Protecting bycaught species in mixed fisheries (PROBYFISH) (39549)

PROBYFISH aims to develop a modelling framework and a support tool to assess whether proposals for regionalised management measures in the North Sea, Southwestern and Northwestern waters are in accordance with the objectives of the CFP. The project approaches this aim by developing agreed and robust methods to define target and bycatch species, identifying the bycatch species for which TAC management of target species would be sufficient, identifying measures that will lead to the sustainable development of the bycatch stocks (technical, spatial etc), producing agreed reference levels to safeguard stocks and combining the results of all activities in a user-friendly and flexible tool.

The project is coordinated by DTU Aqua and is funded by EU Executive Agency for Small and Medium-sized Enterprises (EASME).

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24/05/2018 → 23/05/2021

Keywords: Research areas: Fisheries Management & Ecosystem based Marine Management
Project: Research

Investigation of causes affecting distribution and density of cod and plaice in Danish coastal areas (Kystfisk 3) (39413)

Danish coastal fishermen have for several years wondered at the apparent drastic decrease in coastal fish abundance and have raised the question of the reason for these changes.

The objective of Kystfisk 3 is to investigate the causes of the decline in coastal cod and plaice by providing:

- A thorough analysis of the stock structure of plaice and cod.
- A description of the spatial distribution of plaice and cod.
- A description of the historical development in spatial distribution.
- A model of the distribution and density of cod and plaice stocks in relation to environmental conditions.

Kystfisk3 is a continuation of the work conducted in Kystfisk 1 and Kystfisk 2. In Kystfisk 1 and Kystfisk 2, interviews with fishermen were conducted and the issues reported confirmed by analysis of survey trawl data. In Kystfisk 3 a combinaton of spatial models and genetic analyses are used to determine the contribution of migration, environment and decreased stock abundance. The project analyses are based on existing data, including otoliths collected in the 1990’s. Data are compared to current daya collected from specific areas in Kattegat, Skagerrak and the North Sea.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

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22/12/2016 → 30/09/2019

Keywords: Research areas: Marine habitats, Fisheries Management & Ecosystem based Marine Management
Project: Research

Optimizing water sanitation using alternatives to formalin (39500)

This applied project is a collaboration between Danish Aquaculture, Danish fish farmers, KU Sund and DTU Aqua. The aim is to improve the efficacy of water treatment with easy degradable chemicals that can substitute or reduce the use of formalin. The particular concern is effective water treatment to reduce abundance of skin- and gill parasites (Costis and gill amoeba).

The project has four work packages:
• Practical trials on fish farms (all).
• Test and development of a method to assess disinfection demand (DTU Aqua).
• In vitro test with Costia and use of different chemicals (KU Sund).
• PCR identification of amoebic gill disease (KU Sund).

The project is coordinated by Danish Aquaculture Association and is funded by Direktør Ib Henriksens Fond.
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01/01/2019 → 31/12/2020
Keywords: Research area: Aquaculture
Project: Research

Supporting veterinary measures (39362)
The project is a collaboration between the Danish Aquaculture Association, DTU Aqua, DTU Vet and KU SUND with the help of practicing fish veterinarians, Aquapri and several trout and shellfish farmers.

The project addresses three specific veterinary issues in Danish aquaculture:
-Skin disorders in rainbow trout.
-Water quality and the importance of microparticles for breeding fish in RAS.
-The importance of the parasite Bonamia ostreae for oyster farming in the Limfjord.

The project is coordinated by the Danish Aquaculture Association and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
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01/01/2017 → 31/12/2018
Keywords: Research area: Aquaculture
Project: Research

Veterinary improvements of trout RAS with focus on water quality and design (Recirk-vet) (39593)
The purpose of project Recirc-Vet is to study and evaluate the implications of altered farming practice from flow through systems to recirculated aquaculture systems in DK. The project will evaluate the rearing conditions on four selected trout RAS and try to identify important factors affecting fish and system performance. The project will compare the farms and look into temporal patterns, based on traditional water quality parameters, new microbial assays and monitoring of oxygen and carbon dioxide.

The project consists of a network, which includes veterinarians, researchers and farm managers. They will try to link rearing conditions and fish diseases as well as fish welfare indicators.

The project is coordinated by Danish Aquaculture Association and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
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**Peracetic acid as a potential treatment for amoebic gill disease (AGD) in Atlantic salmon (39544)**

The overarching aim of PERAGILL is to explore the potential of peracetic acid as an alternative and sustainable treatment to amoebic gill disease, a threat in the Norwegian Atlantic salmon aquaculture.

The project includes several workpackages, in which the following topics will be:

- To investigate the amoebicidal activity of PAA and identify factors influencing this feature.
- To assess the impact of PAA treatment on fish health and welfare.
- To determine the potential environmental risk of PAA treatment.
- To develop integrative assessment toolbox to evaluate treatment impacts and efficacy.
- To characterise the different factors affecting the dynamics of PAA treatment in AGD-infected fish.
- To compare conventional AGD treatments with PAA application.

The project hence include controlled prolonged trials with Atlantic salmon post smolts (exposure and recovery), where samples of gills, skin and plasma will be analyzed. Controlled degradation trials in seawater will be performed and in vitro experiments will be conducted.

The project is coordinated by NOFIMA, Ås, Norway and is funded by the The Norwegian Seafood Research Fund (FHF). Pedersen, L., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

**Launch of ozone application in freshwater fish farms (Lanozo) (39595)**

The accumulation of suspended bacteria and micro-particles poses a great challenge for recirculating aquaculture systems (RAS). Microparticles (1-40 µm) cannot be removed by traditional measures (sludge-cones, drum screen filter) and protein skimming is only done in saltwater due to the characteristic surface tension, small bubble size and associated removal efficacy.

The aim of this project is to explore and test well-known water treatment technologies (ozone and protein skimmers) to improve water quality in freshwater fish farms by removing accumulated microparticles. The project include both controlled lab experiments and tests performed in full scale commercial RAS.

The expected work package activities in the project include

- Identify technologies to effectively remove accumulated micro-particles in freshwater.
- Testing methods for removing microparticles and foams on fish farms.
- Evaluate combination of ozone and protein skimmer under controlled conditions.
- Document potential of ozone and protein skimmers with tests on a commercial fish farm.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
Investigating coastal fish stocks and fishery opportunities at the west coast of Denmark
The project aims to increase our understanding of the ecosystem of the west coast of Denmark, focusing on important commercial species.

In the beginning of the project all available information will be collected on fish species and environmental conditions of the area. More importantly, the project will collect new information from a scientific survey using DTU Aqua’s Havfisken and fishing of participating commercial vessels. Combining historical and newly acquired information will help improve management of commercial species that utilise the coastal area.

Finally, the project will investigate potential fishing opportunities in the area.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Sustainable cockle fishery in the Limfjorden (COCKLE) (39508)
In the Limfjorden, cockles are only caught as a by-catch of the blue mussel dredge fishery, mostly associated with cockle surfacing behavior where buried cockles move to the surface of the sediment.

In the last five years (2013-2017) cockle landings in the Limfjorden reached the same value as blue mussel landings and now represent ca. 35% of European Union cockle catches by weight. Therefore, industry and governmental agencies are interested in the regulation and management of the cockle fishery and population in the Limfjorden. The COCKLE project implements the first research plan on the cockle population of the western Limfjorden.

Project aims:
- Evaluate the historical cockle fishery in the Limfjorden as a by-catch of the blue mussel fishery
- Evaluate the cockle population abundance and structure in the western Limfjorden
- Assess the impact of the cockle fishery on cockle populations
- Evaluate cockle surfacing behaviour and its links to environmental, biological and fishing activities
- To perform an initial census of pathogens and parasites in the Limfjorden cockle population

The project is divided into a number of interrelated work packages:
WP 1: Historical data
WP 2: Spatial survey and baseline assessment of cockle populations in the Limfjorden
WP 3: Surfacing survey and fishing events
WP 4: Monitoring and experimental evaluation of cockle population surfacing
WP 5: Pathogens and diseases in C. edule in the Limfjorden: baseline and management perspectives
WP 6: Management and dissemination.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.
**Development of strategies for the control of the pacific oysters in Danish waters (GIGAS) (39507)**

The introduction of Pacific oysters to Danish waters was a consequence of aquaculture experiments carried in the 1970s. Following the establishment of wild populations, Pacific oyster populations have spread dramatically in recent years in a number of important areas for shellfish fishing—areas that are also of natural value—namely the Wadden Sea, the Limfjorden and the Isefjord.

The fishing industry considers Pacific oysters as a threat to their primary fisheries on blue mussels and flat European oysters. Governmental authorities consider the Pacific oyster as one of the potentially most harmful invasive species, threatening both shellfish fisheries and nature values, but action plans against invasive species state that public funds will not be invested in combating or mapping marine invasive species already established in Danish waters. It is therefore a wish of both industry and authorities to undertake actions that can be developed independent of public intervention programs.

The main objective of the project is the development of methods to prevent the spread of the invasive Pacific Oyster into areas where it may compete with blue mussel and flat European oyster populations. Such methods will preferably be based on commercially viable actions to be taken by the fishing industry, which will ensure the maintenance of the efforts without further public investment. Controlling Pacific oysters will protect natural habitats and biodiversity in Nature 2000 areas and the populations of species of commercial interested such as the flat European oyster, the blue mussel or the cockle.

The project is divided into a number of interrelated work packages. Integration of different approaches should result in proposals for a management practice that can provide space for fishing control of Pacific oysters with the aim of limiting their impact on nature, biodiversity and on other shellfish fisheries.

The work packages are:
- WP 1: Mapping and stock assessment of Pacific oysters.
- WP 2: Population dynamics and genetics
- WP 3: Associated pathogens and other organisms.
- WP 4: Development of pacific oyster fishing methods
- WP 5: Communication and project management

The projects is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.

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**Smart fisheries technologies for an efficient, compliant and environmentally friendly fishing sector (SMARTFISH) (39523)**

The objective of SMARTFISH is to develop, test and promote a suite of high-tech systems for the EU fishing sector, to optimize resource efficiency, to improve automatic data collection for fish stock assessment, to provide evidence of compliance with fishery regulations and to reduce ecological impact.

SMARTFISH exploits technological developments in machine vision, camera technology, data processing, machine learning, artificial intelligence, big data analysis, smartphones/tablets, LED technology, acoustics and ROV technology to build systems for monitoring, analyzing and improving processes for all facets of the fishing sector, from extraction, to assessment, to monitoring and control.

The SMARTFISH systems will:
- assist fishermen in making informed decisions during pre-catch, catching, and post-catch phases of the extraction process. This improves catch efficiencies and compositions in fisheries across the EU, leading to improved economic
efficiency while reducing unintended fish mortality, unnecessary fishing pressure and ecosystem damage.
- provide new data for stock assessment from commercial fishing and improve the quality and quantity of data that comes from traditional assessment surveys. This provides more accurate assessment of currently assessed stocks and allow the assessment of data-poor stocks.
- permit the automatic collection of catch data to ensure compliance with fisheries management regulations.

The SMARTFISH systems are tested and demonstrated in several EU fisheries. This contributes to promoting the uptake of the systems by extraction sector and fisheries agencies.

An interdisciplinary consortium with technology developers and instrument suppliers, fishing companies, research and fisheries management institutes and universities will realize SMARTFISH. They are active at national and international levels and well placed to ensure the uptake of SMARTFISH systems by fishing industry and fisheries managers and stock assessment scientists.

The project is coordinated by SINTEF, Norway and is funded by EU through Horizon 2020 Framework Programme. O'Neill, B., PI, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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01/01/2018 → 31/12/2021
Keywords: Research area: Fisheries Technology
Project: Research

Scaring lines - an innovative and flexible solution for the Norway Lobster fishery (Flexselect) (39387)
The aim of the project is to develop and demonstrate a simple and effective system which quickly can be mounted and unmounted on all existing bottom trawls. The system will reduce the catch of fish e.g. to improve the species selectivity in the Danish mixed species fishery for Norway Lobster.

The majority of the work on improvement of species and size selection in trawl fisheries have focused on the codend. Scaring lines focus on reversing the herding process between the trawl doors and thus scare the fish out of the path of the trawl. The process is called counter herding and basically exploit the same means to guide fish out of the trawl path as is used to gather the fish in front of the trawl mouth. The developed system will be easy to mount and demount even from one haul to another and thus allows an ongoing adjustment of the properties of the trawl according to the catch composition observed by the fisher.

The principle of scaring lines will be applicable for different sizes of vessels and trawls as well as the number of towed trawls (1-, 2-, and 4 trawl rigging). Efficient scaring lines allows for an improved species selection in the mixed species fishery for Norway Lobster and will thus act as a mean to prevent the quota on choke species is fished up resulting in fishery closures.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
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07/09/2016 → 23/12/2018
Project: Research

Sustainable, cost-efficient, and responsive fishing gear solutions under the landing obligation (FAST TRACK II) (39578)
The project is a follow up on FAST TRACK I, where a functioning and innovative cooperation platform for industry, scientists, and managers is established. The aim of FAST TRACK II is to consolidate and further develop the FAST TRACK platform which serves as an efficient track from idea to implementation of selective gears. The project builds on a dynamic cooperation between all partners involved in the fishery and this setup ensures an efficient approval procedure according to the EU Common Fisheries Policy. The FAST TRACK platform thereby allows an ongoing development of specialized fishing gears which again ensures the fishermen the best possible economical and biological sustainability under the landing obligation.

In FAST TRACK II, special attention is given to two topics:
- To ensure that the FAST TRACK platform continuously facilitates an efficient development of innovative fishing gears.
- To establish regional and international networks to ensure knowledge sharing on selective gear solutions in specific fisheries. Furthermore, the networks will support a broad acceptance of the attained results.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

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01/06/2018 → 07/11/2020
Keywords: Research area: Fisheries Technology
Project: Research

Real-time camera observation in the Danish trawl fishery—technology based intelligent fishery (TEKNOFISK) (39579)
The aim of the project is to develop and commercially test an innovative real-time camera system on board Danish trawlers. The system will allow fishermen to observe, evaluate, and if relevant, actively react on information about the fishing process. A reaction could be to terminate the haul or to shift to alternative depth or fishing ground. Through innovative use and combination of existing technology, the project will develop a real-time tool for decision making. The tool will make the trawl fishery a more knowledge based process, where decisions can be made on better grounds.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

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06/12/2018 → 09/11/2020
Keywords: Research area: Fisheries Technology
Project: Research

From science to innovation in the Nephrops fishery to comply with the Common Fisheries Policy: development of an optimal and flexible selection system for trawl by use of new technology and underutilized fish behaviour (VISION) (39375)
The aim of the VISION-project is to develop a new generation of trawl designs towards a targeted and controllable species and size selection in the mixed fisheries targeting Nephrops by improving vertical separation of the catch and gear selectivity. This will contribute to an economic viable fishery and sustainable use of resources under a landing obligation.

The mixed fisheries targeting Nephrops is one of the most economically important Danish fisheries. It is characterized by high proportions of discards and will have a low capitalization of the vessels' quotas under a landing obligation.

In the VISION-project, a horizontally divided codend developed in the FishValue-project (vaerdifisk.dk) will be refined to increase the vertical separation of cod, flatfish and small fish in general from Nephrops. The project will combine new technology and knowledge of fish behavior in an innovative way to develop new selection principles and thus gear designs with an increased species and size selectivity. Furthermore, the project seeks to provide solutions for a highly flexible fishery so fishermen can change their gear to match the selective properties with the current fishing situation.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Ministry of Environment and Food of Denmark.
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19/01/2016 → 08/08/2019
Keywords: Research area: Fisheries Technology
Project: Research

Caught and released: an overview of fishes’ sensitivity to being discarded as a tool to aid pursuing ecosystem-based management (COPE) (39416)
One main goal of the project is to provide a catalogue of the survival rates of different species subject to the landing obligation under the Common Fisheries Policy (CFP) regulation seen in relation to the discard ratios of different fisheries. Another main goal is to obtain survival rates for selected important species and fishing gear.

This information can, in the cause of high survival rates, be used in proposals for exemptions from the landing obligation. Species exempted from the landing obligation can be returned to the ecosystem as discards, and contribute to reproduction and recruitment, and thus productivity of the stock. Landings of unwanted catch may cause unintentionally increase in fishing mortality and unsustainable fishery.

Exemptions from the landing obligation may facilitate the implementation of the CFP, especially for small vessels in the mixed fishery for which there is a mismatch between the size of the deck area and the number of species and size groups in a catch that needs to be kept separately during sorting. Also, exemptions from the landing obligation can improve the economic viability of fisheries as the CFP does not allow landed catch below the minimum conservation reference size to be used directly for human consumption, which mostly limits the utility to low value products.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Ministry of Environment and Food of Denmark.

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13/09/2016 → 31/12/2018
Keywords: Research area: Fisheries Technology
Project: Research

Marine litter in the water column of the North Sea (MARLINS) (39561)
MARLINS (Marine litter in the water column of the North Sea) will utilize a unique collection of marine litter, sampled in connection with annual herring larvae surveys, to investigate the composition, amount, distribution and potential sources of marine litter in the North Sea. In contrast to most other investigations on marine litter which are largely focussed on beach surveys, bottom trawl surveys or sampling in surface waters, the present project will provide information about marine litter in the entire water column.

The main output of the project will be a marine litter database and a detailed description of the composition of the marine litter by different categories, colours and sizes as well as maps of the spatial distribution, amount and where applicable weight of the different litter categories in the entire North Sea area. In addition, drift model runs will be conducted to further investigate potential source and sink areas of the litter.

The knowledge gained from the project is expected to be relevant for various stakeholders and authorities such as Ministries of Environment and Fisheries, nature conservation organizations, tourism organizations as well as the International Council for the Exploration of the Sea (ICES) and the scientific community in general, in particular in relation to the Marine Strategy Framework Directive. For example, information about the most likely sources of litter and identification of potential source areas for certain litter types may allow responsible authorities and stakeholders to investigate if actions can be taken to reduce or entirely prevent the continuing, future introduction of certain types of litter into the marine environment by diminishing or completely shutting down the sources.

The project is coordinated by DTU Aqua and funded by Velux Fonden.
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01/10/2018 → 30/09/2020
Keywords: Research areas: Fish Biology, Marine Living Resources & Ecosystem based Marine Management
Project: Research

MAB4: MacroAlgae Biorefinery for Value-added products
The MAB4 project focus on cultivating seaweed on a large scale and using it for food and skin care products.

While running out of farmland, new opportunities show up for growing sea-crops in the oceans. Many seaweed species are highly nutritious and rich in bioactive substances, those can serve as ingredients for food and cosmetics.

In Far East, longlines of seaweed – also known as macroalgae – is a common sight at the surface of the sea, however, seaweed cultivation is still at a modest level in Denmark and in Europe.

The MAB4 project which is financed by “Innovation Fund Denmark” aims at cultivating seaweed – in particular brown seaweeds – in Danish and Faroese waters. Brown seaweeds contain various valuable substances such as antioxidants,
protein, polysaccharides and minerals that may be used as functional ingredients in feed, food products and skin lotions. For example, the sugar component laminarin has proven antitumor, anticoagulative, anti-inflammatory and anticoagulation effects.

MAB4 is a project with a consortium of national and international experts on algea cultivation and biorefinery from universities, GTS institutes, small and medium-sized businesses as well as relevant industrial end-users. The results from MAB4 will be a beacon for industry stakeholders and future seaweed cultivation.

The role of DTU Food in the project is to evaluate 1) the antioxidant potential of polyphenols extracted from sugar kelp in skin care products, 2) the emulsifying and antioxidant properties of polysaccharides from sugar kelp in food emulsion models.

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01/05/2015 → 01/05/2020
Nature of activity type: Research
Project: Research

Development of management models for fish stocks (39415)
The aim of the project is to support the ongoing process of developing long-term management plans for short-lived species of great importance to the Danish fishery and to maintain the international position of Danish fisheries research.

The project contains the following objectives: (1) provide a data-driven basis for developing an alternative management model for sandeel in the North Sea, (2) Evaluate a portfolio of management strategies for short-lived species in the North Sea, and (3) contribute with new data to the ICES multi-species model that provide natural mortality estimates to be used in single-species stock assessment models and in relation to an ongoing international effort to take on a holistic ecosystem approach to management.

The project also include scientist-stakeholder collaboration and participation in international meeting in EU and ICES.

The project is coordinated by DTU Aqua and funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.
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15/12/2016 → 15/12/2018
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Project: Research

Maintaining a sustainable sprat fishery in the North Sea (BEBRIS) (39548)
The aim of the project is to support the maintenance of a sustainable sprat fishery in the North Sea, Skagerrak and Kattegat; A fishery of great importance to the Danish industrial fishery. In the project we will be working with the stock assessment model and forecast models (as preparation for the ICES sprat benchmark). In order to support the development of a long-term management, a generic Management Strategy Evaluation tool will be developed according to ICES guidelines. The project will also analyse the role of weather conditions on catchability and distribution of catches. Lastly, the project will look into the possibility of using the IBTS Q3 survey to develop a recruitment index. The project also include scientist-stakeholder collaboration and participation in international meetings.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund and the Danish Fisheries Agency.
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Rindorf, A., Project Participant, National Institute of Aquatic Resources
Brooks, M. E., PI, National Institute of Aquatic Resources
01/06/2018 → 30/12/2020
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Project: Research
Investigation into online microbial water quality measurements (39471)
Danish SME Lagur produces a novel electromagnetic treatment system for the chemical-free treatment of water, that reduces the impact from lime scale in water on pipes, heating, and cooling systems. The system also has a significant impact on reducing microbial/bacterial levels within these systems. The product benefits have been proven through practical experience, but further expansion was limited by the customers' requirement for integrated water quality monitoring. The goal of this project is therefore to progress towards development of a system that can monitor microbial, chemical, and physical water quality with the results available online, and be integrated with Lagur’s water treatment systems.

The project is coordinated by DTU Aqua and is funded by the European Regional Development Fund.
Hambly, A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Stedmon, C., Project Manager, National Institute of Aquatic Resources
01/07/2017 → 30/12/2017
Keywords: Research area: Observation Technology
Project: Research

Monitoring of invasive species in Danish harbours (MONIS4) (39451)
The overarching objective is to carry out proof-of-concept for monitoring of invasive species in 16 Danish harbours. Monitoring methods include multiple types of conventional observation methods as well as eDNA based assessment of presence/absence of a total of 20 prioritized species for which eDNA assays have been developed by the project consortium in the previous project MONIS 3.

The project is funded by the Danish AgriFish Agency through subcontracting by NIVA DK.
Bekkevold, D., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
01/03/2017 → 30/06/2018
Keywords: Research areas: Population Genetics & Coastal Ecology
Project: Research

Distribution of mackerel, herring and sprat (MAKSIBRI) (39434)
The overarching objective of the project is to increase knowledge about the spatial distribution of populations of herring, sprat and mackerel in the North Sea, Skagerrak and Kattegat. Application of new genetic marker based analyses has proven especially useful in this context and the project aims to apply newly developed markers in herring and sprat. In mackerel, the distribution of stock components in the North Sea will be examined using existing material and data. For herring, focus is on validating genetic and morphological methods and testing them to assess samples of herring bycatch from the sprat fishery. In sprat focus is on determining population components in the North Sea and Skagerrak using both genetic and modeling other types of biological data.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
Bekkevold, D., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Lindegren, M., Project Participant, National Institute of Aquatic Resources
Mena, B. J., Project Participant, National Institute of Aquatic Resources
06/09/2016 → 26/01/2019
Keywords: Research areas: Marine Populations and Ecosystem Dynamics, Population Genetics & Marine Living Resources
Project: Research

Validating age-determination of anglerfish and hake: an exploratory investigation using microchemistry analysis (39498)
The estimation of the biological reference points used in fish stock assessment requires reliable length-at-age information which is usually obtained by counting and measuring seasonal growth marks in otoliths for a representative sample of the population.

However, for some stocks, clearly defined growth marks do not occur, hampering age estimation and age based assessment and presenting a challenge to the implementation of MSY based management as required under the CFP. For the stocks of anglerfishes (Lophius spp.) and hake (Merluccius merluccius) that are the focus of this tender the reliability of available age-estimation methods is low and the estimation of MSY reference points is problematic. For these stocks, improved growth models are needed to inform length based assessments.

The specified objective of this tender is to analyse microchemistry patterns in otoliths and illicia with the intention of developing improved growth models to inform length-based assessments for the hake and anglerfish stocks of interest.
This proposal addresses that objective by combining the reanalysis of previously collected microchemistry data with additional analyses of existing and newly collected material and a comprehensive analysis of length distributions from available survey data. For hake, direct validation of seasonal microchemistry patterns is possible using existing collections of chemically tagged otoliths. For anglerfish, seasonality will be confirmed using marginal microchemistry analysis of quarterly collections. Pairwise comparisons of otoliths and illicia will allow us to establish the extent to which growth marks and opacity profiles in each structure correspond to seasonal trends in microchemistry.

The tender is funded by EASME/EMFF/2017/012 and is coordinated by Galway Mayo Institute of Technology, Ireland. Hüsey, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/01/2018 – 13/12/2019
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Galway - Mayo Institute of Technology, Marine Institute, Spanish National Research Council, University of Bergen, IFREMER
Project: Research

**Future growth in sustainable, resilient and climate friendly organic and conventional European aquaculture (FutureEU Aqua) (39567)**

The overall objective of FutureEU Aqua is to effectively promote sustainable growth of resilient to climate changes, environmentally friendly organic and conventional aquaculture of major fish species and low trophic level organisms in Europe, to meet future challenges with respect to the growing consumer demand for high quality, nutritious and responsibly produced food. To this end, FutureEU Aqua will promote innovations in the whole value chain, including genetic selection, ingredients and feeds, non-invasive monitoring technologies, innovative fish products and packaging methods, optimal production systems such as IMTA and RAS, taking into account socioeconomic considerations by the participation of a wide spectrum of stakeholders, training and dissemination activities.

To achieve the objective and to relate to the work program, nine work packages will contribute to improvements of future aquaculture. To ensure sustainable and resilient production of fish FutureEU Aqua will work with tailor made fish and feed, and validate fish performance and water quality in cost effective production systems. Consumer demand and awareness of how to choose sustainable and climate friendly seafood. With the increasing production of seafood, we face space- conflicts, which, in combination with the current regulatory frameworks will be considered. Wireless sensor technology for health and welfare monitoring and novel technology for product quality and packaging to meet future demands, will be implemented.

Stakeholders’ knowledge and views will be important, and communication, dissemination as well as training sessions will be emphasized.

The project is coordinated by NOFIMA, Norway and is funded by HORIZON 2020 Blue Growth Programme.
Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Pedersen, L., Project Participant, National Institute of Aquatic Resources
Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources
von Ahnen, M., Project Participant, National Institute of Aquatic Resources
01/11/2018 → 30/09/2022
Keywords: Research area: Aquaculture
Project: Research

**Sand banks and fisheries impact in relation to EU fisheries and environmental policy (39519)**

Objective of the project: The project will improve the knowledge base for ongoing and upcoming Natura 2000 and MSFD implementations in the North Sea. For nature-type 'sand banks', in particular Danish sandeel and plaice fishing will be affected. Activities in the project: The key activities of the project are targeted method developments and knowledge production in relation to EU fisheries and environmental policy: 1) Development of a gear and sediment-specific model for bottom impact from all types of mobile bottom-contacting fishing gears in the North Sea. 2) Field trials to document short-term impact on sandbank fauna from demersal seine fishery. 3) Analyses of data from the seine gear field trials and of existing data for the impact of sandbanks from trawlers, including impact differences between bottom and floating trawl doors. 4) Estimation of sediment impact from natural disturbance on sand banks (e.g. tide and wave impact) as well as scaling of these in relation to physical effects of different types of gear. 5) Integrated analysis of the impact of different fisheries and other pressure factors on sand banks. 6) Dissemination. Project Expected Effects: The project’s results and method developments can be used directly in the management to separate different fisheries with regard to bottom
impact; e.g. by nature conservation via area restrictions. Activity 4 and 5 will generate management tools that can quantitatively address descriptor 6 under the Marine Strategy Framework Directive relative to sand banks.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Eigaard, O. R., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Dinesen, G. E., Project Manager, National Institute of Aquatic Resources

Gislason, H., Project Participant, National Institute of Aquatic Resources

Bastardie, F., Project Participant, National Institute of Aquatic Resources

Nielsen, J. R., Project Participant, National Institute of Aquatic Resources

Egekvist, J., Project Participant, National Institute of Aquatic Resources

Pedersøn, E. M., Project Participant, National Institute of Aquatic Resources

Støttrup, J. G., Project Participant, National Institute of Aquatic Resources

Nielsen, A., Project Participant, National Institute of Aquatic Resources

Hansen, F. T., Project Participant, National Institute of Aquatic Resources

O’Neill, B., Project Participant, National Institute of Aquatic Resources

Noack, T., Project Participant, National Institute of Aquatic Resources

Lundgaard, L. S., Project Participant, National Institute of Aquatic Resources

Hansen, A. D., Project Participant, National Institute of Aquatic Resources

01/02/2018 → 31/01/2020

Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology & Marine Living Resources & Fisheries Technology & Fisheries Management

Project: Research

Seal-safe fishing (39421)
The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Larsen, F., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Krag, L. A., Project Participant, National Institute of Aquatic Resources

Rindorf, A., Project Participant, National Institute of Aquatic Resources

Berg, C. W., Project Participant, National Institute of Aquatic Resources

Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources

Kroner, A., Project Participant, National Institute of Aquatic Resources

12/09/2016 → 19/12/2018

Keywords: Research areas: Ecosystem Based Marine Management & Fisheries Technology

Collaborators: Swedish University of Agriculture Science

Project: Research

Restocking of lobster at stone reefs in the sea at North West Jutland (39555)
The overall idea is to capture mature female lobsters, hatch the eggs and grow larvae to juveniles for restocking in coastal waters around Hirtshals to Løkken. Partners are NSC, Hirtshals/Løkken Fisheries Associations, fishermen and restaurants. DTU Aqua is involved in optimizing knowledge about nutritional requirements of lobster larvae and juveniles to ensure a high survival and growth.

The project is coordinated by the North Sea Centre and is funded by "ENV"-Fonden and FLAG (Local Actions Groups within Fisheries).

Lund, I., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

Goncalves, R., PhD Student, National Institute of Aquatic Resources

01/07/2018 → 30/06/2020

Keywords: Research area: Aquaculture

Collaborators: Villa Vest (restaurant), North Sea Centre, Hirtshals Fisheries Association, Løkken Fisheries Association, Lilleheden (restaurant)

Project: Research

Cormorant and salmon in Skjern River—the extent of predation and test of strict measures (Skjern Skarv) (39356)
We test if strict measures to prevent cormorants from eating salmon smolts have any effect. In Skjern River and Ringkøbing Fjord cormorants are causing high mortality of migrating smolts. In this project we compare the estimated mortality between 2016, where no special measures were taken with that of 2017 where intensive protective shooting and harassment of birds were undertaken. Cormorants are monitored and various methods of shooting and scaring is tested.

The projects is coordinated by Danish Centre for Environment and Energy, Aarhus University and is funded by the Danish Environmental Protection Agency.

Jepsen, N., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

01/01/2016 → 31/12/2018
Arctic impact on weather and climate (Blue-Action) (39390)

Blue-Action will provide fundamental and empirically-grounded, executable science that quantifies and explains the role of a changing Arctic in increasing predictive capability of weather and climate of the Northern Hemisphere. To achieve this Blue-Action will take a transdisciplinary approach, bridging scientific understanding within Arctic climate, weather and risk management research, with key stakeholder knowledge of the impacts of climatic weather extremes and hazardous events; leading to the co-design of better services. This bridge will build on innovative statistical and dynamical approaches to predict weather and climate extremes. In dialogue with users, Blue-Arctic will take stock in existing knowledge about cross-sectoral impacts and vulnerabilities with respect to the occurrence of these events when associated to weather and climate predictions. Modeling and prediction capabilities will be enhanced by targeting firstly, lower latitude oceanic and atmospheric drivers of regional Arctic changes and secondly, Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments will be key to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations assets are planned. Blue-Action thereby demonstrates how such an uptake may assist in creating better optimized observation system for various modelling applications. The improved robust and reliable forecasting can help meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales, will take Arctic climate prediction beyond seasons and to teleconnections over the Northern Hemisphere. Blue-Action will through its concerted efforts therefore contribute to the improvement of climate models to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation.

The project is coordinated by DMI, Denmark and is funded by EU Horizon 2020 Programme Blue Growth.

Project: Research

Marine forests (39470)

The purpose of the project is to make an overview of benthic marine vegetation (eel-grass, seaweed and salt marsh) in Denmark based on existing data, both present and historic as well as to synthesize knowledge about the ecosystem functions and services of the respective habitats.

The project is coordinated by the University of Southern Denmark and is funded by the VELUX Foundation.

Project: Research

Stock assessment and management of sole fishery (39383)

The project is focused on improving the stock assessment and management of sole fishery in the Skagerrak, Kattegat, Belts and Western Baltic Sea. Input to the stock assessment and the scientific basis for counseling on the sole population in Danish waters is developed continuously. This project aims at collecting biological data and acquire new knowledge on sole distribution as well as including knowledge from the fisherman and give advice on efficiency of using different fishing gear.

Project: Research
The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Edelvang, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Jørgensen, O. A., Project Participant, National Institute of Aquatic Resources
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
Brown, E. J., Project Participant, National Institute of Aquatic Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Stør-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Boje, J., Project Participant, National Institute of Aquatic Resources
Hüssy, K., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Krag, L. A., Project Participant, National Institute of Aquatic Resources
Hansen, J. H., Project Participant, National Institute of Aquatic Resources
Frandsen, R., Project Participant, National Institute of Aquatic Resources

The future modular fishing vessel (FMF) (39454)
The FMF project (the future modular fishing vessel) is a development project aiming at developing an innovative fishing vessel for coastal fishing, which is multi-functional and optimized in terms of operation, maintenance and energy consumption.

JOBI VÆRFT A/S, together with ShipCon ApS (Frederikshavn) and SafeEx ApS (Nørresundby) plan to design an innovative fishing vessel in the size range somewhere between 15-30 meters for coastal fishing.

DTU Aqua participates as a knowledge institution in the project and will support the project by supplying knowledge on fishing gear and catch handling, including improved processing and storage facilities on board fishing vessels.

The project is coordinated by and is funded by the North Jutland Regional Fund and JOBI VÆRFT A/S.
Edelvang, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Larsen, E., Project Manager, National Institute of Aquatic Resources
Egekvist, J., Project Participant, National Institute of Aquatic Resources
Jessen, T. K., Project Participant, National Institute of Aquatic Resources
01/05/2016 → 01/05/2020
Project: Research

Development and demonstration project for ecosystem based marine spatial planning (ØKOMAR) (39530)
Following the decision of the EU Marine Framework Directive in 2014, Denmark has to transpose the Directive into Danish legislation. By 2021, a strategy for the Danish marine areas needs to be implemented to achieve the objectives including how to obtain the goals for growth and exploitation of the territorial sea taking into account the interaction between land and sea, environmental and economic aspects and organizes the use of the best available data.
The ØKOMAR project will develop and test data-based tools for ecosystem-based marine planning in the Danish waters, partly to explore the use of these tools, partly to make these tools available to relevant users and authorities.
The project is coordinated by NIVA Denmark and funded by the VELUX Foundation.

