zita Bak-Jensen

Background
Several demersal fisheries are by nature mixed species fisheries because of abundance of several species simultaneously in the fishing ground. In the capture some species are target species while others should be avoided or at least minimized as much as possible. Therefore, there has been focus on developing gear solutions that can address the mixed-species challenge. In the Baltic Sea the challenge is having an effective fishery targeting flatfish species while avoiding or at least minimizing the capture of cod. Traditionally, the approach of dealing with gear development has typically been towards single species, where the selectivity for each species is evaluated individually, but is in this PhD project shifting to a multi-species approach.

Project
With the demersal trawl fisheries being used as case studies, this PhD project will focus on developing and testing new approaches and data frameworks that bring the currently used method from single to multi-species assessments in evaluating fishing gear performance. A special focus will be on cod avoidance in the demersal trawl fishery in the Baltic Sea targeting flatfish species such as plaice and flounder.

Perspective
The aim is to develop a new approach and data framework for evaluating the performance of the selectivity in multi-species fisheries making selection and selectivity models more adequate when dealing with multi-species fisheries. Even though this PhD project will focus on cod in the Baltic Sea the method will be extrapolatable to much larger scaled mixed-species fisheries.

Title:
Shifting from single to multi-species methods when evaluating fishing gear performance

Principal supervisor:
Bent Herrmann

Section:
Fisheries Technology

Mette Svantemann Lyngby

Background
Today's limited insight into what is occurring throughout fishing processes means that commercial fishing is still mainly undertaken in the blind. Consequently, current commercial fishing practices result in unnecessary bycatch and environmental impacts, carbon dioxide outputs, all while reducing the economic competitiveness of the sector. DTU Aqua has developed a cable-based real-time camera to be applied in fishing operations such as bottom trawling. The camera will provide the fishermen with a stable real-time video of the process and enable them to observe catch items that enter the trawl. DTU Aqua has undertaken development work to improve the camera observation scene in the trawl to accurately monitor the entire catch and the species composition passing towards the codend.

Project
This PhD project will use the established data stream from the newly developed and installed real-time trawl camera system. The focus of the PhD project will be to quantify the system's performance and its overall effect on both the ecological and economic sustainability in selected trawl fisheries. The project will further develop new AI-based solutions to automate the extraction of important information from the real-time UW observations to improve catch efficiency and specific bycatch avoidance.

Perspective
Such real-time catch descriptions will allow fishermen, for the first time, to continuously monitor catch volumes and compositions and actively improve the catch composition in the ongoing fishing process. This new technology has significant news value, both nationally and internationally, and will contribute to the development of a technology-based fishery where fishermen in real-time will know what is being caught and have the opportunity to direct the ongoing catch compositions towards the quotas available.

Title:
Developing real-time decision support tools for commercial fisheries to facilitate a more dynamic fisheries management

Principal supervisor:
Ludvig Ahm Krag

Section:
Fisheries Technology

Martin Mathias Nielsen

Background
Electronic monitoring (EM) was introduced into demersal fisheries in Europe in 2008. The EM cameras were installed to produce video footage of the fishing operations on-board with the objective to verify declared catches to attain a fully documented fishery. Since then, it has become clear that these data have much wider applications than merely control and enforcement. A key challenge in utilizing these data has been the reliance on manual reviews for analyzing the EM footage, which today is processed on land by trained humans. This procedure severely limits the application of the data as only a fraction of the collected data is getting analyzed due to the workload involved, and since the analysis is not conducted in real-time.

Project
In this PhD project, the application of new computer vision methods is investigated to address some of the existing challenges in automatically documenting catch compositions in terms of species identification and length distributions. This new data can potentially challenge conventional fisheries management practices, provide fishers more insight into their fisheries, and change the way fishing gears are developed, tested, controlled and monitored – which will be investigated to further incentivize the adoption of EM.

Perspective
Besides being a control and enforcement tool to verify declared catches, this new data has the potential to significantly increase the 1% catch coverage from observer programs today. This data can, among others, support more accurate stock assessments, identify bycatch hotspots, help fishers avoid choke situations, and provide insights into interactions with protected species, mammals, and birds.

