DTU

DTU Aqua
National Institute of Aquatic Resources

PhD students at DTU Aqua

Who are they, and what do they do?

Preface

This web-publication presents current PhD students and their projects at DTU Aqua.

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

Learn more about being a PhD student at DTU Aqua on our website:
aqua.dtu.dk/english/education/phd

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March 2026

Yixin Zhao

Background
The Earth's oceans play a crucial role in regulating the Earth's climate system, absorbing approximately 30% of anthropogenic carbon emissions through the physical and biological carbon pump. In the biological pump, carbon dioxide (CO_2) is initially fixed by phototrophic organisms, forming the foundation of the marine food webs. This fixed carbon can be transported to the deep ocean through particle sinking (e.g., aggregates, carcasses, and fecal pellets), organism vertical migration, and water movement where it can be stored for long periods, ranging from months to millennia. So far, most studies have focused on plankton's role in the biological carbon pump, while our comprehension of the contributions of fish to the biological carbon pump remains largely uncertain.

Project
This project aims to bridge this knowledge gap by applying the FishErIes Size and functional TYpe model (FEISTY) alongside earth system models to assess and quantify the role of fish in global ocean carbon cycles, as well as the effects of fishery and climate change. To accomplish the goals, the FEISTY model will be two-way, online coupled with biogeochemical models through the Framework for Aquatic Biogeochemical Models (FABM). We will utilize reconstructed global fishing data with historical fishing patterns and different emission scenarios to force the coupled models, to investigate how fish-mediated carbon fluxes and sequestration vary under various climate change scenarios and fishing scenarios from past to future.

Perspective
We expect the project to significantly improve our comprehension of fish-mediated carbon flux and sequestration in marine carbon dynamics. We will offer a novel approach to investigating and quantifying fish-mediated carbon fluxes and sequestration through coupling with earth system models. Furthermore, this research will underscore the importance of sustainable fisheries management in maintaining carbon sequestration from fish, thus contributing to climate change mitigation strategies and corresponding policy decisions.

Title:
The role of fish in carbon cycling and the impact of climate change

Principal supervisor:
Ken Haste Andersen

Section:
Centre for Ocean Life

Camilla Juul Dahl Jensen

Background
In the face of climate change, it is important to understand how our ecosystems are affected. Zooplankton offers a lens to this understanding being a link in the food-web. Gelatinous zooplankton species (e.g. jellyfish and larvaceans) have traditionally been 'invisible' in our understanding of zooplankton, highly due to sampling challenges and their invisible transparency. Increasing recognition of their role in ecosystems are evident, together with stories of emerging abundances, now make it the time to find a way of reliantly observing the 'invisible'.

Project
In my PhD project, I work with novel technologies to observe plankton across the full size-spectrum (phytoplankton to macro-zooplankton), with a special focus on seeing gelatinous species. I use shadowgraph cameras to make the 'invisible' visible, and work on connecting optical data to other platforms such as acoustics, eDNA and environmental measurements (CTD) to get datasets highly valuable for climate change modelling. Further, I work with statistical 'functional trait' methods that investigates the mechanisms of zooplankton and how they will act with climate change. The overarching objectives of my work is thus, to 1) observe zooplankton communities including gelatinous species, 2) obtain data applicable for modelling, 3) analyze zooplankton biodiversity and distribution data in relation to climate change.

Perspective
What functional role does gelatinous species play compared to crustaceans (e.g. copepods) in shared and non-shared communities? How do the functional traits of zooplankton (including gelatinous species) connect to environmental changes we can relate to climate change? Are specific functional traits the reason for gelatinous species to be 'the winner of climate change'? Can we use traits to predict future ecosystems? These are the key questions I wish to answer. To answer them, data on zooplankton communities including gelatinous species is needed.

Title:
Observing gelatinous zooplankton in the face of climate change

Principal supervisor:
Cornelia Jaspers

Section:
Centre for Ocean Life

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

Themistoklis Konstantinopoulos

Background
The shipping industry is shifting to greener fuels, like ammonia (NH_3) and methanol (MeOH), following the instructions of the International Maritime Organization (IMO) to substantially reduce greenhouse gas (GHG) emissions. This shift imposes the risk of spilling these substances into the marine environment. The effects of NH_3 and MeOH on marine microbial life are not yet fully understood. Existing literature indicates potential adverse effects on marine food webs. However, plankton communities, especially in areas like the Baltic and North Seas, are not sufficiently studied. Given the significance of zooplankton in energy transfer within marine food webs, it is crucial to study their response to NH_3 and MeOH under different environmental conditions.

Project
During my PhD, I will collaborate with experts from Danish and Swedish universities. We will conduct sampling surveys to assess current conditions in the Baltic and North Seas, focusing on environmental parameters and zooplankton community composition. Subsequently, I will perform ecotoxicology experiments by introducing ammonia and methanol under various environmental gradients to simulate changing conditions in these areas. Finally, I will implement the results to create computational numerical models to be used in environmental impact and risk assessments.

Perspective
Copepods play a crucial role in energy transfer and greatly contribute to ecosystem services. My project aims to understand and explain the toxicity mechanisms of ammonia and methanol on copepods under different environmental conditions. The knowledge produced by this PhD will help us understand the ecosystem effects of the energy transition in the shipping industry. Additionally, I will develop numerical tools that can be used in future ecotoxicology studies.

Title:
Ecosystem effects of maritime activities

Principal supervisor:
Marja Koski

Section:
Oceans and Arctic

Emilie Skrubbeltrang Thomsen

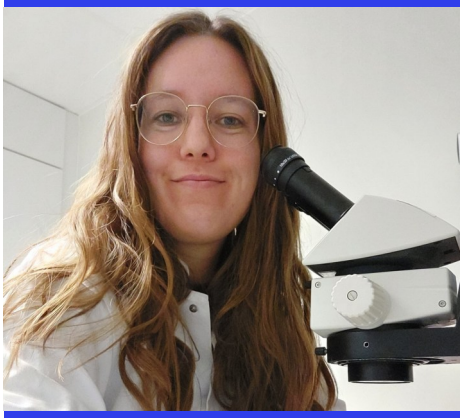
Background
Ships produce various types of waste water from the machinery, fuel, showers, dishwater etc. The waste water is often released into the ocean and can contain excess nutrients, heavy metals, polycyclic aromatic hydrocarbons (PAHs) among other things. These contaminants can alter the marine ecosystem by affecting the species involved by reducing reproduction and survival. Worldwide, research has mainly focused on understanding the impacts of individual contaminants with occasional studies on two pollutants, but studies on multiple contaminants are scarce. Furthermore, climate change is also considered a stressor that can potentially influence the effects and toxicity of pollutants; therefore, it should also be considered in the context of multiple stressors. The current challenge lies in developing a realistic method to determine the impacts of multiple stressors, which can then guide management decisions.