Edelvang, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Hansen, F. T., Project Participant, National Institute of Aquatic Resources
Egekvist, J., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Frandsen, R., Project Participant, National Institute of Aquatic Resources
01/04/2018 → 31/03/2020
Keywords: Research area: Ecosystem Based Marine Management
Collaborators: Aarhus University, University of Copenhagen, Geological Survey of Denmark and Greenland, NIVA Denmark Water Research
Project: Research

Arctic Research Icebreaker Consortium (ARICE) (39506)
ARICE’s overall aim is to provide Europe with better capacities for marine-based research in the ice-covered Arctic Ocean.
ARICE aims at reaching this goal with the existing polar fleet by:
1. Networking: ARICE will develop strategies to ensure the optimal use of the existing polar research vessels at a European and international level. The aim is to establish an International Arctic Research Icebreaker Consortium which shares and jointly funds ship time for scientists on the available research icebreakers.
2. Transnational access: ARICE will provide transnational access to four European and two international research icebreakers. Access is granted based on scientific excellence of the research proposals, which researchers need to submit during the application process. The participating icebreakers are: PRV Polarstern (Germany), IB Oden (Sweden),
Green switch in Danish Aquaculture by changeover to recirculation (GODAOR) (39462)
The overall aim of the project is to disseminate scientific knowledge and practical experiences regarding optimum use of recirculation technology in land based fish farming.

The main concrete aims are:
1. To promote green and economic sustainability in recirculation fish farming by optimum use of recirculation technology to minimize the specific discharge of nutrients (nitrogen, phosphorus and organic matter) from the fish production.
2. To strengthen green switch by increased use of recirculation technology by supporting the changeover from traditional pond farming to modern recirculation technology. This is based on knowledge and experience from research- and development projects. E.g. will optimum designed farms and management reflect less fish diseases, less mortality and improved feed utilization concomitant with better fish welfare.

This project is coordinated by the Danish Aquaculture Organisation and is funded by Green Growth and Development Program (GUDP).

01/07/2017 → 30/06/2021
Keywords: Research area: Aquaculture
Brown shrimp fishery in the North Sea (39418)

The purpose of the project is to improve the possibilities for evaluating the self-management of the brown shrimp fishery and develop this through analysis of the impact of management actions on the brown shrimp stock. This objective is to be met in three work packages. Through improved monitoring and survey design (AP2) as well as model based analysis of brown shrimp dynamics and the mechanisms of stock fluctuations (AP1 and AP3) in order to calculate stock development and a number of associated parameters for current and future self-management and thereby increase opportunities for an optimal sustainable fishery on the resource.

The project further aims to build the national preparedness for advice provision on issues concerning the brown shrimp fishery. Some of the main contributions will be in preparation for international survey participation and operational stock modelling (AP3). The project will also set up systems for future fisher – researcher collaboration in management of brown shrimp fisheries and contribute to the increase and facilitating of international scientific cooperation on brown shrimp fishing through enhanced active Danish participation in relevant fora (AP4).

The project will thus

(1) collate all available information about the biology of brown shrimp and its function in the ecosystem in an easily accessible form, for the benefit of fisheries and management.
(2) Design, implement and analyse an optimized monitoring and survey system that can support stock analyses and management decisions.
(3) Analyse brown shrimp population distribution and fluctuations, and in combination with controlled growth and reproduction experiments clarify the key parameters that determine population dynamics.
(4) Develop a stock assessment model based on DTU Aquas statistical modelling framework, which, based on available data, can estimate stock development and provide the basis for international management advice.
(5) Through the results, provide input to international advisory work in ICES and STECF.

The long-term impact of the project will be a scientific contribution to sustainable self-management and utilization of an economically important resource for local fisheries.

This project is coordinated by DTU Aqua.

Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Krekoukiotis, D., Project Participant, National Institute of Aquatic Resources
Andreasen, H., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
Petersen, J. K., Project Participant, National Institute of Aquatic Resources
Veicherts, M., Project Participant
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources

14/09/2016 → 13/12/2018

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Marine Living Resources
Collaborators: Danish Fishermen’s Association
Project: Research

Ecosystem effects of large-scale cultivation of macroalgae (EcoMacro)

Schmedes, P. S., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
29/05/2018 → 04/06/2018

Collaborators: Aarhus University
Project: Research

SEAFOOD-TOMORROW: Nutritious, safe and sustainable seafood for consumers of tomorrow. EU-H2020-project with 35 participants

SEAFOODTOMORROW – Nutritious, safe and sustainable seafood for consumers of tomorrow. EU-H2020-project with 35 participants.
Granby, K., Project Participant, National Food Institute, Research group for Analytical Food Chemistry
Dalgaard, P., Project Participant, National Food Institute, Research Group for Analytical and Predictive Microbiology
Sloth, J. J., Project Participant, National Food Institute, Research group for Nano-Bio Science
Larsen, B. K., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture

FP7 Contract ID: 773400
01/11/2017 → 31/10/2020

Project: Research
Other pressure factors in the marine environment than nutrients (39529)

Anthropogenic pressures are potentially of major importance to the ecological state of the marine environment. In coastal areas, ecological state of the marine environment is assessed according to the EU Water Framework Directive (WFD) using the quality elements phytoplankton, angiosperms (eelgrass), macro algae and benthic fauna. Additional supportive parameters like Secchi depth and occurrence of anoxia or hypoxia can be included in the assessment. Extensive research efforts have shown that excessive loading of the nutrients nitrogen and phosphorous are the most important pressure factors in the coastal marine environment of Denmark. However, other pressure factors like e.g. fisheries, gravel and sand extraction, invasive species, run-off of micro plastics and hazardous substances and physical modifications like sluices and dams. For Danish coastal areas, there is no overarching perspective to other pressure factors than nutrients and assessment of their potential impact on environmental status.

In the present project, the aim is to assess the potential impact of a number of expected pressure factors other than excess loading of nutrients and effects of climate changes on environmental state of the Danish water bodies according to the WFD. The assessment will be based on existing knowledge and existing data. The assessment will be performed as a review of documented effects of the different pressure factors on the quality elements and supportive parameters, assessment of data availability for analysis on water body level and documentation of dependence on the pressure factor of external environmental parameters like salinity and temperature. Based on the review of each pressure factor, an analysis will be performed to assess the impact of the pressure factor on the indicators depth limit of eelgrass, DKI and concentration of chlorophyll a during the summer period. The analysis will only be performed if an effect of the pressure factor is well documented and sufficient data are available. Finally, the project will assess how pres factors can be cumulated.

The project is funded by the Danish Environmental Protection Agency and is coordinated by DTU Aqua.

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Rindorf, A., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Gislason, H., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Christensen, A., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Eigard, O. R., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Svendsen, J. C., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
Nielsen, P., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
Møller, L. F., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, M. M., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre

01/03/2018 → 30/06/2019

Keywords: Research areas: Shellfish and seaweed, Ecosystem based Marine Management & Coastal Ecology
Collaborators: Aarhus University
Project: Research

Optimization of mussel mitigation cultures for fish feed in the Baltic Sea (BONUS OPTIMUS) (39449)

The ambition of BONUS OPTIMUS is to provide robust evidence-based documentation (ecological, social, and economic) on ecosystem goods and services as well as environmental impact of mussel farming to support its future expansion. Harnessing the full potential of the “blue economy” is seen today as one of the most promising means to boost growth, employment opportunities and competitiveness. In marine systems like the Baltic Sea that already are heavily exploited and subject to multiple anthropogenic pressures, it is of key importance for the long-term sustainability of the blue growth that it does not add to the pressure factors.

Aquaculture of extractive species like mussels and seaweed is an example of a blue growth potential that will not add to the pressure on the Baltic ecosystem but in contrast has the potential to mitigate some of the effects of excess load of nutrients. Thus, farming mussels intends to remove nutrients from the aquatic environment based on a mass balance perspective in the recipient water body thereby creating a truly circular economy.

As mussels farmed in most of the Baltic are unsuitable for human consumption due to their small size, BONUS OPTIMUS will document mussel meal as an alternative protein source to replace fish and soybean meal as a component in diets for fish. There is a worldwide demand for alternative and more sustainable fish feed in the aquaculture industry.

Aquaculture of mussels has the largest potential in relation to production volume, economic potential and sustainability in eutrophic system thereby contributing substantially to blue growth in the Baltic. To fulfill the potential, research and development of mussel aquaculture is needed on several levels: documentation of production potential, extent of the environmental goods and services delivered, environmental impact below farms and how mussel farming can fit in the coastal zone and achieve social acceptance.

BONUS OPTIMUS consists of seven work packages and involves nine partners from Denmark, Germany, Poland and Sweden.

The project is supported financially by the BONUS programme and is coordinated by DTU Aqua.

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Saurel, C., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, P., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Mussel farming—mitigation and protein source for organic husbandry (MUMIPRO) (39424)
The central MuMiPro vision is to boost sustainable mussel production in Danish coastal waters thereby meeting some of the most obvious national potentials for blue growth.
The overall objective of MuMiPro is to create a new way of growing mussels with a dual purpose: To create a new business area in Denmark by producing animal protein feed ingredients for organic husbandry and improve the marine environment by mitigating eutrophication effects through harvest of mussels.
MuMiPro consists of six work packages and involves 15 partners including mussel farmers, feed producers and research institutions within mussel production, husbandry, feed production, organic production and environmental management.
The project is funded by Innovation Fund Denmark and is coordinated by DTU Aqua.
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Saurel, C., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, P., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Taylor, D., PhD Student, National Institute of Aquatic Resources, Danish Shellfish Centre
Bak, F., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, N., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
15/01/2017 → 31/12/2020
Keywords: Research area: Shellfish and seaweed: Biology, production and management
Project: Research

Danish seaweed resources - for food, feed and as a helping hand to the marine environment (Tang.nu) (39442)
The overall goal of Tang.nu is to change the flow of nutrient from land to sea from a linear flow where excess nutrients are lost and causes problems with eutrophication, to a circular flow where cultivation and harvest of seaweed will contribute to recapture the nutrients and put them back into the bio-economical system on land.
Seaweed is a valuable resource presently used e.g. in production of food and feed products. Tang.nu will increase the pull and push mechanisms in the seaweed value chain. This will be done by supporting producers (public, commercial, private), and buyers (businesses (feed and food), agriculture, aquaculture, citizens) – partly by documenting the value of seaweed as a bioactive feed additive, and partly by gathering existing knowledge about seaweed legislation and composition and make it publicly assessable.
All part components of the project will be put together in an analysis and a documentation of seaweed cultivation and harvest as a tool to recirculate nutrients from the sea and back on land as a mean of a future sustainable use of bio-resources.
Tang.nu will deliver essential results for future legislation concerning food and feed safety and marine management and will furthermore add to groundwork for the establishment of a balanced and sustainable management of production systems at sea and on land.
This project is coordinated by Aarhus University and funded by the Velux Foundations.
Nielsen, M. M., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Schmedes, P. S., PhD Student, National Institute of Aquatic Resources, Danish Shellfish Centre
01/04/2017 → 31/12/2020
Keywords: Research area: Shellfish and seaweed: Biology, production and management
Collaborators: Nordisk Tang, Fjordgaverne, Kattegatcentret, Danish Technological Institute, Havhaverne i Ebeltoft Vig, Bissrup Havbrug, Aarhus University, SEGES, Danish Agriculture & Food Councili, Multidyk, Seaweed Societe, Roskilde University, Økologisk landsforening, Danish Veterinary and Food Administration
Project: Research

Adaptability of tropical copepods to warmer and polluted future: with emphasis on metagenomics after multiple-generation exposure
The adaptability of tropical copepods to global warming and polluted environment will be tested using metagenomics approach.
Dinh, K. V., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/09/2017 → 31/08/2019
Keywords: tropical marine ecosystem, Pseudodiaptomus annandalei, global warming, adaptation, metagenomics, gut microbiomes, contaminants, PAH
**Marine pelagic secondary production under environmental stress - impacts of climate change and oil exposure**

In this project, we used copepods as key species to assess the secondary production in marine ecosystems from Arctic to tropical regions under changing environment. We experimentally test the vulnerability of both generalist and specialist copepods to crude oil components in a warmer environment.

Dinh, K. V., Project Applicant, National Institute of Aquatic Resources, Section for Oceans and Arctic
Nielsen, T. G., Supervisor, National Institute of Aquatic Resources, Section for Oceans and Arctic

FP7 Contract ID: H.C.Ørsted COFUNDED by Marie Skłodowska Curie Actions
01/09/2015 → 28/02/2018

Keywords: Copepods, Global warming, climate change, PAH, crude oil, arctic marine ecosystem, tropical marine ecosystem, Acartia tonsa

**REMORA: Reconfigurable Modular Robotic System for Aquatic Environment**

Galeazzi, R., Project Manager, Department of Electrical Engineering, Automation and Control
Christensen, D. J., Project Participant, Department of Electrical Engineering, Automation and Control, Centre for Playware
Mariani, P., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
Visser, A., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
Özkil, A. G., Project Participant, Department of Mechanical Engineering, Engineering Design and Product Development
Nielsen, U. D., Project Participant, Department of Mechanical Engineering, Fluid Mechanics, Coastal and Maritime Engineering

01/02/2016 → 31/01/2018

**Analysis of protected areas in the North Sea and the Central Baltic (Beskyttede områder) (39425)**

The project aims at delivering a report on the scientific basis and coherence of the current system of marine protected areas in the Danish North Sea, Skagerrak and central Baltic Sea EEZ’s. This will enable the Danish Nature Agency to decide whether the existing network of protected areas is coherent (representative, adequate and connected) with respect to the requirements of the MSFD art. 13 part 4.

The most important biodiversity elements, habitats and ecological processes of the North Sea/Skagerrak and the central Baltic Sea will be addressed including selected ecosystem components, oceanographic features and seabed habitats. The work will be based on available data, literature studies and results from recent investigations. Furthermore, ecologically valuable – “hot-spots” – and areas of economic value are to be identified.

The network of ecologically valuable areas will be analyzed based on data, distribution mapping, weighting of data and connectivity consideration using several types of software. Areas of economic value inside and outside the Natura2000 network will be identified based on existing data collected by the partners and located at the partner’s database. Finally, areas of economic importance will be combined to suggest marine protected areas.

The project is coordinated by DTU Aqua.
The project is funded by Danish Agrifish Agency.
Edelvang, K., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
Gislason, H., Project Participant, National Institute of Aquatic Resources

01/01/2017 → 31/12/2017

Keywords: Research area: Ecosystem Based Marine Management
Collaborators: DHI Water - Environment - Health, Geological Survey of Denmark and Greenland, Danish Centre for Environment and Energy

**Management plan for development of sustainable fisheries for blue mussels, cockles and oysters in the Danish Wadden Sea (39357)**

The aim of this project is to develop options for a sustainable fishery for blue mussels, oysters and cockles in the Wadden Sea both within and outside the Natura 2000 site. This is achieved by estimation of stock sizes of blue mussels, cockles and Pacific oysters within the Natura 2000 site as well as cockles and razor clams in relevant fishing areas outside Natura 2000 site.

Furthermore, new and more cost-effective methods for monitoring each target species will be developed and tested. Finally, a management plan for sustainable fishing for mussels, cockles and oysters in the Wadden Sea will be provided. The effect of the project will be that within 3 years, one or more sustainable fisheries for mussels, cockles and oysters will be initiated in the Wadden Sea, as well as a scientific documentation of important fishing grounds for shellfish is provided to counter potential closures of significant areas for shellfish fishing due to spoil dumping. In addition, new and more cost-effective methods for stock assessments will be developed. In conclusion, this will result in a scientific based management of the shellfish fishery in the Wadden Sea, which will be beneficial for the shellfish fishery.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
**Effects of seal-related liver worm on Baltic cod growth and mortality (39411)**
The number of grey seals has increased markedly in the Baltic Sea within recent years. Grey seal is final host for the liver worm Contracecum osculatum, where cod is one of several transport hosts. Concurrent with the rise in number of grey seal, the prevalence (number of infected cod) and intensity of infection (number of liver worms per infected cod) with liver worm has increased, and up to 340 worms can now be found in single cod livers. Field studies have shown that intensity of infection correlates negatively with the condition of the fish, indicating that liver worm may have a negative effect on the health status of the fish. Yet, from field investigations it is difficult to separate potentially negative effects of liver worms from that of reduced food availability or poor oxygen conditions. In the present study we will perform controlled laboratory experiments to i) determine the potential costs of housing liver worm, ii) estimate the effects of liver worm on cod growth and mortality, and iii) use data generated in i) and ii) in bioenergetic modeling to calculate the effect of liver worm on the maximal food consumption and growth of individual cod. This will subsequently be scaled to the level of the population.

The projects is coordinated by University of Copenhagen and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

**The invasive round goby in Danish waters: Investigations of depth distributions in relation to a targeted, efficient fishery after the species for human consumption (39402)**
Round goby is an invasive benthic fish, native to the Ponto-Caspian region. It has on several occasions been introduced to the Baltic region, and is now wide spread here, with established populations in many areas. In some areas it dominates the local fish fauna, having out-competed native, and often commercially important, fish species. Round goby is generally referred to as a coastal, shallow-water species. Yet, when temperatures drop at the onset of winter, the fish disappear from the shallow, cool waters, presumably to migrate to deeper, water waters. How deep they go, and how the onset of migration to deeper waters may relate to temperature (and hence season) however remains unknown. This information is nevertheless imperative in an evaluation of when, at what depths, and with what type of gear a potential targeted fishery after round goby should occur.

The present project will use all available national and international survey data throughout the Baltic region to map depths distributions of round goby, and analyze the correlations between depth distributions and temperature.

The project is coordinated by DTU Aqua.

**Resource efficiency in practice: from sugar beet waste to fish feed ingredient (Starfish) (39368)**
Sugar beet is a commonly cultivated crop in Denmark and the waste pulp is primarily sold as cow feed. The pulp, however, contains a potential prebiotic compound (pectin) that, if added to fish feed at low concentrations is hypothesized to:
1) improve the feed utilisation by the fish allowing more fish to be produced per amount of feed applied
2) stabilize the structure of the faecal waste so that it may be easier collected and removed reducing the discharge of nitrogen- and phosphorous
3) improve the overall immunological system/health status of the fish whereby the use of medicine and therapeutics may be reduced.

The objective of the project is to test these potential, beneficial effects of pectin in rainbow trout (Oncorhynchus mykiss) and tilapia (Oreochromis niloticus) by adding different molecular sizes and concentrations to the feed and measuring the effects on feed utilisation, faecal structure and fish health.

The project is coordinated by DTU Aqua.

The project is funded by Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).
Design and operation optimization of constructed wetlands at rainbow trout farms (39430)

This project aims at improving the design and operation of constructed wetlands with respect to the removal of waste nutrients and organic matter deriving from model trout farm systems type I and III. The project contains five work packages: 1. Selection of representative fish farms to be part of a user group and where testing and measurements will be carried out2. Mapping and characterization of selected wetlands3. Measuring the effects of flow velocity, water column depth, and hydraulic retention time on the removal of nutrients and organic matter4. Data analysis5. Project management, administration and dissemination of results.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Investigations of the potential "nitrogen effect" of stone reefs, and contribution to the re-establishment of a stone reef in the Natura 2000 area "Legster Broad, Vejlerne and Bulbjerg" (The Stone Reef Project I & II) (39354 & 39450)

As well as many inner Danish waters, Limfjorden is highly eutrophied due to land-based nutrients runoff, and some areas in the fjord often suffer from anoxia events. The current project evaluates the effect of stone reefs as a possible complementary tool in water planning related to the water framework directive (2000/60/EF) to reduce the negative outcome of such events. For this purpose, the project involves the establishment of a stone reef in Legster Broad in 2017 as well as comprehensive analysis of the potential "nitrogen effect" of already existing stone reefs in the broad. The outcome of the project will help to assess whether stone reefs can be a future use as an instrument of retaining nitrogen in water management plans.

The project is coordinated by Limfjordsrådet, Aalborg Municipality.

Mechanistic approach to ocean ecology (39427)

The overarching goal of the proposed research is to develop a mechanistically underpinned, trait-based model of marine plankton ecosystems ranging across multiple trophic levels from bacteria to zooplankton. The rationale and methods and rooted in the trait-based approach developed by the Centre for Ocean Life. Zooplankton has a key role in the model, and the themes guiding model design are trait biogeography (i.e., spatio-temporal distributions of traits) and vertical material fluxes and carbon sequestration.

The work will be organized in four interlinked work packages (WPs), each guided by a particular research question. All models will be implemented in a physical setting, and WPs 1-3 represent an increasing degree of complexity from unicellular plankton in a 0D environment toward a full size-based model in 2D environment. WP1 and 2 develop the unicellular and multicellular components, WP3 the full size based model, and WP4 sets up the model for the California Current system and tests the model against field observations collected by the Zooglider and through the CalCOFI monitoring program.

The project is coordinated by DTU Aqua.
Development of new tools to assess the environmental effects of fishing (TASSEEF) (39371)

The project aims to develop new knowledge about the indirect effects on the marine environment of fishing dredgers, in particular to develop new tools and methods at the level of entire basins to establish new knowledge about fishing effects. The primary outcome of the project will be new tools for the management of shellfish fisheries in the Limfjorden. Specifically, it will be possible to establish:- protection zones around eelgrass. - ecosystem services that mussel fishing supplies in very nutrient-enriched regions. - development of the scientific basis for the management of fisheries in coastal areas – mussel translocation/relaying.- perennity of the tools.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Saurel, C., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources
Møller, L. F., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
Veichters, M., Project Participant, National Institute of Aquatic Resources
18/01/2016 → 04/08/2018

Ecophysiology of great feasts in nature

The project investigated the ecophysiology of the great feasts in nature, exemplified by cod in the sound that feasts on migrating herring in fall.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

van Deurs, M., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
01/10/2014 → 31/03/2016

Intelligent oceanographically-based short-term fishery forecasting applications (GOFORIT) (39270)

Fisheries for short lived species are highly variable because they primarily target a low number of age groups within stocks as well as irregularly recruiting year-classes. As a result, environmental fluctuations (e.g., temperature, food abundance), which cause major changes in fish productivity, can lead to rapid fluctuations in fishing opportunities and stock declines if fishing effort is not reduced accordingly. Such fluctuations are not foreseen or accommodated by management advisory frameworks for short-lived species, which generally assume environmental stability and constant productivity. The GOFORIT project will use climatic and oceanographic process knowledge with the goal to improve short-term fishery forecasts.

The project is coordinated by DTU Aqua.

Funding
The project is funded by EU, COFASP, ERA-NET.

MacKenzie, B., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/04/2015 → 01/04/2018

REKREA: Forbedring af forvaltningsgrundlaget for bestande i det rekreative fiskeri (39370)

The primary outcome of the project will be new tools for the management of shellfish fisheries in the Limfjorden. Specifically, it will be possible to establish:- protection zones around eelgrass. - ecosystem services that mussel fishing supplies in very nutrient-enriched regions. - development of the scientific basis for the management of fisheries in coastal areas – mussel translocation/relaying.- perennity of the tools.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Saurel, C., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources
Møller, L. F., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
Veichters, M., Project Participant, National Institute of Aquatic Resources
18/01/2016 → 04/08/2018

Saurel, C., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources
Møller, L. F., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
Veichters, M., Project Participant, National Institute of Aquatic Resources
18/01/2016 → 04/08/2018

Ecophysiology of great feasts in nature

The project investigated the ecophysiology of the great feasts in nature, exemplified by cod in the sound that feasts on migrating herring in fall.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

van Deurs, M., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
01/10/2014 → 31/03/2016

Intelligent oceanographically-based short-term fishery forecasting applications (GOFORIT) (39270)

Fisheries for short lived species are highly variable because they primarily target a low number of age groups within stocks as well as irregularly recruiting year-classes. As a result, environmental fluctuations (e.g., temperature, food abundance), which cause major changes in fish productivity, can lead to rapid fluctuations in fishing opportunities and stock declines if fishing effort is not reduced accordingly. Such fluctuations are not foreseen or accommodated by management advisory frameworks for short-lived species, which generally assume environmental stability and constant productivity. The GOFORIT project will use climatic and oceanographic process knowledge with the goal to improve short-term fishery forecasts.

The project is coordinated by DTU Aqua.

Funding
The project is funded by EU, COFASP, ERA-NET.

MacKenzie, B., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/04/2015 → 01/04/2018

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Scripps Institution of Oceanography
Project: Research

Keywords: Research area: Shellfish and seaweed
Collaborators: Association of Mussel Producers, Aarhus University, Danish Meteorological Institute, Limfjorden Fishermen Organization
Project: Research

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources
Collaborators: National Institute for Marine Research and Development, Marine Research Institute Reykjavik, Institute of Marine Sciences, Central Fisheries Research Institute
Project: Research

Keywords: Research areas: Oceanography & Marine Living Resources
Collaborators: National Institute for Marine Research and Development, Marine Research Institute Reykjavik, Institute of Marine Sciences, Central Fisheries Research Institute
Project: Research
The project was funded by Danish Center for Marine Research.

This project was coordinated by DTU Aqua.

**Gene flow from stocked salmonids to wild populations (38273)**

The aim of the project was to develop and implement genetic marker based methods to assess population characteristics, such as genetically effective population sizes and exchange of dispersers among salmonid populations, focusing on brown trout, Salmo trutta. Strong focus was on an assessment of the genetic effects of stocking wild populations based on releases of juveniles of native wild brood-stock or from domesticated hatchery strains. Analyses of temporal samples, both archived and continuously sampled, have contributed to an understanding of effects of stocking on wild populations on short to long term.

Bekkevold, D., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

01/01/2001 → 31/12/2015

Keywords: Research area: Population Genetics

Project: Research

**BONUS BIO-C3 Cruise (39117-DCH)**

The multidisciplinary research cruise (16-30 September 2015) was aiming to investigate the distribution, abundance, biomass, production, nutritional condition and genetic diversity of several, trophically interlinked Baltic key species, ranging from zoo-, and ichthyoplankton over gelatinous organisms to adult fish, including non-indigenous species. The collected samples and data are used in the BONUS project Biodiversity changes—causes, consequences and management implicati

Using the contrasting environments of the Arkona, Bornholm, Gdansk and Gotland Basin, the major scientific goals of the cruise have been to resolve:

- **Physiological preferences and tolerances of key meso-zooplankton species** (Pseudocalanus acuspes, Temora longicornis, Centropages hamatus and Acartia spp), through controlled experiments on board with specimens caught in different areas of the central Baltic in contrasting environments, including a verification of species based on genetics,
- **Abundance, distribution, nutritional condition and phenology of key zooplankton** (see above) and their life stages as well as gelatinous plankton species (Aurelia aurita, Cyanea capillata, Mertensia ovum, Mnemiopsis leidyi) in different areas of the central Baltic, through net-sampling and deploying hydroacoustics and optics, as well as biochemical analyses,
- **Individual condition, abundance and distribution of spawning herring and cod based on trawl sampling and hydroacoustics including biochemical investigations on the quality of spawning products,**
- **Abundance and survival of herring and cod ichthyoplankton, through net-sampling based stage specific production estimates, including age determination, nutritional condition and growth in relation to abundance, phenology and composition of zooplankton prey,**
- **Predation pressure on copepods and fish early life stages by herring and sprat as well as gelatinous plankton** (see above) through resolving the spatial overlap between predator and prey at relevant scales as well as diet composition analyses,
- **Distribution (vertical and horizontal)** of sprat and herring through trawl sampling and hydroacoustics in relation to hydrography, zooplankton prey and predator (cod) abundance, with specific focus on growth, condition and survival of young of the year sprat in different areas of the central Baltic.

This project was coordinated by DTU Aqua.

The project was funded by Danish Center for Marine Research.

Köster, F., Project Coordinator, National Institute of Aquatic Resources

Huwer, B., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

Tomkiewicz, J., Project Manager, National Institute of Aquatic Resources

Lundgren, B., Project Participant, National Institute of Aquatic Resources, Arctic Section

Krüger-Johnsen, M., Project Participant, National Institute of Aquatic Resources

Neumann, V., PhD Student, National Institute of Aquatic Resources

16/09/2015 → 30/09/2015

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Climate Change and European Aquatic Resources (CERES) (39344)
CERES advances a cause-and-effect understanding of how climate change will influence Europe’s most important fish and shellfish resources and the economic activities depending on them. It will provide tools and develop adaptive strategies allowing fisheries and aquaculture sectors and their governance to anticipate and prepare for adverse changes or future benefits of climate change.
The project has 24 additional partners spread across Europe and is coordinated by University of Hamburg, Germany. The project is funded by EU, Horizon 2020.
Payne, M., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Saurel, C., Project Participant, National Institute of Aquatic Resources
01/03/2016 → 29/02/2020
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Shellfish and seaweed
Collaborators: University of Hamburg

Collaborative modular underwater robotic system for long-term autonomous operations (REMORA) (39341)
In this project we aim to bootstrap new high-impact underwater robotics activities at DTU. We propose to develop a novel robotic platform, the REMORA1 system, for research, education and innovation. The objectives of the project are to develop the necessary infrastructure, i.e., underwater robotic system, test facilities, educational framework and external collaboration, to perform world-class research and innovation in the area of offshore underwater robotic technology.
With this project we aim to eventually strengthen the Danish maritime sector in dealing with the high cost and technical challenges of inspections and maintenance in increasing amount of offshore installations. The project is a collaboration between DTU Electrical Engineering, DTU Mechanical Engineering and DTU Aqua who have complementary expertise within development and innovation of robotic technology and applications of underwater robotics.
This project is coordinated by DTU Electrical Engineering.
The project is funded by A/S Dampskibsselskabet Orients Fond.
Mariani, P., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
21/12/2015 → 21/12/2017
Keywords: Research areas: Oceanography & Observation Technology & Marine Populations and Ecosystem Dynamics
Collaborators: Technical University of Denmark

Environmental impact assessments of mussel and oyster fishery in Natura 2000 sites (39241)
Annual Environmental Impact Assessments (EIA) are conducted for each Natura 2000 site and in the Limfjorden in general before fishery on wild beds of mussels or oysters can be initiated. The Danish mussel and oyster fishery is managed by several regulations both implemented by government institutions as well as internal regulations within the fisheries associations. The overall framework was implemented in 2012 as "The mussel policy", which states that the fishery should be sustainable and in accordance with the EU Habitat Directive. Furthermore, four key ecosystem components (eelgrass, blue mussels, macro algae and benthos) are designated in The Mussel Policy. For blue mussels, macro algae and benthos 15% cumulative area impacted by fishery is accepted, whereas for eelgrass it is 0 %. DTU Aqua performs annual surveys determining blue mussel and flat oyster abundance and biomass, regular surveys of eelgrass and macroalgae in all relevant Natura 2000 areas. Data are used for impact assessment of fishery and contain sustainable quotas of either mussel or oysters, protected areas for eelgrass and an assessment of the effects of fishery on the species included in the Natura 2000 plan. Furthermore, the cumulative area affected by fishery is calculated by analyzing black box data. The black box data show where the fisheries have taken place and how large areas that has been affected by logging the position of the vessels every 10 seconds and register any activity by the winch (starting or ending of fishing time).
This project is coordinated by DTU Aqua.
The project is funded by the Ministry of Environment and Food of Denmark.
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, P., Project Manager, National Institute of Aquatic Resources
Canal-Vergès, P., Project Participant, National Institute of Aquatic Resources
Nielsen, C. F., Project Participant, National Institute of Aquatic Resources
01/01/2008 → …
There is a pressure from consumers on the fishing industry to legitimate sustainability in the fisheries, which normally species and their utilization. fish landed in Skagerrak and Kattegat, comprising all commercial species and thereby valuable for historic studies of the logbooks/landing slips from the fishery. The output from the project is a database with landings and economic values of (DTU Aqua) participated in the project. Data has been extracted from various national statistical databases and Research institutes from Sweden (Swedish University of Agricultural Sciences), Norway (Oxford Research) and Denmark economics in the specific area.

The project has compiled catch and economic data from fisheries in Skagerrak and Kattegat since 1946. The aim of the

The project was commissioned directly by the Danish Ministry of Food, Agriculture and Fisheries. Serensen, T. K., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Egekvist, J., Project Participant, National Institute of Aquatic Resources
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
Brown, E. J., PhD Student, National Institute of Aquatic Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources

03/12/2014 → 31/08/2015

Keywords: Research area: Ecosystem based Marine Management & Coastal Ecology
Collaborators: University of Copenhagen
Project: Research

Assessing and improving the quality of aquatic animal gametes to enhance aquatic resources – The need to harmonize and standardize evolving methodologies and improve transfer from academia to industry (AQUAGAMETE) (39130)

The aim of the AQUAGAMETE COST Action is to reach a consensus on protocols and guidelines (using internationally defined terminology, units of measurement and format of reporting) that permit the use of results in relational databanks for sound and common application in aquaculture research and commerce. There is an urgent need towards a universal scale to assess both the precise state of sexual maturation (for secure broodstock use) and related life history traits (gamete quality assessment, incubation of eggs) in teleost fish and other commercially important invertebrates used in either bioassays or aquaculture.

During the past six years, three international workshops on fish gametes demonstrated a rapid development of methodologies that encompass extensive opportunities for promising use in basic reproductive biology, genetic research, biotechnology and aquaculture practice. All of these can have far-reaching consequences on conservation of endangered species, assessment of anthropogenic and climatic impacts on aquatic species and application in aquaculture, as well as in fisheries management. In particular, it has been recognized that there are many highly diverting details in the practical application of these new methods used by most scientists and laboratories, which can cause highly variable if not contradicting results, even using the same species.

COST action management and scientific activities comprise meetings, congresses and workshops, training schools and short term training mission (STSM) program. The action has funded participation of delegates Jonna Tomkiewicz and Ian A.E. Butts in action management meetings and three AQUAGAMETE conferences, participation of two students in training schools, six short term missions (STSM) of MSC and PhD students performing work at the labs of international collaborators as well as their participation in AQUAGAMETE conferences. Exchange of students and collaboration has resulted in a series of publications enhanced through collaboration as well as enriched learning by students through international networking.

Other partners than DTU Aqua (countries and number of institutes): Austria (1), Belgium (1), Bulgaria (2), Croatia (1), Czech Republic (1), Finland (3), France (3), Macedonia (1), Germany (1), Greece (4), Hungary (1), Israel (2), Italy (2), Netherlands (1), Norway (1), Poland (2), Portugal (1), Serbia (1), Slovenia (2), Spain (10), Sweden (2), Turkey (2), UK (2), International Partner Countries (IPC): Brazil, Japan (1), Singapore, South Africa (1).