Title:
Unravelling the potential of electronic monitoring data for facilitating innovation within demersal trawl fisheries

Principal supervisor:
Jordan Feekings

Section:
Fisheries Technology

Laura Diernæs

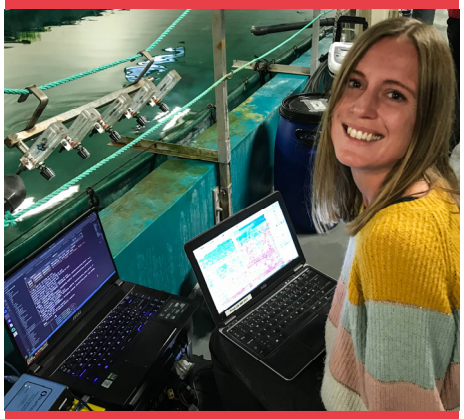
Background
Trawl gears are responsible for a large portion of unwanted catches, globally. Conse-quently, there is a large focus on improving their environmental sustainability while ensuring that the fisheries remain economically viable. Animal behaviour is one of few main components that are decisive for the efficiency and selectivity of commercial trawl gears and so, the amount of unwanted catches retained. Behaviour of marine animals is typically studied using underwater cameras attached to the fishing gear. This technology has however limitations in the operational conditions during which observations can be obtained.

Project
Recent technological developments, such as high frequency acoustics, as well as alternative platforms for collecting data, such as remotely operated vehicles, provide new ways to quantitatively study fish behaviour in relation to fishing gear. This project focuses on using hydroacoustic to develop methods for optimal identification and tracking of individuals. Such tracking enables detailed observations of animal behaviour during the capture process with trawls.

Perspective
Using hydroacoustic techniques to observe detailed animal behaviour facilitates the understanding of the behavioural mechanisms involved when animals respond to fishing gears. This information will reduce the huge knowledge gap found for many commercial species and has the potential to support the development of more sus-tainable trawl designs.

Title:
Observing and quantifying fish behaviour in relation to active fishing gear

Principal supervisor:
Junita Diana Karlsen



Section:
Fisheries Technology

Nurul Huda

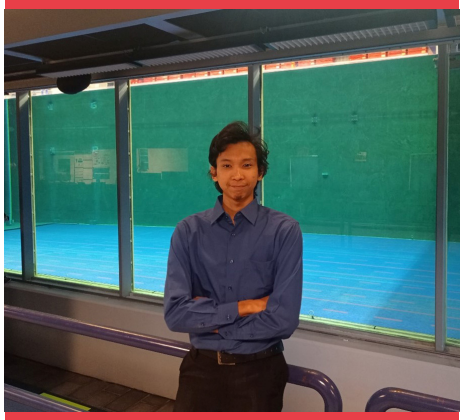
Background
In recent years there have been increasing concerns regarding demersal trawl physical impacts on the seabed, which can give rise to (i) increased fuel consumption, (ii) the release of carbon sequestered in the seabed, (iii) habitat modification and (iv) benthic mortality. In order to promote the environmental and economic sustainability of towed demersal fisheries, we must reduce the physical impacts of these gears when they are towed across the seabed. One of the main approaches in the design and development of fishing gears is small scale model testing in recirculating flume tanks. These approaches are based on maintaining the ratio of the gravitational and hydrodynamic drag forces, (characterised by the Froude and Reynolds numbers) so that the observations at the small scale can be extrapolated to the full scale. The current approaches do not account for bottom contact forces, and hence are not particularly suitable for designing demersal gear which are towed across the seabed.

Project
This project will focus on developing generic scale-modelling rules for demersal trawls that balance the gravitational, hydrodynamic drag and contact forces acting on a trawl gear. The theoretical framework will be established based on the fundamental relationships between these forces. This will be done by analysing the geometry and force measurements on different scale representations of a given trawl gear. Small scale trials will take place in a flume tank and full-scale trials will take place at sea, using a research vessel.

Perspective
The resulting scale modelling criteria will allow small-scale experiments on demersal fishing gear, which are carried out in flume and towing tanks, to be scaled up and extrapolated accurately to full scale. This will permit the design and development of low impact, fuel efficient fishing gears that will help ensure the environmental and economic sustainability of towed demersal fisheries.

Title:
The scale modelling of towed demersal fishing gears

Principal supervisor:
Barry O'Neill



Section:
Fisheries Technology

Sissel Kolls Bertelsen

Background
The Common Fisheries Policy (CFP) aims to ensure sustainable fish stock exploitation and eliminate discards. To achieve this, the EU has implemented the Technical Measures Regulation, outlining complex restrictions to e.g. fishing gear and area. The complexity and prescriptiveness of the Technical Measures Regulation restricts fishers' ability to adapt their fishing practices according to changes in the fishery. Presently, however, emerging technologies such as electronic monitoring can potentially facilitate automatic catch registration, and thereby provide fully documented fisheries. Thus, by providing fully documented fisheries, electronic monitoring could increase the data input to stock assessments, enhance enforcement of regulations, replace time consuming control procedures, and potentially render large parts of the Technical Measures Regulation redundant.