Project
During this PhD project, I aim to contribute to improved understanding of how shipping discharges impact marine biodiversity at the base of the food web through mixture toxicity. The main focus will be on assessing the cumulative effects of contaminants and their interactions with climate change through a combination of multiple stressor experiments, chemical analysis of contaminants and damage modeling. The PhD aims to create a damage modeling framework that quantifies the environmental effects of shipping activities on marine environments.

Perspective
My project aims to understand the environmental impacts of shipping discharges by conducting ecotoxicological experiments on copepods using multiple stressors. These results will be used in a damage modeling framework used to model the impact of shipping on marine ecosystems and their services. This can hopefully be used in maritime spatial planning and promote sustainable shipping practices.

Title:
Linking pressure from mixture toxicity of shipping discharges to loss of biodiversity in the marine environment

Principal supervisor:
Marja Koski



Section:
Oceans and Arctic

David Dylan O'Brien-Møller

Background
Argo floats are autonomous, freely drifting profiling instruments capable of adjusting their buoyancy to move vertically in the water column. Typically deployed in open ocean environments for periods of 4-6 years, Argo floats operate by drifting at approximately 1000 meters depth for about 10 days before descending to 2000 meters. From there, they ascend toward the surface, collecting vital oceanographic data such as temperature and salinity. Upon surfacing, they transmit collected data via satellite. Over the past two decades, thousands of Argo floats have revolutionized ocean data collection, significantly enhancing our understanding of ocean dynamics and climate processes.

Project
Despite their widespread use and success, Argo floats face limitations in specific marine environments. In areas with strong currents, Argo floats are quickly displaced from regions of scientific interest. Additionally, in shallow coastal areas, these floats risk being driven ashore or are unable to perform their standard deep-water profiling cycles. This project aims to develop technology to enable Argo floats to operate in coastal areas through developing methods for Argo floats to control their position. To take advantage of the new areas open to Argo floats, novel sensor technology will be integrated into Argo floats, enabling collection of new types of oceanographic data previously unavailable in these regions.

Perspective
Increasing the types of data that can be collected by Argo floats and increasing the area in which they can operate in, especially in coastal areas, will yield critical data from currently under-sampled coastal regions. Ultimately, these advancements will improve our understanding of coastal marine ecosystems, ocean processes, and human impacts on these vital environments.

Title:
Building the coastal ARGO (ARGO+)

Principal supervisor:
Patrizio Mariani

Section:
Oceans and Arctic

Asta Clara Heidemann

Background
Greenlandic waters play a crucial role in global climate regulation, contributing to ocean circulation, carbon cycling, and biological productivity. In fact, this region houses some of the most productive areas of the Arctic, largely driven by phytoplankton communities. These communities vary in terms of both size and composition, which impact the efficiency of the food web and in turn the biological pump.

Project
Despite the region's ecological significance, the underlying mechanisms driving productivity remain relatively poorly understood, due to the remoteness and logistical challenges. A main goal of this research is to investigate processes that modulate local and regional variability of primary productivity in West- and East Greenlandic waters, with a focus on understanding the influence of oceanographic features across these regions. In particular, phytoplankton composition – especially in terms of size classes – will be explored to examine how physical and biogeochemical factors contribute to spatial and temporal variability.

Perspective
Results from this research will provide insight into the patterns of biogeochemical cycles related to primary production. This will be contextualized within a broader Arctic and global framework to improve our understanding of dynamics within lower levels in remote polar regions, that are known to be more susceptible to climate change. This will ultimately help improve future monitoring capabilities of this region.

Title:
Biogeochemistry of Greenlandic waters

Principal supervisor:
Rafael Gonçalves-Araujo

Section:
Oceans and Arctic

Thor Carit Andersen

Background
West-Greenlandic waters are among the most productive marine areas in the arctic and is one of the main gateways of water exchange between the Arctic and Atlantic. The ecosystems found here are essential for the livelihoods of many Greenlanders and contributes substantially to the global carbon sequestration budget. Lipid-rich arctic zooplankton ensures efficient energy transfer of primary production to higher trophic levels; however, this might change because of climate change. Zooplankton are vulnerable to changes in their physical environment, and thus it has long been speculated that warming and freshening arctic oceans will result in phase-shifts to ecosystems dominated by smaller less lipid-rich boreal zooplankton species, with detrimental effects for the ecosystems. However, concrete evidence of such tipping points is lacking, and thus the aim of this project is to improve the knowledge and understanding of the current topic.

Project
The current project aims to unravel relationships between climate change and zooplankton dynamics in Davis Strait through a combination of laboratory experiments, investigating temperature and salinity tolerances, field observations from cruises, and historical data from the Davis Strait Observatory and the Greenland Ecosystem monitoring program.

Perspective
The results from this project will provide a mechanistic understanding of responses of smaller zooplankton to changes in their physical environment and extrapolate this knowledge to habitat models with the ability to understand current and predict future species' distributions. This knowledge can then be used to predict consequences for entire ecosystems.

Title:
Plankton dynamics at the Davis Strait – Ecosystem tipping cascades in an Arctic gateway

Principal supervisor:
Torkel Gissel Nielsen

Section:
Oceans and Arctic

Daniel Anthony Hancock

Background
A rapidly changing climate will have a major impact on the distribution, evolution and persistence of species, with marine ecosystems being particularly vulnerable, facing gradual threats like ocean acidification, temperature shifts, and alterations in currents, as well as immediate crises such as marine heatwaves. Considering these challenges, climate vulnerability assessments that account for nuanced, population-specific responses such as divergent range shifts and local adaptation, as well as highlighting potential maladaptation to future environments are becoming increasingly important. Such assessments are crucial for proper evaluation and mitigation of the impacts of climate change on the persistence of species of economic and ecological importance.

Project
The objective of this project is to evaluate the risks associated with climate change to marine species in the Kattegat-Skagerrak transition zone. To achieve this, genomic and climatic data will be integrated in a comparative approach across multiple aquatic taxa to make predictions about evolutionary responses to climate change. This will involve spatial and evolutionary modelling to predict the connectivity, future distribution and adaptive capacity of populations, as well as investigating genetic vulnerability metrics such as mutational load, genetic diversity and inbreeding.

Perspective
This PhD is part of the Interreg Øresund-Kattegat-Skagerrak BlueBioClimate project, which aims to facilitate cross-border co-operation for climate-adapted management of aquatic biodiversity. Through collaboration with project partners across the region and national and regional resource management practitioners, it aims to provide guidance for the prioritization of effective conservation strategies in aquatic ecosystems, to ensure ecosystem resilience and safeguard natural resources.