AQUAGAMETE is funded by COST, EU (European Cooperation in Science and Technology).

Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Butts, I., Project Participant, National Institute of Aquatic Resources

01/01/2012 → 31/12/2016

Keywords: Research areas: Fish Biology & Marine Populations and Ecosystem Dynamics
Project: Research

Changes in marine resources in Skagerrak and Kattegat 1946-2012 – Catch and revenue in the post war fishery and transformation of the fleet (DIGIFISH) (39103)

The project has compiled catch and economic data from fisheries in Skagerrak and Kattegat since 1946. The aim of the project was to establish a common database for future utilization in the research of development of fisheries and socio-economics in the specific area.

Research institutes from Sweden (Swedish University of Agricultural Sciences), Norway (Oxford Research) and Denmark (DTU Aqua) participated in the project. Data has been extracted from various national statistical databases and logbooks/landing slips from the fishery. The output from the project is a database with landings and economic values of fish landed in Skagerrak and Kattegat, comprising all commercial species and thereby valuable for historic studies of the species and their utilization.

There is a pressure from consumers on the fishing industry to legitimate sustainability in the fisheries, which normally
requires assessments and advice consistent with international criteria on sustainability. A prerequisite for such an approach is complete catch data back in time. Therefore, the present project provides important data to base assessments on and to perspective recent fisheries with historic data.

Economic data in the database will enable socio-economic analyses of the different fisheries, including changes on structure of society and fishery.

This project was coordinated by DTU Aqua.

The project was funded by the AG Fisk (Working Group for Fisheries), Nordic Council of Ministers.

Boje, J., Project Participant, National Institute of Aquatic Resources, Arctic Section
01/01/2013 → 31/12/2013

Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management
Collaborators: Swedish University of Agricultural Sciences, Oxford Research
Project: Research

**Development of an energy saving trawl (39029)**

The aim of the project was to test and document the reduced drag in a novel trawl design made by Herman Trawl. Detailed testing and drag measurements was conducting at the flumetank in Hirtshals where the new designs measurements were compared with similar drag measurements of a standard trawl of similar size.

The developed design demonstrated a relative large reduction in drag compared to similar sized standard gears. The specific effect was documented at different towing speeds. All measurements were made on scale models.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Agency for Science, Technology and Innovation.

Krag, L. A., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
10/10/2010 → 31/12/2012

Keywords: Research areas: Fisheries Technology & Fisheries Management
Collaborators: Municipality of Frederikshavn, SINTEF, Herman Trawl
Project: Research

**Net escapement of Antarctic krill in trawls (NEAT) (38919)**

The pelagic trawlers involved in the Antarctic krill harvest apply different trawl systems and fishing gear. There were many unknown parameters on which to estimate the catch efficiency of the different trawls that were used.

The aim of the project was to establish morphology based description of the selection process of Antarctic krill in towed fishing gear (FISHSELECT). This knowledge lead to optimizations of trawl designs in the krill fishery and was used to quantify the consequences in terms of catch efficiency, potential escape mortality and catch loss of using different gear designs of different population structures. Such information is valuable both for managers and the industry exploiting the resource. We performed a study including morphology based mathematical modeling (FISHSELECT) of different krill sex and maturity groups, from data acquired through AKES (Antarctic Krill and Ecosystem Studies). The FISHSELECT method has previously been used to describe and predict size selection of fish and crustaceans. The methodology was used to describe and predict size selection of krill in trawl gear. The model was used to predict basic selective characteristics of different netting designs. The results from these calculations were used to quantify the theoretic catch efficiency and escape mortality in different nets and to construct a net configuration with optimal mesh size and shape in order to minimize escape mortality. Finally, we constructed design guides, which described the basis selective properties for krill in different mesh shapes and sizes.

This project was coordinated by DTU Aqua.

The project was funded by the Research Council of Norway.

Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Herrmann, B., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2014

Keywords: Research area: Fisheries Technology
Collaborators: Institute of Marine Research, Olympic A/S, Aker Solutions AS
Project: Research

**Collaboration between the scientific community and the fishing sector to minimize discards in Baltic cod fisheries (38918)**

The main aim of this study was to identify technical solutions, both economically and biologically sustainable, to mitigate the discards of cod in the Baltic Sea cod fishery.

The aim of the project was divided into three main tasks:
- Assessing the present knowledge on discards and causes of discards in the Baltic cod fishery, and exploring the temporal and spatial distribution patterns of discard sensitive size classes of cod and of the fishery effort.
- Identifying technical solutions and suggesting final technical measures to further mitigate discards in the trawl fishery for Baltic Sea cod.
- Evaluating the possible impacts of the proposed technical solutions and technical measures on the stock and on the economy of the fisheries concerned.

These tasks were undertaken through a desktop study, a technical study and an impact study.

In order to engage trawl fishermen in the project, a questionnaire was sent in spring 2012 to active fishermen in Sweden,
Denmark, Germany and Poland. The aim was to establish a dialogue with the industry on selectivity, gear selection, discard patterns and management options, and to collect their views, problems and potential solutions to mitigate discards. This questionnaire was the basis for further discussions with the industry during a workshop. This project was coordinated by Swedish University of Agricultural Sciences.

HPLC – Implementation of new analytical methods (39227)

This is an internally funded project with the purpose of developing and implementing new analytical methods aimed at determining indicators for growth i.e. protein metabolism and synthesis, and includes amino acids and ATP, ADP, AMP in tissue. It is investigated whether a developed technique can be implemented. We will investigate, whether we can use a western blotting technique to enable us to estimate to which degree protein synthesis is stimulated, more specifically by measuring the degree of phosphorylation of certain markers within the mTOR signaling pathway. In addition, selected marker(s) of protein degradation is included. This will enable us to obtain an in-depth knowledge regarding protein synthesis/turnover and protein utilization in fish. We thereby presume to be able to investigate and document which/how nutritional factors (e.g. new protein sources & specific amino acids) and rearing conditions (e.g. feeding strategy, water quality, exercise, stress etc.) affect protein turnover, and thereby growth in fish. The relationship between growth/protein utilization and mTOR response need to be investigated further, but potentially this technique may e.g. allow us to compare a large number of diets and very quickly determine the response in muscle tissue. This means that a large number of diets can be screened without the cost of large and long-lasting growth trials, and it may become faster/easier to select the most optimal diets based on the response. As growth and growth efficiency are vital factors in aquaculture, the method might have great potential under a variety of circumstances.

This project is coordinated by DTU Aqua. The project is internally funded.

Larsen, B. K., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
01/01/2016 → …

Keywords: Research area: Aquaculture
Project: Research

Helpdesk for aquaculture (HelpDesk) (38696)

In the project different environmental issues related to regulation of aquaculture have been addressed according to specific needs and questions from the Ministry of Food, Agriculture and Fisheries and the Ministry of Environment. Specifically, a calculation model for predicting waste generated from fish farming has been developed. This Excel-based model is able to calculate the waste generated by the fish depending only on the fish performance (FCR) and the composition and digestibility of the feed used.

The model, valid for rainbow trout up to 800 g/pcs in freshwater, was verified through various experiments using commercial feed types, and is now a central element in the regulation of the Danish freshwater trout farming industry. It is used throughout the industry and administration and has generated a common background and baseline for all stakeholders.

A group consisting of the Ministry for Food, Agriculture and Fisheries, the Ministry of Environment, the Danish municipalities’ organization Local Government Denmark was formed and acted as reference/steering group.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Pedersen, P. B., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Jokumsen, A., Project Manager, National Institute of Aquatic Resources
Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 30/11/2013

Keywords: Research area: Aquaculture
Project: Research

Monitoring and documentation of the performance of ModelTroutFarms (ModelTroutFarm) (38192)

De-coupling fish production and environmental impact is a sustainable way of increasing aquaculture. In order to achieve increased production and, simultaneously, reduced environmental impact a new farming concept was developed, tested and demonstrated.

Applying cost-efficient technologies from recirculation on large, traditional flow-through farms provided the basic concept for ModelTroutFarms. Through intensified production in concrete tanks, the former earthen ponds could be used as constructed wetlands for end-of-pipe treatment of the discharged water. Due to recirculation, water consumption was reduced by a factor 25, so damming of natural water courses was no longer needed for supplying water to the farm. As a consequence, dammings could be removed leaving the water course to its natural flow.

A reduction of some 80 % in organic matter and phosphorous discharge was achieved, and 50 % of the nitrogen was
removed.

Through the concept, technical an practical means of decoupling fish production and environmental impact was demonstrated in large scale commercial operations. Concomitantly, legislation was changed and now approximately 50% of the Danish fresh water production is in ModelTroutFarms.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Pedersen, P. B., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Rasmussen, R. S., Project Participant, National Institute of Aquatic Resources
Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources
Suhr, K. I., Project Participant, National Institute of Aquatic Resources

01/01/2003 → 31/07/2011

Keywords: Research area: Aquaculture
Collaborators: Aarhus University, Eight trout farms
Project: Research

Macroalgae biorefinery for value-added products (MAB4) (39372)

MAB4 will bridge the gap between research, innovation and market within the macroalgae (seaweed) sector. The goal is to establish seaweed cultivation as a Danish discipline for providing seaweed biomass for the business sectors of food and feed ingredients, and cosmetics. MAB4 will breed and mature sea-farmed crops of seaweed by improved and new cultivation methods in Danish and Faroese waters, with particular attention to seasonal development of algae bioactive substances and their conservation during harvesting and storage. The project will also develop sustainable enzymatic and Green Solvent extraction methods for development of new algae products i.e. antioxidants, fucoidan, laminarin, alginate, proteins, and minerals. The products will be tested as food and feed ingredients as well as in skincare products. Techno-economic feasibility and LCA will assess for the whole value chain from cultivation to final marketed seaweed products. MAB4 is a trans-disciplinary project running for 3½ years. The project consists of a strong consortium of national and international algae cultivators, biorefinery experts from universities, RTO’s, SMEs and relevant industrial end-users. The results from MAB4 will provide guidelines for stakeholders from industry and for future seaweed cultivation.

This project is coordinated by Danish Technological Institute.

The project is funded by Innovation Fund Denmark.

Canal-Vergés, P., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, M. M., Project Participant, National Institute of Aquatic Resources

01/05/2016 → 31/10/2019

Keywords: Research area: Shellfish and seaweed
Collaborators: BHJ, Hortimare BV, University of Copenhagen, Nordisk Tang, Melissa, AgroKorn, Kattegatcentret, Danish Technological Institute, Aarhus University, Morgenfruerne på Læsø ApS, SEA-Invest, Fermentationexperts AS, Ocean Rainforest
Project: Research

The effect of bottom trawling on marine bottom fauna and eelgrass (ØB Bundfauna) (39192)

The project provided input to the analysis of the impact of fishing on the ecological quality of the Danish marine environment to the Danish Nature Agency in relation to the water plans needed in connection with the implementation of the Water Framework Directive.

It contained three subprojects:
- Quantifying the area of seabed swept by Danish bottom trawl fisheries.
- Quantifying the impact of bottom trawling on marine benthos.
- Quantifying the possible interaction between bottom trawling and the depth distribution of eelgrass (Zostera marina).

This project was coordinated by DTU Aqua.

The Project was funded by the Danish Nature Agency.

Gislason, H., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Dinesen, G. E., Project Manager, National Institute of Aquatic Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Egekvist, J., Project Participant, National Institute of Aquatic Resources
Seersen, T. K., Project Participant, National Institute of Aquatic Resources

01/05/2014 → 31/12/2015

Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology & Fisheries Management
Collaborators: Aarhus University
Project: Research

Value of the landing obligation – Former discard fraction (39347)

The aim of the project is to increase the value of those fish species that are landed due to the new regulation of the fisheries policy in EU – the landing obligation. This creates challenges both on board the fishing vessels and in the harbours. It is necessary to have smooth and efficient procedures to solve the challenges and to have a suitable both environmental and economic for both the fishermen and the fishing harbours.
Upgrading pangas and tilapia value chains in Bangladesh (39244)

Growth in aquaculture is important because it can help alleviate poverty by providing food and creating jobs in Bangladesh. The purpose is to promote green growth in freshwater pangas/tilapia aquaculture by providing knowledge on how to improve water quality and farm management and exploit the market potential for farmed fish through value chains functioning. Focus is on water quality since pangas/tilapia might include contaminants, offflavors and be a bit yellow, not white, as preferred by the consumers at export markets.

Farm management, governance of value chains, knowledge on domestic/international markets and on fish quality can improve the basis for sustainable growth, increase value added and prepare the sector for export, thereby providing livelihood for locals and foreign exchange. Knowledge is increased through senior research cooperation and by educating PhDs.

Research questions are: To what extent are fish-depleting microorganisms, arsenic, lead and pesticides of economic importance? Can they be reduced? Do water quality initiatives pay? Who are the main actors in the value chain? What are the major bottlenecks? How are prices formed? How much are consumers willing to pay for improved quality of fish? Can chains be upgraded through governance, water and fish quality and export focus?

The foundation is value chain analysis, economic optimization, applied economics and environmental science. The knowledge provided forms basis for assessing governance and firm management. It will be disseminated to actors in the chains.

This project is coordinated by Department of Food and Resource Economics, University of Copenhagen, Denmark. The project is funded by DANIDA, Ministry of Foreign Affairs of Denmark.

Keywords: Research area: Fisheries Management
Collaborators: University of Southern Denmark, Kiel University, University of Copenhagen, Norwegian University of Life Sciences, Bangladesh Agricultural University, Patuakhali Science and Technology University
Project: Research

How Danish fisheries can exploit the CFP discard ban – An elucidation (39075)

European fisheries should ultimately operate without discards. This is clearly expressed by both the European Union and the most important fishery nations outside the Union in Europe. This is in accordance with the overall intention to reduce the ecological impact through changing production and consumption patterns. The most important tool introduced by the Union is the Landing Obligation (LO). The new Common Fisheries Policy (CFP) will move towards a gradual elimination of discards on a case-by-case basis (EC, 2013). This policy is fully implemented in 2019. To be in due time, before the implementation of the LO, a project trying to describe the consequence of this new policy, was done in the years 2012 to 2014. The state of the art of knowledge of discard and the future use of this fraction that will be landed have been evaluated.

The final report suggests that the practical implementation of the LO-principle may take place as a scheme where large scale trials on results based management demonstrate the possible needs of prescriptive regulation in addition to full catch accountability.

The report thoroughly investigates the issues related to a management that can give the fishermen the incentive and tools to comply with full catch accountability. It assesses the amounts of discard and offal in Danish fisheries and it points to solutions regarding handling and marketing of the “discard fraction” in the form of fresh raw material or silage solutions. The report recommended to:
- Evaluate the economy of a silage solution on vessels and in relevant harbours. The evaluation should be made as a commercial venture projects including storage, handling distribution, marketing and economic performance.
- Analyse the values fish under reference sizes if sold for human consumption.
- Establish reliable and cheap methods to quantify species composition in silage.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Keywords: Research areas: Fisheries Management & Population Genetics
Collaborators: Aquamind A/S
Project: Research
Developing competences in the fishing activities of round goby (39071)
The fishermen in the southern part of the island of Zealand have the last years fished large quantity of the invasive fish species round goby (Neogobius melanostomus). When the project started the fishermen lacked the necessary skills to handle these catches and to find buyers of the catch. The majority of the catches were discarded or sold to fishmeal- and fish oil factories. So it was evident that a proper catch handling and reliable sale was needed.
The main results are:
- The nature History Museum of Denmark has mapped the distribution of the round goby and has gained new knowledge of the goby’s biology and behaviour.
- The fishermen have developed new fishing gear, especially as traps. The catch handling has been improved with rapid cooling.
- Small round goby has been found to be of no value as fish for human consumption.
- Silage has proved to be a good method to store the catch, before used as raw material to the feed producers. The only drawback is that the prices paid to the fishermen were too low.
- A manual for proper handling of the catch has been produced.
This project was coordinated by Danish Seafood Association.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Larsen, E., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2012 → 31/12/2014
Keywords: Research area: Fisheries Management
Collaborators: Natural History Museum of Denmark, Danish Seafood Association, Fishermen, Gemba Seafood Consulting
Project: Research

Study on approaches to management for data-poor stocks in mixed fisheries (MIXDLS) (39342)
The tender requires advancement of methods for advice on the status and management of data-poor stocks in mixed fisheries. In order to meet this requirement, we will undertake a detailed review of assessment and management approaches for data-poor stocks and identify relevant approaches for application in the case studies and wider EU fisheries.
The approaches should be compatible with the Common Fisheries Policy (CFP; EU 2013) in terms of (i) fishing mortality ranges compatible with Maximum Sustainable Yield (MSY), (ii) fish caught to be landed, and (iii) addressing uncertainty in significant components of the marine fish ecosystem.
The most promising methods will be tested through simulation to ensure robustness to uncertainties and to deliver confidence in methods for future operational use. The suite of identified, assured methods will then be used to develop an objective framework to apply the most relevant assessment or management methods to each stock in each of the case study areas. Based on the output of these assessments of data-poor stocks, and where relevant, the existing assessments of data rich stocks, a mixed fisheries simulation framework will be developed to assess the performance of candidate management strategies.
Adaptation of the existing mixed fisheries tools will be required in order to incorporate data-poor stocks in the simulation framework.
This project is coordinated by DTU Aqua & IMARES, Netherlands.
The project is funded by EU, Calls for proposals/tenders (EU DG Mare).
Ulrich, C., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Worsøe Clausen, L., Contact Person, National Institute of Aquatic Resources
01/01/2016 → 31/12/2017
Keywords: Research areas: Fisheries Management & Marine Living Resources
Collaborators: French Research Institute for Exploitation of the Sea, Hellenic Centre for Marine Research, IMARES, Italian National Research Council, Cefas Weymouth Laboratory, AZTI-Tecnalia, Galway - Mayo Institute of Technology, Thunen-Institut
Project: Research

Sound herding system for sustainable fisheries (GUDP-SHS) (39365)
The purpose of the project is to develop a new type of fishing gear, Sound Herding System (SHS), which applies sound to influence fish swimming direction and thereby herding them into a trawl. The sounders are mounted on the trawl boards, so as to create a wall of sound on both sides of the trawl opening. This increases the effective width and height of the trawl opening, resulting in higher catch rates. The frequency of the sounders is selected to be 4 kHz, which can be used to affect the clupeoid species herring, sprat and anchovy. Most other relevant species are not sound sensitive at this frequency.
The system can be used to avoid by-catches of herring in the mackerel fishery by closing trawl opening for herring with sound. Customers receive economic gains from higher catch rates and smaller by catch. The gain for the environment is a reduction in CO2 emissions and improved resource utilization.
The central work in the project is the development of trawl doors equipped with sounders as tested by exploratory scare effect measurements and mapping of sound fields. Fish response to sound is studied experimentally and finally the sounders’ impact on the environment is examined.
This project is coordinated by Sonus Aqua Aps, Denmark.
The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).

Stage, B., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
01/01/2016 → 31/12/2018
Keywords: Research areas: Observation Technology & Marine Living Resources
Collaborators: Sonus Aqua Aps, Aalborg University
Project: Research

**Strengthening the Danish populations of Atlantic salmon – Increasing populations, genetic resources and recreational fishing (39340)**

In the beginning of the 1980’s indigenous Danish salmon populations were close to extinction due to habitat degradation and stocking with non-native strains. Conservation efforts, led to a resurge of the populations in western Jutland. However, following the initial increases, Danish salmon populations have stagnated in recent years. Whether this is a response to limiting local factors or a correlated response across population (e.g. to climate change), is unknown. A profitable recreational fishery has developed on the Danish salmon. If the productivity of Danish salmon populations can be improved, this fishery and the related economical gain have the potential to increase correspondingly.

Atlantic salmon has a highly complex and specialized life cycle where the weakest link(s) determines the productivity of the salmon population. Accordingly, there is a need for a multifaceted research project The main objectives of this project will be reached through six work packages aiming to: 1. Identify key local and global bottlenecks production of salmon across four life-stages, 2. Determine genetic characteristics (‘quality’) of local populations and identify how measures of ‘quality’ should be implemented into stocking programmes and 3. Communicate and implement insights on optimal management and exploitation to stakeholders.

The overarching aim of the project is to provide research based knowledge that can be directly implemented into a self-sustainable management framework that maximizes salmon population sizes, and hereby vastly increases local income from a recreational fishery with a high economic potential.

This project is coordinated by Danish Center for Wild Salmon.

The project is funded by Innovation Fund Denmark.

Koed, A., Project Manager, Section for Freshwater Fisheries Ecology, National Institute of Aquatic Resources
Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources
Bekkevold, D., Project Manager, National Institute of Aquatic Resources
Mena, B. J., Project Participant, National Institute of Aquatic Resources
Aarestrup, K., Project Manager, National Institute of Aquatic Resources
01/01/2016 → 31/12/2019
Keywords: Research areas: Freshwater Fisheries and Ecology & Population Genetics
Collaborators: Danish Center for Wild Salmon
Project: Research

**Environmental and Fisheries Influences on Fish Stock Recruitment in the Baltic Sea (STORE)**

The objectives of the research project are to:

1. Determine stock-recruitment relationships for Baltic cod and sprat in relation to key environmental factors influencing the production of viable spawn and the survival of early life history stages.
2. Improve short-term predictions of stock development by integrating recruitment estimates based on the present status of the stock and its biotic and abiotic environment.
3. Develop predictive recruitment models for medium- to long-term forecasts of stock development under different environmental and fishery scenarios.
4. Estimate biological management reference points, critical stock limits and target spawning stock sizes based on stock-recruitment relationships and stock development simulation models, and considering the precautionary approach for fisheries management.

Köster, F., Project Participant, National Institute of Aquatic Resources
01/01/1999 → 30/06/2002
Collaborators: Institute of Marine Sciences, Kiel, Uppsala University, Federal Research Centre for Fisheries, Institute for Baltic Sea Fishery, Baltic Sea Research Institute, Finnish Game and Fisheries Research Institute
Documents:
Final STORE Project Report
Final STORE Project Report - Tables and figures
Project: Research

**Environmentally friendly fisheries (Skånfisk) (39161)**

The project consists of two sub-projects:

Ecosystem Approach to Danish gill- and trammel nets

Although the fleet has reduced since the mid-1990s, Danish gill- and trammel nets are still of importance and are likely to
gain increasing interest as environmentally friendly practices. However, such a development may only happen if the ecosystem approach is guaranteed. There is limited knowledge about ecosystem impacts, such as for example physical damage to habitats or discards, and their minimization may require development of alternative practices. With regard to the upcoming challenges of an Ecosystem Approach to Fisheries, the project aims at (1) studying the sweeping behavior of nets and their effect on the seabed; (2) quantifying invertebrates and fish discards and understanding how the capture process can influence discard behavior; (3) developing technical innovation that could improve catch quality and therefore maximize the production. Trials are conducted on gill- and trammel nets within the Danish coastal waters.

Danish seine - ecosystem effects of fishing
The amount of scientific studies on Danish seining is rather low. Therefore, the current study “Danish seine – Ecosystem effects of fishing” investigates various topics to increase the knowledge of impacts, Danish seines have on the environment and further to give advices to potentially improve selectivity characteristics and efficiency of the gear. We compared catch profiles of Danish seines and bottom trawls based on a perennial observer dataset. Furthermore, we carried out two sets of experimental trials on commercial vessels. The first set in 2014 looked at codend selectivity as well as direct interactions the gear has on the benthic and demersal fauna. The second set of trials in 2015 allowed us to create detailed descriptions of the fishing process in terms of geometry and forces acting between net and ropes and furthermore, to evaluate the behavior of fish in relation to the gear and to evaluate impacts of the gear on the sea bottom. This project is coordinated by DTU Aqua.

The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through a special governmental Funding for sustainable fisheries (“Bæredygtighedspuljen”).
Madsen, N., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Krag, L. A., Project Participant, National Institute of Aquatic Resources
Savina, E., PhD Student, National Institute of Aquatic Resources
Noack, T., PhD Student, National Institute of Aquatic Resources
01/01/2014 → 31/03/2017
Keywords: Research area: Fisheries Technology
Project: Research

Ecosystem based method for impact assessment (39142)
The project aimed to develop a methodology for impact assessment and measures to support the implementation of the Marine Strategy Framework and Natura 2000.
The project included
- Development of an approach to impact assessment and step by step guide for management actions to ensure biodiversity, marine food webs and seabed integrity.
- A Case Study on the Dogger Bank to support the implementation of the Natura 2000 processes was evaluated and best practice identified.
- A Case study in the Kattegat with monitoring and ecosystem analysis of muddy habitats to optimize nature conservation and fisheries management under the Marine Strategy was evaluated and best practice identified.
- Development of cost-effective methods for management, monitoring and control in a report that describes the best practices in the subareas and the related costs.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Stage, B., Project Coordinator, National Institute of Aquatic Resources, Arctic Section
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources
23/07/2013 → 01/05/2015
Keywords: Research areas: Observation Technology & Marine Living Resources & Coastal Ecology
Collaborators: Dalsgaard Data A/S, Danish Anglers Association, Silkeborg Fiskeriforening
Project: Research

Environmentally effective nitrogen removal in fish farming using sludge hydrolysis (wiN-wiN) (39119)
Reducing nitrogen discharge is important to fish farms and their environmental performance. Removal of nitrogen can be done by applying denitrification filters end-of-pipe (i.e. before discharge) through an anearobic de-nitrification process using organic carbon as energy source.
Using external carbon is costly and introduces additional organic matter into the system. In contrast, sludge produced by the farmed fish might provide the organic matter given that a hydrolysis process can be controlled and optimised according to the needs of the denitrification process.
The project strives to establish, optimize and demonstrate an integrated system in commercial scale able to hydrolyse generated sludge and subsequently use it as energy source for nitrogen removal in end-of-pipe denitrification filters.
This project is coordinated by HME, Denmark.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP) and the partners involved.
Pedersen, P. B., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
von Ahnen, M., Project Participant, National Institute of Aquatic Resources
Traditional trout farms (39095)
Nutrient removal is imperative for Danish fish farms and upcoming requirements for environmental performance though application of BAT (Best Available Technology) cannot be met by traditional fish farms since simple, low-cost technologies does not exist. Removal of dissolved nutrients in low concentrations and large water volumes is especially difficult. In the project, potential low-cost technologies for removing nitrogen and organic matter were tested and documented. Removal and turn-over of organic matter and nitrogen in biofilters was studied, and the performance of constructed wetlands on traditional farms was also investigated during a full year. In these farms, wetlands efficiently remove particulate matter and associated nutrients (O and P) whereas dissolved matter is almost not removed due to the hydraulic load and short residence time. Depending on the concentrations in the incoming water, requirements for O and P net-removal could be met, whereas a need for simple, low-cost nitrogen removal was clearly demonstrated.
This project was coordinated by the Danish Aquaculture Association.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

IT-solutions for environmental control of trout farms (39094)
In the project a IT-solution for direct reporting of environmental performance data from trout farms to the Municipality registration system was developed. Also, calculations of compliance with allowances etc. can be calculated and evaluated regularly by the farmer.
DTU Aqua further developed a discharge prediction model, able to calculate the resulting discharge from a ModelTroutFarm of any given layout and dimensions. This model ("Dambrugsmodellen" i.e. "the Trout Farm Model") is based on the existing Produktionsbidragsmodel ("Waste Production Model") and data and monitoring results from all treatment devices added and incorporated into a prediktive model. Both models are now widely used by the authorities as well as in the industry.
This project was coordinated by the Danish Aquaculture Association.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Monitoring and Documentation of the Performance of ModelTroutFarms (ModelTroutFarm)
De-coupling fish production and environmental impact is a sustainable way of increasing aquaculture. In order to achieve increased production and—simultaneously— reduced environmental impact a new farming concept was developed, tested and demonstrated.
Applying cost-efficient technologies from recirculation on large, traditional flow-through farms provided the basic concept for ModelTroutFarms. Through intensified production in concrete tanks, the former earthen ponds could be used as constructed wetlands for end-of-pipe treatment of the discharged water.
Due to recirculation, water consumption was reduced by a factor 25, so damming of natural water courses was no longer needed for supplying water to the farm. As a consequence, dammings could be removed leaving the water course to its natural flow.
A reduction of some 80 % in organic matter and phosphorous discharge was achieved, and 50 % of the nitrogen was removed.
Through the concept, technical an practical means of decoupling fish production and environmental impact was demonstrated in large scale commercial operations. Concomitantly, legislation was changed and now approximately 50 % of the Danish fresh water production is in ModelTroutFarms.
This project was coordinated by DTU Aqua.
Pedersen, P. B., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Rasmussen, R. S., Project Participant, National Institute of Aquatic Resources
Tagging Baltic cod (TABACOD) (39333)
The aim of this project is to improve the management of eastern Baltic cod by 1) providing new information on growth and mortality patterns, and 2) develop a validated method for deriving this information from historic and future samples.
In recent years, the traditional age-based stock assessment had to be abandoned owing to extensive uncertainties in stock trends. These uncertainties were to a large extent attributable to inconsistencies in age estimation. As a consequence thereof, the current stock status is unknown.
Estimates of growth and mortality rely on unbiased age information. TABACOD will provide this information through a large scale tagging experiment, where 20,000 cod are tagged with and externally visible tag as well as with an internal tag on their otoliths. This experiment will also provide the samples for the development and validation of a new age estimation method based on the chemical composition of the cod’s otoliths.
The knowledge gained will be incorporated in length-based assessment models and their performance compared to the traditional methods evaluated in order to provide the ICES stock assessment group with the relevant tools to provide a reliable advice and to improve stock exploitation.
This project is coordinated by DTU Aqua.
The project is funded by BalticSea2020.

FishHab-II (39345)
The aim of the project is to map fish habitats to improve data and information for Maritime Spatial Planning. The project focuses on mapping the habitats for 9 commercially important fish species and one invertebrate species in the inner Danish waters. Within the project methods will be developed to map habitats in data-poor as well as data-rich areas. Data derived from different sources; surveys, fisheries, citizen science will be used and combined with information derived from fisher interviews. The mapping will include coastal habitats to provide the basis for advice on management of coastal fish nursery areas.

The project is coordinated by DTU Aqua and is funded by the Ministry of Environment and Food of Denmark and the European Maritime and Fisheries Fund (EMFF).

Development of sustainable mussel production (Idékataloget) (39250)
It is the overall objective of the project to develop sustainable methods of mussel production involving mussel fisheries, on-bottom culture and off-bottom long-line culture.
With regard to mussel fisheries, a GIS-based model of eelgrass habitats and their potential recovery was developed and has been reported. Further, macro algae were mapped in selected estuaries. In relation to on-bottom culture, focus has been on testing whether moving mussels from deeper to shallower areas during oxygen depletion was tested. Results showed that this can be a good strategy to move mussels that grew rapidly after relay in contrast to mussels not moved that died due to oxygen depletion. It is however important that careful monitoring of the relayed mussels are carried out by
the fishermen as mussels otherwise risk to be eaten by starfish. Experiments with relay of mussel spat from water column spat collectors are currently being carried out. In relation to long-line farming, DTU Aqua provided basic information and numbers to an economic analysis of the industry carried out by Copenhagen University, Department of Food and Resource Economy. This project is coordinated by DTU Aqua. The project was funded by the Ministry of Food, Agriculture and Fisheries through a special governmental funding for sustainable fisheries (“Bæredygtighedsfuljen”).

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Canal-Vergès, P., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources
Saurel, C., Project Participant, National Institute of Aquatic Resources
Nielsen, C. F., Project Participant, National Institute of Aquatic Resources
Tørring, D. B., Project Participant, National Institute of Aquatic Resources
Fitridge, I., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Project: Research

Implementing robot and drone technology in fisheries (39303)
The project aims to provide proof of concept for the use of robots in the fishery, focusing on three specific types for three different implementations. One will be used to determine the species and size composition of fish in the catch to prevent discards, the other to search for fish optically with a drone (capelin in Greenland) and the third a sailing robot to search for fish using sonar. The robots/drones to be employed are available on the marked. A development project must subsequently design software etc. to produce marketable products. It is estimated that there is a great potential in Denmark and a huge world market for these technologies that presently are not employed in fishery. This project is coordinated by DTU Aqua.
The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).
Stage, B., Project Participant, National Institute of Aquatic Resources, Arctic Section
Mosegaard, H., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Marine Living Resources & Observation Technology
Collaborators: Blue Ocean Robotics, Partrederiet M/S Isaold HG 333, Aquamind A/S, Danish Pelagic Producers Organisation
Project: Research

Ballast water - Tool for supporting the delimitation of a "same risk area" (39348)
A project financed by the Danish Maritime Fund via the Danish Nature Agency, to develop a decision support tool for authorities and consultants involved with the ballast water convention and measures preventing the spread of marine invasive species. The tool will support decision makers in member nations of the International Maritime Organisation (IMO) to identify and delimit marine areas with high connectivity considering hydrography and species biology. Identification of marine areas with high connectivity can provide a basis for granting exemptions in relation to the ballast water convention and the requirement for ships to treat ballast water before being discharged into the sea. The tool development is based on existing freeware including “IBM Lib” (DTU Aqua’s own individual-based modeling system for linking individual-based models to hydrographical model data), Netlogo (a widely used IBM simulation system) and R (a statistical programming and data handling package).
This project is coordinated by DTU Aqua.
The project is funded by the Danish Maritime Fund via the Danish Nature Agency.
Christensen, A., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Hansen, F. T., Project Manager, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Pedersen, E. M., Project Manager, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources
Worsøe Clausen, L., Project Participant, National Institute of Aquatic Resources
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Marine Living Resources & Observation Technology
Collaborators: Danish Meteorological Institute, Anchor-Lab
Project: Research

Eastern Baltic cod - New knowledge of growth and mortality is the way to improved management advice (39366)
The aim of the project is to improve the knowledge and data basis for stock assessment and management for cod in the eastern Baltic Sea. In later years, changes in growth and natural mortality of cod have presumably taken place and new
knowledge on these parameters is essential for restoring analytical stock assessment for Eastern Baltic cod that is currently lacking. Improved knowledge on cod growth and mortality is therefore a prerequisite for being able to evaluate the stock status in relation to management targets and implement management plans that are built on quantitative stock assessment. Ecological situation in the Baltic Sea has changed in later years, which requires updated biological information. This is done in the project using different approaches, bringing together expertise of different research areas. The approaches applied include molecular-genetic analyses of cod growth, bioenergetic modelling, and analyses of monitoring data on predation and condition/growth of cod. An important component of the project is cooperation with fishing industry to support tagging experiments of Baltic cod, to obtain updated estimates of cod growth. Finally, the project combines the new knowledge on cod that becomes available from this and other relevant projects to ensure that the assessment of stocks status and management advice is based on best available scientific information.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Eero, M., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources
Hansen, J. H., Project Participant, National Institute of Aquatic Resources
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources

15/08/2016 → 15/08/2018

Keywords: Research areas: Ecosystem based Marine Management & Fish Biology & Marine Populations and Ecosystem Dynamics & Population Genetics & Marine Living Resources & Fisheries Management
Collaborators: University of Copenhagen, Danish Fishermen's Association
Project: Research

Genetic adaptions underlying population structure in herring, Clupea harengus (GENSINC) (39355)

The objective is to document genetic differentiation and local adaptations in Atlantic herring populations spanning the majority of the species’ distribution in the Northeast Atlantic, thereby strengthening the scientific basis for management of herring stocks. This will be done by using new genomic analyses and by taking advantage of unique multi-generational experimental populations under controlled environmental conditions. Whole genome resequencing of 19 populations of herring from East Atlantic (including the North Sea, Skagerrak, Kattegat, and the Baltic Sea revealed low genetic differentiation at the great majority of examined genes. This supports earlier genetic studies suggesting that genetic drift at selectively neutral loci is extremely low in these populations. However, highly significant differentiation at a limited number of loci

Bekkevold, D., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources

01/01/2016 → 31/12/2019

Keywords: Research area: Population Genetics
Collaborators: University of Bergen, Queen's University Belfast, Uppsala University, Institute of Marine Research
Project: Research

Management of mussel fishery in Horsens Fjord and Lillebælt (39338)

It is the main aim of the project to the scientific basis for managing mussel fishery in two Natura 2000 areas: H52 Horsens Fjord and H96 Lillebælt with focus on the key ecosystem components eelgrass and macro algae. Based on detailed mapping of eelgrass beds, occurrence of macro algae and composition sampled using video transects, sampling by diver of macro algae and sediment sampling maps of eelgrass and macro algae are created. The data will also serve as input to a GIS model of potential recovery of eelgrass based on several different layers of information, e.g. sediment characteristics, shear stress (from hydro dynamic modelling), presence of eelgrass etc. Maps and models will serve as input to management in relation to permits to dredging for mussels in Natura 2000 areas according to guidelines in the Danish mussel policy. As a specific, additional activity it will be tested if drones can be used to map eelgrass beds. This will be performed in collaboration with DTU Space.