Project
The overall aim of this PhD is to understand whether the implementation of new technologies for catch monitoring and reporting can facilitate a simpler and more flexible management framework, while ensuring improvements in the environmental and economic performance of fisheries. The project will be made in close collaboration with the fishing industry and the Danish Fisheries Agency and contribute to the EU Horizon project EveryFish.

Perspective
Simplifying the management framework may act as an incentive for the fishing industry to adopt electronic monitoring. Additionally, this project will explore fisher's perceptions of electronic monitoring, to understand challenges and advantages related to this from a fisher's perspective. Finally, the project will investigate how information from electronic monitoring data can be made useful for fishers to increase the efficiency of the fishing process. Hence both management, technical, and social aspects related to the implementation of electronic monitoring are considered in this project.

Title:
Electronic monitoring and new management structures for facilitating innovation within fisheries

Principal supervisor:
Jordan Feekings

Section:
Fisheries Technology

Cristina Fernández García

Background
Demersal fishing gears, particularly beam trawls, lead to significant negative impacts on the seabed and benthic communities. Heavy gear components are used to mechanically lift target catches into the net, damaging benthic habitats, causing alterations in sediment composition and disrupting marine ecosystems. Overall, these effects contribute to reduced biodiversity, altered species composition, resuspend sediments, and nutrients, and release CO_2 that was sequestered in the seabed, compromising the overall marine ecosystem health. With increased awareness towards sustainability in recent years, there is significant demand for innovative technologies that can be both less aggressive towards the seabed and selective for the target species with high commercial value, thereby reducing bycatch. Fishing gear development, specifically the modification of towed gear design to enhance fisheries sustainability and optimize fishing performance, therefore, has great potential for mitigating environmental impacts.

Project
This PhD project will start building on the results of a recent study in the Limfjord sea star fishery, where it was demonstrated that the turbulence in the wake of a beam towed close to the seabed can replace the mechanical gear components to raise sea stars from the seabed. This new data constitutes the foundation to investigate further modifications of the beam design and the project will shed light on the understudied behavioral responses of several demersal target and bycatch species in response to hydrodynamic flow.

Perspective
By leveraging this innovative gear modification, this project aims to explore new possibilities for sustainable fishing practices which, in turn, strive to make cost-effective technology readily available to fishers enhancing their efficiency and sustainability practices, with a focus on minimizing environmental impacts and reducing bycatch in various highly impactful fisheries.

Title:
Using hydrodynamics to modify the performance of towed fishing gears

Principal supervisor:
Barry O'Neill

Section:
Fisheries Technology

Satish Pawar

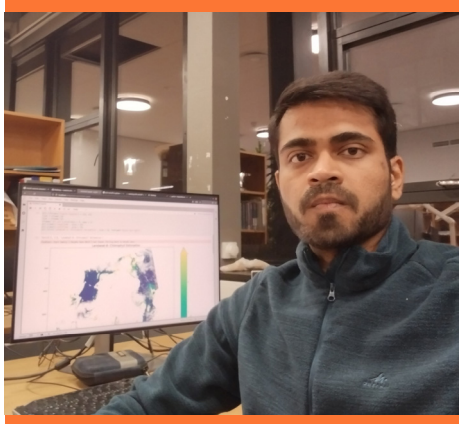
Background
Eelgrass is one of the common aquatic vegetation in the northern temperate coastal regions. It provides valuable ecosystem services like nursery grounds to juvenile fish, improve water quality and sequester carbon as green biomass. The eelgrass meadows in Danish coastal waters were damaged due to stone fishing and frequent eutrophication episodes. These activities have been discontinued and water quality has improved over the last decade. However, the eelgrass has not recolonized the previously occupied habitat sites. Understanding the factors affecting eelgrass recovery is primary task in eelgrass habitat restoration and future management.

Project
The eelgrass growth could be affected from local disturbances along with global phenomena of climate change. This project aims to understand the combined effect of these factors affecting eelgrass recovery. This will be achieved by combining the monitoring data of eelgrass environment and habitat suitability modelling techniques. Continuous satellite data will provide spatial habitat variables like light availability, turbidity and Sea Surface Temperature (SST) of shallow waters. The habitat suitability analysis will be performed by implementing the eelgrass growth model with spatial habitat data along with correlation-based niche models to spatially map potential habitats. The growth models can simulate climate change scenarios to evaluate effect of eutrophication and increased water temperature.

Perspective
Combining satellite data and modeling will provide new knowledge on shallow water environment in Danish coastal waters. The project will contribute significant insight into the combined effect of eutrophication and climate change on eelgrass health. From the spatial outputs of habitat suitability, eelgrass zones for potential recovery can be identified for their management. The information obtained from spatial simulations can aid in planning restoration activities and forming policies for eelgrass conservation.