Title:
Climate change population genomics

Principal supervisor:
Jakob Hemmer-Hansen

Section:
Marine Living Resources

Nina Strand

Background
Inadequate bycatch assessment in fisheries can lead to declining spawning stock biomass and reduced recruitment, impacting both target and non-target species. In Denmark, the "bucket method" is currently used to document bycatch in pelagic fisheries, which typically have landings over 500 tons. This method involves sampling 10 kg of fish for every 25 tons at fish factories, with species composition determined manually by third-party observers. It is expensive, time-consuming, and requires taxonomic expertise, creating challenges in accuracy and cost-effectiveness. Environmental DNA (eDNA) analysis, which detects genetic material from organisms in environmental samples, offers a promising alternative. It can reduce time, costs, and workload, while eliminating the need for taxonomic expertise. Despite its potential, eDNA's widespread adoption in large-scale monitoring remains limited.

Project
The DNAcatch project aims to develop, evaluate, and implement eDNA-based methods for biomass quantification of bycatch in pelagic fisheries, enhancing fisheries management. Building on the pilot study DNAmix, which showed the feasibility of using eDNA for quantifying catch composition, this PhD project will focus on comparing molecular methods (dPCR vs. qPCR) for their impact on biomass estimations, developing eDNA-based methods for several target fisheries, and comparing these results with traditional methods.

Perspective
Implementing eDNA-based methods for bycatch quantification in pelagic fisheries could improve fisheries management by providing more accurate, cost-effective, and scalable monitoring tools. By optimizing molecular techniques such as dPCR and metabarcoding, the project aims to improve the precision and sensitivity of bycatch detection, especially for rare species. The findings could lead to more effective management strategies, particularly for multi-species fisheries like sandeel. Ultimately, this research could support sustainable fisheries practices by enabling more accurate stock assessments.

Title:
DNA based catch quantification for pelagic fisheries (DNAcatch)

Principal supervisor:
Einar Eg Nielsen

Section:
Marine Living Resources

Karoline Bruun Degn

Background
The transition to sustainable energy is a crucial part of global efforts to combat climate change. Offshore wind farms are set to expand significantly as part of this green transition. For instance, the Esbjerg Declaration by Danish authorities aim to increase wind power production in the North Sea by tenfold by 2050. However, this expansion raises concerns about potential disruptions to marine ecosystems. To address these concerns, political goals have shifted from “No Net Loss” to “Marine Net Gain” in biodiversity, meaning offshore wind farms should enhance rather than harm marine ecosystems.

Project
This PhD project focuses on using environmental DNA (eDNA) metabarcoding techniques to monitor marine biodiversity around offshore wind farms. By employing advanced autonomous robotic instruments for in situ eDNA sampling and DNA analysis, the project aims to achieve high spatial and temporal resolution. Techniques such as 3rd generation sequencing, digital PCR (dPCR), and oceanographic modeling will be applied. Sampling will primarily take place around the offshore wind farm Horns Rev II located in the North Sea and at the Ørsted windfarm off the coast of Anholt. The overarching goal is to develop a robust, cost-efficient eDNA-based tool for offshore biodiversity monitoring and marine environmental impact assessment.

Perspective
We hope to transform eDNA from a basic science concept into a practical monitoring tool that can be adopted by the industry and national authorities. In that way we can ensure that the establishment of wind farms contributes positively to marine biodiversity and supports nature-based solutions for artificial reef structures.

Title:
Assessing biodiversity at offshore wind farms using eDNA (WINDDNA)

Principal supervisor:
Einar Eg Nielsen

Section:
Marine Living Resources

Magnus Højen Husen

Background
Decreased frequencies of major inflow events of oxygenated water, together with increasing sea surface temperatures and immense anthropogenic pressures, have intensified the extent and severity of hypoxia in the Baltic Sea. These factors have in recent decades negatively affected key physiological and ecological parameters of cod (*Gadus morhua*) in this region. Notably however, recent reports from the Åland Sea in the northern Baltic have shown noticeably larger and healthier cod, compared to cod from the southwestern and central Baltic. The reasons for this difference have been hypothesized to be better oxygen conditions in these northerly areas, in addition to higher availability of *Saduria entomon*, a key prey item in the diet of cod which in recent times has decreased in the central parts of the Baltic.

Project
Combining controlled experiments with information derived from the field, the aim of this study is to investigate the physiological changes that occur when Baltic cod is exposed to prolonged moderate hypoxia. In addition, the project will include historical analysis of Saduria distributions coupled to environmental data of oxygen conditions across the Baltic, and stomach content analysis of the Åland cod, to test the hypothesis of Saduria as a key determinant of the health status of the Baltic cod.

Perspective
Findings from this study will provide important insights for fisheries management and conservation efforts in the Baltic. Understanding the link between environmental stressors, such as hypoxia, and food quality can inform strategies to protect and restore Baltic cod populations. Moreover, recognizing the importance of Saduria as essential prey could lead targeted efforts to preserve or its populations in the central Baltic, potentially improving the resilience of Baltic cod.

Title:
Effects of moderate hypoxia and food quality on growth of Baltic cod

Principal supervisor:
Jane W. Behrens

Section:
Marine Living Resources

Tunca Deniz Yazici

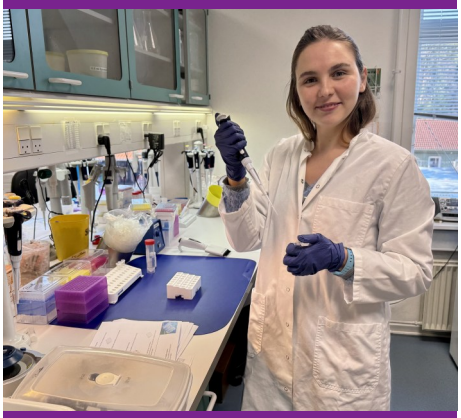
Background
Climate change is a significant driver of global environmental change. Rising temperatures, ocean acidification, deoxygenation, and changing sea levels severely affect biodiversity and ecosystem functions. Further anthropogenic activities such as pollution, habitat destruction, and overfishing profoundly affect biodiversity and ecosystem health at both temporal and spatial scales. While conservation of biodiversity and habitat restoration are highlighted by management authorities, determining which areas and species to prioritize for protection and restoration presents a significant challenge. To ease and enhance management strategies, it is crucial to understand climate change vulnerability for species and community-level impacts in marine ecosystems.

Project
This PhD project focusses on various biodiversity metrics using sugar kelp in Danish waters. We will analyze genetic diversity through integrated genomic, environmental, and ecological analyses. We tackle the question of how diversity can be preserved in a changing climate through spatial planning and habitat restoration. Using sugar kelp both as a target species, and as an ecosystem indicator, we will investigate biodiversity and ecosystem health.