This project is coordinated by DTU Aqua.

The project is funded by the Ministry of Environment and Food of Denmark and the European Marine and Fisheries Fund (EMFF).

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Canal-Vergés, P., Project Participant, National Institute of Aquatic Resources
Nielsen, M. M., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources

26/01/2016 → 14/07/2018

Keywords: Research areas: Coastal Ecology & Shellfish and Seaweed
Collaborators: National Space Institute
Project: Research
**Forward management of sandeel in the North Sea (39316)**
The project will define and align the management of sandeel considering the goals and desires of the fishing industry, administration and science while taking the biology and importance of the sandeel in the ecosystem into account. The project is structured by several work-packages, each dealing with specific aspects of sandeel biology and/or fishery relevant for management. Among these will the sandeel population structure and its influence on stock assessment, CPUE and counselling be discussed. Analyses of fisheries development and sandeel availability over the fishing season will enable a more accurate calculation of fishing mortality. Furthermore, it is examined whether the increasing concentration of fishing effort on certain banks potentially causes an error in the stock assessment in relation to recruitment from unfished banks. The project will perform a statistical evaluation of fisheries-independent data for sandeel in the North Sea and evaluate existing and alternative methods of stock assessment for sandeel in the North Sea with current and alternative management areas, including implementing an analytical stock assessment of sandeel in sandeel area 4. Finally the project will evaluate existing biological and management reference points, and discuss these in relation to ecosystem reference points. Throughout the project period, a series of workshops and meetings will be held in order to discuss possible management strategies for sandeel in the North Sea. These discussions will imply a number of fundamental prerequisites defined in collaboration between management, fisheries and science in order to form the basis for an optimal management of sandeel.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Worsøe Clausen, L., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Bekkevold, D., Project Participant, National Institute of Aquatic Resources
Mortensen, L. O., Project Participant, National Institute of Aquatic Resources
Christiansen, A., Project Participant, National Institute of Aquatic Resources
11/11/2015 → 17/08/2018

**Keywords:** Research areas: Marine Living Resources & Population Genetics & Fish Biology & Marine Populations and Ecosystem Dynamics & Fisheries Management & Ecosystem based Marine Management

**Collaborators:** Danish Fishermen's Association, Danish Pelagic Producers Organisation, Marine Ingredients Denmark

**Project:** Research

**Danish Fisher-Researcher Network (39315)**
The project aims to bring the active Danish fishing sector and operational fisheries research closer together through “fisher- researcher” networking activities. The project will contribute to the collection and exchange of information and knowledge on fisheries and research herein across sectors and generations. This knowledge exchange will take place at several levels of education (secondary schools, university studies and training of working fishermen). The project will support innovation and development of sustainable fisheries through collation of ideas as well as preparation and planning of project cooperation for the solution of current and future challenges about fisheries, fish stocks and management. Bringing the primary fishing industries in direct contact with research and management in a network will support local skills in fishing ports to serve the development and succession in the coastal communities. Workshops and demonstrations of novel development are intended to direct technology transfer, innovative collaborative proliferation of businesses and recruitment of newly qualified academic staff. In addition, Danish fishing industry participation at the international level will be strengthened through increased technical scientific support from DTU Aqua before and under meetings in e.g. Thematic and Regional Advisory Councils.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Manager, National Institute of Aquatic Resources

06/11/2015 → 06/11/2017

**Keywords:** Research areas: Marine Living Resources & Observation Technology & Population Genetics

**Collaborators:** Danish Fishermen's Association, Danish Pelagic Producer Organization

**Project:** Research

**CodStory (39308)**
The main objective of this project is to examine spatiotemporal genetic and trophic change of North Atlantic cod populations over the last millennium, a period of significant temperature fluctuations. This project addresses several important issues in current conservation and resource management, for example, population size fluctuations, migrations and distribution shifts of Atlantic cod in relation to climate change. The project will provide long term data (approximately 1100 years) on the genetic population structure, adaptive genetic change and trophic ecology of a single species, the Atlantic cod, expanding the application of cod as a model species in historical eco-genetics.

Specific research questions include:
- How have climate fluctuations effected migration, gene flow, distributional shifts and interactions of Atlantic cod populations in the North Atlantic?
- How have climate fluctuations affected the trophic niche of Atlantic cod through ecological regime shifts and change in Atlantic cod feeding migrations?
- How have climate fluctuations affected the trophic niche and trophic position of seabirds and do directional changes in seabird isotope values, together with isotope values from Atlantic cod, indicate specific ecosystem effects?
- How has climate change affected the adaptive evolution of Atlantic cod at centennial scales as revealed by spatiotemporal SNP analysis with broad genomic coverage?

This project is coordinated by the University of Iceland.
The project is funded by the Icelandic Research Council.
Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources Hansen, J. H., Project Participant
01/03/2015 → 28/01/2018

Keywords: Research area: Population Genetics
Collaborators: City University of New York, University of Iceland, National Museum of the Faroe Islands, University of Saskatchewan
Project: Research

Expertise in marine and aquatic ecology and genomics for sustainable management of fish and shellfish in Skagerrak-Kattegat-Øresund (MarGen) (39301)
The marine and freshwater regions encompassing Skagerrak, Kattegat, Øresund and the North Sea are biologically highly productive and contain plentiful living aquatic resources that are important for the region. At the same time the coastal areas are densely populated and industrialized, fish and shellfish resources are heavily harvested, and waters are subject to pollution and eutrophication. The region is also markedly affected by the ongoing global warming, with sea temperature rising nearly 2 degrees C during the last 40 years. These environmental pressures call for investigations into the consequences for aquatic organisms, their potential for adapting to environmental changes, and for identifying management strategies that could mitigate deteriorating environmental conditions, using state-of-the-art methodology. Here, we will capitalize on the revolutionizing developments in genomics, electronic tagging and computer modelling to obtain insights on the ecology, evolution and management of aquatic biodiversity in the region.
The ØKS region harbours leading scientific environments within the aquatic, marine and genomic sciences that are complementary with respect to research and education and that would strongly benefit from better integration and networking. This proposal also aims to establish a research cluster and expand the number of active PhDs, postdocs and senior researchers within the region, thereby fostering an innovative research and educational network in the ØKS region.
This project is coordinated by DTU Aqua.
The project is funded by EU, InterReg (regional collaboration).
Hansen, J. H., Project Manager, National Institute of Aquatic Resources Bekkevold, D., Project Participant, National Institute of Aquatic Resources Aarestrup, K., Project Participant, National Institute of Aquatic Resources Kristensen, M. L., PhD Student, National Institute of Aquatic Resources Mensberg, K. D., Project Participant, National Institute of Aquatic Resources Meldrup, D., Project Participant, National Institute of Aquatic Resources Mikkelsen, J. S., Project Participant, National Institute of Aquatic Resources Le Moan, A., PhD Student, National Institute of Aquatic Resources 01/07/2015 → 30/06/2018
Keywords: Research areas: Population Genetics & Freshwater Fisheries and Ecology
Collaborators: Aarhus University, University of Oslo, Institute of Marine Research, University of Gothenburg, University of Agder, Norwegian Institute for Water Research
Project: Research

Marine management of ecosystem dynamics under climate change (MARmaED) (39300)
MARmaED is an EU Initial Training Network that unifies specific and complementary competences in marine sciences from Norway, Finland, Denmark, the Netherlands, Germany and France to investigate how the cumulative stress from biodiversity loss, climate change and harvesting will affect Europe’s complex marine systems and the consequences for optimal resource management. MARmaED incorporates feedbacks between the socioeconomic and the ecological systems that give rise to critical transitions.
This project is coordinated by University of Oslo, Norway.
The project is funded by EU, Marie Curie.
Andersen, K. H., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life Lindegren, M., Project Participant, National Institute of Aquatic Resources van Gemert, R., PhD Student, National Institute of Aquatic Resources Beukhof, E. D., PhD Student, National Institute of Aquatic Resources 01/10/2015 → 01/10/2019
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: University of Bergen, University of Oslo, Météo-France, University of Helsinki, Åbo Akademi University, Wageningen University & Research, University of Hamburg
**Effects of dispersed oil droplets and produced water components on growth, development and reproduction of Arctic pelagic copepods (PWC-Arctic)** (39297)

As the Oil & Gas industry moves north towards the Arctic, it is crucial to understand and be able to predict the potential for detrimental effects of regular (produced water) and accidental oil spills on Arctic organisms, which often are characterized by high lipid content. Organisms with high lipid content are susceptible to accumulation of lipophilic organic components like produced water components (PWC) including oil droplets. Limited data exist on accumulation of oil components in Arctic lipid-rich species which are parameterized so they can be applied as input to models predicting bioaccumulation and body residues as a function of exposure time/concentration. Even less data exist where body residues of oil components are explicitly linked to sub-lethal and delayed effects (e.g. on offspring). Finally, the potential contribution of oil droplets to bioaccumulation has never been studied in Arctic species.

The present project aims at:
- providing parameterized data on uptake/elimination kinetics and internal administration (partitioning coefficients between lipids and body fluids) for PW components in the Arctic lipid-rich copepods Calanus glacialis and C. hyperboreus;
- determine effect concentrations for PW components on early life stages of these copepods; and finally
- assess the potential for maternal transfer of PW components to eggs by exposing females prior to egg-laying and determine potential developmental effects in early stages developing in clean sea water.

The parameterized data collected in this project will provide direct input to numerical models aimed at predicting impact of PW on Arctic organisms. The approaches and methodologies used are based on extensive experience from previous toxicological studies on the two Arctic species and in particular the related boreal species Calanus finmarchicus. The main objective of the current proposal is to increase the knowledge of the potential effects of dispersed oil and other produced water components on growth and reproduction in lipid-rich Arctic planktonic crustaceans.

This project is coordinated by SINTEF, Norway.

The project is funded by the Research Council of Norway.

Nielsen, T. G., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
Dinh, K. V., Project Participant, National Institute of Aquatic Resources
Toxværd, K. U., PhD Student, National Institute of Aquatic Resources
01/01/2016 → 31/12/2018

Keywords: Research area: Oceanography
Collaborators: SINTEF
Project: Research

**Understanding and predicting size selectivity and escape mortality in commercial zooplankton fisheries: Case study on Antarctic krill (SILF)** (39245)

Antarctic krill is an important fisheries resource, regarded as one of the most under-exploited fisheries in the world. Concern is expressed regarding the future sustainability of harvesting and the impact this may have on dependent predators. This is associated with the cumulative pressure from ongoing environmental changes, which modify abundance, distribution and life cycle of krill.

Due to large gaps in knowledge about this marine ecosystem and potential negative effects caused by fishery activities, both the Commission and Scientific Committee of CCAMLR strongly request knowledge about the effects of different fishing gear on krill escape and the indirect mortality on the krill stock. Indirect fishing mortalities include organisms that die after escaping from fishing gear due to injury.

CCAMLR is currently improving their management system, by establishing feedback management procedures and Small Scale management Units. They recommend members to have scientific observers on board to enhance control measures and Marine Protected Areas around the continent is established with various degrees of allowing for exploratory fishing and rational use. It is highly uncertain to establish such a management regime without scientific knowledge about the impact of fishing on the ecosystem. There is an urgent need to address these questions, also for the sake of the development of other new and exploratory fisheries.

A pilot study (NEAT) using both mathematical modeling techniques and practical experiments on size selection of krill shows that escape occurs even from some of the smallest commercial meshes used in the fishery. In this study, we will assess different trawl designs sizes selectivity and establish predictions of sizes selectivity of krill in any given trawl design.

We will also perform experiments to examine the rate of escape mortality of krill in trawls and couple this to full gear sizes selectivity to allow evaluation and optimization of trawls in the commercial krill fishery.

The developed methods are directly transferable to similar fisheries e.g. fisheries targeting species lower in the food chain. This project is coordinated by the Institute of Marine Research, Norway.

The project is funded by the Research Council of Norway.

Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2015 → 31/12/2017

Keywords: Research area: Fisheries Technology
Collaborators: Institute of Marine Research, SINTEF, Olympic Seafood AS, Aker Solutions AS
Project: Research
Optimising and enhancing the integrated Atlantic Ocean Observing Systems (AtlantOS) (39243)
The vision of AtlantOS is to improve and innovate Atlantic observing by using the Framework of Ocean Observing to obtain an international, more sustainable, more efficient, more integrated, and fit-for-purpose system. Hence, the AtlantOS initiative will have a long-lasting and sustainable contribution to the societal, economic and scientific benefit arising from this integrated approach. This will be achieved by improving the value for money, extent, completeness, quality and ease of access to Atlantic Ocean data required by industries, product supplying agencies, scientist and citizens. The overarching target of the AtlantOS initiative is to deliver an advanced framework for the development of an integrated Atlantic Ocean Observing System that goes beyond the state-of-the-art, and leaves a legacy of sustainability after the life of the project.

The specific task of DTU Aqua is to conduct analysis of environmental DNA (e-DNA) using an Environmental Sample Processor (ESP). All living organisms secrete DNA to the surrounding environment. Recently it has been shown that such “e-DNA” can be extracted from seawater and used to identify the organisms present within a designated sea area. The “ESP” is a moored automated DNA laboratory, which can be deployed for up to three months for in-situ analysis and at the same time send back real-time analytical results. Hitherto it has been used for identification of marine bacteria, phyto- and zooplankton with very good results. We will modify the ESP to allow its use for e-DNA analysis. The aim is to conduct unprecedented “proof of concept” of e-DNA sensors for monitoring of important species in a number of sea areas and time periods.

The project is funded by EU, Horizon 2020. This project is coordinated by DTU Aqua and has 54 additional partners across Europe.

Keywords: Research area: Population Genetics
Collaborators: National Center for Scientific Research, Scottish Association for Marine Science, Natural Environment Research Council, Institute of Marine Research, GEOMAR - Helmholtz Centre for Ocean Research Kiel, Marine Institute, International Council for the Exploration of the Sea
Project: Research

Short-term projections for short-lived species managed under MSY: Management of the sandeel stock in the North Sea (39148)
The industrial fishery for small short-lived species represents the economically most important fishery in Denmark, and traditionally the North Sea sandeel (Ammodytes marinus) has played a key role in this fishery.

Currently, quota advice for sandeel is based on the so-called B-escapement strategy, the purposes of which is to ensure that the spawning stock biomass remains large enough to maintain the survival of the population even after fish-eating fish, birds, and mammals have taken their share; and whatever is left is made available to the fishery. This type of management strategy relies on accurate predictions about the size of the incoming year class (the recruitment), if the criteria of MSY are to be fulfilled.

The aim of the project was therefore to ensure that the short-term prognosis reflects current knowledge about the biology of sandeels in the North Sea and applies all relevant data time-series.

A new recruitment index was introduced. Seasonal and spatial patterns in log-book based catch rates of age-1 fish were analysed and compared to recruitment indices from the year before. Spatial differences in local larval retention strength were found.

A genetic tool that allowed us to distinguish between different sandeel species in a quick and accurate way was developed. Lastly, development of a state based assessment model that can handle seasonal data (something which is necessary for sandeel) and estimate shifting selection patterns was initiated.

All of this work is currently contributing significantly to the preparation of the coming North Sea sandeel benchmark assessment in ICES to be held in the fall of 2016.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Keywords: Research areas: Marine Living Resources & Population Genetics
Collaborators: Cefas Weymouth Laboratory, Sir Alister Hardy Foundation for Ocean Science
Project: Research

Sustainable bycatch in Danish fishery - Reasonable management under the landing obligation (39028)
he project facilitated a more robust advice of by-catch species in the Danish fishery in the Skagerrak by suggesting and testing stock assessment approaches for data poor stocks as well as providing guidance for various options to reduce by-catch without limiting the target fishery.
The approach applied in the projects was suggested to be adopted for other areas where the landing obligation potentially can be restrictive for target fisheries (mixed-fish cases). Through thorough exploration of existing data in survey time-series it was possible to provide size-based life-history models to gauge the sensitivity of stocks in relation to fishing pressure.

The models were used to determine relevant biological reference points for the most relevant by-catch species and the resulting assessment and stock status was then compared to the prevailing ICES/RGLIFE classification. Finally, the project suggested upgrading the stocks to a higher and less restrictive ICES category for management purposes where possible.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Worsaae Clausen, L., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Gislason, H., Project Participant, National Institute of Aquatic Resources
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Jørgensen, O. A., Project Participant, National Institute of Aquatic Resources
Kokkalis, A., PhD Student, National Institute of Aquatic Resources

01/06/2012 → 31/01/2014

Keywords: Research areas: Marine Living Resources & Fisheries Management & Marine Populations and Ecosystem Dynamics
Collaborators: Danish Agricultural Agency, Danish Fishermen's Association
Project: Research

Aqua Fingerprint - Early warning for contamination of drinking water (38966)

The majority of Danish drinking water supplies to some extent have at some point been troubled with periods of decline in water quality. For the majority of instances the contamination event is discovered by the routine microbiological control grab sampling and occurs in conjunction with extreme events, such as intense rain, where contaminated water enters the network as a short pulse with high concentration. For most cases the actual source of the contamination cannot be traced as the event has already passed through the network and this hinders progress in improving the network.

Some events could have been avoided if an early warning system indicating the occurrence of such a pulse was available. This project was focused on developing such an on-line sensor using organic matter fluorescence. Proof of concept was proved and a prototype online sensor was built to prove the feasibility of the technology.

This project was coordinated by Krüger AS, Denmark.

The project was funded by the Danish Environment Agency.

Stedmon, C., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

01/01/2012 → 31/12/2012

Keywords: Research area: Oceanography
Collaborators: Technical University of Denmark, Krüger Veolia Water Technologies, TREFOR Vand A/S
Project: Research

Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis (META-OCEANS) (38154)

This project was an EU Marie Curie Early Stage Training PhD network. The project was designed to improve and apply meta-analytical methods to oceanographic and fishery research questions.

There are significant gaps in knowledge regarding the structure of marine food webs, the ecological roles of taxa of different sizes and the factors controlling linkages between different functional groups. Moreover, marine ecosystems continue to suffer from the impacts of human society superimposed on naturally and anthropogenically induced climate variability. These impacts include exploitation, eutrophication, pollution, species transfers and habitat alteration; they cause changes in the structure, function and biodiversity of marine ecosystems. However, the ability of marine scientists to predict the magnitude and direction of how marine taxa, functional groups and entire ecosystems respond to these changes, remains fragmentary. As a result, when asked by society for advice about how marine ecosystems will respond to different kinds of perturbations (including management actions), the marine science community can often only provide answers with high levels of uncertainty.

Students were trained in the use of meta-analysis techniques for marine ecological problems. The statistical methods were comparative and involved regression analysis, time series analysis, Bayesian analysis and trophic modelling. Students attended seminars organized by network scientists and visited scientists in partner institutes to attain additional training.

Meta-analyses approaches make use of existing data, produced in the context of different specific analyses, but which gain new value when assembled and re-analysed in a broader perspective. Meta-analyses involve several stages: (1) data mining; (2) quality control, (3) data analysis, and (4) validation. Students were trained in all these steps.

DTU Aqua had two PhD students involved in the project. These projects used Bayesian and meta-analytical methods to show that standardized estimates of maximum population growth rate for all assessed cod stocks vary spatially across the Atlantic and in a dome-shaped relationship with temperature, and that extremely good or bad recruitment occurs in years with extreme temperatures. In addition, new time series-based ways of forecasting cod population dynamics under climate change-exploitation scenarios were developed and the role of a trawling ban on a local cod population was shown to override temperature or other climate effects on stock productivity. Both projects produced papers in high impact journals (2 in Proc. Roy. Soc., 1 in PNAS), as well as in other leading fishery-marine ecology journals (MEPS, ICES, JMS, etc.) s in other leading fishery-marine ecology journals (MEPS, ICES JMS, etc.).

This project was coordinated by AZTI Tecnalia, Spain.
This project was funded by EU, Marie Curie.
Mackenzie, B., Project Manager, National Institute of Aquatic Resources
Lindgren, M., PhD Student, National Institute of Aquatic Resources, Centre for Ocean Life
Mantzouni, I., PhD Student, National Institute of Aquatic Resources
01/03/2006 → 09/12/2011
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: National Center for Scientific Research, CSIC, University of Bergen, AZTI-Tecnalia, Plymouth Marine Laboratory
Project: Research

**Sustainable management of Kattegat cod; Improved knowledge about stock components and migration (39346)**
The Kattegat cod has been categorized as a data limited stock, mainly due to a large unallocated mortality, which may be caused by migration between Kattegat and neighbouring areas. In this project, we aim to improve our understanding of migration patterns and mixing of different stock components within the Kattegat through a novel combination of genetic and micro-chemical signatures for individual fish. Results from the project will feed directly into the ICES advisory process, including a scheduled benchmark meeting in early 2017 where new procedures for stock assessment will be discussed. As cod are also caught as bycatch in other fisheries, a more robust stock assessment for cod will also be important to fisheries for other species under the landing obligation, which is scheduled for implementation in the Kattegat in 2017.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.
Hansen, J. H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Hüssey, K., Project Participant, National Institute of Aquatic Resources
Eero, M., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Meldrup, D., Project Participant, National Institute of Aquatic Resources
Levinsky, S., Project Participant, National Institute of Aquatic Resources
01/03/2016 → 28/02/2018
Keywords: Research areas: Population Genetics & Marine Living Resources & Fisheries Management
Collaborators: Danish Fishermen's Association
Project: Research

**Dynamic user-driven marine e-maps for the advancement of Danish industrial fisheries (GUDP-VIND) (39246)**
This project aims at strengthening Danish industrial fisheries development in order to (i) reduce the search time and fuel consumption per ton of fish caught (revenues: 16 million DKK/year), (ii) make better use of the sprat quota (revenues: 15 million DKK/year, by a full quota uptake), (iii) pave the way for sustainable self-management of resources in the industrial fisheries sector and (iv) contribute to creating and maintaining jobs in the local fishing community.

The specific objectives of the project: Development of an IT tool that will contain (i) a platform to improve sharing of knowledge and registration of observable and derived variables (data), and (ii) user-defined and user-controlled digital Marine Maps with those specific data that fishermen consider important as background information in the planning and implementation of fishing trips. These marine data include (but are not limited to) a portfolio of Marine Maps spanning from the North Sea hydrography and bottom conditions over distribution of plankton and fish to water-DNA.

The needs for a technological development of this fishery comes from increasing average vessel size, while the number of large vessels is reduced to about 1/8 of what it was in the past. The immediate consequence is a reduction in the collective search performance and knowledge sharing. In addition, the area based management of the sandeel fishery introduced in 2011 has contributed to a reduction of fishermen's opportunities to diversify fishing and explore a wider variety of fishing grounds. Finally, the sprat fishery is uncertain because of by-catch limits and a very variable CPUE driven by wind and weather. This has led to an underutilization of the sprat quota by around 100,000 tons per year.

Fisherman knowledge of good fishing opportunities is based on the correspondence between historical catches and observable variables at the time of capture, such as the seasons, wind, waves and tides, and it is precisely this kind of knowledge that the project wants to combine with a technological solution, so that all relevant data is made widely available to the fishermen by developing user-controlled dynamic digital Marine Maps. The project includes a business plan for the IT company Anchor Lab, which develops the user-controlled Marine Maps, and plans for derived effects in terms of better utilization of the sprat quota and fuel savings through the use of the Marine Maps. Besides the economic effects, the project contributes to CO2 reduction, and supports the technological development of a modern industrial fishery sector, based on a natural resource to be managed by the EU in accordance with ICES’ advice.

This project is coordinated by DTU Aqua.
The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).
Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Manager, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources
Baltic Sea Check Point (BSCP) (39294)
The overall aim of this project is to examine the current data collection, observation, surveying, sampling and data assembly programs in the Baltic Sea basin, assess and demonstrate how they can fit into purpose in the 11 challenge areas in terms of data uncertainty, availability, accessibility and adequacy, and deliver the findings to stakeholders through an internet portal with dynamic mapping features and a stakeholder workshop. The Baltic Sea region is as defined by the Marine Strategy Framework Directive, i.e., the semi-enclose sea bounded by the parallel of the Skaw in the Skagerrak at 57°44.43.

The project is coordinated by the Danish Meteorological Institute and is funded by the EU Executive Agency for Small and Medium-sized Enterprises (EASME), the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Assessment and management of linked stocks (39325)
The purpose of this project is to develop operational models for linked stocks. Fish stocks are not isolated units. Fish eat, and are eaten, by fish from other stocks. The definition of fish stocks is often arbitrary or determined by management considerations. The bottom line is that some linkage must be expected between the defined stocks. For some stocks these effects are essential to give reliable assessment and management. Single species assessment and management does not include effects from linked stocks. Ecosystem and multi-species assessment models are not practically operational for assessment and management. These models are designed to describe all interactions between all important species in an ecosystem. These models often attempt to estimate detailed effects between all length- or age groups. These models often require data, which are not routinely available. This project will develop models, which are directly applicable in the scientific advice. The aim is not to describe all interactions, but simply to harvest the main benefits of considering two or more stocks in a joint model. The aim is to identify few links between the stocks, which describes the main part of the interaction, and to base the models only on standard data sources. The models will be developed to be generally applicable, but applied to two important cases (Cod EB and WB, and Cod stocks around Kattegat). Final tool will be available via stockassessment.org, so it can easily be applied to any stocks defined there.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Initiative to improve mackerel assessment via tagging data (39080)
The assessment of NEA mackerel had issues with this assessment related to the data. The most problematic data issue for NEA mackerel is the unknown amount of unreported catches in the past. The single index was available only every third year, which caused substantial revision of the perceived stock each time a new survey point was incorporated. Furthermore, the uncertainty in the stock estimate in the terminal assessment year increased as one moved away from the last available egg survey point.

This project extended the state-space assessment model SAM (developed at DTU-Aqua) to use tag-recapture information. This was done in order to correctly propagate uncertainties associated with the tag-recapture data. In preparation of the benchmark two meetings were held with the objective to analyze the information given by the tagging data and write the code for the model extension. The model was extended and accepted as the primary model for NEA mackerel at the following benchmark assessment.
meeting. This project was coordinated by Danish Pelagic Producer Organization. The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Nielsen, A., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
23/07/2013 → 01/05/2015
Keywords: Research area: Marine Living Resources
Collaborators: Danish Pelagic Producer Organization
Project: Research

Workshop on Baltic Sea Trout Helsinki, Finland, 11-13 October 2011 (38836)
In order to provide solutions for the possible implementation of management initiatives suggested in ICES recommendations a three day workshop was established. An updated status of sea trout populations in the Baltic Sea was presented directly to invited managers from all countries around the Baltic Sea and to the EU Commission DG MARE/E2. The status in each country was presented by national experts from all countries around the Baltic Sea. For a wider perspective the status of sea trout in Scandinavia, the status for Norwegian trout populations was presented by an invited expert from Norway. Possible solutions to problems for the sea trout already implemented in some countries were presented and discussed between managers and scientists. Furthermore expected effects from additional implementations and the need of these were discussed. A set of statements were formulated.

Project report can be downloaded from aqua.dtu.dk
This project was coordinated by DTU Aqua.
The project was funded by Nordforsk, Nordic Council of Ministers.
Pedersen, S., Project Coordinator, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/11/2010 → 01/02/2012
Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Natural Resources Institute Finland
Project: Research

Assess the yield from eel stocking in a marine fjord (38262)
The overall objective of the project was to estimate the outcome of stocking eel in a marine area, to estimate the yield to the fishery and the proportions of eels escaping the fishery. To reach this goal it was necessary to estimate the total catch in the fjord, the fishing mortality and whether eels stay in the fjord area or migrate to adjacent waters.

Stocking is a widely used measure to enhance local eel populations throughout Europe. About 1.5 million elvers are stocked annually in Danish marine waters. There are only vague indications that these stockings actually improve the number of fish that are available to the fishery and the spawning population. In 1998 and 1999 a total of 100,000 coded wire tagged eel were stocked in the inner parts of Roskilde Fjord. During 1999-2015 the eel catches made by professional and recreational fishermen were analyzed for recapture of tagged fish in order to establish the ratio of tagged to untagged fish in the eel catches. Based on the knowledge of numbers of fish caught in the yellow eel fishery as well as the silver eel fishery, the yield to the fishery was calculated. Migration patterns of the stocked eel were studied by collecting data from different strata of the fjord and adjacent fisheries, Isefjord and Arresø. Migrating silver eels were Carlin tagged and released to the fishery in September and October. Based on reported recaptures from fishermen an estimate of fishing mortality was established as well as of the number of silver eels leaving the Fjord and migrating toward the Sargasso spawning grounds. The total catches made by recreational fishermen were established through questionnaires to recreational fishermen.

The overall result suggests that about 13 % of the stocking were captured by the fishery in Roskilde Fjord and 5 % left the fjord as silver eels on spawning migration. This project was coordinated by DTU Aqua.
The project was funded by the Danish Rod and Net License Funds.
Pedersen, M. I., Project Coordinator, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Rasmussen, G., Project Manager, National Institute of Aquatic Resources
Christensen, H. A., Project Participant, National Institute of Aquatic Resources
Carøe, M., Project Participant, National Institute of Aquatic Resources
Mikkelsen, J. S., Project Participant, National Institute of Aquatic Resources
01/01/1996 → 31/12/2015
Keywords: Research areas: Freshwater Fisheries and Ecology & Coastal Ecology
Project: Research

Discard survival (DISCO) (39152)
This project has developed methods and accumulated competencies and facilities, to be able to estimate discard survival and generate knowledge about the factors that affect this. The focus was on two commercially important species, plaice and Norway lobster. These species are relevant because there is a likelihood of a substantial survival.

The first trial was conducted from November to March from a less commercial trawler with Hirtshals as port. There was fishing for plaice with a consumption trawls and towed time was 3 hours. Test plaice were collected at four different time periods exposed to air on the deck, with a half-hour intervals up to one and a half hour. Furthermore, control plaice were
Sustainable, cost effective and responsive gear solutions under the landing obligation (FAST TRACK I) (39323)

With the reform of the Common Fisheries Policy and the introduction of a Landing Obligation the ability of fishers to adjust the selectivity of their gears to suit the quotas which are available to them will be an important factor in determining the revenue and profitability in the fishery. As the combination of gear, fishing practice and quota shares will differ between vessels, changes to the selectivity of the gears will need to be implemented at the vessel level and based on the quotas which are available to the vessel at a given time. For this to be realized, simple and cost effective solutions which can be quickly coupled with existing gears will be in demand. These solutions will need to be implemented quickly in order for them to solve the issues at hand without losing substantial income. Furthermore, these solutions will need to be scientifically tested to document their effect before being considered for implementation into the legislation. Fast-Track aims to increase flexibility and ownership over the gears used while ensuring an effective introduction of the new EU Common Fisheries Policy. To achieve this, Fast-Track aims to facilitate the development of more selective gears by

Optimizing the value of fish caught in the Danish mixed fishery – Improved quality and selectivity as a consequence of gear development (FishValue) (39033)

In the FishValue project (VærdiFisk) the main goal was to increase the biological and economical sustainability of the Danish Mixed fishery by increasing the gear selectivity and improve the quality of whole and processed fish. A horizontally divided codend was developed in the project to separate four fish species from Nephrops (Nephrops norvegicus) in an upper and lower compartment, respectively, to avoid physical contact between fish and animals with hard or spiny body surfaces. Focus was given to design and placement of a grid in the lower compartment to obtain an effective separation. Square meshes of different mesh sizes in the upper and lower compartment were used to investigate if it is possible to customise the selection of fish and Nephrops separately while retaining the most valuable catch. Quality assessments of the catch were performed to measure whether catch from the two compartments increased quality of whole fish and fish fillets, compared with the standard codend in which the catch components were mixed.

Design and placement of a grid in the lower codend gave an effective separation of all the species investigated when compared to the first version of the experimental codend. Catch from the upper compartment showed a significant quality improvement for whole fish, fillets and Nephrops compared to the standard codend. It was possible to customize the selection of fish and Nephrops separately and at the same time retain the most valuable catch using different mesh sizes of square meshes in the upper and lower codend. In fact, the horizontally divided codend had 10% higher catch rate of Nephrops compared to the standard codend. This more efficient fishery gives less fuel consumption per kilogram Nephrops caught, and may, if evaluated over longer time periods, imply less impact on the sea bottom than when fishing with the standard codend.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Karlsen, J. D., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

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01/01/2013 → 27/05/2014

Keywords: Research areas: Fisheries Technology & Aquaculture

Project: Research
Baltic Sea project to boost regional coherence of marine strategies through improved data flow, assessments, and knowledge Base for development of measures (BalticBOOST) (39312)

General objectives

The general objective of the project is to enhance regional coherence in the accomplishment of the 2018 reporting under the EU MSFD by developing joint tools, defining data needs and to set up data arrangements to support indicator-based assessments of the state of and pressures on the Baltic Sea. The project takes steps towards development of joint environmental targets for pressures affecting seabed habitats by developing a knowledge base and principles for defining such targets. The project addresses in particular MSFD Descriptors 1, 6, 8 and 11.