Title:
Habitat suitability and potential recovery of eelgrass

Principal supervisor:
Karen Timmermann



Section:
Coastal Ecology

Isabelle Johansson

Background
Blue mussels are an ecosystem engineering bivalve that enhances biodiversity by creating habitats for other species, contributes to a local particle reduction by controlling phytoplankton biomass and water clarification. Stability of blue mussel beds and factors influencing variation in populations between years is not always understood, especially in eutrophied subtidal areas. Limfjorden is the main area for both blue mussel fishery and aquaculture in Denmark and the mussel stocks are surveyed annually. However, the current large-scale mapping is resource intensive.

Project
This project aims to understand factors influencing development and stability of mussel bed in subtidal areas. This will be achieved by performing survival analysis on temporal mussel beds using a time series of stock assessment data, black box data from fishing vessels and environmental data. Furthermore, production efficiency for wild mussel seeds in on-bottom culture in Limfjorden will be explored, to find the optimized density of mussels to relay in culture plots. Finally side scan sonar imagery collected for various mussel beds (wild, culture plots and restored beds) will be investigate regarding the possibilities to develop automated data processing methods to optimize the mapping of areal distribution, coverage, and biomass of mussel beds.

Perspective
This project is expected to assess the stability and document factors affecting the stability of mussel beds in eutrophic subtidal areas. The outputs will contribute to the sustainable development of mussel production and can improve management of biogenic habitats as well as fisheries/aquaculture management. During this project existing non-invasive techniques will be optimized and developed to map areal distribution, densities, and biomass of blue mussel beds. The methodology could be applied for multiple purposes benefitting fishery management by improve methods for stock assessments, optimizing the cultivation practices of on-bottom mussel aquaculture or establishment and monitoring of restored mussel beds.

Title:
Stability of subtidal blue mussel bed in coastal areas

Principal supervisor:
Pernille Nielsen

Section:
Coastal Ecology

Thiviya Nair

Background
The Danish Limfjorden was once rich with European Flat Oysters (*Ostrea edulis*), treasured as a reef engineer and a nutritious source of protein by local and foreign markets. Unfortunately, the spread of the invasive micro-parasite, *Bonamia ostreae*, and overfishing for the flat oysters in Europe eventually caught up with the region, decimating their populations. In 2020, the Limfjorden lost its disease-free status and relies on the production of Bonamia-free spat to seed shellfish aquaculture and reef restoration efforts. Bonamia-free spat production relies on accurate and early detection of the parasite, as its life cycle outside of its host is unclear, and infections are often diagnosed when it is too late.

Project
My projects will aim to investigate the biotic and abiotic factors that contribute to the activation of bonamiosis in flat oysters and potential treatments that can be applied to limit *B. ostreae*'s infectivity. The project will also include testing early and non-destructive sampling methods for parasite detection and provide a basis for biosecurity protocols required for successful Bonamia-free oyster spat production in the Danish Shellfish Centre hatchery at Nykøbing Mors.

Perspective
The discoveries that will be made in this project will fill up the knowledge gaps on the life cycle and behaviour of *B. ostreae*. The disease testing methods refined in this project will also serve as a potential early alarm system for hatcheries and Bonamia-free sites. Developments from this project will enable shellfish farm managers to formulate the best mitigation strategies and avoid financial losses. The Bonamia-free spat produced through the efforts of this project can go on to seed future reefs and fisheries, thereby reviving the flat oyster populations in the Limfjorden.

Title:
Disease-free production of European flat oysters

Principal supervisor:
Camille Saurel

Section:
Coastal Ecology

Bruno Ibanez Erquiaga

Background
There is growing evidence that oil and gas platforms may provide productive habitats for fish communities, partly because of reef effects associated with the foundations, but also because the areas within and surrounding the platforms may act as *de facto* marine protected areas with limited or no ongoing fishing. For example, the Atlantic cod (*Gadus morhua*), which constitutes an important target for North Sea fisheries, but its populations are considered to stand below sustainable thresholds, have been preliminarily associated with these structures. However, there is still a poor understanding of the mechanisms behind platforms' effects and scarce assessments of the ecological outcomes in relation to fish ecology and fisheries. This makes it difficult to predict possible fisheries scenarios associated with different decommissioning and abandonment options.

Project
The project aims to provide an understanding of the role that platforms are playing for fish and fisheries in the Danish North Sea, using cod as a case study. The experimental approach involves estimating catch variation along distance-to-platform gradients, and spatiotemporal 3D mapping of cod individuals nearby an oil platform. This knowledge seeks to inform decision-making processes related to platform decommissioning in the North Sea by evidencing how these structures are acting as artificial reefs, potentially providing refuge and substrate to different species.