Perspective
This PhD is part of a larger project funded by Aage V. Jensen Naturfond titled as “Integrated ecological, genomic and oceanographic analysis for planning marine habitat protection”. In collaboration with Aarhus University, Aalborg University, Havsamarbejdet i Østjylland, and The Institute of Marine Research, we seek to answer the question: “how can connectivity among Danish marine habitats be preserved and strengthened to secure marine biodiversity and ecosystem functioning under future climate change?”. We gather expertise to develop predictive tools aimed at enhancing assessments and strategies for conserving and managing biodiversity amid climate change. By fostering robust and resilient marine ecosystems in Danish waters, these predictive tools will help us to achieve the ambitious goals of protecting and restoring large proportions of our marine areas.

Title:
Integrating ecological and genomic diversity for climate resilient marine spatial planning

Principal supervisor:
Jakob Hemmer-Hansen



Section:
Marine Living Resources

Georgina Vickery

Background
Fisheries stock assessment is integral to facilitating sustainable management of this valuable marine resource. However, all sources of assessment data have limitations, from size or species selectivity of fishing gears to the spatial and temporal coverage of both fisheries dependent and independent data. Furthermore, there is increasing focus on reducing environmental impact of scientific activities and increasing the use of non-invasive sampling. If successfully integrated into existing timeseries, autonomous underwater vehicles (AUVs) and other imaging platforms coupled with AI have the potential to become a low-impact solution to the limitations of existing data collection techniques.

Project
Combining new technology from Institute of Marine Research, Norway, with academic expertise from DTU, this PhD will integrate new technologies and methods into the three main steps of stock assessment. Species detection models with tracking and length estimation will be developed to process high intensity synthetic aperture sonar (HiSAS) data from AUVs as well as video data from towed and in-trawl cameras. These data will be integrated into existing timeseries, with a focus on optimising spatial-temporal coverage and accuracy of data collected. The final step of the project is to apply management strategy evaluation (MSE) to elucidate how the incorporation of new data from AUVs and other new technologies impacts stock assessment and the subsequent management advice.

Perspective
Globally, fisheries institutions are transitioning to increased use of autonomous systems. This PhD project will demonstrate the full pathway of deploying an AUV to collect fisheries-independent data suitable both for use in stock assessment and to be integrated into existing timeseries. This revolutionary leap forward will facilitate sustainable management of fisheries and create a template for optimal deployment and assimilation of these systems into stock assessment processes.

Title:
New approaches in marine living resource assessment

Principal supervisor:
Carsten Hvingel

Section:
Marine Living Resources

Daniel Rooth

Background
Anthropologically induced effects such as eutrophication and hypoxia in marine coastal environments are today widespread and often severe, resulting in habitat loss, reduced biodiversity and trophic cascades. Loss of important habitats can delay or hinder the recovery and integration of fish populations into the ecosystem. Restoration and transplantation of habitats such as eelgrass meadows have proven successful in terms of promoting taxonomic biodiversity and abundance of slow-moving marine fauna. By reintroducing these habitat types to the ecosystem, complex three-dimensional structures may provide refuge as well as foraging opportunities for invertebrates, fish and other organisms, forming biodiversity hotspots. However, knowledge of the effect on community dynamics, behaviour and biodiversity of fish in these environments, remain insufficient.

Project
The objective of this PhD project is to study the fish community dynamics in relation to the coastal habitats such as transplanted and naturally occurring eelgrass. The potential re-colonisation of fish communities associated with the transplantation of eelgrass will be investigated with a strong emphasis on the roles of top- and mesopredators. With public collaboration together with recreational anglers, continuous monitoring of degraded areas is carried out whilst evaluating ecosystem function of eelgrass- and stony reef habitats.

Perspective
The PhD project contributes to a deeper understanding of the biodiversity and community dynamics, including predator-prey interactions and habitat preferences, of marine fish in shallow coastal waters, with the hopes of contribute to improving rewilding efforts in restored marine areas. The project will also critically assess various underwater monitoring methodologies commonly used to assess fish, in a complex coastal ecosystem, as well as involving local anglers and volunteers.

Title:
Rewilding marine coastal ecosystems - fish community dynamics in transplanted eelgrass habitats

Principal supervisor:
Mikael van Deurs

Section:
Ecosystem based Marine Management

Markus Varlund Strange

Background
Many species are struggling in the inner Danish waters compared just 50 years ago, and some of our previously most important fisheries there have declined or even closed. These fish stocks have been subject to several different stressors, i.e., overfishing, food scarcity, parasites, oxygen depletion, predation, etc. For mitigation efforts to be successful, it is essential to disentangle the effects of the stressors, and especially understand the natural components. One of these is predation from seals and cormorants, which have both increased dramatically since the 1970's.

Project
My project aims to quantify the natural mortality of cod, herring, and various flatfish due to seals and cormorants, both in the current situation and historically. This is achieved through a combination of empirical diet data from the predators, and modelling approaches. The diet data are acquired from otoliths in seal scats and cormorant pellets, and the modelling framework includes a stochastic stock assessment model, and a spatiotemporal species distribution model. The culmination of the project is a management strategy evaluation, where I will investigate the effects of different seal and cormorant management scenarios.

Perspective
This project will increase our understanding of predators' role in the recovery process of deteriorated fish stocks, and enable informed decision-making on management of conflict species. Furthermore, as numerous fish stocks worldwide are in poor condition and human-wildlife conflicts occur everywhere, results from this project can inspire managers all over the world. Lastly, the project will also contribute to the ongoing efforts of developing methods for including good estimates of natural mortality in fish stock assessments.

Title:
Cormorant and seal predation on fish in inner Danish waters

Principal supervisor:
Nis Sand Jacobsen

Section:
Ecosystem based Marine Management

Leo Joseph Sheils

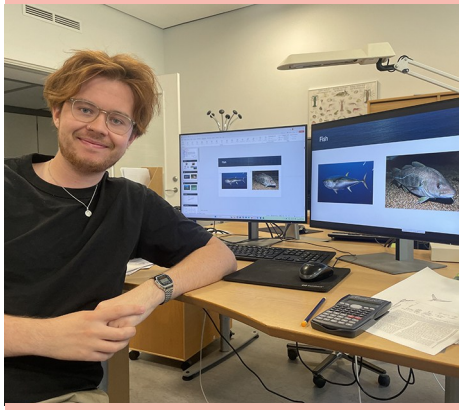
Background
How growth varies between organisms is of special interest in the context of climate change as we hope to anticipate changes to ecosystem structure and function, following previously established associations of biological rates and environmental variables. Typically, one would expect an organism to grow at a faster rate in warmer waters. This has been shown to occur both intra- and interspecifically. Recent work has shown that this is not in fact the case for large demersal fish, predators that live on the sea floor on continental shelves. If this group of organisms doesn't play by the same rules as others, what impacts could that have on global marine ecosystems?

Project
The aim of this project is to create a framework where the dynamics of growth in large demersal fish can be more accurately represented in global ecosystem models. To do this I will use morphological data to identify differences in demersal species across a range of temperatures to demonstrate niche differences. Using these relationships, I will work with an existing trait-based food-web model and incorporate the different strategies of large demersal fish which will elucidate more realistic ecosystem dynamics.