BalticBOOST is based on five themes with one or several work packages: Theme 1 (Biodiversity), Theme 2 (Hazardous substances), Theme 3 (Physical loss and damage to seabed habitats), Theme 4 (Noise), and Theme 5 (Joint documentation of Programmes of Measures).

DTU Aqua is involved in themes 3 and 5:
- Theme 3, Physical loss and damage to seabed habitats, develops joint principles for defining environmental targets for pressures affecting seabed habitats (WP 3.1). The development of such environmental targets is challenging and as a starting point the WP explores ways to determine how much disturbance from different activities that specific seabed habitats can tolerate while remaining in Good Environmental Status (GES). Under this Theme, a tool for assessing the impacts of fishing gear on specific habitat types and species is also developed (WP 3.2). Finally, an arrangement for regular collection of data and information on pressures and activities that affect the Baltic Sea is piloted, to provide support to this Theme as well as future assessment of pressures impacting the Baltic Sea (WP 3.3). A shared component across Themes 1-3 is improving access to high quality data to carry out future assessments feeding into the MSFD reporting. This involves alignment of the formats of reported data to relevant international or European data format and making the resultant spatial data products (indicator maps) available as INSPIRE compliant (OGC WMS/WFS) web map services.
- Theme 5, Joint documentation of Programmes of Measures (PoMs), provides support for HELCOM GEAR, the working group responsible for regional coordination in the implementation of the HELCOM BSAP and the MSFD. Support is provided to the agreed development of a joint document on regional coordinated PoMs and a system to follow-up actions agreed by HELCOM.

Tasks and Deliverables

DTU Aqua is involved in Theme 3, WP3.1 and especially WP3.2, where we will develop methods for assessing and apply fishing intensity maps according to fishing gear (footprint), explore benthic sensitivity indicators of fishery, and evaluate fishing impact according to MSFD indicators, all with focus on the Femern Belt Case Study, DTU Aqua is responsible for and coordinating the Technical WP3.2 (coordinator Prof. J. Rasmus Nielsen).

This project is coordinated by DTU Aqua.

The project is funded by the Ministry of Environment and Food of Denmark and the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

Feekings, J. P., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Krag, L. A., Project Participant, National Institute of Aquatic Resources
Ulrich, C., Project Participant, National Institute of Aquatic Resources
Mortensen, L. O., Project Participant, National Institute of Aquatic Resources
Malta, T. A. M. D. V., PhD Student, National Institute of Aquatic Resources
Frandsen, R., Project Participant, National Institute of Aquatic Resources

15/12/2015 → 15/12/2018

Keywords: Research areas: Fisheries Technology & Fisheries Management

Collaborators: SINTEF, Aalborg University, Danish Fishermen's Association
Project: Research
The Program is organized in four main branches, or Work Packages: Population Dynamics and Stock Assessment, carry out the best efforts to guarantee sustainable exploitation of fishery resources and ensure economic viable fisheries. The overall principle underlying this effort is the food security of SA, and the duty to meet the exploitation status and enhance the sustainability of finfish and invertebrate stocks of Saudi Arabia (SA) Exclusive Economic Zone in the Arabian Gulf. The general aim of the Fisheries Program at the Marine Studies Section, Center for Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals (KFUPM/RI), is to establish a modern system of data collection, biological and ecological assessment, stock assessment modelling, and government management, in order to evaluate the exploitation status and enhance the sustainability of finfish and invertebrate stocks of Saudi Arabia (SA) Exclusive Economic Zone in the Arabian Gulf. The overall principle underlying this effort is the food security of SA, and the duty to carry out the best efforts to guarantee sustainable exploitation of fishery resources and ensure economic viable fisheries. The Program is organized in four main branches, or Work Packages: Population Dynamics and Stock Assessment, Essential Fish Habitats, Environmental Impacts of Fishing Methods, and Management Strategy Framework.
New methodologies for an ecosystem approach to spatial and temporal management of fisheries and aquaculture in coastal areas (ECOAST) (39339)

ECOAST aims to identify, develop and test new methodologies for spatial and temporal management of fisheries and aquaculture in coastal areas. The overall approach will assess the impact of fisheries and aquaculture on coastal ecosystems, including essential fish habitats and conservation priority habitats, as well as synergies and conflicts between human activities.

Building on previous methodologies and experiences the project will evaluate marine spatial planning in seven coastal case study areas having different ecological and socio-economic characteristics: 1) Adriatic Sea (ADR), 2) Ionian Sea (ION), 3) Black Sea (BLK), 4) Tyrrhenian Sea (TYR), 5) Baltic Sea (BAL), 6) Norwegian Fjords (NOR) and 7) NE Atlantic Coasts (ATL).

The project outcomes will produce case specific evaluation of the ecological footprints of aquaculture and fisheries in coastal areas, maps of optimal areas for fisheries and aquaculture, evaluation of compatibility between fisheries, aquaculture and other human activities in coastal areas, as well as implementation of holistic methods and an operational modelling framework to evaluate and predict stakeholder responses to coastal spatial management options covering marine cross sector occupation of space. Several methodologies already exist to assess the impacts on the ecosystem and the socio-economic effects of some spatial management measures, as well as to spatially manage some cross sector marine activities, but none of them integrate all relevant management aspects for coastal areas. Therefore, the holistic methodology will cover in a single system different approaches and management aspects, identifying realistic spatial and temporal potentials and limitations for the integration of fisheries and aquaculture in coastal areas, in order to allow policy makers and stakeholders to evaluate management measures from different points of view and share decisions in a transparent manner on case specific basis. ECOAST results will support the EU and national policies through the provision of tools and data for an ecosystem based allocation of space and sustainable use of marine resources in coastal areas on case specific basis.

This project is coordinated by Institute of Marine Science of the National Research Council, Italy. This project is funded by EU, COFASP, ERA-NET.

Bastardie, F., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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01/03/2016 → 31/12/2018

Keywords: Research area: Fisheries Management
Sustainable use of the invasive round goby in favour for the fishery and the environment (SORTMUND) (39336)
The overarching aim of SORTMUND is to establish a profitable and environmentally sustainable fishery after the invasive round goby in inner Danish waters. Round goby was first seen in south-eastern Danish waters in 2008 and have since then increased rapidly in abundance along the coastline where it has severe negative effects on local biodiversity and the traditional coastal fishery. We aim to launch the fish as a high-quality Nordic product for human consumption, in addition to for animal feed. The project covers the entire value chain, and has broad participation, ranging from local fishermen and their trade organization, the processing industry, university institutes and a Michelin restaurant. Specific activities will be estimations of stock sizes, investigations of seasonal migrations of the fish, development of seal-safe of gear to avoid damages to the catch, test of methods to fillet the fish for human consumption, documentation of nutritional quality of the fish, development of a fermented fish sauce to add umami to the food, and optimization of logistics in relation to collection, cooling and transportation of fish from small harbors to processing. This project is coordinated by DTU Aqua. The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP). Behrens, J., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources Christoffersen, M., Project Participant, National Institute of Aquatic Resources Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources van Deurs, M., Project Participant, National Institute of Aquatic Resources 01/03/2016 → 28/02/2019 Keywords: Research areas: Fish Biology & Marine Living Resources Collaborators: Enspire, NF340 Lasse III, Gilleleje Fillet Factory, National Food Institute, Danish Fishermen’s Association, Gemba Seafood Consulting

Optimal sustainable use of cod stocks accessible for Danish fisheries (DEL-TORSK) (39147)
Optimal sustainable utilization of cod stocks that contain several biological sub-populations requires taking population structure into account in stock assessment and management. The aim of this project was to develop scientific basis for cod management decisions in the North Sea and the Baltic that takes biological units of cod and their dynamics into account. Methodological challenges concerning advising on stocks that contain sub-populations with differences in dynamics and biological parameters are common for North Sea and the Baltic. Therefore, the project considered both seas, in terms of developing methodological basis for addressing population structure in management advice. The results were presented at ICES benchmarks for North Sea and Baltic Sea cod in 2015, and used to developing further the management basis for optimal use of cod stocks. The project included mapping of distribution of sub-populations using genetic analyses and modelling of transport of early life stages. These results were combined with existing knowledge on cod population structure both in the Baltic and North Sea, to identify distribution areas of sub populations. This information was then incorporated in area-specific stock assessment analyses. This project was coordinated by DTU Aqua. The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF). Eero, M., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management Hansen, J. H., Project Participant, National Institute of Aquatic Resources Mariani, P., Project Participant, National Institute of Aquatic Resources Berg, C. W., Project Participant, National Institute of Aquatic Resources Hüsey, K., Project Participant, National Institute of Aquatic Resources Huwer, B., Project Participant, National Institute of Aquatic Resources Nielsen, A., Project Participant, National Institute of Aquatic Resources Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources 17/07/2013 → 30/04/2015 Keywords: Research areas: Ecosystem based Marine Management & Marine Populations and Ecosystem Dynamics & Population Genetics & Fish Biology & Marine Living Resources & Fisheries Management

Bycatch of marine mammals and seabirds - Assessment and mitigation (39337)
The aim of the project is to develop innovative mitigation methods to reduce the unintended bycatch of marine mammals and seabirds in Danish gillnet fisheries. The project includes the following components:- determine the distribution in time and space of the bycatches; - identify the factors that determine the occurrence of the bycatch and its distribution; - identify behaviour that are correlated with bycatch; - conduct pilot trials of mitigation methods; - propose further mitigation methods to test in a continuation of the project. The results of the project will contribute to a better management of protected species of marine mammals and seabirds, as well as placing Denmark in a better position with respect to its obligations in relation
to the EU Habitats Directive, the EU Bird Directive, the EU Marine Strategy Framework Directive, the EU Council

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the
Danish Fisheries Agency.

Larsen, F., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine
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Kindt-Larsen, L., Project Manager, National Institute of Aquatic Resources

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Rindorf, A., Project Participant, National Institute of Aquatic Resources

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01/03/2016 → 28/02/2018

Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology

Collaborators: Kolmården Wildlife Park

Project: Research

Gillnet fishing in Natura 2000 areas – Porpoises and stone reefs (39125)
The aim of the project was to determine the effects of gillnet fishing in Danish Natura 2000 areas, specifically the effects
on harbour porpoises and on the hard bottom’s flora and fauna.

The project included 3 sub-projects and 9 work packages aimed at:
- documenting the extent of gillnet fishing in selected Natura 2000 areas;
- evaluate the effects of gillnet fishing on porpoises in these Natura 2000 areas;
- evaluate the effects of management initiatives on the gillnet fishing in these areas;
- assess the effects of gillnet fishing on the stone reef’s flora and fauna in these Natura 2000 areas.

The methods employed were a combination of literature reviews, documentation of fishing activities and conduction of field
experiments. The results of the project will contribute to a better knowledge base on the effects of gillnet fishing and
should lead to an improved management of gillnet fishing in Natura 2000 areas, based on facts instead of assumptions
and anecdotal evidence.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Larsen, F., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Sørensen, T. K., Project Participant, National Institute of Aquatic Resources

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15/04/2013 → 31/05/2015

Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology

Project: Research

Supporting the national monitoring of Marine Strategy Framework Indicators (39304)
In support of the national implementation of EU’s Marine Framework Strategy Directive, the project assembles a one-off
monitoring of indicators of the following aspects:
- Quality of sandeel habitat
- Proportion of large top predatory fish
- Biomass of planktonic secondary producers
- Pressure on the sea bed from towed fishing gear
- Marine macro-litter
- Marine micro-litter in the food chain

The quality of sandeel habitat is measured as the fraction of sampling sites in known sandeel habitat which are unsuitable
for sandeel due to excessive silt content. The proportion of large top predatory fish describes the proportion of large cod
and saithe in Danish waters, and biomass of secondary producers is measured as the annual average biomass of
zooplankton of three size categories in Skagerrak/Kattegat in summer.

Pressure on the seabed is measured from VMS data and the minimum area which sustains 90 % of all pressure estimated
together with the effectively unfished area. Macro-litter is measured as the average catch of litter in fish trawl surveys,
whereas micro-litter in the food chain is monitored as the amount and occurrence of microplastic particles in stomachs
from pelagic and demersal fish.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Nature Agency.

Rindorf, A., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine
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Siedmon, C., Project Participant, National Institute of Aquatic Resources

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15/05/2015 → 31/12/2015

Keywords: Research areas: Ecosystem based Marine Management & Oceanography

Collaborators: Danish Fishermen’s Association
**The macroalgae biorefinery - Sustainable production of 3G energy carriers and fish feed from macroalgae (MAB3)**

MAB3 is a four-year research project promoting biomass resources from the sea, namely algae. The overall goal is to contribute to solving the challenges with food and energy supply and find ways to exploit the sea instead of farm land. The project aim is to develop new technologies in laboratory and pilot scale that will lead to sustainable growth and subsequent conversion of two brown algae (Saccharina latissima and Laminaria digitata) into three energy carriers - bioethanol, biobutanol and biogas - and a high-protein fish feed supplemented with essential amino acids.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Strategic Research.

**MAB3**

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01/03/2012 → 29/02/2016

**Keywords:** Research areas: Shellfish and seaweed & Coastal Ecology

**Collaborators:** DONG Energy AS, Aarhus University, National University of Ireland, Aller Aqua A/S, DanGrønt Products A/S, Orbicon, Vitalys I/S, Technical University of Denmark, University of Siena, University of Hamburg

**Project: Research**

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**Macroalgae - Technical support for new principles of management in mussel fishery**

The main purpose of the study was to provide knowledge on key ecosystem components, with special emphasis on macroalgae in Natura 2000 areas in Limfjorden in order to improve the scientific basis for management of shellfish fisheries. In addition, effects of closing areas for shellfish fisheries on benthic vegetation were studied by comparing coverage of macroalgae and eelgrass in two adjacent areas, one of them having been protected from fisheries for the last 20 years.

Primary method was monitoring through video surveys to create a description of seabed composition, existing habitats and coverage of macroalgae and eelgrass. Approximately 800 recordings were performed covering 5 broads in Limfjorden.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

**Macroalgae**

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Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources

01/01/2012 → 31/01/2015

**Keywords:** Research area: Costal Ecology & Shellfish and Seaweed

**Project: Research**

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**Oyster hatchery**

Hatchery production of European oyster spat (Ostrea edulis) in a land-based hatchery facility and feasibility study with analysis of the technological and economic conditions for the establishment of a new large scale shellfish hatchery with multiple functions.

The aim is to optimize hatchery processes in order to get stable output at all stages from mother to spat. It is a specific object to develop techniques to insure stable survival in the settling phase, including working with different feed concentrations and compositions.

A particular aim is also to maintain hatchery knowledge at Danish Shellfish Centre, DTU Aqua for research purpose and dissemination centre as well as to ensure the base for the establishment of a real full-scale hatchery with capacity for both research/development and production in partnership with private companies. Moreover produces spat for other projects, restoration and further breeding at Danish Shellfish Centre.

This project is coordinated by DTU Aqua.

The project is funded by the fund “Fonden Limfjordens Skaldyrcenter”.

**Oyster hatchery**

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Møller, L. F., Project Manager, National Institute of Aquatic Resources
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01/01/2014 → 31/12/2016

**Keywords:** Research area: Shellfish and Seaweed

**Project: Research**

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**Oyster care in Limfjorden**

The purpose of the project was to develop methods for long-term efforts to support a stable population of oysters (Ostrea edulis) suitable for the fishery.

The project aimed to determine the real size of the stock of oysters in Nissum Broads by calculating the stock in shallow water and hence the overall reproductive potential in the area. Knowledge of the population size distribution can also be
used to identify areas with frequent reproduction.

The project tested whether it was possible to collect oysters on collectors placed in the water column. On bottom growth and survival rates of different types of oysters (oysters collected in the water column, oysters from hatchery and oysters fished in shallow water) were tested. The end result was a best practices description concerning the best sources of spat. Estimation of oysters in shallow waters showed that in several areas there was a significant amount of oysters. The study also showed that in some areas of the fjord especially in shallow water there were many oysters of the invasive pacific oyster, Crassostrea gigas.

Stock assessment of oysters in shallow water provides a much more detailed picture of the total population of oysters in the Limfjord.

The collection of oyster spat from the water column is not uniform in different areas and release date of larvae also had some impact on the amount of oysters on the collectors. In some areas collection of pacific oysters is a problem.

Stock enhancement of the European flat oysters in Limfjorden can be done in different ways, but will have to take place over a longer period, it apparent that a stock enhancement in Limfjorden is more difficult than expected. A successful program must involve several parameters, such as:

- Amount of pacific oysters in sub-areas of Limfjorden.
- Areas suitable for relaying of oysters spat
- Best source and size of spat for the area

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, C. F., Project Manager, National Institute of Aquatic Resources

12/07/2012 → 30/11/2014

Keywords: Research areas: Shellfish and seaweed & Coastal Ecology

Collaborators: OysterBoat, The Mussel Industry Association

Project: Research

New application of farmed blue mussels: Mussel meal (39089)

The aim of this project was to create knowledge and develop the use of mussels as feed supplement for poultry and pigs. Specifically, the objective was to optimize the rearing of mussels, optimize the process and examine the biological basis for the use of mussels as feed supplement for poultry and pigs.

The results show that crude protein content and fatty acid content in mussel meal was at 57% and 15%, whereas the silage had a content of 17% and 5%. The analyzes showed a high proportion of pure protein and mussel amino acid composition was close to the values found in fish meal.

Experiments on pigs showed that there was no problem getting the pigs to eat the feed mixes with mussels and the digestibility of crude protein and amino acids was higher than for the control feed mixture of fish protein. Feed mixed with mussel silage gave the best digestibility. Overall experiments show that there is a clear potential for mussels as a protein source especially for pigs.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and Vækstforum Region Nordjylland.

Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Nielsen, C. F., Project Manager, National Institute of Aquatic Resources

13/07/2012 → 31/12/2014

Keywords: Research areas: Shellfish and seaweed & Coastal Ecology

Collaborators: Aarhus University, Vilsund Blue

Project: Research

Stone reefs: Review of the biological and ecological knowledge on stone reefs and their function in temperate areas (Stenrev) (39038)

Boulder reefs have been the subject of extensive mining where a number of reefs have been wholly or partially removed from the marine areas, especially the shallow coastal waters less than 10 m depth. A review on the importance of cold temperate reefs was requested. The review summary highlighted the following. Reefs are known for their high species richness and are biologically very productive. They are home to many fish using reefs for refuge. In particular cavernous reefs with high complexity and many small niches (between and around stones) are characterized by high species diversity, high productivity and have an important function as a feeding area for many species of fish and marine mammals. There are no quantitative estimates of the impact and effects of reefs for fish stocks in Danish waters.

However, the relationship between refuge options and survival was shown for goby, as well as for juvenile cod. Larger cod are attracted to reefs during autumn before they start their spawning migration. Results of the first reef restoration project in Danish waters showed a clear development of both macro-algae and benthic fauna and in fish abundance for fish normally associated with reefs. The many fish had probably attracted porpoises, which are now observed more frequently and for longer periods in the area. The European lobster occurs in salty water (> 25 parts per thousand) at 2-40 m depth around vegetated reefs or rocky ground, and therefore, this habitat is an important habitat for lobster. Of the sessile invertebrates highlighted, mussels were found in several different types of habitats, including reefs and is one of the species that are first to colonize new habitats - such as newly established reefs.

This project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund
Development of educational opportunities for Danish aquaculture (39157)

Danish aquaculture systems have faced substantial changes during the recent years, which have necessitated further education and practical implementation of new knowledge.

This project was initiated by Danish Aquaculture Organization (DAO). Based on an increasing demand for improved and updated education/training to people in the aquaculture industry, DAO identified various initiatives to develop educational opportunities for Danish aquaculture. Key players within the aquaculture sector were identified to support these initiatives.

The outcome of the project was:
- Initiation and implementation of a new education at Hansenberg in Kolding, (www.hansenberg.dk),
- Participation in developing the courses for aquaculture trainees (practical/theoretical exercises),
- Production of advertising material (posters, pamphlets) promoting the education and aquaculture in general,
- Production of the first public available E-book (“Aquaculture”: 14 chapters, 360 pp.) (http://www.danskakvakultur.dk/uddannelse/e-bog/)

This project was coordinated by the Danish Aquaculture Organization.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Coastal mussel banks: The importance for the fish fauna and possibilities for habitat restoration (MusFisk) (39133)

Coastal mussel banks are commonly assumed to be good areas for recreational fishing, but few quantitative studies have investigated how fish abundance and diversity covary with mussel coverage. In many Danish coastal waters, mussel coverage is reduced compared to historic records, but the impact of the reduction on coastal fisheries remains largely unknown.

This project investigates fish abundance and diversity in various coastal habitats to predict possible effects of mussel bank restoration projects. Because it is increasingly recognized that restoration of coastal habitats support both pelagic and benthic fisheries, this study hypothesized that mussel banks may provide important shelter and foraging habitats for various trophic levels of fish. Covering different habitats, catch per unit effort (CPUE) was quantified using fyke nets, and fish abundance and behaviours were measured using stationary underwater video cameras. These studies revealed that blue mussel (Mytilus edulis) banks support fish abundance and diversity comparable to areas covered by eel grass (Zostera marina), indicating that mussel bank restoration projects could benefit fisheries in a fashion similar to eel grass habitats. Moreover, fish abundance, but not diversity, differed between mussel banks exposed to different current velocity regimes, suggesting that mussel banks exposed to higher current velocities support higher fish abundances. These findings indicate that mussel bank restoration carried out in high current velocity regimes may provide the most favorable habitats for fish. Surprisingly, fish behaviours were similar in different current velocity regimes, suggesting comparable ecological function of the habitats.

Planned data collection in 2016 includes experimental manipulations of mussel coverage in laboratory studies where habitat preferences and stress levels (cortisol) will be examined in a number of fish species. These findings will be useful to test findings from the field studies and help predicting the effects of mussel bank restoration in coastal areas.

This project is coordinated by DTU Aqua.

The project is funded by the Danish Rod and Net Fishing License Funds.

Coastal Ecology & Oceanography (39123)

Coastal Ecology & Oceanography (39123)
Sustainable fish feed development in Ghana (Susfeed) (39158)
The overall objective of the project is to enable Kwame Nkrumah University of Science and Technology (KNUST) to serve as a centre of excellence for sustainable development of aquaculture and to take a scientific approach to the continued improvement of fish feed formulation using local raw materials, through controlled experiments and in collaboration with the private sector in Ghana. The immediate objectives of the project are to formulate cost effective tilapia feeds assessed for digestibility, nutritional value and amino acid profiles based on local feed ingredients; to facilitate the growth of the tilapia aquaculture industry in Ghana through promoting the production and application of locally developed high quality feeds; to achieve a zero change in nutrient discharge to the environment through the application of balanced feed and efficient feeding strategies; and to improve the methodological and scientific capacity at KNUST to provide a platform of excellence in research and teaching.
The project is funded by DANIDA, Ministry of Foreign Affairs of Denmark.

Skov, P. V., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Lund, I., Project Participant, National Institute of Aquatic Resources
Larsen, B. K., Project Participant, National Institute of Aquatic Resources

01/04/2014 → 31/03/2017
Keywords: Research area: Aquaculture
Collaborators: Kwame Nkrumah University of Science and Technology
Project: Research

Environmental neutral aquaculture water treatment (MIVANAK) (39295)
Despite a transition from flow-through systems to more advanced open water reuse aquaculture systems (e.g. model trout farms), the need for water treatment still exists. In brackish and saltwater reuse systems, blooms of toxic microalgae in an example of a recently new challenge.
The purpose of this project is to further develop current aquaculture water treatment practice and reduce the total amount of disinfectants used.
The project includes 3 different work packages, investigating
- ecological consequences of continuous application of peroxyacetid acid.
- toxicological effects of easy degradable disinfectants.
- alternative biological methods to control / avoid blooms of toxic heterotrophic dinoflagellates.
Trials will include mesocosmos experiments where disinfectants are added continuously or by daily pulses over a prolonged period of time where phyto- and zoo-plankton abundance and compositions will be investigated. Other trials will be made in batch experiments with pure algae cultures, as will prolonged continuous peroxyacid application experiments be made.
This project is coordinated by DTU Aqua.
The project is funded by the Environmental Protection Agency's Programme for Pesticide Research.

Pedersen, L., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Rojas-Tirado, P. A., PhD Student, National Institute of Aquatic Resources
Sproegel, U., Project Participant, National Institute of Aquatic Resources
Frandsen, D., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources

01/08/2015 → 31/12/2017
Keywords: Research areas: Aquaculture & Marine Populations and Ecosystem Dynamics
Project: Research

Nordic Network and Conference on Aquaculture Recirculation Technology (NordicRAS) (38842 & 39099 & 39223)
DTU Aqua has taken the initiative to establish a Nordic Network on Recirculating Aquaculture Technology (RAS). The idea is motivated by the facts that: (i) the geographical location and species composition requires certain breeding conditions and solutions, and (ii) the Nordic region has an excellent academic and commercial background for initiating such collaboration.
The purpose of the network is to strengthen Nordic research and research collaboration in RAS and associated water treatment including e.g. application of existing techniques in new setups, resolving potential new research areas, and investigating innovative operation forms that ensure high water quality. We anticipate that the network will become a continuous activity which could result in the establishment of consortiums that perhaps could apply for national and transnational European research funding, exchange of students, development of projects and potential educational programmes, etc.
The network is coordinated by DTU Aqua, and was founded at a steering committee meeting in April 2011 with country representatives from Denmark, Norway, Sweden, Finland and Iceland.
The main activity of the network will be to organise a RAS workshop every second year in one of the Nordic countries. The first workshop was held in Helsinki (Finland), October 2011, the second workshop in Aalborg (Denmark) October 2013, the third workshop in Molde (Norway) September - October 2015, and the fourth workshop in Aalborg (Denmark) October
The aim of the workshops is to bring researchers and industrial partners with an interest in RAS together, creating a unique opportunity for exchanging practical experiences and scientific knowledge on the newest developments in RAS. This project is coordinated by DTU Aqua.

In 2011, the project was funded by AG-Fisk (Nordic Council of Ministers) and "Formandskabsplujen" (Nordic Council of Ministers). In 2012, follow-up activities and planning of future activities was funded by AG-Fisk. In 2013 and 2015 it was funded by AG-Fisk.

Dalsgaard, A. J. T., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Manager, National Institute of Aquatic Resources
01/01/2011 → 31/12/2021
Keywords: Research area: Aquaculture
Project: Research

**Proteins of the future in feed for recirculating aquaculture systems (ProffAqua) (39274)**

There is an increasing shortage of available high quality proteins for feed. More than half of all aquatic species is now produced by aquaculture. Aquaculture production will double in the next 15 years and so will the need for protein into aquafeed. As substantial amount of worldwide wild fish catch is processed into fishmeal and fish oil for feed production, raising concerns regarding the sustainability of this arrangement. The industry’s growing need for feed therefore requires new approaches. This project focuses on turning waste streams into valuable products. Organic chemicals found in pulp mills steam for cellulose fibre production can be used to grow fungi and turned into Single Cell Proteins (SCP), suitable as protein-rich components in fish feed. Due to the low protein content of waste materials from agriculture and fish processing, this raw material is not suitable for direct use in fish feed. The black soldier fly larvae (BSF) are very efficient in transforming such waste streams into high quality protein and oil ingredients. Based on the available waste streams, several thousand tonnes of both SCP and BSF can be produced at a very favourable price compared to the current price and quality of fish meal.

The role of DTU Aqua in the project is to evaluate BSF and SCP as protein sources in fish feeds by performing digestibility and growth trials using the two types of protein sources at several inclusion level in the diets.

DTU Aqua participates in the project by performing feeding trials using contaminated feed for Atlantic salmon and seabass respectively. Furthermore, the project also investigates potential effects of microplastic incorporated into feed pellets, on accumulation and elimination of the selected priority contaminants. The feeding trials consist of a 12 week to 15 week accumulation period for seabass and salmon respectively and a 8 week depuration period where all groups are fed control feed. The results obtained from the trial will be the used to develop mathematical models estimating accumulation and elimination of priority contaminants in filet.

This project is coordinated by Matís Itd., Icelandic Food and Biotech R&D.
This project is funded by Nordforsk, Nordic Council of Ministers.
Larsen, B. K., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources
Vega, V. V., Project Participant, National Institute of Aquatic Resources
Sproegel, U., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
01/02/2015 → 31/12/2017
Keywords: Research area: Aquaculture
Collaborators: SP Processum AB, Matís ltd., Tydalfisk, Domsjö Fabriker AB, Danish Technological Institute, Veðurstofa Íslands
Project: Research

**Fluorescence analysis and monitoring of recirculating aquaculture systems (FAMoSAS) (39177)**

FAMoSAS aimed to investigate fluorescence spectroscopy for potential utilization within 3 main areas of recirculating aquaculture system operation:

1. system "health" monitoring
2. treatment performance
3. feed utilization.

Using sensitive lab-scale spectroscopic analysis and mathematical modeling, the project aimed to identify single wavelengths for future use as online, in-situ aquaculture system sensors.

This project was coordinated by DTU Aqua.

The project is funded by EU, Marie Curie.
Hamblin, A., Project Coordinator, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources
Stedmon, C., Project Coordinator, National Institute of Aquatic Resources
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Pedersen, L., Project Participant, National Institute of Aquatic Resources
16/06/2014 → 16/06/2016
Keywords: Research areas: Oceanography & Aquaculture
Project: Research
EUROMARINE Consortium (39185)
EUROMARINE is a European, marine science network launched in 2014. It represents the scientific communities of three former European Networks of Excellence: EUR-OCEANS, Marine Genomics Europe, and MarBEF. It was designed by the EuroMarine FP7 preparatory project (2011-13) as a bottom-up organization and meant to be a voice for the European marine scientific community. It is intended as a durable structure and was established as a consortium for an initial duration of 10 years. A legal entity will be established in 2016 as a support structure under the control of the consortium. As of 2016 EuroMarine counts 72 member organisations (MOs), 57 of which are ‘full voting’ members contributing to the budget.

Two primary goals of EuroMarine are:
- to support the identification and initial development of important emerging scientific topics and methodologies in marine sciences
- to foster new services relevant to the marine scientific community.

EuroMarine will achieve these goals through internal competitive calls for proposals, within the available budget. It is expected that support for these activities and their outcomes will help to leverage larger projects under European, national or joint research funding programmes.

EuroMarine also intends to advocate for marine science and to contribute to improving the science-governance interface, providing expertise and transferring knowledge.

This project is coordinated by French Research Institute for Exploitation of the Sea & The National Center for Scientific Research, France.
The project is self-funded.
Mariani, P., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2014 → 31/12/2017
Keywords: Research area: Oceanography
Collaborators: National Center for Scientific Research, IFREMER
Project: Research

COLUMBUS (39239)
COLUMBUS overarching objective is to ensure that applicable knowledge generated through EC-funded science and technology research can be transferred effectively to advance the governance of the marine and maritime sectors while improving competitiveness of European companies and unlocking the potential of the oceans to create future jobs and economic growth in Europe (Blue Growth).

This project is coordinated by AquaTT UETP Ltd.
The project is funded by EU, Horizon2020.
Mariani, P., Project Participant, National Institute of Aquatic Resources
Thøgersen, T. L., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Larsen, E., Project Participant, National Institute of Aquatic Resources
01/03/2015 → 28/02/2018
Keywords: Research areas: Oceanography & Observation Technology
Project: Research

Process integration into multispecies and ecosystem models: Resulting ecological, economic and social trade offs (PRIME TRADE OFFS) (39324)
Extensive multispecies and ecosystem research has been done in the Baltic, North Sea, Barents Sea/Norwegian Sea, Bay of Biscay and the Black Sea in the past about 30 years. There has been invested substantially in the research on multispecies interactions, and ecosystem functioning.

In parallel, significant knowledge on the environmental impacts on recruitment processes, movements or migrations, and species interactions has been accumulated, but not yet consequently integrated in multispecies and ecosystem models and management concepts.

The major questions raised in PRIME TRADE OFFS are hence, (i) how the integration of environmentally-driven variability in population and ecosystem dynamics affects short- and long-term predictions of economically important fish species, and (ii) how the inclusion of environmental variability changes our perceptions of tradeoffs between utilization of different resources, including for example fuel cost due to changed resource distributions in space and effects on targeted species, as well as socio-economic efficiency.
There have been several initiatives to improve multispecies and ecosystem modelling in order to make it operational for both tactical and strategic assessment and ecosystem-based fisheries management. PRIME TRADEOFFS is the logical continuation of these initiatives and will make the concepts of multi-species maximum sustainable yield and environmental impact on biological key process such as distribution, growth and recruitment operational for ecosystem-based management of marine resources, as demanded in the Marine Strategy Framework Directive and the reformed Common Fisheries Policy.

This project is coordinated by DTU Aqua and is funded by the EU, COFASP, ERA-NET.

Neuenfeldt, S., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
01/03/2016 → 28/02/2019

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Fisheries Management
Collaborators: AZTI Technalia, Institute of Marine Research, University of Hamburg, IFREMER
Project: Research

Integrating spatial processes into ecosystem models for sustainable utilization of fish resources (INSPIRE) (39118)
The BONUS INSPIRE Project conducts pilot ecosystem field surveys that help resolving the habitat requirements of different life-stages of the focal species by combined use of traditional methods and application of modern advanced analysis and modelling techniques.

The research is conducted in a matrix approach with four species specific case (cod, herring, sprat and flounder) and five research work-packages. The work packages deal with (i) habitat requirements and survival probability for different life stages, (ii) connectivity between habitat occupied in successive life stages, (iii) spatial scaling from local events to regional population dynamics, (iv) spatially explicit analytical stock assessments (including a comprehensive flatfish programme), and (v) ecosystem-based management and Marine Strategy Framework Directive indicators.