Perspective
We expect to evidence the potential importance of oil and gas platforms for Atlantic cod in the Danish North Sea. Considering that fishing is banned within 500m around the platforms, these structures could be functioning as fish sanctuaries and fish hubs, supplying juvenile fish to other areas of the North Sea. Provided the intense trawling in the North Sea, platform decommissioning could contemplate a partial scheme in which some structures are left to provide refuge for fish communities. Our information will help in the design of future decommissioning and abandonment plans.

Title:
The importance of oil and gas platform foundations for a key commercial species, the Atlantic cod

Principal supervisor:
Jon C. Svendsen

Section:
Freshwater Fisheries and Ecology

Lene K. Sortland

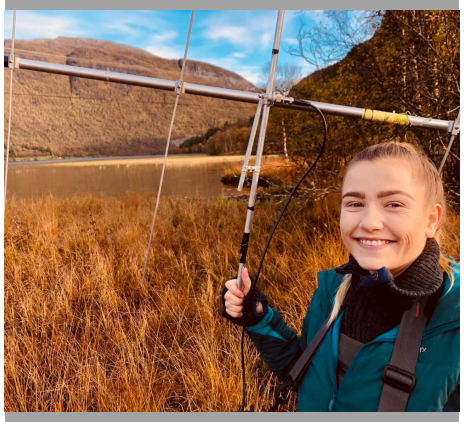
Background
Salmon and sea trout are iconic salmonids that migrate between the freshwater and marine environments. Salmonids reproduce in rivers, where they spend their juvenile phase before migrating to sea as "smolts" for feeding and growth. During their seaward migration smolts can experience high mortality rates, both natural (e.g., predators) and human induced (e.g., hydropower regulations). Smolt survival is generally considered to be density-independent, meaning there should be a correlation between smolts leaving the river and adults returning to spawn. Thus, increasing the number of smolts leaving a river can increase the number of adult returns.

Project
The aim of my PhD is to use telemetry to identify bottlenecks that limit the survival of seaward migrating smolts. Telemetry involves attaching animals with electronic transmitters and tracking their movements through listening stations in the river, estuary, and fjord or with manual tracking along the river. Using telemetry and other sources of information (i.e., physiology, environmental conditions), I will investigate how migration and survival of smolts are influenced by predators, surrounding temperature, energetic status of individuals, and also look into the impacts of trapping, handling and tagging smolts with electronic transmitters.

Perspective
Salmonids are facing multiple threats in their marine and freshwater environments, with humans often being the source. Despite conservation efforts, the number of wild Atlantic salmon has declined during the last couple of decades. Identifying and reducing bottlenecks for smolt survival can aid management actions to optimize adult returns and aid population recoveries.

Title:
Increasing adult salmon recruitment via optimizing management decisions during outmigration

Principal supervisor:
Kim Aarestrup



Section:
Freshwater Fisheries and Ecology

Benedikt Merk

Background
The eutrophication of lakes can alter aquatic ecosystems, by creating algal blooms and anoxic conditions, often resulting in reduced water quality and a loss of biodiversity. Zooplanktivorous fish like roach (*Rutilus rutilus*) reduce the predation of phytoplanktonic algae increasing their abundance. Thus, water turbidity increases and growth of benthic macrophytes that provide valuable micro-habitats for zooplankton and piscivores, e.g., pike (*Esox lucius*) is hindered. Alteration of the fish composition, in combination with reduction of nutrient influx, can minimize the effect of eutrophication on the lake, and lakes can even be restored to their mesotrophic origin. However, alterations in fish biomass (e.g., by removing roach from lakes) and environmental changes (e.g., water clarity and lake stratification) likely have various effects on the ecology, behaviour, inter- and intraspecific interactions of the remaining fish community.

Project
This PhD project is centred around a eutrophicated lake undergoing restoration efforts through first biomanipulation and next sediment-removal with the aim to improve water quality and biodiversity. The project utilizes high-resolution acoustic telemetry allowing for fine scale 3D-postioning of tagged fish in combination with continuous measurements of several biotic (e.g., growth, fecundity, density) and abiotic parameters (e.g., water temperature, oxygen). Thus, detailed behavioural and ecological analyses of roach and pike before, during and after lake restauration measures can be conducted.

Perspective
The project contributes to expanding our knowledge regarding fish behaviour in a changing environment by exploring novel aspects of fish behaviour relating to inter- as well as intraspecific interactions which can be of relevance for future management of other eutrophic lakes. Additionally, biomanipulation and fish observation methods are assessed, aiming to increase their effectiveness. All in all, a wider understanding of the impacts lake restoration methods have on fish behaviour and lake ecology can be generated.