Perspective
This project will provide insights into how large demersal fish, a functional group with great commercial interest, grow across latitudes and potentially respond to warming. Improving our understanding of this process is vital to effective management of coastal shelf marine ecosystems.

Title:
Challenging the fish growth paradigm in a changing climate

Principal supervisor:
Daniël van Denderen



Section:
Ecosystem based Marine Management

Maria Francisca Rodrigues

Background
Fish are constantly interacting with other fish and with their environment; that shapes how different fish feed, grow, reproduce, and survive – and even how they look like. Fish community models translate these interactions to mathematical equations to estimate trophic links, community structure and biomass. Trait-based approaches model individuals instead of species by identifying a few dominant traits and trade-offs that characterize the "average" fish. Body size is the primary trait in most models because several traits scale with it (e.g. metabolism, maximum consumption) and because it serves as a proxy for trophic level in marine systems – where the general rule of "big eats small" applies. However, body size is not enough to explain the diversity of marine fish.

Project
This project will investigate what explains marine fish diversity beyond body size. Our candidate is pace of life: a qualitative measure of the rate at which an individual progresses through life. It has been correlated with both physiological and life-history traits and can be described by trade-offs between growth, reproduction and survival. My hypothesis is that adding pace of life as a secondary trait can improve the mathematical representation of marine fish in the size- and trait-based fish community model, FEISTY.

Perspective
Fish community models directly depend on the quality of current knowledge on fish physiology and ecology. If my hypothesis is confirmed, it will improve the forecast of fish community biomass and re-assembly on a global scale, and contribute to the study of past, present and future scenarios under climate change and fishing pressure, among other applications.

Title:
Modelling the pace of life of marine fish

Principal supervisor:
Daniël van Denderen

Section:
Ecosystem based Marine Management

Amalie Broegaard-Iversen

Background
Knowledge of data-limited fish species is essential for ensuring effective and sustainable marine management. These species are often overlooked in traditional fisheries assessments because they are not commercially targeted, occur at low abundances, or appear only sporadically as bycatch. Consequently, their population trends, life-history traits, and ecological roles remain poorly understood, increasing the risk that declines go unnoticed until they become severe or irreversible. This knowledge gap is particularly important in the North Sea, a region of major economic and cultural significance for Danish fisheries. The North Sea supports valuable commercial stocks such as cod, plaice, sole, herring, and sandeel, forming the basis of key fisheries and industries. Its high productivity, driven by nutrient-rich waters and diverse habitats, makes it one of the most important fishing grounds for Denmark.

Project
The objective of this PhD project is to investigate key fish habitats associated with data-limited species in the North Sea. It also aims to improve understanding of ecological linkages between coastal and offshore environments for these species. The project will integrate diverse datasets, including trawl surveys, commercial catch and bycatch records, habitat data, citizen science observations, and environmental variables. This work will involve managing complex data sources and collaborating with biological and technical experts to identify patterns in fish distribution and habitat use.

Perspective
The project will generate new insights into fish habitat use and species distribution, supporting improved marine spatial planning and conservation. The findings will contribute to the designation and management of marine protected areas and support broader biodiversity targets, while also strengthening the scientific basis for managing data-limited species in the future.

Title:
Marine fish habitats in Denmark

Principal supervisor:
Mikael van Deurs

Section:
Ecosystem based Marine Management

Laura Diernæs

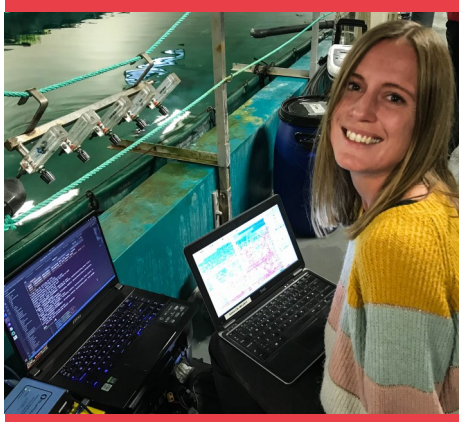
Background
Trawl gears are responsible for a large portion of unwanted catches, globally. Consequently, there is a large focus on improving their environmental sustainability while ensuring that the fisheries remain economically viable. Animal behaviour is one of few main components that are decisive 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 sustainable trawl designs.

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

Principal supervisor:
Junita Diana Karlsen



Section:
Fisheries Technology

Nurul Huda

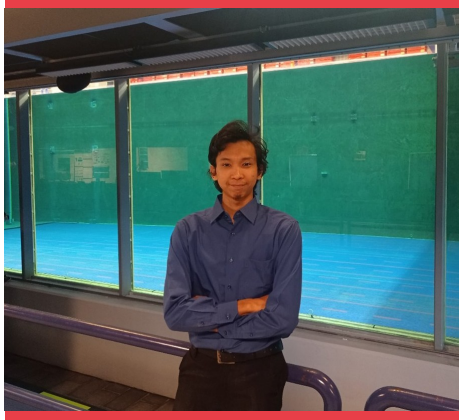
Background
In recent years there have been increasing concerns regarding demersal trawl physical impacts on the seabed, which can give rise to (i) increased fuel consumption, (ii) the release of carbon sequestered in the seabed, (iii) habitat modification and (iv) benthic mortality. In order to promote 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

Samitha Nuwan Thilakarathna

Background
Monitoring commercial fishing catches via human observers is currently limited by high costs, harsh working conditions, and low data coverage. While Electronic Monitoring (EM) systems offer a solution by recording fish catch, they currently rely on time-consuming manual video analysis that often focuses only a narrow range of species. This project aims to integrate Machine Learning (ML) and computer vision to automate this review process, enabling the automatic detection, identification, and size estimation of catches to significantly improve data quality and efficiency.

Project
Supported by a triad of EU funded projects–OptiFish, TEFIMO, and ECOCATCH—this research develops tailored computer vision solutions for diverse fishing methods. The work ranges from quantifying high-velocity flows in pelagic dewatering systems to prioritizing bycatch detection in gillnets. Furthermore, it will address adaptive "open set" recognition, enabling identification of comprehensive catch compositions that include macro benthic species in demersal trawl fishery.

Perspective
Automating the catch registration process will eventually increase the transparency of fishing operations and facilitate a shift from a physical Landing Obligation to a digital documentation obligation. Instead of relying solely on bringing catch to shore for manual inspection, this technology provides the precise, verifiable data need for Fully Documented Fisheries (FDF). This ensures accurate stock assessments and a complete quantification of total removal from the ecosystem.