The overarching questions of the BONUS INSPIRE Project are:
- What habitat (both pelagic and benthic) conditions characterize the spatial distributions of cod, herring, sprat and flounder?
- To what extent do fishing and species interaction affect the local and basin-scale distribution of exploited stocks?
- What drives spatial connectivity and migrations of different fish species/populations?
- How does stock structure and separation of natural populations impact stock assessment outcomes?
This project is coordinated by University of Tartu, Estonia.
The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.
Neuenfeldt, S., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Hüssy, K., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Eero, M., Project Participant, National Institute of Aquatic Resources
01/02/2014 → 30/08/2017
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Ecosystem based Marine Management
Collaborators: Swedish University of Agricultural Sciences, Stockholm University, Thunen-Institut, Lund University,
Uppsala University, National Marine Fisheries Research Institute, GEOMAR - Helmholtz Centre for Ocean Research Kiel, Institute of Food Safety Animal Health and Environment BIOR, University of Tartu, University of Hamburg, National Resources Institute Finland
Project: Research

Welfare, health and individuality in farmed fish (WIN-FISH) (39236)
In modern aquaculture, production costs are the major driver. This has resulted in culture practices and rearing environments aimed at maximizing production capacity. Consequently, fish are exposed to unavoidable stressors, which can be detrimental to animal health and welfare. Moreover, it is increasingly clear that individuality in stress reactions have to be included in the concept of animal welfare. Such differences often take the form of suites of traits, or stress coping styles (SCS), where traits like sympathetic reactivity, aggression and the tendency follow and develop routines show positive relationships. In addition, these traits show a negative relationship with plasma cortisol levels and are also associated with differences in immune function. The project will validate behavioural and physiological welfare indicators for selected fish species at the individual and rearing unit level. This will generate new information about responses to environmental factors, knowledge that can be applied to improve husbandry and management practices. Recirculating aquaculture systems (RAS) have been developed as a sustainable alternative with low ecological consequences compared to traditional flow through systems. However, in RAS factors such as higher rearing densities and water quality parameters may challenge the welfare of fish. In WIN-FISH, health, welfare and production related effects of RAS rearing of species at different densities will be monitored. In order to account for individual variation, these studies will be performed on fish screened for SCS. Similarly, in flow through systems, health, welfare and production related effects of rearing densities will be further investigated in sea bream differing in SCS. Generally, environmental enrichment has positive effects on animal welfare. WIN-FISH will investigate effects of environmental enrichment on rainbow trout with contrasting SCS. In an attempt to generate genetic markers for selective breeding to optimize performance and welfare of farmed Atlantic salmon, a genome-wide association analysis will be performed on salmon with divergent SCS, focusing on proactive fish differing in aggressive behaviour. In addition, zebrafish will be used as a model to gain additional knowledge
on mechanisms underlying SCS and aggressive behaviour. This project is coordinated by DTU Aqua. The project is funded by EU, Framework Programme 7.

Gesto, M., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Skov, P. V., Project Participant, National Institute of Aquatic Resources
18/05/2015 → 17/05/2018

Keywords: Research area: Aquaculture
Collaborators: Universidad Politécnica de Madrid, Uppsala University, Instituto Zooprofilattico Sperimentale delle Venezie, Institute of Agri-food Research and Technology, IFREMER

Project: Research

Ocean Literacy: Ocean Literacy capacity for DK
The workshop builds on previous TOL efforts, but with a more specific focus. The overarching goal is to draft recommendations on how Ocean Literacy can serve marine research projects for greater societal impact, and contribute to Blue Growth objectives (What is Blue Growth? A short, and a long version) through more effective knowledge exchange and engagement with non-academic stakeholders and the public.

The recommendations should assist transatlantic marine research consortia supporting the Galway Statement on Atlantic Ocean Cooperation to capitalize on citizen science, promote a science-literate citizenry, and increase public awareness on Societal Challenges issues (e.g., ocean health, responsible ocean stewardship, food security, climate mitigation).

Grigorov, I., Project Participant, National Institute of Aquatic Resources, Research Secretariat
Kiørboe, T., Project Applicant, National Institute of Aquatic Resources, Centre for Ocean Life Canal-Vergès, P., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
01/05/2015 → 30/09/2015

Keywords: ocean literacy
Collaborators: University of Maine, IOC-UNESCO, European Environment Agency, Denmark, College of Exploration, University of Gothenburg, National Oceanographic and Atmospheric Administration, University of Rhode Island

Project: Research

Development of an electrochemical method to remove nitrate in RAS (Electro-nitrate) (39327)
This project is done in collaboration with two industrial partners, testing the nitrate removal potential of an innovative technique applied to aquaculture. Nitrate is a dissolved N-waste product from fish production in recirculating aquaculture systems (RAS). The amount and concentration of nitrate in the effluent are determined by the daily feeding, biological filtration and the feed loading (kg feed pr. m3 water exchange) among others. Discharged nitrate is a main factor affecting the recipient hence important to reduce in order to obtain sustainable production in RAS.

As an alternative to denitrification, electrochemical reduction of nitrate to N2 is considered in this project. Electrochemical water treatment rely on physio-chemically controlled redox processes that includes a flow cell with two electrodes connected to an external current source This aim of this project is preliminary test and screening of different types of electrode material and combinations and investigate factors affecting removal capacity. The effect of current density, flow rates, substrate concentrations and pH on nitrate removal will be tested and removal capacity will be evaluated. This project is coordinated by DHI. The project is funded by Innovation Network for Environmental Technologies (Inno-MT), Danish Agency for Science, Technology and Innovation.

Pedersen, L., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
01/02/2016 → 31/12/2016

Keywords: Research area: Aquaculture
Collaborators: AquaPri, DHI Water - Environment - Health, Electrocell A/S
Project: Research

Efficient and innovative fish production via best available technology (RAS2020) (39328)
This project includes a full scale test and development of a conceptual recirculating aquaculture system (RAS) for king fish production. The innovative aspect of this modular RAS2020 concept regards the design—a one unit circular module designed to have a 1200 MT/Y capacity.

The aim of this project is to build and develop a RAS unit with small footprint, low cost and reduced construction time. The RAS2020 unit includes state of the art treatment units (Hydrotech drumfilters, Krüger biofilters—nitrification and denitrification) and is built with flexible interconnected rearing sections. When the RAS2020 is built and stocked with kingfish, an extended sampling and monitoring program will be performed in order to assess system performance in particular N, P and organic matter removal. This project is coordinated by Sashimi Royal. The project is funded by the Danish Environmental Protection Agency.

Pedersen, L., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
SeaChange: SeaChange (39237)
Sea Change is an EU H2020 funded project that aims to establish a fundamental "Sea Change" in the way European citizens view their relationship with the sea, by empowering them, as Ocean Literate citizens, to take direct and sustainable action towards a healthy ocean and seas, healthy communities and ultimately a healthy planet.

The project is funded by EU, Horizon2020.

Collaborators: Dansk Akvakultur, Sashimi Royal, Aqua-Partners ApS
Project: Research

Anglers Mobile App: A mutual service platform between research and citizens (39122)
Recreational fishing is an extremely popular pastime in Denmark, with as many as 400,000-500,000 regularly engaging in the activity. In order to secure that fish are available for the anglers and at the same time understand how fish stocks interact with biotic and abiotic factors, knowledge about the fish stocks in Danish lakes, rivers and coastal areas is crucial. However, data gathering on national scale, and at regular intervals is expensive and logistically prohibitive. This lack of data limits scientific understanding as well as sustainable management. Consequently, DTU Aqua has developed an electronic platform where anglers can report their catch in a standardized way for their own pleasure as well as for the benefits of angler clubs and national research on fisheries management. The "Fangstjournalen" platform consists of a browser version as well as a native mobile app (Iphone and Android). The platform allow anglers to record the details of their fishing trips and catches, but is also used as a vehicle for gaining human dimension information, i.e information about angler distribution as well as aspects of angler motivation and satisfaction.

Angler apps for mobile devices are not new, but the existing market (e.g. FishBrains ; iAngler ; iFish App ) focus on aspects such as "socializing" "curiosity" and "entertainment" more that on gathering the minimum necessary data for use for research, and centralizing it to underpin stock management. The angler app developed by DTU Aqua has several novelty aspects and integrates both catch statistics and human dimension aspects. During the two years it has taken to develop the platform there has a strong focus on optimizing the scientific value of the data that is sampled, and at the same time recognizing opportunities as well challenges associated with angler mobile apps as a source of recreational fisheries data. For example, catch efficiency of anglers depend on human dimension factors such as skills, gear and experience. The angler should provide this information during registration so researchers can calibrate data. Likewise, in case of blank fishing trips with "no catch", the anglers should also report to strengthen data quality. To secure such compliance from the anglers, we focus on strong and clear communication from researcher to angler.

The platform was released for the public at the end of 2015, so the outcome of this citizen science project is still in its infancy and uncertain. However the omnipresence and wide use of mobile internet devices offers a unique opportunity to use a citizen science approach to bridge the gap between the lack of knowledge, research and impact of recreational fishermen in a mutually beneficial way. In that perspective DTU Aqua are first movers. Moreover, in time, the platform has the potential to instill responsible stewardship among recreational fishermen i.e. to engage and educate as much as 5 % of Denmark’s population on a regular basis.

This project is coordinated by DTU Aqua.

The project is funded by the Danish Rod and Net Fishing License Funds.

Collaborators: University of Connecticut
Project: Research
Starfish as a new source of marine protein (STARPRO) (39272)
The amount of starfish (Asterias rubens) is increasing in Danish coastal waters – especially in the Limfjorden. They consume large amounts of mussels thus creating a big problem for the mussel fishery. STARPRO will try to establish a sustainable fishery of starfish in order to transform them into feed ingredient thereby reducing predation and at the same time create a new source of valuable protein.
The purpose of STARPRO is to establish a sustainable fishery for starfish in preparation for producing a 100% organic feed ingredient for monogastric livestock. The project includes the whole value chain with the concrete goal to develop cost-effective methods for production of starfish flour and within a few years establish a fishery of 10,000 t of starfish a year amounting a production of 2,500 t of flour a year. Activities in STARPRO will be stock assessment of starfish, testing of methods for the production of starfish flour from pretreatment to the grinding of dried starfish, development of feed blend for poultry and pigs.
Expected results:
- Organic feed with a large protein content
- Frame work for sustainable fishery for starfish in Denmark
Expected effects of the project:
- Establishing a new profession in fabrication of starfish flour
- Increase employment through the establishment of starfish fishery and Danish production of starfish
- Removal of nutrients from the fjords and coastal waters through fishing of starfish.
- Reduced the discharge of nutrients from organic animal husbandry due to increased feed efficiency.
- Increased sustainability and profitability of mussel fishery as a result of reduced predation on mussels.
This project is coordinated by DTU Aqua.
The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).
Møller, L. F., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources
Nielsen, C. F., Project Participant, National Institute of Aquatic Resources
Saurel, C., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
Andersen, L. K., Project Participant, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
01/01/2015 → 30/04/2018
Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Collaborators: Foreningen Muslingeerhvervet, Aarhus University, Agro Korn A/S
Project: Research

UTOFIA: Underwater Time Of Flight Image Acquisition system
Thøgersen, T. L., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Project ID: 39240
External Project ID: 633098
01/02/2015 → 30/04/2018
Project: Research

Grow mussels and oysters - Sea Gardens in Limjorden (39249)
The aim for this project is to create a focus on healthy and sustainable exploitation of Limfjordens potential and bring life back into the harbour areas.
- Better utilization of Limfjorden's resources.
- Increased focus on seafood and seaweed as exciting, healthy and delicious produce on the dinner table.
- More readily available social activities for the general public.
- Development of sustainable activities on empty harbors.
- Better links between water and city.
- Participate in social activities with sustainability in focus.
The project will give ordinary citizen the opportunity to "grow" mussels, oysters and seaweed in a social community without needing separate skills and without having to invest in an area.
This project is coordinated by Limfjordsrådet.
Nielsen, C. F., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
Petersen, J. K., Project Manager, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
01/01/2015 → 31/12/2017
Keywords: Research area: Shellfish and seaweed: Biology, production and management
Collaborators: Limfordsmuseet, Nykøbing Mors Municipality, Legaster municipality, Orbicon, Lemvig municipality, Aalborg municipality, Limfjordsrådet
Project: Research
Local strength - strengthening the rural areas, by adding competencies (39086)
The overall aim of the project "Local strength" was to demonstrate how the supply of knowledge and skills to a rural area with low income, high unemployment and decreasing job opportunities can stimulate local industries and companies and thereby prepare it for the necessary development and adaptation into a national and international context. The objectives of the project were based on innovation and change within the sustainable exploitation and production of shellfish in the western part of the Limfjorden because this part of the country is the main area for shellfish production. The specific objectives were: - To strengthen the overall shellfish industry through networking and joint activities within shellfish businesses and a R&D institution on common issues like e.g. food safety. - Adaptation of the shellfish fishery into a more sustainable and competitive fishery by developing new methods and forms of production, e.g. by the development of relay cultures, documentation of environmental impact and creation of buffer zones around eelgrass beds. - Develop cost-saving methods for mussel farming in relation to e.g. buoy handling, optimal socking etc.- Creating added value through development of new mussel and oyster products. - Create broader revenue for the mussel farmers by development of new species e.g. seaweed. - Establish a generic branding of shellfish from the Limfjorden.This project was coordinated by DTU Aqua. The project was funded by Danish Business Innovation fund, The North Denmark Region and Morsø Municipality.

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Saurel, C., Project Participant, National Institute of Aquatic Resources

11/01/2010 → 31/10/2013

Keywords: Research areas: Shellfish and seaweed & Coastal Ecology
Project: Research

Long-term management plans for mussel production (39121)
The purpose of this project was to point out areas suitable for blue mussel production – using Vejle Fjord as a study case area – in relation to environmental factors e.g. distribution of eelgrass, macro algae and benthos but also using input from the local municipalities, environmental NGOs, mussel fishermen and other stakeholders like e.g. anglers, sailors, canoeist, kayaker and divers and their use of the sea into account. Based on input from authorities, environmental conditions like e.g. occurrence of eelgrass and concentrations of Chl. a were mapped establishing the basis for optimal location of fishery, relay plots and mussel farming. This was contrasted to local use of the Veje Fjord and other recreational values. The two sets of information was merged a different areas in the Vejle Fjord were appointed suitable for various forms of mussel production. Furthermore, the project also wanted to inform how each mussel production approach (fishery, long-line farming and on-bottom cultures) is carried out, managed by the authorities as well as the environmental impacts associated to the different mussel production methods in order to create local awareness. During the course of the project, the information campaign changed local perception of mussel production resulting in a new local policy on utilization of the fjord for mussel production.

This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

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Funk, E. S., Project Participant, National Institute of Aquatic Resources

05/07/2012 → 31/12/2014

Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Project: Research

Starfish - power and management (Søstjerner) (39087)
The overall objective of the project was to provide the scientific basis for management that can lead to the establishment of a commercial fishery of starfish (Asterias rubens) in primarily the Limfjorden, including Natura 2000 areas. The project background was the increasing prevalence of starfish that is both a threat to the mussel fishing and a potential source of income for fishing. In the project, the population of starfish and production was determined and analyzed and based on population stock estimates and stock modeling a total allowable quota of 10,000 tonnes annually was estimated as a conservative annual catch, which is considered sufficient to maintain a potential starfish meal industry. Effect of fishing was determined both for the population of starfish, the stock of mussels and benthic components like infauna and macroalga. It was shown that using the starfish purse seine will have no or negligible effects on infauna and blue mussels. In terms of biodiversity and biomass of macro algae, no significant effects of the purse seine, including a load of 300 tonnes of starfish in the net, could be detected. Torn of macro algae leafs were however detected in the purse seine after fishery over macro algae habitats and this was included in management advise on effects of starfish fisheries. A guide for management including recommendations on environmental impact and starfish populations were developed. This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

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Gislason, H., Project Participant, National Institute of Aquatic Resources
01/01/2014 → 30/06/2015
Keywords: Research areas: Shellfish and seaweed & Coastal Ecology & Marine Living Resources & Ecosystem based Marine Management
Collaborators: Foreningen Muslingeerhvervet, Centralforeningen for Limfjorden
Project: Research

New methods and models for population estimates of mussels with the use of GPS data (39088)
Based on the new management requirements from authorities and industry, the access to new data collection and the desire for more mussel fishing areas, there is a need for the development of new tools for monitoring and managing shellfish stocks.
The aim of the project was to develop new methods and models for estimating shellfish stocks in Denmark that may include several types of information to the management. The project worked with stratified extensive sampling strategies such as sidescan sonar, video recordings, data from automated GPS loggers from industry's own data and classical biomass collection.
Based on the data collected different types modeling tools was developed. The project has resulted in a new management tools for population estimation with different degrees of detail and types of information.
This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
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Stage, B., Project Participant, National Institute of Aquatic Resources
Kristensen, K., Project Participant, National Institute of Aquatic Resources
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Geitner, K., Project Participant, National Institute of Aquatic Resources
01/01/2014 → 30/06/2015
Keywords: Research areas: Coastal Ecology & Observation Technology & Marine Living Resources
Collaborators: Foreningen Muslingeerhvervet, Orbicon
Project: Research

Mussel season prolongation (FOMUS) (39273)
The overall objective of FOMUS is to increase the production of longline farmed mussels and ensure that a larger proportion of the increase in value of the primary product takes place in Danish companies.
This is achieved through the development of new production methods with a focus on changing production cycle in order to extend the harvest season. Sales only cover a short period of time from June to August and the goal is to extend the season for 6-8 months.
FOMUS covers the entire value chain and supports the development of sustainable mussel production.
The project is funded by the Ministry of Environment and Food of Denmark through the Green Development and Demonstration Program (GUDP).
This project is coordinated by DTU Aqua.
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Boessen, H., Project Participant, National Institute of Aquatic Resources
Barreau, P. D. A., Project Participant, National Institute of Aquatic Resources
Bak, F., Project Participant, National Institute of Aquatic Resources
Andersen, L. K., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources
01/04/2015 → 01/06/2018
Keywords: Research area: Shellfish and Seaweed
Collaborators: Seafood Limfjord ApS, Vilsund Blue
Project: Research
Underwater time of flight image acquisition system (UTOFIA) (39240)

This project offers a compact and cost-effective underwater imaging system for turbid environments and will fill the current gap between short-range, high-resolution conventional video and long-range low-resolution sonar systems. The camera system utilizes high frequency laser pulses synchronized with rapid shutter operations on nano second time scales to radically reduce the interference of back scatter on visual images. Using this range-gated imaging technology, the system will extend the imaging range by factor 2 to 3 over conventional video systems. At the same time, the system will provide video-rate 3D information. UTOFIA offers a new modus operandi for the main targeted domains of application: marine life monitoring, harbour and ocean litter detection, fisheries stock assessment and aquaculture, seabed mapping, offshore industry and civil security.

The project is a collaborative effort between engineering companies producing the laser components, the camera systems, the software control and processing systems as well as the deployment platforms. The project also involves companies charged with integrating the system and its commercialization into the market place. The role of DTU Aqua is twofold; it is responsible for a series of field and laboratory trials to demonstrate the proof-of-concept and to feed back into the engineering design process, and it is responsible for the exploitation and dissemination dimension of the project, particularly with respect to marine science, fisheries and aquaculture applications.

The consortium is coordinated by SINTEF, Norway.

The project is funded by EU, Horizon2020.

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Bridda, J., Project Participant, National Institute of Aquatic Resources
Thøgersen, T. L., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources

01/02/2015 → 30/04/2018

Keywords: Research areas: Oceanography & Fish Biology & Observation Technology
Collaborators: Odos Imaging Ltd., SINTEF, Subsea Tech, AZTI-Tecnalia, Fraunhofer-Gesellschaft, Bright Solutions Srl
Project: Research

Biocide: Biocide Resistance; An emerging threat to public health

Biocides are chemical substances capable of killing or inhibiting bacteria and their use have become an integrated part of the industrialized world. The potential negative effects of biocides on development of virulence and antimicrobial resistance in bacteria is to a large extent unknown. The purpose of this project is to determine the response of bacteria to selected biocides. The work will include studies of bacterial gene transcription, as well as determination of mutation-rates and horizontal gene-transfer when exposed to different biocides.

Aarestrup, F. M., Project Manager, National Food Institute, Research group for Genomic Epidemiology
Carlsson, S., Other, National Food Institute, Research group for Genomic Epidemiology

External Project ID: Innovationsfonden
Innovationsfonden: DKK14,993,406.00
01/01/2009 → 01/05/2015

Keywords: Biocides, Resistance, Biocides resistance
Collaborators: University of Copenhagen, DHI Water - Environment - Health, Hvidovre Hospital
Award relations: Biocide: Biocide Resistance; An emerging threat to public health
Project: Research

Catch Quota Management and choke species 2014 (39079)

The aim of the project is further development and test of Catch Quota Management (CQM) systems in Danish demersal fisheries by the use of electronic monitoring systems. Furthermore, to test whether electronic monitoring – video and sensor recordings – can provide the necessary documentation to support a CQM system. In addition the project will illustrate whether full documentation of catches can support implementation and certification and traceability solutions which requires linkage to project dealing with these issues.

This project is coordinated by DTU Aqua.

Olesen, H. J., Project Manager, National Institute of Aquatic Resources, Section for Monitoring and Data
Dalskov, J., Project Participant, National Institute of Aquatic Resources
Hákansson, K. B., Project Participant, National Institute of Aquatic Resources
Degel, H., Project Participant, National Institute of Aquatic Resources
22/07/2013 → 15/07/2015

Keywords: Research area: Fisheries Management
Collaborators: Ministry of Environment and Food of Denmark
Project: Research

Sandeel Dredge Survey (39064)

The scientific sandeel dredge survey is carried out each year in November/December and it covers the most important sandeel fishing banks in the North Sea.

The aim is to collect the sandeels when they are buried in the seabed and compare the catches (number and age
composition) with the previous year's collections. The specific year class strength of sand eels is assessed for the different areas adopted by ICES in 2009.

Data from the dredge survey is the basis for calculating an index, which is used in the stock assessment.

This project is coordinated by DTU Aqua.

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Håkansson, K. B., Project Participant, National Institute of Aquatic Resources
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Hansen, A. D., Project Participant, National Institute of Aquatic Resources
Rasmussen, H., Project Participant, National Institute of Aquatic Resources

01/11/2006 → 31/12/9999

Project: Research

Pilot project for the preparation of certification (MSC) of gillnet fishing in the Baltic Sea (38974)

Fishing for some important stocks has been assessed in accordance with Marine Stewardship Council (MSC) principles for sustainable fisheries. All these fisheries have now passed the assessment and are certified, with a single exception: Gillnet fishing in the Baltic. This is due to the lack of evidence for gillnet fishing East of Bornholm not having by-catches of the very small population of harbor porpoises which are found in the Baltic Sea in ICES Subdivision (SD) 24 and East. There has not been registered by-catch of porpoises in the Danish gillnet fishing East of Bornholm, neither in biological studies nor by fishermen themselves. But as the Swedish and Polish studies have shown individual by-catches in some gillnet fisheries and the current estimates of stock size means that the by-catch of even a few individuals can prevent it from being restored, the MSC considered that it was not sufficiently proven that the Danish gillnet fisheries did not constitute a threat to the population.

There is therefore a need for documentation of the level of by-catch of harbor porpoises in the Danish gillnet fisheries.

This project is coordinated by Danish Fishermen's Association.

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Larsen, F., Project Participant, National Institute of Aquatic Resources
Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources
Degel, H., Project Participant, National Institute of Aquatic Resources
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Lundgaard, L. S., Project Participant, National Institute of Aquatic Resources

09/06/2011 → 01/05/2015

Keywords: Research area: Fisheries Management
Collaborators: Danish Fishermen's Association
Project: Research

Strategies for the gradual elimination of discards in European fisheries (DiscardLess) (39238)

DiscardLess will help provide the knowledge, tools and technologies as well as the involvement of the stakeholders to achieve the gradual elimination of discarding. These will be integrated into Discard Mitigation Strategies (DMS) proposing cost-effective solutions at all stages of the seafood supply chain.

This project is coordinated by DTU Aqua.

The project is funded by EU, Horizon2020.

Ulrich, C., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Larsen, E., Project Participant, National Institute of Aquatic Resources
Feekings, J. P., Project Participant, National Institute of Aquatic Resources
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Mortensen, L. O., Project Participant, National Institute of Aquatic Resources
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01/03/2015 → 28/02/2019

Keywords: Research areas: Fisheries Management & Population Genetics & Fisheries Technology & Ecosystem based Marine Management
Collaborators: Instituto Español de Oceanografía, AlphaFilm, Marine Institute, Marine Scotland Science, UiT The Arctic University of Norway, Cefas Weymouth Laboratory, TRACE Wildlife Forensics Network Limited, IFREMER, NAYS Ltd, Irish Department of Communications, Marine and Natural Resources, University of Bergen, Universite de Bretagne Occidentale, Malis ltd., FishFix, Memorial University of Newfoundland, University of the Azores, University of Strathclyde, Pôle AQUIMER, Food and Agriculture Organization of the United Nations, Simrad Spain SLU, Barna Group, Agrocampus Ouest, Hambúrg Group, University of Copenhagen, Nusience Group, SafetyNet Technologies LTD, Marel hf, Sea Fish Industry Authority, ShipCon, AZTI-Tecnalia

Documents:
DiscardLess - An overview of the project
**Eel hatchery technology for a sustainable aquaculture (EEL-HATCH) (39181)**

Hatchery and rearing technology for commercial production of glass eels is fundamental to sustainable and profitable eel aquaculture. The vision is to enhance existing technology to rear European eel larvae to the glass eel stage, thereby closing the lifecycle in captivity. Pioneering research of the consortium has raised eel breeding from a state of reproductive failure to stable production of viable larvae.

Objectives include: Design "state of the art" hatchery facilities, optimize broodstock feeds, enhance assisted reproductive technology, and develop larval culture systems and diets. The main success criterion is achievement of large scale culture of larvae throughout the larval stage, leading to glass eel production. The establishment of sustainable aquaculture of this endangered species, presently relying on captive glass eel will rebuild the highly profitable market for eel aquaculture and suppliers as well as assist in conservation and stock management plans.

Results obtained during the half of the project period include the design and establishment of a dedicated research facility in relation to DTU Aqua in Hirtshals, involving several partners. The facility applies recirculation aquaculture systems with emphasis on matured water technology and microbial control. Scientific highlights include successful production of recombinant European eel gonadotropic hormones; enhanced reproduction, fertilization and incubation procedures; and optimized larval culture conditions, including e.g. temperature, salinity, and light regime. Larval diets have been developed and tested in first feeding and behavioral experiments, leading to the first published work on larval feeding for this species. Experiments on improved diets and optimized rearing tanks for larval growth are ongoing.

This project is coordinated by DTU Aqua.

The project is funded by Innovation Fund Denmark.

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Krüger-Johnsen, M., Project Participant, National Institute of Aquatic Resources
Serensen, S. R., Project Participant, National Institute of Aquatic Resources
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01/04/2014 → 30/09/2017

Keywords: Research areas: Fish Biology & Aquaculture & Coastal Ecology

**Biochemical assessment of larval fish feeding ecology and the importance of protozoans (39271)**

Growth and survival of early life stages of fish result from complex bio-physical processes. Availability of suitable prey is especially crucial during the early life where fish are most vulnerable to starvation and predation. However, the feeding ecology and importance of unicellular protozooplankton in the diet larval fish is still poorly understood.

This project will provide new insight into the trophic ecology of the ecologically and economically important Pacific sardine and Northern anchovy. To estimate trophic level, cutting edge biochemical tools such as Compound Specific Isotopic Analysis on Amino Acids will be applied. The observed differences in larval trophy relative to growth and to environmental conditions will help to determine their trophic flexibility.

Moreover, changes in larval trophy related to inter-annual and decadal changes in environmental conditions may explain the relationship between larval feeding opportunities and fluctuations in recruitment to the adult population. Therefore, the expected results will contribute to improved predictions of fish population size and changes in marine ecosystem structures.

This project is coordinated by DTU Aqua.

Swalethorp, R., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

01/01/2015 → 31/12/2016

Keywords: Research area: Ocenography and Climate
Collaborators: University of California at San Diego, National Oceanographic and Atmospheric Administration

**The development of tools for tracing and evaluating the genetic impact of fish from aquaculture (AquaTrace) (38948)**

The genetic changes associated with domestication in aquaculture pose an increasing threat to the integrity of native fish gene pools. Consequently, there is a bourgeoning need for the development of molecular tools to assess and monitor the genetic impact of escaped or released farmed fish. In addition, exploration of basic links between genetic differences
Minimising discards in Danish fisheries (MINIDISC) (39020)
The landings obligation, currently being implemented in the new CFP, puts major constraints on fishers, by making the landing of unwanted catch mandatory. Less restrictive technical rules (TR) in a results-based management frame under Catch Quota Management (CQM) have been suggested as a mechanism to release some of these constraints. To investigate the effects of the existing TR, some fishers were relaxed from TR during the trial and could freely choose and develop alternative gears, aiming to optimize annual catch value, while reducing discards. The study included 14 demersal fishing vessels, operating in the North Sea, Skagerrak and the Baltic Sea.
Fishers used test and control gears interchangeably or in pairs during up to 6 months and were required to sort and weigh all discard of seven common target species on a haul by haul basis. All vessels were equipped for Fully Documented Fisheries (FDF), including cameras. Collected data were analyzed to investigate differences in landings, discards, discard ratio, CPUE, VPLUE and DPUE, between conventional (control) and new gears (test). The results showed a varying degree of success, depending both on area and on choices made by the individual fisher. The best results were observed in the Baltic Sea, where relaxing technical rules led to major improvements in fishing patterns. But gear changes did not contribute much in fisheries where initial discard rates were already low. Interviews realized with the skippers around the end of the trial were performed and analyzed to investigate (i) their experiences with “free” choice of gear, (ii) the processes that they followed for developing their gears and (iii) their tools for evaluating the efficiency and selectivity of their trial.
In addition to the trial, a number of other activities were performed under the MINIDISC project, including (i) the publishing of a catalogue (in Danish) of the selectivity devices experimented in Danish fisheries, (ii) a scientific selectivity trial on Danish seines fisheries in Skagerrak and (iii) a review of international experiences in the uptake of selective devices. The project has been disseminated through several meetings and conferences. A number of scientific publications are in review or close to submission.
This project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

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Mensberg, K. D., Project Participant, National Institute of Aquatic Resources

01/11/2012 → 31/10/2016

Keywords: Research area: Population Genetics
Collaborators: INRA Institut National de La Recherche Agronomique, European Commission - Joint Research Center, Høvskingsinstituttet, Universita di Padova, Stichting Katholieke Universiteit, University of Santiago de Compostela, Bangor University, TRACE Wildlife Forensics Network Limited

Project: Research
Development of seal-safe fishing gear (Seal-Safe II) (39188)
Increasing numbers of seals in Danish waters have in recent years made it difficult to conduct a economically sustainable coastal fishery with gillnets and hooks/lines. The objective of Seal-Safe is to improve the viability of these fisheries by developing efficient, environmentally friendly and seal-safe pots for catching cod. The pots will make it possible for the coastal fishermen to conduct a sustainable fishery without damages inflicted by seals.
This project is coordinated by DTU Aqua.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).
Larsen, F., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Kindt-Larsen, L., Project Manager, National Institute of Aquatic Resources
Sørensen, T. K., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
01/06/2014 → 31/07/2016
Keywords: Research areas: Ecosystem based Marine Management & Fish Biology
Collaborators: Swedish University of Agricultural Sciences, Aarhus University, Neksø Vodbinderi ApS
Project: Research

Development of a by-catch excluder for the Danish and European trawl fisheries (39285)
The project aims to develop and test a widely usable gear that effectively sorts out unwanted species and sizes of fish during trawling. This objective should be seen in light of a future discard ban for the EU—a ban which, in Denmark and in other European countries, will result in a growing demand for technical solutions that can increase the sorting of fish in the gear during fishing.
The development work of the project is based on a so-called "Excluder system" that can be integrated into most standard trawl gears. The "Excluder system" is developed for the North American market by Tor-Mo Trawl in Hirtshals in collaboration with the Green Line Fishing Gear. The Excluder is used today on a voluntary basis by approximately 15 large fishing vessels in Alaska, but is not directly applicable in Danish and European fisheries because the species composition, trawl size and type of vessel is significantly different in fisheries in Alaska.
The project's main result will be the development, testing and documentation of an Excluder system, which is targeted the Danish and European trawl fisheries.
In light of the political development in EU, a very large market potential is expected to appear for such an Excluder and the redemption of this market potential will result in 1) more successful implementation of the discard ban, 2) more selective and sustainable fisheries, and 3) increased growth and revenue for companies in the project.
This project is coordinated by Denmark's Pelagic Producer Organisation.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).
Eigaard, O. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Krag, L. A., Project Participant, National Institute of Aquatic Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources
Thaarup, F., Project Participant, National Institute of Aquatic Resources
Feekings, J. P., Project Participant, National Institute of Aquatic Resources
01/01/2015 → 31/12/2016
Keywords: Research areas: Fisheries Management & Fisheries Technology
Collaborators: Danish Pelagic Producers Organisation, Tor-mo trawl ApS, HG62 Beinur, Greenline Fishing Gear A/S
Project: Research

The shrimp fisheries in the Skagerrak area of Sweden, Norway and Denmark analyzed using a systems perspective (39191)
In recent years the Shrimp stock in the Skagerrak has been drastically reduced. The three countries, who fish on the stock, differ substantially in terms of fleet structure, national quota management, fishing patterns and market. The market situation combined with the quota being fished has led to incentives for discarding of smaller shrimps (high-grading), mainly in the Swedish fishery. Discard of shrimp has been banned in Europe for a few years, and in 2016 more general EU discard ban will be implemented. Therefore the development of more size selective gear is being pushed in several countries.
The developments in the stock, the differences in the three countries’ resource utilization and the coming management changes makes it very interesting to map and compare environmental and socio-economic aspects of the three countries’ shrimp fishing in the Skagerrak. Life Cycle Assessment (LCA) is an ISO-standardized methodology that maps resource consumption and environmental impact of products from a systems perspective. There are now a number of case studies where you look at the role of management in the impact of the product. In these cases the product is mostly followed only during fishing until landing (not during processing, packaging and distribution after landing). A Canadian study compared
Canadian and American fishing on the same stock of lobster using LCA and demonstrated significant differences in environmental impacts that mainly depended on the countries' management.

The aim of this study was to quantify a set of indicators that together give a broad picture of the sustainability of the three fisheries to provide an objective basis for a discussion on needed measures. The different indicators concerned environmental, economic or social aspects of sustainability and were quantified per tonne of shrimp landed by each country in 2012. The Danish fishery was most efficient in terms of environmental and economic indicators, while the Swedish fishery provided most employment per tonne of shrimp landed. Fuel use in all fisheries was high, also when compared with other shrimp fisheries. Interesting patterns emerged, with smaller vessels being more fuel efficient than larger ones in Sweden and Norway, with the opposite trend in Denmark. The study also demonstrated major data gaps and differences between the countries in how data are collected and made available. Various improvement options in the areas data collection and publication, allocation of quotas and enforcement of regulations resulted and are described in more detail in a scientific paper in ICES Journal of Marine Science in 2016. This project was coordinated by SIK-SP Food and Bioscience. The project was funded by Nordforsk, Nordic Council of Ministers.

Eigaard, O. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Jørgensen, M. S., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources

01/05/2014 → 30/04/2015

Keywords: Research area: Fisheries Management

Collaborators: Swedish University of Agricultural Sciences, SIK-SP Food and Bioscience, SINTEF

Project: Research

Water treatment technology for microbial stabilization in landbased aquaculture systems (MicStaTech) (39277)

MicStaTech is a transnational research project (COFASP) between Norwegian, German and Danish research groups. The paradigm of this project is that a stable, elevated microbial abundance in the water phase of land based aquaculture systems can be beneficial for fish health and economically profitable. A common challenge in land based systems, and shown across species, is the loss of fish due to unfavourable conditions and disease outbreaks that may be linked to opportunistic bacteria. A popular approach to prevent this is to attempt to reduce the load of bacteria in the systems by the use of UV, ozone or chemical disinfection. This is however not possible or sufficient in the majority of systems, because disinfection has a non-lasting effect on the numbers and a destabilising effect on the composition of bacteria. In most systems, the water exchange rates and organic loading applied for biological reasons allow for microbial regrowth in the rearing tanks. Hence, alternative approaches to reduce the chances of disease outbreaks are needed. This project pursues the concept of establishing and maintaining stable microbial systems.