Title:
Lake restauration and its effects on fish behaviour

Principal supervisor:
Christian Skov

Section:
Freshwater Fisheries and Ecology

Marie Hartlev Frausing

Background
Marine habitats in Denmark have undergone degradation during past decades due to factors as stone fishing and global warming. Suitable marine habitats are important for the commercially and recreationally valuable species Atlantic cod (*Gadus morhua*) and anadromous brown trout (*Salmo trutta*). Brown trout smolts are particularly dependent on suitable coastal habitats as smolts are vulnerable when they enter the marine environment and often experience severe predation. Atlantic cod populations in the Baltic Sea are currently under pressure and most cod stocks in this region have been depleted and are unable to reproduce in a stable manner. Despite various efforts to increase populations of cod and trout, only little attention has until now been put into understanding the dynamics and beneficial effects of coastal habitat improvements and marine protected areas (MPAs) for these species in the Baltic Sea.

Project
The aim of this PhD project is to examine and document the effects of coastal habitat improvements and MPAs on the presence of anadromous brown trout and Atlantic cod. Acoustic telemetry will be applied to track and examine the presence of juvenile and adult trout as well as cod at different coastal sites in Denmark. The presence of juvenile trout will be studied in association with the establishment of a coastal boulder reef. The reef is expected to provide appropriate habitats for the juvenile trout when they migrate into the marine environment. The presence of adult trout and cod will be investigated in two coastal MPAs and examined in relation to temperature.

Perspective
The results of this PhD project will strengthen our understanding of the beneficial effects that coastal habitat improvements and MPAs may have on trout and Atlantic cod. The movement patterns and presence of the tagged fish within the study areas will provide crucial information for future coastal habitat improvements and MPAs and how to use such management tools in the years to come.

Title:
Documenting the effects of coastal habitat improvements and marine protected areas on the presence of anadromous brown trout and Atlantic cod

Principal supervisor:
Jon C. Svendsen

Section:
Freshwater Fisheries and Ecology

Marie Pedaccini

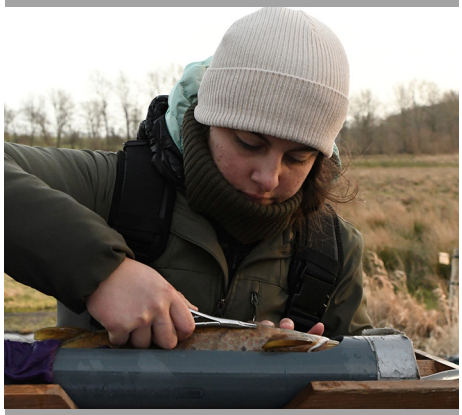
Background
Fish must cope with numerous stressors and threats, including pollution, habitat destruction, overfishing, fisheries interactions, and climate changes. Understanding when and why fish are vulnerable is crucial for conservation, especially for migratory species, facing energy-intensive migrations and relying on specific environmental conditions. Although previous studies have assessed the vulnerability of salmonids and tunas under some circumstances, many knowledge gaps on the threats they face remain. Understanding the behaviour and threats of brown trouts (*Salmo trutta*) in direct sea systems (without fjords) and the impact of increasing temperatures on their behaviour, activities and performance remains unclear. Additionally, crucial information is lacking regarding how catch-and-release interactions affect the behaviour and survival of Atlantic bluefin tuna (*Thunnus thynnus).*

Project
The main goal of this PhD project is to assess the underlying mechanisms that determine when and why migratory fish are vulnerable to stressors in the marine and freshwater regions of the Skagerrak-Kattegat-Øresund region, using brown trout and Atlantic bluefin tuna as model species. Biotelemetry and physiological data help assess vulnerability by tracking movements and analyzing fitness, offering insights into critical instances and factors influencing vulnerability.

Perspective
This PhD project will strengthen our understanding of the critical instances or circumstances under which fish are most vulnerable, as well as the factors that may modulate this vulnerability. Those findings should enable adaptative handling practices and the development of conservation measures for brown trout and Atlantic bluefin tuna, but the findings are expected to be transferable to similar species.

Title:
When and why are fish vulnerable?