Title:
AI and computer vision for automated fisheries monitoring

Principal supervisor:
Jordan Feekings

Section:
Fisheries Technology

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

Ana Lilia Tovar Aguirre

Background
Aquaculture, a rapidly growing sector of food production, is crucial for meeting the global demand for seafood. The European flat oyster (*Ostrea edulis*) is of significant ecological and economic importance. A critical factor in the success of oyster hatcheries is the quality of microalgal feed, which must meet the nutritional needs of oysters at various life stages. While monocultures of microalgae have been the traditional choice, studies highlight the advantages of using mixed microalgae cultures. Native, local, undefined poly microalgae cultures may offer cost-effectiveness, and high-quality nutritional profiles, making them a promising alternative for sustainable oyster farming.

Project
This PhD project focuses on using local, undefined poly microalgal cultures as a sustainable and effective feed source for *Ostrea edulis* in hatcheries. The research will explore the potential of these natural microalgal communities by adapting them to controlled hatchery environments. By examining different factors, the project aims to optimize the cultivation of these polycultures to enhance their suitability as oyster feed. Additionally, the study will investigate the scalability of these cultures from lab-scale to larger production systems, assessing their impact on oyster growth, tissue composition, and overall health.

Perspective
The findings from this project will advance sustainable aquaculture practices by demonstrating the viability of local, native, microalgal polycultures as a high-quality feed option for oyster hatcheries. This approach could lead to reduced feed costs and improved oyster productivity, contributing to the long-term sustainability of the aquaculture industry. Beyond aquaculture, the insights gained could have broader applications in different areas where polycultures could be suitable.

Title:
Microalgae production for shellfish hatchery

Principal supervisor:
Camille Saurel

Section:
Coastal Ecology

Morten Højen Kristiansen

Background
Horse mussel beds are marine formations consisting of dense congregations of living mussels, empty shells, and various substrates, all held together by the mussels' byssus threads. High densities of mussels are vital for their function as ecosystem engineers that stabilize sediment and create habitats, promoting a rich biodiversity and high biological productivity. In addition, horse mussels provide regulating ecosystem services through suspension feeding, removing phytoplankton and particles from the water column, thereby improving water quality. However, historical records reveal a significant decline in the spatial extent of horse mussel beds, mainly driven by physical disturbances from human activities. The management of threatened horse mussel beds can be supported through targeted restoration efforts, with a promising approach being the deployment of cultured juvenile mussels (spat) to boost recruitment.

Project
Horse mussel spat has been produced in hatcheries before, but not in quantities that are sufficient to meet the demand for horse mussel reef restoration projects. A limitation in production is largely due to a significant lack of research on horse mussel biology and behaviour. Therefore, to close the knowledge gaps, this PhD project will focus on investigating the life-stage-specific demands of horse mussels in aquaculture. This requires refinement of feeding procedures and control of environmental parameters to create an ideal environment in a hatchery that can help maximize reproductive potential and offspring survival and growth. Additionally, the project will explore biological mechanisms or conditions that trigger spawning and larvae settlement.

Perspective
This project will contribute with new insights into the biology of the horse mussel and the biological responses that aquaculture conditions impose on the species. The development of a novel horse mussel hatchery will provide the means to restore degraded horse mussel beds and potentially establish new ones, contributing to global efforts to enhance biodiversity and ecological health of marine ecosystems. This project has the potential to drive innovation in ecological restoration techniques and set new standards for sustainable marine conservation.

Title:
Horse mussel, *Modiolus modiolus*, production for restoration

Principal supervisor:
Camille Saurel

Section:
Coastal Ecology

Anna Steinmann

Background
Coastal ecosystems depend on bivalves for several ecosystem services (ES), including the improvement of water clarity and the formation of long-lasting, complex habitat structures to promote biodiversity. However, human activities such as overfishing and climate change have led to a decline of the populations, thereby threatening these ES. While restoration efforts have been made, they often lack standardized monitoring methodologies or monitoring all together. Consequently, it is challenging to evaluate restoration impacts and identify potential issues that require adaptations to the restoration strategy.

Project
The objective of this project is to assess the impact of restoration efforts, while considering biotic and abiotic pressure factors that shape and determine the evolution and stability of restored bivalve habitats. Thus, different methods for a standardized monitoring will be developed and compared. A combination of imaging-based techniques, side-scan sonar, and traditional physical sampling will be applied to assess metrics such as the footprint area, sediment coverage, and patterns of self-organization. Alongside those assessments, water clarity as an important ES will be investigated. In-situ sensors will be utilized to monitor particle depletion, which will be linked to relevant abiotic factors. This aims at establishing a monitoring protocol for the assessment of water clarity in and around bivalve beds, with considerations of spatialtemporal changes.

Perspective
A key outcome will be a detailed assessment of the advantages and limitations of different monitoring methods. This will provide an evaluation of their applicability and thereby support the identification of appropriate techniques for assessing restoration impacts. Ultimately, protocols for standardized monitoring across different restoration projects and studies will be proposed. The implementation of the developed methods will provide a detailed understanding of short-term trends, and the ES provided. It should also provide a perspective on assessment metrics and the expected effort required to implement long-term monitoring.

Title:
Evolution, stability and ecosystem services provided by restoration of marine bivalve habitats

Principal supervisor:
Pedro Seabra de Freitas

Section:
Coastal 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

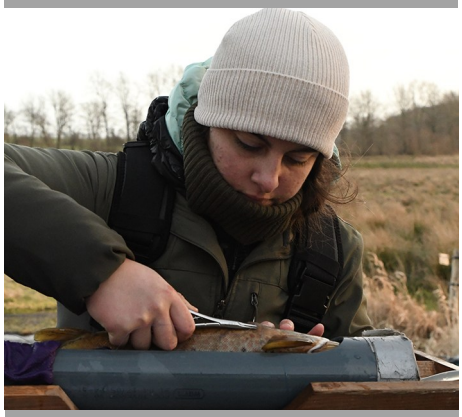
Background
Fish must cope with numerous stressors and threats, including pollution, habitat destruction, overfishing, fisheries interactions, and climate changes. Understanding when and why fish are vulnerable is crucial for conservation, especially for migratory species, facing energy-intensive migrations 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

Franziska Bockelmann

Background
Freshwater fish represent one of the most threatened taxonomic groups in Europe, highlighting the urgent need for improved conservation and monitoring strategies. Despite being a significant driver of fish population declines, the extent of cormorant predation on threatened fish species remains underexplored, posing a challenge for informed conservation decision-making. Another main problem is the lack of reliability of monitoring data. EU member states are mandated to report on species listed in the Habitats Directive, yet monitoring data for riverine fish is often incomplete or absent.

Project
Through my PhD, I aim to address these challenges by investigating the relationship between cormorant predation and fish population dynamics in European rivers. Using a combination of historical data analysis, field studies, and experimental approaches, I seek to quantify the extent of predation pressure and identify key environmental factors that influence its severity. For example, I am exploring how habitat complexity may mitigate predation and assessing the effectiveness of exclusion measures in protecting fish populations.
This PhD is part of the EU-wide ProtectFish initiative and uses the European grayling (*Thymallus thymallus*) as a case study, to highlight the predator-prey dynamic of cormorants and riverine fish, and propose solutions to enhance protection measures.