Water treatment technology for promoting K-selection, which is a selective pressure disfavouring the r-selected opportunists, has shown very promising results for several marine species in small scale experiments, but the up-scaling and optimization for flow through systems (FTS) and recirculating aquaculture systems (RAS) remains. The paradigm favouring a stable and elevated bacterial abundance is foreseen to reduce fish mortality and also reduce water treatment costs. This project will investigate fish health and microbial carrying capacity in experiments performed at three locations – NTNU, DTU Aqua and University of Applied Sciences, Saarlandes, Germany.

This project is coordinated by Norwegian University of Science and Technology, Norway. The project is funded by EU, COFASP, ERA-NET.

Pedersen, L., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Rojas-Tirado, P. A., Project Participant, National Institute of Aquatic Resources
Sproegel, U., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
Nielsen, S. M., Project Participant, National Institute of Aquatic Resources

01/03/2015 → 31/12/2017

Keywords: Research area: Aquaculture

Collaborators: Hochschule fur Technik und Wirtschaft des Saarlandes ? University of Applied Sciences Saarland,
Norwegian University of Science and Technology

Project: Research

A systems approach framework for coastal research and management in the Baltic (BaltCoast) (39201)

The ultimate objective of this project is a coherent and systematic management approach that encompasses multiple impacts in a spatially heterogeneous context.

In BaltCoast we tackle this complex task using the Systems Approach Framework (SAF). The SAF is an issue oriented investigation and methodology that applies a holistic perspective. It investigates and quantifies the functions of systems in order to simulate specific questions concerning their functions or policies. It comprises the process from issue identification through system analyses to policy implementation.

This Systems Approach can, hence, competently address implementation of international directives (e.g. Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD)). In BaltCoast we address multiple issues through case studies that reflect current regional management challenges and develop a generic tool for integrated system assessment.
The project aims to describe changes in distribution of different age groups of cod and plaice in coastal areas. Changes in the distribution of plaice off the Danish west coast were documented and correlated to changes in nutrient loadings. These results were submitted for peer review. Potential changes in the distribution of cod of different size classes in inner Danish waters are being modelled to see if there are any consistent patterns. Datamining has been undertaken to provide environmental data to conduct analyses of potential causes for changes observed.

The project is coordinated by DTU Aqua and is funded by the Danish Ministry of Food, Agriculture and Fisheries through a special governmental Funding for sustainable fisheries ("Bæredygtighedspuljen").

Munk, P., Project Coordinator, National Institute of Aquatic Resources
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Stenberg, C., Project Participant, National Institute of Aquatic Resources

01/01/2014 → 31/12/2016
Keywords: Research areas: Coastal Ecology & Marine Living Resources & Oceanography
Project: Research
probabilistic exposure tools.
- Develop mitigation measures for risk managers, such as an online tool for different stakeholders, guidelines, phycoremediation (the use of algae to remove pollutants) and processing.
- Develop, validate and provide new, easy and fast tools to assess the presence of environmental contaminants in seafood.
- Confirm/refine the European Maximum Reference Levels in seafood for contaminants that are real hazards and for which no legislation exists or information is still insufficient.

DTU Aqua participates in the project by performing feeding trials using contaminated feed for Atlantic salmon and seabass respectively. Furthermore, the project also investigates potential effects of microplastic incorporated into feed pellets, on accumulation and elimination of the selected priority contaminants. The feeding trials consist of a 12 week to 15 week accumulation period for seabass and salmon respectively and a 8 week depuration period where all groups are fed control feed. The results obtained from the trail will be the used to develop mathematical models estimating accumulation and elimination of priority contaminants in filet.

The project is coordinated by Portuguese Institute of Sea and Atmosphere (IPMA), Portugal.
This project is funded by EU, Framework Programme 7.
Larsen, B. K., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources
15/02/2013 → 15/02/2017
Keywords: Research area: Aquaculture
Collaborators: Hortimare BV, Wageningen IMARES, Portuguese Institute for the Sea and Atmosphere, University of Maribor, Catalan Institute for Water Research, Institute for Agricultural and Fisheries Research, University of Porto, Universidad Rovira i Virgili, Agency for Marine Research and Valorisation, Aeorgia Srl, National Veterinary Institute, Institute of Research and Technology in Food and Agriculture, AquaTT, Dan Salmon A/S, AZTI-Tecnalia, Polyintell, Ghent University
Project: Research

Towards stable water quality in RAS by use of a new rapid microbial test (Biostable water) (39154)
Water quality control is central for successful management of recirculating aquaculture systems. Most common and important chemical parameters (i.e. pH, TAN, nitrite, alkalinity) are measurable, whereas microbial water quality (abundance and activity) is more complicated to measure. Microbial water quality measurements are important for several reasons: it can be used to ensure safe and stable conditions (baseline), to identify sudden changes (deviations from baseline) and potentially contribute to improve system performance by identifying suboptimal treatment component or practices.
The aim of this project is to test a rapid microbial methods developed by Mycometer; a test that quantifies the microbial activity in different types of water samples within 30 minutes from sampling to measurement. The Bactiquant® method is expected to provide new insight of microbial succession within RAS and will be used to monitor microbial water quality in commercial recirculating aquaculture systems.
The project includes controlled batch experiments where disinfection efficiency and regrowth potentials can be estimated. The new knowledge can be applied in RAS management, and the project also includes method verification under commercial RAS conditions. The equipment has been introduced and implemented on a large model trout 3 farm with mixed effect and valuable experiences. The method is also being introduced to a huge smolt RAS facility build by Billund Aqua; here daily monitoring as well as intensive campaigns including diurnal measurements will be performed.
The project is coordinated by DTU Aqua.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).
Pedersen, L., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Rojas-Tirado, P. A., Project Participant, National Institute of Aquatic Resources
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Sproegel, U., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
Nielsen, S. M., Project Participant, National Institute of Aquatic Resources
Frandsen, D., Project Participant, National Institute of Aquatic Resources
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources
01/02/2014 → 01/07/2016
Keywords: Research area: Aquaculture
Collaborators: Mycometer A/S, Billund Aquaculture Service Aps
Project: Research

Cost efficient solutions for reducing the waste discharged in land-based marine recirculating aquaculture systems (WASTE-TREAT) (39190)
Growth in aquaculture production demands a high degree of environmental engineering to minimize nutrient discharge thereby reducing the environmental impact. This industrial collaboration project aims at finding the cost-efficient treatment methods for reducing the waste discharged from large-scale land-based marine recirculating aquaculture systems. End-of-pipe solutions for minimizing the N, P, and organic matter waste discharge from seawater RAS are to be developed,
demonstrated and evaluated. The project is coordinated by AKVA Group Denmark A/S. The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Letelier-Gordo, C. O., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Manager, National Institute of Aquatic Resources
Fernandes, P., Project Participant, National Institute of Aquatic Resources
15/08/2014 → 01/09/2017
Keywords: Research area: Aquaculture
Collaborators: AKVA Group Denmark A/S, Danish Salmon A/S
Project: Research

Landbased aquaculture of European lobster (39156)
The aim of the project is to solve remaining biological and technical challenges concerning commercial farming of European lobster. These include optimizing reproduction and broodstock production, improving larval survival and examining nutritional requirements and metabolism in the first life stages. Furthermore, the technical system set-up will be improved.
The work during the first two years have been focusing on survival and growth tests, comparison of diets, respiration tests and novel cage design for European Lobster farming.
Furthermore, active collaboration and exchange of knowledge have taken part in the established European Lobster Centre of Excellence (ELCE) group that now includes partners from seven countries (Norway, Denmark, Iceland, Sweden, United Kingdom, Italy and Spain).
The project is coordinated by Svinna-verkfrædi ehf, Iceland.
The project is funded by Nordforsk, Nordic Council of Ministers.
Lund, I., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/03/2014 → 28/02/2017
Keywords: Research area: Aquaculture
Collaborators: Svinna-Engineering Ltd., Norwegian Lobster Farm AS
Project: Research

New possibilities for growth and robustness in organic aquaculture (ROBSTFISH) (39159)
Main aim:
To support the credibility, growth and robustness in the production of healthy and stress resilient Danish organic rainbow trout, considering environmental, ethical as well as economic aspects.
Sub goals:
1) Develop methods for selecting robust fry.
2) Investigating how sustainable non-fish based feed given early in the development affect the robustness of the fry.
3) Include welfare and environmental aspects in relation to water treatment procedures.
4) Improve economic competiveness of Danish organic aquaculture.
The project is coordinated by DTU Aqua.
This project is funded by Organic RDD 2 Programme, which is coordinated by the International Centre for Research in Organic Food Systems (ICROFS). It has received grants from the Danish Ministry of Food, Agriculture and Fisheries through the Green Growth and Development Programme (GUDP).
Jokumsen, A., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Gesto, M., Project Participant, National Institute of Aquatic Resources
Pedersen, L., Project Participant, National Institute of Aquatic Resources
Skov, P. V., ProjectParticipant, National Institute of Aquatic Resources
Larsen, E., Project Participant, National Institute of Aquatic Resources
Lazado, C. C., Project Participant, National Institute of Aquatic Resources
01/04/2014 → 31/12/2017
Keywords: Research areas: Aquaculture & Fisheries Management
Collaborators: University of Copenhagen, Aalborg University, Danish Aquaculture Association
Project: Research

Organic line mussels – Securing availability for the consumers (ØKOMUS) (39155)
The project objectives was to establish and develop an economically sustainable market for organic line mussels in Denmark by support and development of relevant channels of distribution to secure availability of Danish organic mussels for the consumers.
The project was coordinated by Danish Aquaculture Association.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/07/2013 → 31/05/2015
Keywords: Research area: Aquaculture & Shellfish and Seaweed
Collaborators: Danish Mussel Farmers, Danish Aquaculture Association
**Evaluations of tagging effects (39124)**

Much of the science-based management of fish and fisheries are based on results from various electronic tagging methods be it radio-, acoustic-, Data Storage- or PIT tags. This project aims to investigate and document possible effects of commonly used tagging methods and improve these methods to ensure that results from tagging studies are representative and unbiased. Hand in hand with this goes animal welfare issues, where we try to reduce the impact on each fish as well as refine the methods used for capture, handling and tagging, according to the 3R’s. In field-based research post-treatment evaluations are difficult and thus rare, however needed. Within this project we will focus on evaluation of sub-lethal effects of surgical implantation, identify size thresholds for PIT-tagging small fish and testing new suture materials.

The project is coordinated by DTU Aqua.
The project is funded by Danish Rod and Net Fishing License Funds.

Jepsen, N., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Skov, C., Project Participant, National Institute of Aquatic Resources
01/01/2014 → 31/12/2016

Keywords: Research area: Freshwater Fisheries and Ecology

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**Ecology and evolution of a notorious invader: Is invasion success influenced by rapid adaptation to global change? (39175)**

Marine invasive species have globally increasing biological and economic impacts. However, evolutionary mechanisms favoring range expansion and invasiveness remain poorly understood. This project will describe the environmental envelope of the comb jelly Mnemiopsis leidyi, one of the most notorious marine invasive species, and experimentally investigate the potential for rapid adaptive evolution, which might enable the species to overcome current physiological constraints on the range of its distribution. This includes the possible role of intra-specific hybridization for accelerating adaptive evolution. The results will have implications for the assessment of future invasion risks by M. leidyi in a global change perspective.

The project is coordinated by DTU Aqua.
Jaspers, C., Project Manager
01/12/2014 → 30/11/2016

Collaborators: GEOMAR - Helmholtz Centre for Ocean Research Kiel

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**Benchmarking and extending models of real estate price prediction, under financial regulation requirements**

Guillot, G., Main Supervisor, Department of Applied Mathematics and Computer Science, Cognitive Systems
Katossky, A., Project Participant, Department of Applied Mathematics and Computer Science, Cognitive Systems
Thygesen, U. H., Project Participant, Department of Applied Mathematics and Computer Science, National Institute of Aquatic Resources, Section for Marine Living Resources
Dalhoff, J., Project Participant, Lokalebasen
01/09/2014 → 01/10/2017

Collaborators: Lokalebasen

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**New physicochemical and technological approach for high quality and sustainable fish feed production (Exipro) (39189)**

Aquaculture is the globally fastest growing food producing sector, and extruded fish feed is the largest expenditure in the production of carnivorous fish.

The quality of the different protein raw materials used in fish feed varies considerably, and even small differences in the nutritional quality can have large effects on fish performance, their degree of feed utilization and consequently the environment.

The production of high quality, nutrient-dense fish feed requires that the dietary matrix is extruded into pellets. However, the extrusion process can alter and deteriorate the nutritional quality of proteins. Currently, the extrusion process is based entirely on empirical learning, and little is known about the chemical reactions and physical processes that take place inside the extruder, i.e., the extruder is largely a ‘Black Box’. In addition, little is known about concomitant effects on feed utilization.

The aim of Exipro is to optimize the extrusion process by clarifying the changes and damages on different protein ingredients that happen in the extruder, and to use the knowledge to improve the quality of fish feed. Hence, the objectives of the project are to:
- Determine the effects of extrusion on the physicochemical and chemical properties of proteins in fish feed
- Determine the effects of these changes on fish growth performance, metabolism, protein retention, and nitrogen excretion
- Develop a generic extrusion optimization tool for different protein ingredients.
The project is coordinated by University of Copenhagen.
The project is funded by Innovation Fund Denmark.
Dalsgaard, A. J. T., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
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Vega, V. V., Project Participant, National Institute of Aquatic Resources
01/09/2014 → 31/12/2017
Keywords: Research area: Aquaculture
Collaborators: BioMar A/S, Aarhus University, University of Copenhagen
Project: Research

Round goby – need for collaborative science and management in Nordic and Baltic countries (39171)

Originating from the Ponto-Caspian region, the round goby Neogobius melanostomus has within recent years proliferated in several Nordic and Baltic coastal waters. Round goby is now not only posing a threat to native goby species occupying similar habitats, but also to the traditional coastal fishery through competition for food resources with commercially and recreationally important costal species, and consumption of their fry and eggs. Furthermore, fishermen report on declined shrimp catches, one of the preferred prey items of adult round goby.

The overarching aim of this project is to have a common Nordic and Baltic workshop on round goby. This will enable knowledge transfer across borders, identification of knowledge gaps and creating wide research projects on issues related to round goby invasion. Equally important, it would provide an opportunity to inform relevant authorities on the challenges of managing the species and to develop instruments to mitigate the impact on native costal species and fisheries.
Outcome of the workshop will be a report on the current distribution and status of round goby in the Nordic/Baltic countries that could be used for future risk analyses and basis for management decisions, indicating future needs.

The project is coordinated by DTU Aqua.
Behrens, J., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
van Deurs, M., Project Participant, National Institute of Aquatic Resources
01/05/2014 → 31/05/2014
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Finnish Environment Institute, Lund University, University of Tartu
Project: Research

Developing seal-safe fishing gear (Seal-Safe I) (39163)

Developing seal-safe fishing gear will primarily be focused on fish pots, which have the best potential for protection against seal attacks. Other advantages of pots includes being size selective, that the catch can swim freely inside the pot and is alive when the pot is emptied resulting in a higher quality and thus a higher price, high survival for discards, low bycatch of small cetaceans and seabirds, and that the pot does not have to be tended every day. Disadvantages include low catch rates compared to gillnets, and that they are not good at catching flatfish.
DTU Aqua will carry out a development project that includes the following components:
- Review of fishing gear as alternatives to gillnets.
- Optimizing existing pots to Danish conditions in collaboration with the fisheries.
- Fishing trials for cod with the optimized pots.
- Experiments with bait types.
- Studies of fish and seal behavior around pots.
- Dissemination of results to the Danish fishery.
DTU Aqua has established a collaboration with Swedish scientists, who have extensive experience with development of seal-safe fish pots.
The main challenge will be to increase the catch rates of the fish pots, so that seal-safe fish pots can be an economically viable alternative to set gillnets. If this is successful, changing from gillnets to fish pots can ensure the continued survival of the small-scale coastal fishery and at the same time reduce bycatch of e.g. marine mammals and seabirds.
The project is coordinated by DTU Aqua.
The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through a special governmental Funding for sustainable fisheries ("Bæredygtighedsfonden").
Larsen, F., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources
01/02/2014 → 01/07/2016
Keywords: Research area: Ecosystem based Marine Management
Collaborators: Swedish University of Agricultural Sciences, Aarhus University, Neksø Vodbinderi ApS
Project: Research
Seal-inflicted damages to Danish fisheries (39143)
In recent years, there has been an increasing conflict between commercial fisheries and the increasing seal populations. Direct damages in the form of reduced or damaged catch is frequently seen in fishing with set gillnets, poundnets and hooks/lines. Fishermen have proposed that the diminishing fish stocks are a result of increased predation from seals. The problems appear to be most widespread in the small-scale coastal fisheries, which there is a political will to preserve, but basic information about the scale of the problem is lacking.
The present project aimed to remedy this situation by collecting information on the scale of the seal-inflicted damages to Danish commercial fisheries and assessing the economic consequences of the damages. The project focused on the following areas:
- Seal populations in Danish waters – distribution, size, behaviour and feeding preferences (WP 1)
- Damage to catch and fishing gears inflicted by seals (WP 2, 3 and 4)
- Potential mitigation measures (WP 5).

The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Kindt-Larsen, L., PhD Student, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
15/07/2013 → 01/05/2015
Keywords: Research area: Ecosystem based Marine Management
Collaborators: BioApp, University of Copenhagen, Krog Consult ApS
Project: Research

The early life of eel in the Sargasso Sea – Influence of oceanography and climate (SARGASSO-EEL) (39107)
The recruitment of the European eel has been in dramatic decline during the last 30 years, and is at a severe low of only 3-5% of earlier magnitude. This change and its influence on the eel fishery have led to an intensified research in the oceanic phase of the European eel.
In order to contribute to further understanding of the life cycle of eel the Danish eel expedition set out in 2014 for the eel spawning grounds in the Sargasso Sea. Here a consortium of Danish scientists and international collaborators focused on the linkages between oceanography, biological production, eel spawning and the growth and drift of eel larvae.
During the expedition, a wide range of organisms was collected: From the smallest plankton of less than a millimeter to very large fish. A number of research groups are now working on samples and data from the expedition and assembling information on key processes in the early life of eels. Preliminary findings indicate that biological and physical changes have taken place in the spawning areas that may affect the eel larvae’s chances of survival and their journey to Europe.
The project was coordinated by DTU Aqua.
The project is funded by the Carlsberg Foundation and Danish Centre of Marine Research (cruise).

Munk, P., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Nielsen, T. G., Project Manager, National Institute of Aquatic Resources
Ayala, D. J., PhD Student, National Institute of Aquatic Resources
Thomsen, H. A., Project Participant, National Institute of Aquatic Resources
Sersen, S. R., Project Participant, National Institute of Aquatic Resources
Bekkevold, D., Project Participant, National Institute of Aquatic Resources
Malsk, E., Project Participant, National Institute of Aquatic Resources
Jaspers, C., Project Participant, National Institute of Aquatic Resources
Christoffersen, M., Project Participant, National Institute of Aquatic Resources
Hansen, S., Project Participant, National Institute of Aquatic Resources

01/08/2013 → 01/08/2016
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Oceanography
Collaborators: Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, University of Alaska Fairbanks, Aarhus University, University of Copenhagen, Université de la Méditerranée Aix-Marseille II, Pierre and Marie Curie University - University of Paris VI, Sir Alister Hardy Foundation for Ocean Science (SAHFOS), University of Rhode Island, International Council for the Exploration of the Sea

Boulder reefs as spawning and nursery areas for fish (RevFisk) (39144)
The project aimed to build knowledge about marine boulder reefs and their biological function for fish as spawning and nursery areas.
The field work was conducted on a stone reef, Hatter Barn at two depths 6-12 m and 13-17 m. These two depths were chosen to provide information on fauna and flora in the upper photic zone and a deeper zone. The dominant fish were labrids, which also spawned in the area and juvenile cod. Acoustic tagged cod provided information on their presence around the reef. Many exhibited a diurnal rhythm, concentrating on the reef during nighttime, although some cod were stationary on the reef the whole time. The deeper reef was more frequently visited (fourfold) by cod than the shallower reef.
Experimental work conducted at the Blue Planet aquarium revealed that corkwing wrasse are highly territorial and able to prevent juvenile cod from occupying their crevices. Goldsinny wrasse showed little interaction with cod and generally
utilized very small crevices. Both labrids and cod utilized shelter from current flows provided by the structures and cod were often seen in high concentrations near the bottom where the current flows were laminar.

The results are useful for further developing models that quantify boulder reefs impact on fish (larvae, juvenile, adult) as a function of the reefs condition, size and depth location. The results are useful in helping plan and design the restoration of destroyed boulder reefs but also to manage existing boulder reefs.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Stenø, C., Project Coordinator, National Institute of Aquatic Resources
Støttrup, J. G., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Christoffersen, M., Project Manager, National Institute of Aquatic Resources
van Deurs, M., Project Manager, National Institute of Aquatic Resources
Nielsen, A., Project Manager, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources

01/12/2013 → 01/02/2015
Keywords: Research areas: Coastal Ecology & Marine Living Resources & Oceanography
Collaborators: Aarhus University, DHI Water - Environment - Health
Project: Research

Akvakulturuddannelse
Boutrup, T. S., Project Participant, National Veterinary Institute, Section for Virology
01/05/2012 → 10/06/2014
Collaborators: Dansk Akvakultur, University of Copenhagen, Danish Centre for Environment and Energy
Project: Research

FOOP: Forbedret Opræststeknologi til Optimering af Produktion, vandkvalitet og sygdomsforebyggelse i modeldambrug
Boutrup, T. S., Project Participant, National Veterinary Institute, Section for Virology
Skov, P. V., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
01/10/2011 → 01/10/2013
Collaborators: Dansk Akvakultur
Project: Research

Network towards phasing out formalin in aquaculture (39140)
Formalin is still used in large quantities in aquaculture systems despite unwanted side-effects and efforts to reduce the amount used. Apparently the need for water treatment increases with shift from flow-through to RAS. This project established a network of fish farmers (8 persons representing different systems), three national fish-vets covering >95% of Danish fish farms, DTU Aqua researchers and Danish Aquaculture organization. The common goal was to identify methods to cease the aquaculture related use of formalin. Recent knowledge, new techniques and practical experience with alternative disinfectants (e.g. hydrogen peroxide or peracetic acid) were applied and tested. In particular, distribution, degradation and automatic dosage of Peracetic acid by digital pumps was analytically verified. The project tested and developed better water treatment protocols for different types of rearing systems (hatcheries and grow out production systems, flow-through, model trout farms to fully recirculated systems) in close collaboration between fish-vets, fish farmers and DTU Aqua. Results from monitoring on a number of fish farms and experience over 2 seasons were obtained and the new practically applied knowledge/information was presented at workshops/seminars with the aquaculture industry as well as reported in a Danish report (Danish Aquaculture 2015-10). A number of veterinarians and fish farms were partners in the project. The project was coordinated by Danish Aquaculture Association.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Pedersen, L., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Sprogel, U., Project Participant, National Institute of Aquatic Resources
Møller, B., Project Participant, National Institute of Aquatic Resources
01/12/2013 → 01/05/2015
Keywords: Research area: Aquaculture
Project: Research

Development of filtering technologies for microalgae and sustainable high quality feed for fry (FIMAFY) (39115)
There is an urgent need for alternative resources to fishmeal and fish oil for the production of fish feed to the aquaculture industry. The resource problem is due to a combination of the rapid growth of the aquaculture, and the fact that catches of fish for the feed industry is stagnating.

The idea to use microalgae as fish feed originated from an ongoing EU-project, which aims at demonstrating that algae can be grown on process water from the industry.
The partners in the project will develop, test and demonstrate new technologies for harvesting and refining microalgae. The project will develop a technology to open the cell walls of the microalgae in order to make it possible to extract micro- and macronutrients for use as an alternative resource to fish oil and fishmeal in the production of fish feed for the aquaculture industry. The project is coordinated by the National Food Institute, Technical University of Denmark. The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Lund, I., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Högland, E., Project Participant, National Institute of Aquatic Resources
01/10/2013 → 31/03/2017
Keywords: Research area: Aquaculture
Project: Research

ECsafeSEAFOOD: ECsafeSEAFOOD. Priority environmental contaminants in seafood: safety assessment, impact and public perception

Seafood has been recognised as a high-quality, healthy and safe food type and is one of the most important food commodities consumed worldwide. However, seafood, like other types of food, can also be a source of harmful environmental contaminants with potential to impact on human health.

ECsafeSEAFOOD will assess food safety issues related to priority contaminants present in seafood as a result of environmental contamination (including those originating from harmful algal blooms and those associated with marine litter) and evaluate their impact on public health. ECsafeSEAFOOD will provide scientific evidence to serve as a basis for further development of common food safety, public health and environmental policies and measures, by seeking to establish a quantitative link between the contamination of the marine environment and that of seafood.

www.ecsafeseafood.eu
Granby, K., Project Participant, National Food Institute, Division of Food Chemistry
Sloth, J. J., Project Participant, National Food Institute, Division of Food Chemistry
Larsen, B. K., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
Rasmussen, R. R., Project Participant, National Food Institute, Division of Food Chemistry
FP7 Contract ID: 31180
Project ID: 31180
15/02/2013 → 15/02/2017
Project: Research

European organic aquaculture - Science-based recommendations for further development of the EU regulatory framework and to underpin future growth in the sector (OrAqua) (39131)

The overall vision of the OrAqua project is the economic growth of the organic aquaculture sector in Europe, supported by science based regulations in line with the organic principles and consumer confidence. OrAqua will suggest improvements for the current EU regulatory framework for organic aquaculture based on:
- a review of the relevant available scientific knowledge
- a review of organic aquaculture production and economics
- consumer perceptions of organic aquaculture.
The project will focus on aquaculture production of relevant European species of finfish, molluscs, crustaceans and seaweed.

To ensure interaction with all relevant stakeholders throughout the project a multi stakeholder platform will be established. The project will assess and review existing knowledge on fish health and welfare, veterinary treatments, nutrition, feeding, seeds (sourcing of juveniles), production systems, including closed recirculation aquaculture systems (RAS), environmental impacts, socio-economic and aquaculture economic interactions, consumer aspects, legislations and private standards for organic aquaculture. The results will be communicated using a range of media and techniques tailored to involve all stakeholder groups. Further, Multi Criteria Decision Analysis (MCDA) and SWOT analysis will be used to generate relevant and robust recommendations.

A wide range of actors from several countries will participate and interact through a participatory approach. The 13 OrAqua project partners form a highly qualified and multidisciplinary consortium that includes four universities, five aquaculture research institutes, three research groups in social science, a fish farmer organisation, a fish farmer and two organic certification/control bodies.

The main outcomes of the project will be recommendations on how to improve the EU regulation, executive dossiers and a Policy Implementation Plan (PIP). Further the project will deliver recommendations on how to enhance economic development of the European organic aquaculture sector.

The project is coordinated by NOFIMA, Norway. The project is funded by EU, Framework Programme 7. Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Development of monitoring plans for incidental bycatch of harbour porpoises in inner Danish waters (38869)

Incidental bycatch of harbour porpoises in Danish fisheries has till now primarily been documented by on-board observers or voluntary reporting by fishermen. An observer program in 1992-98 showed bycatch in Danish North Sea fisheries to occur primarily in bottom-set gillnets for turbot, cod, hake and plaice, but a similar program has not been conducted in inner Danish waters and the Baltic Sea.

The objective of the present project is thus to further develop and carry out plans for monitoring of incidental bycatch of harbour porpoises in inner Danish waters by use of CCTV camera systems. Further, to ensure full documentation of smaller gillnet vessels’ fishing operations by:

- monitoring all seasons of the major gillnet fisheries;
- providing information on bycatch of harbour porpoises and seabirds by fishery/season/area with a view to develop management plans for Natura2000 areas;
- providing information on discard of cod by gillnet vessels in inner Danish waters.

The project is coordinated by DTU Aqua.

Larsen, F., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Kindt-Larsen, L., PhD Student, National Institute of Aquatic Resources
Rasmussen, M. L., Other, National Institute of Aquatic Resources
16/06/2011 → 28/02/2014
Keywords: Research area: Ecosystem Based Marine Management
Project: Research

Enhancing the European aquaculture production by removing production bottlenecks of emerging species, producing new products and accessing new markets (DIVERSIFY) (39132)

Following the objectives of this Call, DIVERSIFY identified a number of new/emerging, large and/or fast growing finfish species, which are believed to be excellent candidates for the expansion of the aquaculture industry of Europe. The emphasis is on the Mediterranean or warm-water cage culture industry, but also addressed is pond/extensive culture, fresh water recirculation systems and cold-water species. These new/emerging species are marketed at a large size and can be processed easily into a range of products to provide the consumer with both a greater diversity of fish species and new processed products. In collaboration with a number of SMEs, DIVERSIFY will build on recent/current national initiatives for species diversification in aquaculture, in order to overcome the documented bottlenecks in the aquaculture production of these selected species.

DIVERSIFY will provide knowledge where needed to solve bottlenecks in juvenile production, grow-out, nutrition and feeding husbandry, new product development and marketing. The programme will also provide tools for genetic improvement and disease control. This will provide improved efficiency in production and reduced costs, and identify markets for the new products.

The expertise in the consortium and lessons learned, could provide in a 5 year period what took the Atlantic salmon industry 20 years of development. DIVERSIFY focuses on meagre (Argyrosomus regius) and greater amberjack (Seriola dumerilli) for marine warm-water cage culture, wreckfish (Polyprion americanus) for warm- and cool-water marine cage culture, Atlantic halibut (Hippoglossus hippoglossus) for marine cold-water culture, grey mullet (Mugil cephalus) an euryhaline herbivore for warm-water pond, extensive and integrated culture, and pikeperch (Sander lucioperca) for freshwater intensive culture using Recirculation Aquaculture Systems (RAS).

The project is coordinated by the Hellenic Center for Marine Research. 31 research institutions etc. are involved in the project.

The project is funded by EU, Framework Programme 7.

Lund, I., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
Skov, P. V., Project Participant, National Institute of Aquatic Resources
Gesto, M., Project Participant, National Institute of Aquatic Resources
01/01/2014 → 01/01/2018
Biodiversity changes - causes, consequences and management implications (BIO-C3) (39117)

BIO-C3 will investigate the dynamics of biodiversity in the Baltic Sea, their causes and the consequences for the function of food webs, including implications for biodiversity management policies.

Baltic biodiversity is historically dynamic responding to various drivers operating at different time and space scales. Species diversity is generally low and contains many recent immigrants and glacial relict species because of low salinity and relatively young age. Nevertheless, Baltic food webs sustain many goods and services valued by society.

We focus on functional consequences of ongoing and projected distributional and compositional changes of benthic and pelagic communities with a focus on invasive and resident key species. Using spatial and temporal projections of abiotic/biotic drivers including their interaction (climate change, eutrophication, species invasions, fisheries), we will assess how biodiversity (e.g., of species, traits, habitats) responds in time, space and along gradients of human impact and hydrography. We will investigate the potential and genetic basis for colonisation, acclimation and adaptation of species and populations to the Baltic Sea, and how compositional and adaptive changes of Baltic biodiversity affect ecosystem functions with an emphasis on trophic linkage and food web dynamics.

Results will feed into impact assessments that guide management policies including improved operationalization of status indicators, and guidelines for MPAs.

The project is coordinated by Helmholtz Centre for Ocean Research, Kiel (GEOMAR). DTU Aqua is co-coordinator. The project is funded equally by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

Köster, F., Project Coordinator, National Institute of Aquatic Resources
Neuenfeldt, S., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources
Mackenzie, B., Project Participant, National Institute of Aquatic Resources
Jaspers, C., Project Manager, National Institute of Aquatic Resources
Eero, M., Project Participant, National Institute of Aquatic Resources
Bekkevold, D., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
Huwer, B., Project Participant, National Institute of Aquatic Resources

01/03/2014 → 28/02/2018

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Population Genetics & Ecosystem based Marine Management

Collaborators: Klaipeda University, Stockholm University, Finnish Environment Institute, National Marine Fisheries Research Institute, DHI Water - Environment - Health, GEOMAR - Helmholtz Centre for Ocean Research Kiel, University of Gothenburg, Thunen-Institut, Åbo Akademi University, University of Tartu, Swedish Meteorological and Hydrological Institute, University of Hamburg

Project: Research

Restoration and management of cod in the Skagerrak/Kattegat (CodS) (38969)

The project had two main aims:

- To develop plans for ecosystem based and sustainable management of coastal stocks of cod in Skagerrak/Kattegat.
- To develop necessary scientific knowledge needed for a first pilot restoration of a locally extinct stock of cod.

The work in the project was highly multi-disciplinary and included aspects of law, policies and institutional rules, socio economy, genetics, ecology, physiology and behavioural ecology. The work was divided into 10 work packages and one work package responsible for coordination.

The different WPs addressed the following tasks:

- WP1: Genetic mapping of potential donor stocks of cod.
- WP2: Genetic characterization of extinct cod stocks in fjord areas of Skagerrak.
- WP3: Ecological inventory of fjords with and without cod, to establish the effect of local cod stocks on fjord ecosystems.
- WP4: Risk assessment in particular focusing on the risk of contamination of released cod larvae or juveniles that migrate into nearby stocks.
- WP5: Legal and institutional aspects of restoring fjord stocks of fish.
- WP6: Societal costs and values of cod restoration.
- WP7: Establishing production of cod juveniles, for tests of feeding and migration behaviours in relation to individual genotype.
- WP8: Developing a step-by-step plan for starting a pilot restoration, including applications for necessary permissions.
- WP9: Development of suggestions of management plans for existing or restored fjord stocks of cod.
- WP10: Synthesis and final report to stakeholders. (Scientific reports will be submitted for publication in scientific journals, in addition).
- WP11: Coordination, internal and external communication including project meetings.

The main results of the project were:

- Cod was present in very small stocks in fjords in eastern Skagerrak, as found from trawling of fish eggs during spawning period. The eggs found were identified as cod from genetic markers. Thus restoration should wait and instead all possible protection should be applied so that these tiny small groups of local spawning cod can increase in numbers over the years to come.
- Several of the fjords in Skagerrak/Kattegat have cod that genetically is a mix of North Sea cod and Kattegat cod. Some fjords along the Norwegian coast have genetically unique elements in the cod stocks.
- The Kattegat spawning stock should be a very important source for eastern Skagerrak cod populations, according to our oceanographic models.