Principal supervisor:
Kim Aarestrup



Section:
Freshwater Fisheries and Ecology

Alexandre Nguyen-tiêt

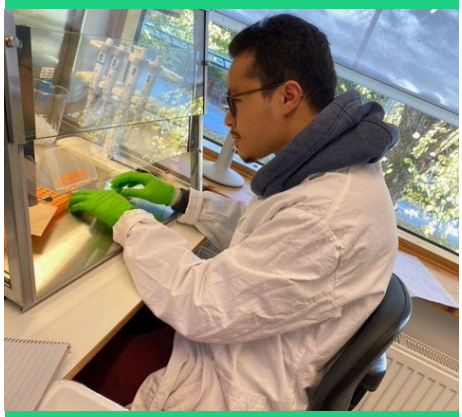
Background
Hydrogen sulfide (H2S) is an extremely toxic compound for organisms, preventing aerobic respiration. In marine land-based recirculating aquaculture systems (RAS), H2S production is a major challenge, leading to fish mortality and thus important economic consequences. Because of the high sulfate (SO42-) and organic matter concentration present in marine RAS, H2S production has been associated with the sulfate-reducing bacteria (SRB). However, there are also other pathways for producing H2S that could play a significant role but are currently neglected, e.g. some bacteria have the capacity to degrade the cysteine to produce pyruvate, ammonia and H2S. In both marine and freshwater RAS, cysteine is present, originating from the uneaten feed and feces of fish, suggesting that cysteine degradation could be an important H2S source in aquaculture environment.

Project
The main goal of this PhD project is to gain knowledge on the bacterial communities responsible of H_2S production in RAS and especially the cysteine degrading bacteria. To do so, I will first enrich and cultivate H_2S producing bacteria from samples collected at several locations in RAS. After that, I will use metagenomic/metatran-scriptomic analysis to identify the bacteria as well as the metabolic pathways responsible of H_2S production and develop primers to examine H_2S production dynamics and microbiology in aquaculture biofilms.

Perspective
The results obtained through this project will give a better understanding of the microbial community responsible of H_2S production in land-based aquaculture. With this new knowledge, I can develop ways to quantify and monitor both the traditional (SRB) and cysteine-degradation H_2S producers in RAS to avoid production losses related to H_2S exposure and to promote safe and stable fish production in the future.

Title:
Characterization of H_2S producers in recirculating aquaculture systems

Principal supervisor:
Sanni-Leea Hellevi Aalto



Section:
Aquaculture

Giulia Zarantonello

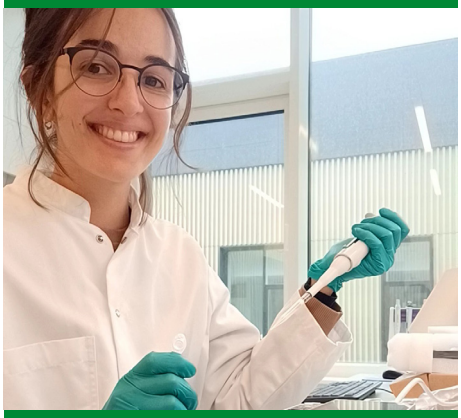
Background
The aquaculture microbiome balance is crucial for the health status of the system, such that dysbiosis has been reported when a stressor, such as a pathogen, is introduced. Current farmed fish diagnostics methods consist in infection event monitoring and imply histopathology, culture isolation, and targeted molecular diagnostics for the suspected pathogen. However, this approach comes with drawbacks: action is only taken after manifestation of clinical signs or increased mortality, and standard diagnostics are targeted towards known pathogens, which impairs new pathogen discovery, especially when the microorganisms are unculturable.

Project
My PhD project aims to develop a rapid, untargeted NGS-mediated workflow for early detection of declining health conditions and microbial disease for farmed animals in aquaculture, by exploiting the microbiome as an indicator for the state of the system. First, I will implement a microbiome sequencing protocol with Oxford Nanopore Technology from various aquaculture-relevant samples, both environmental (eDNA) and host-associated. Then, I will test the protocol in stress-induced conditions (pathogen, organic waste) in experimental RAS facilities, to detect possible changes in the healthy microbiome associated with fish health. The protocol will then be translated to detect distress-correlated dysbiosis in industry samples. Finally, I will apply metagenomics sequencing for pathogen discovery for a salmonid skin disease, whose unculturable disease-causing agent is still unknown.

Perspective
My project aims to exploit aquaculture-related microbiome sequencing to integrate current diagnostics with a non-lethal, fast and untargeted community surveillance method. If successful, the outcome of my PhD could represent the first steps towards the development of a novel indicator of fish health, such as microbiome risk scores for disease prediction. Early detection of distress could favour preventive strategies to minimize the impact on aquaculture production.

Title:
Early warning for disease: improving aquaculture monitoring with real-time microbiome sequencing.