Perspective
We aim to produce actionable insights that can guide policy changes, improve biodiversity monitoring systems, and enhance the conservation status of freshwater fish. Ultimately, this research aspires to contribute to a more sustainable coexistence between predator populations, and the aquatic ecosystems they share. The findings will contribute to policy updates at the EU level, fostering improved biodiversity monitoring frameworks.

Title:
Cormorant predation and river fish conservation

Principal supervisor:
Niels Jepsen

Section:
Freshwater Fisheries and Ecology

Freja Azzopardi

Background
Atlantic Bluefin Tuna (*Thunnus thynnus*) is one of the largest predatory teleosts alive today in our oceans and is both ecologically and economically important. Because of its high economic value to fisheries, the eastern Atlantic Bluefin Tuna population underwent intense, unregulated fishing resulting in a stock collapse in the 1950s and, in turn, their disappearance from northern latitudes, including Scandinavia. Atlantic Bluefin Tuna have since returned to these waters only recently as a result of a successful stock recovery plan. Researchers have hypothesized that climate change and changing ocean currents could also be at play with regards to their resurgence, namely by influencing shifting distributions and abundance of prey resources. Due to the absence of Atlantic Bluefin Tuna in Scandinavia, very little is known about their movement ecology in the region, despite being a relatively well-studied oceanic species.

Project
This PhD project revolves around processing and analysing a large dataset obtained from Pop-off Satellite Archival Transmitters (PSATs) deployed on Atlantic Bluefin Tuna over the last several years in Danish waters. The aim is to investigate the movement and behaviour of Atlantic Bluefin Tuna that visit the Skagerrak and Øresund seas each year, how this relates to the wider Atlantic population and the implications of this in the context of commercial fishing and climate change.

Perspective
Highly migratory marine species such as Atlantic Bluefin Tuna are particularly vulnerable to overexploitation and are also challenging to study and manage, given they regularly cross several jurisdictions and ecosystems. Ascertaining biological information of the population is therefore essential to prevent stock collapse in the future, as well to safeguard the ecosystem services provided by the species.

Title:
Decoding Tuna Movements: Satellite Telemetry and the Behavioural Ecology of Atlantic Bluefin Tuna tagged in Scandinavia

Principal supervisor:
Henrik Baktoft

Section:
Freshwater Fisheries and Ecology

Matthew Mainieri

Background
The global population is on the rise and with this increase comes multiple climatic as well as food security issues. Anthropogenic activity has caused a widespread increase of greenhouse gases including rising CO_2 levels. Microalgae play a crucial role in mitigating rising CO_2 levels through sequestration while also serving as a valuable resource in aquaculture. Their biochemical composition can be altered by environmental stressors such as CO_2 levels and photoperiod, impacting their nutritional value. In marine fish larviculture, microalgae enhance live feeds like rotifers and *Artemia*, improving larval growth, survival, and microbiome development. The "green water technique" further supports larval health by enriching the rearing environment. Optimizing microalgae nutrient profiles for both live feeds and water quality can significantly improve fish larval growth, survival, and long-term robustness.

Project
The project will encompass all aspects of teleost larval rearing. I will begin by applying various abiotic stressors to the microalgae culture of multiple species to manipulate the omega-3 polyunsaturated fatty acids (DHA, EPA) profile which are essential in early larval development. I will follow the microalgal culture trials by culturing and enriching live feeds (rotifers and *Artemia*) with the cultured microalgae and analyzing their nutrient retention efficiency. Lastly, I will culture finfish larvae while utilizing the results from the live feeds trial and condition the water with the cultured microalgae in an attempt to enhance larval growth, development, and survival.

Perspective
The potential gained perspectives of the PhD project are to 1) address how microalgae species respond to various stressors in terms of growth, nutrient profile, and physio-chemical interactions, 2) promote growth and survival of finfish larvae through live feed nutrition and water conditioning and to better understand the mechanisms and interactions behind the growth and survival, 3) discover the short and the long-term effects on larval growth, development, and robustness from initial early nutrition and environmental exposure.

Title:
Microalgae in fish feeds

Principal supervisor:
Ivar Lund

Section:
Aquaculture

Hien La Nguyen The

Background
Nitrogen waste is a major concern in the aquaculture industry, as it can create toxic environments for fish and may lead to eutrophication in receiving water bodies. In aquaculture, dissolved nitrogen waste primarily originates from fish excretion, particularly in the form of ammonia. The amount of ammonia produced by fish largely depends on the amino acid composition of the feed. Both excesses and deficiencies of amino acids can negatively affect growth and nitrogen metabolism in fish. Therefore, optimizing diets to achieve balanced compositions of both essential amino acids (EAAs) and non-essential amino acids (NEAAs) is considered as a key to regulating not only protein retention for growth but also to mitigating the environmental impact of nitrogen-rich effluents. Commercial aquafeeds are designed to meet the dietary requirements for EAAs; however, the composition of NEAAs is generally not considered.

Project
The project aims to investigate and develop nitrogen-optimized feed to reduce nitrogen excretion, improve protein retention and feed utilization in rainbow trout (*Onchorynchus mykiss*). At the beginning of the project, digestibility trials will be conducted to determine the apparent digestibility (ADC) of amino acids, protein, ash, fat, moisture and phosphorus. Based on the digestibility data of raw materials, R&D feed will be formulated with different amino acids profiles (focus on NEAAs) and tested in the mass balance trials for 6-8 weeks in recirculating aquaculture system (RAS) to estimate the optimized diets for rainbow trout. Beside optimized amino acid profiles, the project also aims to investigate the bioavailability of amino acid isomers (DL-amino acids) as well as the role of mammalian target of rapamycin complex 1(mTORC1) in protein synthesis and the normal growth development in rainbow trout.

Perspective
The project is expected to provide new insights into the role of nitrogen-optimized feed for reducing nitrogen excretion and enhancing fish welfare. These findings may later be translated into industrial applications to reduce the environmental footprint of feed and contribute to a more sustainable production.

Title:
Amino acid optimization of fish feed

Principal supervisor:
Anne Johanne Tang Dalsgaard

Section:
Aquaculture

Shana Fresnido Genavia

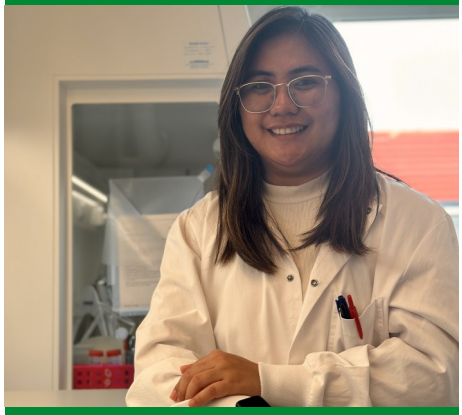
Background
The immune system in animals is a multi-faceted defense mechanism against pathogens. In vertebrates, the immune system operates through both innate and adaptive mechanisms, the latter being capable of generating immunological memory. Traditionally, invertebrates, such as shrimp, have been 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



Section:
Fish and Shellfish Diseases

Chiara Cialini

Background
Rearing fish at high densities increases the risk of spreading pathogenic viruses and bacteria, particularly in larvae and fry. An important fish pathogen in aquaculture is *Flavobacterium psychrophilum*, the etiological agent of Rainbow Trout Fry Syndrome (RTFS), that causes significant economic losses in hatcheries worldwide. Cases of reduced susceptibility to antibiotics underline the need for alternative and more sustainable methods for the treatment of this bacterial infection, such as bacteriophage-based therapy. Bacteriophages (also called phages) are host-specific viruses of bacteria. Their use has recently demonstrated promising results in controlling various infectious fish diseases. However, further development is needed for the commercialization of this solution as a novel prophylactic product.

Project
Besides investigating the efficiency of phage administration in controlling RTFS by performing in vivo experimental infection trials, this PhD project will specifically target rainbow trout (*Oncorhynchus mykiss*) health status and host-pathogen interactions. In particular, the host immune response to phages will be assessed through gene expression analyses using qPCR, while the effects on fish microbiota and tissues development will be evaluated through sequencing and histological techniques, respectively. Once considered as safe, the most efficient phage preparations will be administered to fish/tanks using different strategies (feed pellets, liquid solution, coating on elements of the filtration system of tanks) to establish the best delivery method, before testing this disease control strategy under farming conditions.

Perspective
The final goal of this PhD project is to perform an efficiency and risk assessment of the phage-based solutions. This represents one of the tasks of a larger IFD research project, AQUAPHAGE whose final aim is to develop bacteriophage-based products that target specifically the bacterium *F. psychrophilum,* and to bring these solutions to a commercially viable stage. This new sustainable and innovative method can increase production efficiency and reduce the environmental burden of aquaculture.

Title:
Prophylactic measures against disease with *Flavobacterium psychrophilum* in rainbow trout; effect on pathogen as well as host

Principal supervisor:
Lone Madsen

Section:
Fish and Shellfish Diseases

Joyce Arguelles Hilario

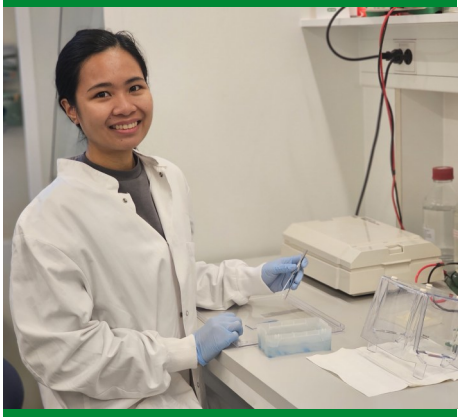
Background
Aquaculture is the most sustainable form of animal husbandry in terms of environmental impact, but infectious diseases cause significant losses, often requiring antibiotics. Lost production as well as use of antibiotics compromise both financial and environmental sustainability of aquaculture. The key to overcoming these problems is improved disease prophylaxis, with vaccination being one of the most effective tools. While injection vaccination is well established for larger-sized fish, early vaccination of smaller fish is less developed due to the lack of efficient vaccines delivered by mucosal routes. The mechanisms of immune activation and protection remain to be fully understood.

Project
The project aims to develop and test formulation strategies for mucosal delivery of recombinant viral vaccines based on DNA and/or recombinant proteins in rainbow trout (*Oncorhynchus mykiss*), targeting diseases that infect early life stages. First, I will optimize the vaccine formulation by incorporating mucosal adjuvants and explore different delivery methods, including inactivated transformed bacterial cells. Next, I will test vaccination strategies, focusing on dose, delivery, and adjuvant aspects under laboratory conditions. Finally, I will evaluate the protective immunity in vaccinated fish through infection trials and identify immune response elements correlating with protection, providing insights into immune mechanisms and ensuring long-term vaccine efficacy.

Perspective
Optimized mucosal vaccines that enhance uptake and stimulate both mucosal and systemic immune responses could address disease problems in small-sized fish. These vaccines would be easier to administer, reduce labor costs, and ultimately contribute to the overall health and welfare of fish population. This approach will not only improve aquaculture productivity and sustainability but also offer valuable insights into the mechanisms of fish mucosal immunity, thus, contributing to the broader field of immunology and vaccine development.

Title:
Development of mucosal vaccine delivery strategies for farmed rainbow trout.

Principal supervisor:
Niels Lorenzen



Section:
Fish and Shellfish Diseases

Caitlin Yoo

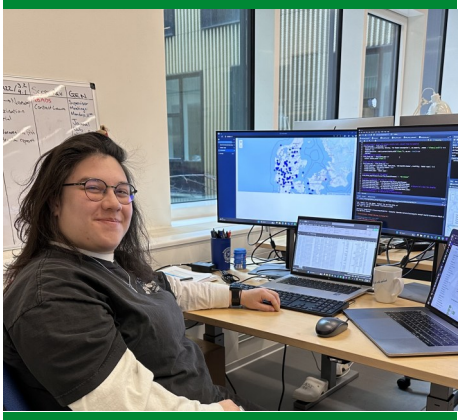
Background
Danish aquaculture is a relatively small but stable food production sector, with a strong emphasis on sustainability. However, disease outbreaks pose a significant threat to productivity and profitability. While economic evaluations of aquaculture diseases exist in other regions, there is limited research specifically addressing the economic impact of diseases in Denmark's aquaculture sector.

Project
The first part of this project aims to assess the economic burden of the fish disease IHN in Danish aquaculture, with the potential to expand its scope to other diseases in later project segments. A combination of economic evaluation methods, including cost-benefit analysis, modeling, and case studies, will be applied. The research will utilize a range of data sources, including industry reports, farm-level data, and government statistics, to provide a comprehensive analysis. Additionally, this work is being conducted as part of the EUPAHW partnership, which facilitates collaboration on animal health and welfare issues at a broader European level.

Perspective
The findings of this research are expected to support key stakeholders—such as farm owners, managers, and policymakers—in making informed decisions regarding disease management. By quantifying the economic impact, the study can contribute to more effective planning for disease surveillance, eradication, and control programs. However, a key challenge may arise if the results suggest increased investment in prevention and eradication efforts, as there could be resistance from those bearing the financial burden. Addressing these concerns through well-informed policy recommendations will be crucial for the practical application of the research outcomes.

Title:
Economic evaluation of diseases in Danish aquaculture

Principal supervisor:
Britt Bang Jensen



Section:
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