Principal supervisor:
Argelia Cuenca



Section:
Fish and Shellfish Diseases

Alejandra Villamil Alonso

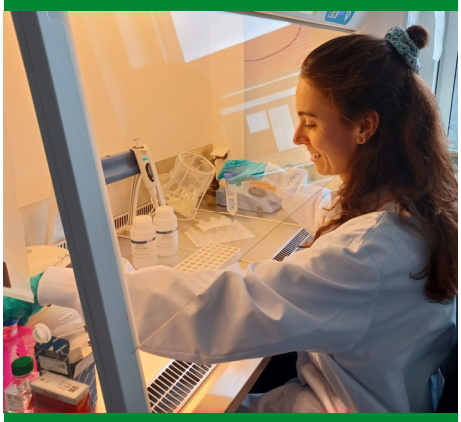
Background
Bacterial kidney disease (BKD) is a systemic infection that affects wild and farmed salmonids, compromising aquaculture systems worldwide. The causative agent of BKD is *Renibacterium salmoninarum*, a Gram-positive intracellular bacterium characterized by chronic disease progression and able to spread both horizontally and vertically. Although efforts have been made to characterize the bacteria mechanisms of transmission, pathogenesis, and immune evasion, they remain poorly understood. Moreover, no knowledge is available on the introduction and molecular evolution of the pathogen in Denmark, which is of foremost importance for understanding the current and past movements of *R. salmoninarum*.

Project
My PhD project seeks to elucidate the interplay between host-pathogen-environment by first establishing a challenge model of *R. salmoninarum* in rainbow trout (*Oncor-hynchus mykiss*), the predominant fish species farmed in Denmark. Bacteria route and persistence inside the fish will be studied, as well as the influence of different environmental stressors such as water temperature and water quality in BKD development. I will also work on the development of improved diagnostics methods for *R. salmoninarum*, focusing on qPCR and targeted detection of eDNA on water systems. Eventually, I will study the origin and molecular evolution of *R. salmoninarum* in Denmark by genome sequencing of a collection of historical and new isolates originated in Danish farms for phylogeographic and molecular analyses.

Perspective
With this project, we expect to gain knowledge on BKD transmission and progression in rainbow trout, as well as to build a deeper understanding on the virulence mechanisms of the pathogen and the subsequent host immune response. Together with the planned genomic studies, this research will facilitate the development of novel diagnostic methods and contribute to the identification of improved prevention and treatment measures for BKD.

Title:
Bacterial kidney disease in rainbow trout, with focus in infection kinetics and molecular tracing of *Renibacterium salmoninarum* in Denmark.

Principal supervisor:
Argelia Cuenca



Section:
Fish and Shellfish Diseases

Shana Fresnido Genavia

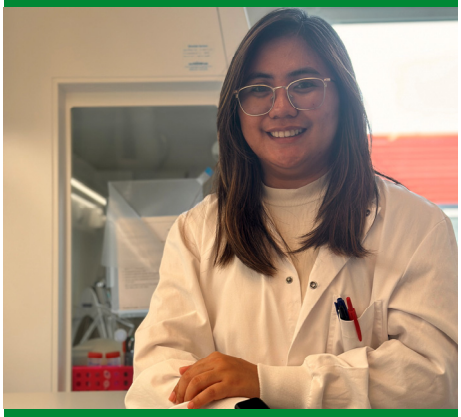
Background
The immune system in animals is a multi-faceted defense mechanism against pathogens. In vertebrates, the immune system operates through both innate and adaptive mechanisms, the latter being capable of generating immunological memory. Traditionally, invertebrates, such as shrimp, have been understood to possess only innate immune systems, devoid of any capacity for immune memory. This paradigm is being challenged as more research suggests invertebrates demonstrating a form of immunological memory, albeit not antibody-based. Understanding this could have a broad impact on industries like aquaculture, which often grapple with viral diseases that threaten shrimp populations.

Project
This PhD project aims to explore the role of circular viral DNA (cvDNA) in the immune response mechanism of shrimps against invading viruses. Utilizing *Penaeus vannamei* (Pacific whiteleg shrimp) as a model organism, the project will investigate whether cvDNA molecules are produced during viral infections and if these molecules serve as templates for RNAi-induced antiviral immune response. The project aims to address the biological aspects of cvDNA as well as its potential for conferring viral resistance and longevity of immunity. Methodologically, the study will employ a combination of molecular techniques, sequencing, and bioinformatics analysis to examine cvDNA and its implications.

Perspective
The implications of this research extend beyond shrimp aquaculture. If shrimp do possess a form of immune memory mediated by cvDNA, this could revolutionize our understanding of invertebrate immunity and even have repercussions for vertebrate immune systems. Moreover, it could open up new avenues for combating viral diseases in commercial aquaculture. The robust nature of cvDNA may offer innovative methods for studying virus-host interactions, both in contemporary and historical contexts. This has implications not only for animal husbandry but also for broader public health policies, especially considering the emerging evidence that vertebrates may utilize similar pathways.

Title:
Potential role of circular viral DNA in the shrimp immune system

Principal supervisor:
Niels Lorenzen



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