The project was coordinated by Department of Biological and Environmental Science, University of Gothenburg. This project was funded by EU, InterReg (regional collaboration).

Keywords: Research areas: Population Genetics & Marine Living Resources & Fisheries Management

Collaborators: Lund University, Institute of Marine Research, University of Gothenburg

Project: Research

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**MSC certification of the plaice fishery in area IIIa – basic investigations and development of a management model (39025)**

A management plan is an important requirement for MSC certification of specific fisheries. However, prior to this project, reliable stock assessments, which are necessary for management plans, were not available for plaice (Pleuronectes platessa) in area IIIa (Kattegat/Skagerrak), had not been available. These problems most likely originated from insufficient knowledge about the geographical distribution of populations as well as the interactions between populations in Kattegat/Skagerrak and neighboring areas. Through a mapping of the distribution and dynamics of populations, this project aimed at providing the missing data that would ultimately allow for the development of a management plan for the plaice fishery in area IIIa. The work included information from genetics, tagging, otolith based growth estimation, oceanographic modelling and analyses of survey and fisheries data.

Results from the project showed evidence of both local population components in the Kattegat/Skagerrak as well as substantial mixing between North Sea populations and these local components, and consequences of lumping or splitting the populations for stock assessment and management were discussed. The outcomes of the work directly influenced the policy decisions since 2015. Decision was finally made to proceed with the lumping option, thus allowing a quantitative analysis as assessment and management advice for the area. However, because of the differences in size between the two populations, there is a risk of depletion of the local Skagerrak population if the fisheries on it increase as a consequence of the increase in the North Sea stock. In terms of management, some mechanisms already exist for reducing the fishing pressure in the Skagerrak if deemed necessary, as plaice in the North Sea and in the Skagerrak are managed by two different Total Allowable Catches (TACs). It has therefore been suggested that routine monitoring of the survey and fisheries patterns would allow detecting any departures from the current situation, i.e., a decoupling of trends in the different areas and the different seasons that could indicate a reduced productivity of the local stock.

In the long-term, the current progresses on the biological knowledge of the stock in Skagerrak should be sustained. Additional genetic allocation of individual fish to the different populations should be performed to obtain a better quantification of the mixing in different areas and seasons, and the survey coverage should be improved in the Skagerrak. The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Keywords: Research areas: Population Genetics & Fisheries Management & Marine Living Resources

Collaborators: Lund University, Institute of Marine Research, University of Gothenburg

Project: Research

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**Investigation of causes for declines in fish abundance in coastal areas (KYSTFISK 1) (39031)**

Danish fishermen complained of drastic declines in coastal fish populations, negatively impacting their fisheries opportunities but the nature and magnitude of the problem was uncertain. This project aimed to collate information from fisheries to map the problem, including which species and geographical areas involved. In total 74 fishers were interviewed and the problem mapped in Støttrup et al. (2014a). The project further aimed to explore existing survey data that could support the observed changes in fish distribution (Støttrup et al. 2014b) and conduct a literature review to explore if similar trends had occurred in neighboring countries and potential causes for the developments had been identified (Dutz et al. in revision).
The project is coordinated by DTU Aqua and funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Støtrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Munk, P., Project Participant, National Institute of Aquatic Resources
Dutz, J., Project Participant, National Institute of Aquatic Resources
Stenberg, C., Project Participant, National Institute of Aquatic Resources
Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources
Egekvist, J., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources
01/11/2012 → 01/10/2013
Keywords: Research areas: Coastal Ecology & Marine Populations and Ecosystem Dynamics
Collaborators: Danish Fishermen’s Association
Project: Research

**FOSTER: Facilitating open science to European research (FOSTER, GA 612 425)(39146)**

FOSTER is a coordination initiative that aims to support the full range of stakeholders in the research lifecycle, but especially young researchers, in adopting Open Science principles (Open Access, Open Data, Open Note Book, Open Educational Resources, Social Media for dissemination of research results) in the context of the European Research Area (ERA) and in complying with the open access policies and rules of participation set out for Horizon 2020 (H2020). FOSTER will focus on integrating Open Science principles and practice in the current research workflow by targeting the young researchers training environment. In addition, FOSTER will strengthen the institutional training capacity to maintain compliance with the open access policies in the ERA and H2020, and will facilitate the adoption, reinforcement and implementation of open access policies from other European funders, in line with the European Commission’s recommendation.

The project is coordinated by University of Minho.
The project is funded by EU, Horizon 2020.
Grigorov, I., Project Participant, National Institute of Aquatic Resources, Research Secretariat
Elbak, M. K., Project Participant, Office for Innovation & Sector Services
Thomsen, K., Project Participant, National Institute of Aquatic Resources
Qvistgaard, N., Project Participant, National Institute of Aquatic Resources
01/02/2014 → 31/07/2016
Keywords: open science , visibility, citations, reuse of research, impact, open access, open data, open notebook science, open code
Collaborators: University of Warsaw, Stichting Sparc Europe, Consejo Superior de Investigaciones Cientificas, Stichting Eif.Net, Consortium Universitaire de Publications Numeriques (COUPERIN), University of Edinburgh, University of Glasgow, Delft University of Technology, University of Minho, Georg-August-Universität Göttingen, The Open University, Stichting Liber
Project: Research

**Nutrient cocktails in coastal zones of the Baltic Sea (COCOA) (39145)**

The overall objective of COCOA is to identify the major pathways of nutrients and organic material (simply referred to as nutrients in the following) across the diversity of coastal ecosystems and assess management implications. Specifically, COCOA will investigate four different types of coastal ecosystems: 1) river- dominated estuaries, 2) lagoons, 3) archipelagos, and 4) embayments with restricted water exchange to:
- Understand the changing nutrient (C/N/P/Si) cocktail across the land-sea continuum.
- Quantify processes that transform and accumulate nutrients.
- Estimate nutrient retention across coastal ecosystems.
- Investigate potential feed-back processes sustaining alternative stable states.
- Analyse how these process rates may have changed over time.
- Evaluate consequences of altered nutrient pathways on ecosystem services
- Identify possible management responses for present and future projections.

The project is coordinated by Aarhus University, Denmark.
The project was funded EU; BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.
Stedmon, C., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/01/2014 → 31/07/2017
Keywords: Research area: Oceanography
Collaborators: Klaipeda University, Russian Academy of Sciences, Finnish Environment Institute, University of Gdansk, Åbo Akademi University, Leibniz Institute for Baltic Sea Research Warnemunde (IOW), Stockholm University, Aarhus University, Lund University, Utrecht University, University of Helsinki, University of Gothenburg, Swedish Meteorological and Hydrological Institute
Project: Research
Linking the optical properties of DOM to its characteristics and origins (LOCO) (39110)
The majority of organic carbon in the ocean exists as dissolved organic matter (DOM). A fraction of DOM absorbs ultra violet (UV) and visible light, while a specific subset of this subsequently exhibits a natural fluorescence. These spectroscopic properties can be used as markers for the turnover of different DOM fractions in the ocean. This project will link the UV-visible characteristics (optical properties) of DOM to its chemical structure. The results will lead to the capacity for widespread proxy measurements of DOM chemical properties estimated from its optical properties, and the ability to trace the production of both new “reactive” DOM and the humification processes that lead to the production of the bio-refractory DOM pool.

An international team of scientists from Denmark, Norway, Sweden, Germany and USA will collaborate to forge links (calibrate) between the optical properties of DOM to its chemical characteristics which will pave the way for new insights into the fate of terrestrial DOM in marine environments and the role of DOM in the global carbon cycle. The project is coordinated by DTU Aqua.

The project is funded by the Danish Council for Independent Research.

Stedmon, C., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
01/06/2013 → 31/05/2016
Keywords: Research area: Oceanography
Collaborators: Lund University, Alfred-Wegener-Institut für Polar-und Meeresforschung, North Carolina State University, Norwegian Polar Institute
Project: Research

Marine litter in Nordic waters (MANOFA) (39104)
“Marine litter in the Nordic waters” was a project funded by The Marine Group (HAV) under The Nordic Council of Ministers in 2013-2014. The main aim of the project was to establish a Nordic forum for collaboration and exchange of knowledge on status for methodologies and available data for marine litter between Nordic experts, environmental managers and stakeholders, due to the common environmental concerns in our shared seas. Among other activities, the project compiled information that can be used as a contribution to facilitate the framing of this environmental problem in a Nordic perspective. Two workshops were held about I) Common knowledge status on marine litter in the Nordic countries, and indicators relevant for EU Marine Strategy Framework Directive (14 November 2013 in Gothenburg, Sweden) and II) Status for monitoring and Future actions (6-7 November 2014 in Oslo, Norway).

The project was coordinated by Aarhus University.

The project was funded by Nordforsk, Nordic Council of Ministers.

Sørensen, T. K., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Andreasen, H., Project Participant, National Institute of Aquatic Resources
01/01/2013 → 31/12/2014
Keywords: Research areas: Ecosystem based Marine Management & Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: N-Research, Aarhus University, Institute of Marine Research, Faroe Marine Research Institute
Project: Research

Marine nanoplankton (39091)
The project is focusing on two groups of marine nanoflagellates, the loricate choanoflagellates and the weakly calcified coccolithophorids from polar seas.

Choanoflagellates are present in all aquatic environments and contribute a significant share of the heterotrophic nanoflagellate biomass. Recent molecular evidence has documented that the choanoflagellates is a sister group of the animal kingdom, a fact that has further increased the research focus on these organisms. This project will result in a monographic treatment of all loricate taxa described (c. 150) building upon the increasing molecular evidence unveiling relationships among genera and species, and a significantly improved understanding of the principles behind lorica formation.

Coccolithophorids are abundantly present with high species diversity in low latitude oceans. However, a small contingent of taxa has been shown to prevail in polar seas. Contrary to all other coccolithophorid species the polar contingent are all non-photosynthetic forms. Within this project attempts will be made 1) to sequence as many of these forms as possible in order to evaluate their relationship with coccolithophorids at large, and 2) provide hard core evidence from TEM thin sectioning of the lack of a photosynthetic organelle. All genera and species described will in turn be revisited in order to prepare a future reference basis.

The projects is coordinated by DTU Aqua.
Reducing bycatch of harbour porpoises – Insight, mitigation and effects (39037)
The main objective of the project was to provide a better basis for management of harbour porpoise by-catch in Danish setnet fisheries by:
- Elucidating the circumstances that leads to by-catch
- Developing and testing by-catch mitigation methods
- Assess the side effects of such mitigation methods
The project included 6 sub-projects organized under three headings:
- Behaviour of harbour porpoises around gillnets
- Reducing by-catch of harbour porpoises
- Effects on harbour porpoises of wide spread use of pingers
The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Benthic ecosystem fisheries impact study (BENTHIS) (39021)
There is general concern about the adverse impact of fisheries on benthic ecosystem which may negatively affect the fisheries yield and integrity of the sea bed. In an integrated approach to marine management, there is a need to develop quantitative tools to assess the impact of fisheries on the benthic ecosystem and at the same time collaborate with the fishing industry to develop innovative technologies and new management approaches to reduce the impact on benthic ecosystems. BENTHIS will provide the knowledge to further develop the ecosystem approach to fisheries management as required in the Common Fisheries Policy and the Marine Strategy Framework Directive. It will study the diversity of benthic ecosystem in European waters and the role of benthic species in the ecosystem functioning. Fisheries impacts will be studied on benthic organisms and on the geo-chemistry. The newly acquired knowledge will be synthesized in a number of generic tools that will be combined into a fishing/seabed habitat risk assessment method that will be applied to fisheries in the Baltic, North Sea, Western waters, Mediterranean and Black Sea. Fisheries will be selected with the fishing industry based on the impact on the benthic ecosystem. BENTHIS will integrate fishing industry partners to collaborate in testing the performance of innovative technologies to reduce fishing impact. Finally, in collaboration with the fishing industry and other stakeholders, new management approaches will be developed and tested on their effects on the ecosystem and their socio-economic consequences. As such BENTHIS will substantially improve the scientific basis to integrate the role of marine benthic ecosystems in fisheries management.
The project has 33 partners from 12 countries.
The project is coordinated by Institute for Marine Resources & Ecosystem Studies (IMARES), Wageningen University, The Netherlands.
The project is funded by EU, Framework Programme 7.

Study on stomach content of fish to support the assessment of good environmental status of marine food webs and the prediction of MSY after stock restoration (Open call for tenders No MARE/2012/02) (39036)
In support of policies for sustainable management strategies of living marine resources, demands for integrated ecosystem advice are growing and more extensive use of long-term management plans, which are consistent with the ecosystem approach to fisheries management, is anticipated. However, long-term management plan evaluations of fish are particularly sensitive to changes in the proportion of fish removed by natural predators (natural mortality). A
prerequisite for estimating this correctly is accurate knowledge of species interactions: Who is eating whom when, where and in which quantity?

Existing stomach content data are currently used in multispecies models using historic stomach content data from before 1995. Since this period, there have been considerable changes in the predator and prey stocks of both the Baltic and the North Sea. Thus, updated information on stomach contents of the essential predators in these two areas is urgently needed.

In order to update and improve the quality and quantity of the available background data for the above mentioned multispecies models and management plans, the aim of this project is to

- conduct new stomach content analyses of Baltic cod to support our knowledge of the spatial and temporal stability of cod preferences
- conduct new stomach content analyses of Baltic whiting as well as grey gurnard, mackerel and hake collected in the North Sea to support our knowledge of potentially important predators for which the diet is presently poorly known or is expected to have changed significantly since the last sampling efforts
- compile historical data, which are existing in several institutes around the Baltic and North Sea, and convert them from paper or outdated electronic format into the necessary standard format
- incorporate the new as well as all appropriate historical stomach content information into the Baltic and North Sea stomach content databases

The end product will be updated stomach content databases for the Baltic and North Sea, which include all available information up to 2013. In the Baltic, the project will increase the number of stomachs available for modeling by more than 170%. In the North Sea, the project will increase the number of years where data are available for grey gurnard from 2 to 8, for mackerel from 2 to 6 and for hake from 0 to 1, hence substantially increasing the confidence in the temporal stability of the modeling results.

The databases will be made freely available to the scientific community and will form the basis for new estimates of natural mortality and improved long-term management plans in the Baltic and North Sea.

The project is coordinated by DTU Aqua.
Huwer, B., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Andreasen, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Haslund, O. H., Project Manager, National Institute of Aquatic Resources
27/11/2012 → 27/11/2014
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Lund University, Wageningen IMARES, National Marine Fisheries Research Institute, Thunen-Institut, Institute of Food Safety Animal Health and Environment BIOR, University of Hamburg, Cefas Weymouth Laboratory
Project: Research

Efficient and low impact gear in the Danish fishery for industrial species (GUDP Tobis) (38849)
The aim of the project was to ensure the future of the Danish industrial fisheries in the increasing demands for reduced environmental impact. The Danish industrial fisheries amount to around 800 million DKK a year in first value. The industrial fishing for sandeel, was seen threatened by a potential ban against bottom trawling in the main fishing areas at Dogger Bank in the North Sea, due to appointment of a large Natura 2000 area by UK, the Netherlands and Germany were bottom trawl could be considered to affect the conservation status of the sand habitat negatively. In addition profitability was threatened by the high vessel operating cost, considering fuel prices at the time. The objective was to develop and document a fishing method for industrial fisheries (sandeel, Norway pout and sprat) where the trawl doors don't have bottom contact and where modern materials are used in the gear and for the wire. Thus,
compared to traditional gear, an overall energy saving of minimum 30% on each kg fish caught was expected, and also the damages on the benthic fauna was expected to be reduced or eliminated.

The new pelagic gear was constructed according to specifications. It behaved as intended and could easily be operated on Dogger Bank. The new gear consisting of pelagic doors and Dynema equipped trawl has attracted considerable attention among fishers and can be considered a business success. Catch volumes (tons/hour) did not differ between the experimental and standard trawl under parallel fishing. Sandeel behavioral differences could not be identified from sonar and UV-camera recordings, and size and oil content of sandeels was not systematically different between the two gears. Calibration experiments demonstrated 24 % lower fuel consumption in the new trawl.

Bottom surveys were carried out annually from 2012 to 2014 in the North-eastern part of Dogger Bank (in the Dutch/NL EEZ) at approximately 35 meters depth. Sediment analyses showed a grain size composition dominated by fine sand mixed with small amounts of gravel, whereas fine particles comprises 1 % maximum ideal as a sandeel habitat. Grain size composition was not altered by trawling or time.

Bottom impact with new gear is estimated to be 30 % reduced compared to a similar trawl using conventional doors. Based on the side-scan sonar recordings it was not possible to distinguish differences between the two trawl types in sediment depth penetration. The foot prints left by both sandeel trawls in one year were not discernible in subsequent years. Results from the video record analyses showed especially conch and hermit crabs were more abundant soon after trawling compared to before impact. The sediment analyses revealed nearly 100 different invertebrate species many of which lives burrowed or tube building in the sand. Overall diversity did not differ significantly between transects trawled by the two gears and the non-trawled transect. Detailed analyses showed, however, that some species (fragile sea anemones, polychaetes and echinoderms) were less abundant after impact from the conventional trawl compared with the newly-designed trawl and the control transect. A few species were more abundant in the transect trawled by the conventional trawl, including some smaller crustaceans. These results suggest the newly-designed sand eel trawl has a lower impact on benthic fauna than the conventional trawl and we expect the final analyses will support these results.

The project is coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Manager, Section for Marine Living Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Madsen, N., Project Participant, National Institute of Aquatic Resources

01/01/2012 → 05/01/2015
Keywords: Research areas: Marine Living Resources & Fisheries Management & Observation Technology
Collaborators: Thyborøn Harbours Fishermen’s Association, Northsea Trawl, Thyborøn Trawldoor.dk
Project: Research

Development of sustainable technologies and modeling tools in aquaculture aiming at increasing overall production (UDTÆNK) (39030)
The project aimed at developing methods and modeling tools that may assist the aquaculture industry in expanding its production while minimizing the environmental impact.

To obtain this, the project included six work packages concerning:
- Increased production of rainbow trout by providing methods for reducing the discharge of nitrogen and organic matter.
- Increased production in net cages by providing academic guidance to social workers on concurrent production of trout and mussels.
- Improved sustainability of the industry by providing guidance on optimal system design with respect to reducing nutrient discharge.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Dalsgaard, A. J. T., Project Coordinator, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
von Ahnen, M., PhD Student, National Institute of Aquatic Resources
Letelier-Gordo, C. O., PhD Student, National Institute of Aquatic Resources
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09/07/2012 → 31/05/2015
Keywords: Research area: Aquaculture
Collaborators: Dansk Akvakultur
Project: Research

Analysis of measures for increased stability in the industrial fisheries (39027)
The objective of the project “Analysis of measures for increased stability in the industrial fisheries” has been to improve fisheries advice to ensure more stable quotas for the three main industrial species in the North Sea; sandeel, sprat and Norway pout. The means to get there was to improve data, calculation procedure and management plans by taking into account the special conditions that exist for each species.

Through an industry-scientist-manager collaboration platform initiatives were taken to a theoretically and practical cooperation, where collection and analysis of biological and fishery-based data and knowledge sharing between fisheries,
bio-economy, management and research has supported development of robust management strategies that may increase economic stability in the industry if implemented in the future.

The project is coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Mosegaard, H., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Living Resources
Pedersen, E. M., Project Manager, National Institute of Aquatic Resources
van Deurs, M., Project Participant, National Institute of Aquatic Resources
Worsøe Clausen, L., Project Participant, National Institute of Aquatic Resources
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Keywords: Research areas: Marine Living Resources & Ecosystem based Marine Management
Collaborators: Danmarks Pelagiske Producentorganisation, Danish Fishermen’s Association, Cefas Weymouth Laboratory, Association of Danish Fish Meal and Fish Oil Manufacturers
Project: Research

Selective and low impact gear for fishing live nephrops (39042)

The Danish nephrops fishery is important with an annual value of the landings of approximately 300m DDK. The quota is high as many nephrops inhabit the inner Danish waters. However, cod is a frequent by-catch which is problematic due to low cod quotas, and as a result, nephros quota is rarely fully exploited. Furthermore, nephrops are traditionally fished with bottom trawl which exert high impact on the seabed. The first aim of the project is to solve the cod by-catch issues by using trawling speed as a selective mechanism, which will take advantage of the superior swimming capabilities of cod as compared to nephrops. Lowering the trawling speed will enable cod to escape the trawl while still ensuring nephrops catch. The second aim is to design and implement a new type of trawl doors that do not touch the seabed and highly reduce impact of the sweeps. Besides, materials used for the new trawl will be produced in much lighter and stronger materials than the traditional trawls. Altogether this reduces the drag in the water and fuel consumption considerably.

Trawling at a lower speed lessens the mechanical damage to the nephrops and this enhances their chances of survival. The project will take this one step further by establishing gentle handling routines on board the ships, in addition to appropriate conditions for keeping live animals. Physiological tests will define threshold levels in relation to temperature, light and moist, and characterise the most favourable conditions for further survival. Besides optimising conditions on board the ships this knowledge will be used in relation to temporary storage and to ensure optimal conditions during transport of live nephrops to southern Europe. The final aim of the project is thus to establish an export chain of live nephrops to markets in southern Europe. This can provide the fishermen up to three times the price as compared to when landing nephrops on ice, and the price that the Danish export companies’ gain will likewise increase. Within the project we successfully developed and tested pelagic doors for use in the nephrops fishery, showing that it is indeed possible to implement these in this fishery. Using reduced speed as a way to allow escape of round fish from the trawl (i.e. reduce catch of these) did however not work as anticipated, and cannot be recommended for future practice. We tested the effects on survival of nephrops of sprinkling with fresh seawater on-board after trawling, light- and air exposure and various temperatures. Of these, air exposure and air temperature (the higher the worse) had the greatest effect on survival and in determining the period it took for nephrops to recover from post trawling and handling stress. Furthermore, a ‘one-tough’ packing system, including optimal conditions for the animals when transported, was successfully developed, tested and implemented, resulting in up to 95% survival of nephrops transported by truck to southern Europe. Finally, a manual with guidelines for optimal practice for fishery and export of live nephrops was made.

The project was coordinated by AquaMind and CATch-Fish.

The project was funded by Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Behrens, J., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Karlsen, J. D., Project Participant, National Institute of Aquatic Resources
Skov, P. V., Project Participant, National Institute of Aquatic Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Fish Biology & Aquaculture & Fisheries Technology & Fisheries Management
Project: Research

Salmon Management Plan revision (38944)

The Atlantic salmon is one of a number of species afforded special protection, along with their habitats, under the EU Habitats and Species Directive (Council Directive 92/43/EEC). This Directive provides for the creation of a network of protected sites across the EU known as ‘Natura 2000’, and includes Special Areas of Conservation (SACs) designated for salmon. In Denmark salmon is under the responsibility of the Ministry of the Environment (ME). ME has engaged DTU Aqua to update and revise the latest Danish Management Plan of Salmon (2004).

The project is coordinated by the Ministry of Environment.
Fish index for streams (39024)
One of the (many) Danish shortcomings in fulfillment of the WFD requirements is the lack of a fish-based assessment method for rivers. DTU Aqua and Danish Centre for Environment and Energy (Aarhus University) was asked by the Danish Nature Agency to make basic analyses to enable the development of a national fish index to be used to produce the WFD required water plans. The challenge was to find a method to evaluate the ecological quality of small streams with only very few fish species. Using the extensive DTU Aqua database, a single-metric system was developed and tested. The results showed that the density of 0+ trout and salmon is a well-suited indicator that reflects water quality, physical modifications and connectivity. The method has now been implemented in the legislation and is used in the national water plans alongside the intercalibrated Lithuanian index LZI that is used in larger streams/rivers.
The project was coordinated by the Danish Nature Agency.
The project was funded by the Danish Nature Agency.

Pre-feasibility study regarding establishment of hatchery facility for production of juvenile lobsters (Homarus Gammarus) (39035)
Pre-feasibility study to obtain "state of the art" knowledge and to determine the biological as well as physical requirements and economic costs for establishing a lobster hatchery at the North Sea Research Centre for restocking purposes and for public communication.
The project was coordinated by the North Sea Science Park.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Sustainable technologies to control microalgae in land based saltwater recirculating systems (39032)
Land based salt water recirculating systems is a potential alternative to fish farming in net pens. This purpose of this project was to test different solutions on how to control unwanted microalgae growth thereby addressing a potential challenges associated with land based farming.
A high degree of water reuse and the associated nutrient accumulation may favour growth of microorganisms and thereby deteriorate the biological water quality.
The project included:
- Test of improved mechanical filtration (application of pilot scale protein skimmers on small to medium sized RAS, and application of full scale 4 meter vacuum airift; an innovative treatment technique tested in full scale RAS)
- Test of chemical water treatment routines using easy degradable disinfectants (Peracetic acid, chloramine-T, hydrogen peroxide) to control and inhibit toxic microalgae,
- Test of electrochemical oxidation disinfection technology to assess the efficacy (radical formation and algicidal effects) of boron doped diamond electrodes.
Numerous batch and pilot scale experiments were made at the section for Aquaculture, Hirtshals. In addition, intensive, diurnal sampling/monitoring and analysis on location was performed on a commercial pike perch RAS facilities facing toxic algae problems.
The project is coordinated by DTU Aqua.
The project was funded by the National Environmental Protection Agency through Programme for Development and Demonstration of Bio-technologies (MUDP).
**Pilot certification of freshwater farms and sea cages (Aquaculture Stewardship Council – ASC) (39041)**

The project
- developed and tested systems and procedures for ASC certification of trout from Freshwater farms and Sea Cages
- collected and disseminated knowledge and experiences with ASC certification
- aimed at Danish ASC certified trout to be the first on the global market.

The project was coordinated by Danish Aquaculture Organization.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

**Improved farming technology to optimize production, water quality and disease prevention in model trout farms (FOOP) (38950)**

The aim of the project was to identify water quality parameters of significance to production traits and disease resistance in rainbow trout; specifically ammonia nitrogen, nitrite nitrogen, carbon dioxide, oxygen and nitrogen gas.

The project further aimed to pinpoint where in the model trout farm changes in water quality occurs. From these findings the project will attempt various rectifying actions to improve water quality. Finally, a series of experiments in collaboration with DTU Vet will clarify the importance of water quality parameters on disease resistance.

Examination of operational conditions at a number of different model trout farms showed that supersaturation with nitrogen gases was a chronic problem, and that dissolved CO2 levels were generally 2-3 fold higher than equilibrium conditions. Nitrogen supersaturation did however not occur at levels that negatively influenced production parameters (feed intake, feed conversion, and growth), however, CO2 levels were shown in laboratory experiments to negatively influence production at the observed levels. Ammonia and nitrogen levels were all within safe thresholds as verified by growth studies performed in the laboratory.

Fixed bed and moving bed biofilters each have their advantages and shortcomings. Hydraulic conditions in fixed bed biofilters caused a reduction in N turnover efficiency; however under laboratory conditions (optimal hydraulic conditions) fixed bed biofilters outperform moving bed. In site observations shown that fixed bed biofilters are also more resilient to variations in operational conditions, and are better at removing chemical therapeutants, possibly due to a higher load of organic material within the filter.

Biofilter performance was shown to be sensitive to both dissolved oxygen levels and alkalinity, but not at levels relevant for daily operation.

The project was coordinated by DTU Aqua.

This project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

**BALTFIMPA generic tool (39001)**

The objective of the BALTFIMPA project (Managing Fisheries in Baltic Marine Protected Areas) was to develop a generic decision making assisting tool to give guidance and advice on impacts of different fishing practices and gear on protected habitats and species in the Baltic Sea. This was based on a comprehensive review of the existing literature. The tool has the form of a matrix of fishing gear types against habitats and species, and includes a generic level, a detailed level and a technical level in addition to a list of the relevant literature. At the generic and detailed levels impacts are scored in traffic light categories (red, yellow, green), whereas the technical level includes summaries of actual impacts.

The project was lead by DTU Aqua.

The project was funded by the Helsinki Commission (HELCOM).
Ecological speciation in salmonids: the genomic background for the evolution of eco-morphs (38957)

Speciation is a fundamental evolutionary process continuously creating the diversity of life. Salmonid fishes have fascinated scientists for centuries due to their iconic and diverse set of habitats and eco-morphs. In addition, the salmonid lineage underwent two whole-genome duplication events that provided an enormous DNA template to support adaptive radiation and speciation. These assets make salmonids excellent model species for studying fundamental issues relating to adaptation and speciation in the wild.

This project took advantage of a unique set of replicated samples representing different migratory eco-morphs in two species of salmonids, state-of-the-art genomic techniques and novel statistical methods to

- infer the genomic extent of adaptive divergence between different migratory eco-morphs in salmonid species.
- infer the genomic architecture during the early stages of ecological speciation by comparing different ecomorphs.
- identify footprints of selection at genomic regions of importance for adapting to local environmental conditions.

Knowledge about the mechanisms and conditions required for species to evolve by adapting to new surroundings is of paramount importance for predicting future responses to climatically (or anthropogenically) induced environmental change.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

Development of genetic tools to distinguish Greenland’s cod stocks (38956)

The goal of this project is to develop genetic tools that can improve the management of Atlantic cod (Gadus morhua) in Greenland by enabling identification of separate population components. Building on results from a previous study that demonstrated pronounced population structure among cod inhabiting Greenlandic waters, we will 1) develop cost-effective DNA tests to reveal the population of origin for unknown individuals, 2) apply these tests in concrete case studies relevant for stock assessment and management advise, and 3) develop a user manual for implementing these tests in the management of cod in Greenland.

Therkildsen, N. O., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources

01/09/2012 → 30/11/2012

Keywords: Research area: Population Genetics

Collaborators: Greenland Institute of Natural Resources

Project: Research

North Atlantic climate (NACLIM) (38945)

The North Atlantic Ocean is one of the most important drivers for the global ocean circulation and its variability on time scales beyond inter-annual. Global climate variability is to a large extent triggered by changes in the North Atlantic sea surface state. The quality and skill of climate predictions depends crucially on a good knowledge of the northern sea surface temperatures (SST) and sea ice distributions. On a regional scale, these parameters strongly impact on weather and climate in Europe, determining precipitation patterns and strengths, as well as changes in temperature and wind patterns. Knowledge of these factors, and of their development in the years to come, is of paramount importance for society and key economic sectors, which have to base their planning and decisions on robust climate information.

NACLIM will contribute to this goal.

DTU Aqua is the leader of work package developing such climate services for marine ecosystems, pioneering the translation of decadal-scale forecasts of the ocean’s physical environment to forecasts of the biological environment.

There are 18 project partners in total. See http://naclim.zmaw.de/Consortium.2126.0.html

The project is coordinated by University of Hamburg, Germany.

The project is funded by EU, Framework Programme 7.

Payne, M., Project Manager, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Section for Oceans and Arctic

MacKenzie, B., Project Participant, National Institute of Aquatic Resources

Miesner, A. K., PhD Student, National Institute of Aquatic Resources

01/11/2012 → 31/01/2017

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography
**Development of a strategy for aquaculture in the Baltic Sea Region (38978) (BESTAQ)**

Development of a strategy for aquaculture in the Baltic Sea Region. The acronym is BESTAQ (Baltic Environmentally Sustainable Aquaculture) and the project was a flagship project, including a range of stakeholders along the whole value chain to provide a tool for the governments and industries for decisions for development of aquaculture as well on national as on regional level.

The project was coordinated by the Finnish Game and Fisheries Research Institute.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

01/12/2010 → 31/12/2014

**Keywords:** Research area: Aquaculture

**Collaborators:** Food Safety, Animal Health and Environment Research Institute, Lund University, Swedish National Board of Fisheries, Finnish Game and Fisheries Research Institute, County Council of Jämtland

**Project:** Research

**MISTRA Working Group for Aquaculture Research in Sweden (38977)**

The main task of the Working Group was to provide MISTRA’s Board with background information for its upcoming decision on whether the foundation should invest or not in aquaculture research. MISTRA is a Foundation for Strategic Environmental Research.

The Working Group should

- describe current Swedish aquaculture research and perform a state of the art review putting Swedish research in an international context,
- make an overview of Swedish aquaculture industry in a global context,
- briefly compare aquaculture to other food production systems,
- briefly discuss the bottlenecks for Swedish aquaculture development,
- critically analyse the arguments for why MISTRA should invest in aquaculture research (cf. MISTRA’s statutes),
- suggest scope and focus of a new MISTRA research initiative (if recommended).

The project was coordinated by DTU Aqua.

The project was funded by Swedish Environmental Strategic Research Foundation MISTRA.

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

01/08/2012 → 31/03/2013

**Keywords:** Research area: Aquaculture

**Collaborators:** Institute of Marine Research, Finnish Game and Fisheries Research Institute

**Project:** Research

**Certification of eel and other minor species (38952)**

Implementation of the “Sustainable Eel Standard” (cf. www.sustainableeelgroup.com) for sustainable production of eel in a Danish pioneer eel-farm as well as dissemination of knowledge about eel and assessment of potentials of sustainability certification of other minor species.

The project was coordinated by Danish Aquaculture Association.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

01/01/2011 → 31/12/2013

**Keywords:** Research area: Aquaculture

**Collaborators:** Danish Eel Farmers Association, Danish Aquaculture Association

**Project:** Research

**Organic Fry-1: Development of Danish farming of organic trout fry (38951)**

Research based advisory for Danish farmers for conversion and management of the first Danish farms for production of organic fry according to the EU regulation on Organic aquaculture (EC no. 710/2009, article 25e) as well as further development of the applied and scientific platform for development of organic aquaculture in Denmark.

The project was coordinated by Danish Aquaculture Association.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

Pedersen, L., Project Participant, National Institute of Aquatic Resources

01/06/2011 → 31/12/2014

**Keywords:** Research area: Aquaculture

**Collaborators:** Producers of Trout Fry, Danish Aquaculture Association

**Project:** Research
**Hiprobe: Detection of strongly histamine-producing and psychrotolerant bacteria in seafood**
Postdoc project in collaboration between the Predictive Microbiology group at DTU Aqua and DTU Systems Biology. Funded by the Danish Research Council for Technology and Production Sciences. Dalgaard, P., Project Manager, National Food Institute, Division of Industrial Food Research. Emborg, J., Project Participant, Section for Aquatic Microbiology and Seafood Hygiene. Danish Research Council for Technology and Production Sciences. 01/01/2007 → 31/03/2010. Award relations: Detection of strongly histamine-producing and psychrotolerant bacteria in seafood. Project: Research.

**Aquaponics NOMA (Nordic Marine) – New innovations for sustainable aquaculture in the Nordic countries (38987)**
A detailed study of the nutritional status of effluents from land-based fish farms as fertilizer for relevant plant species, adapt state-of-the-art technology and compare several aquaponic systems to meet the current and future challenges of both the aquaculture and horticulture industry, to develop commercial Aquaponics in the Nordic countries. The project was coordinated by Bioforsk Øst, Landvik, Norway. The project was funded by Nordforsk, Nordic Council of Ministers. Paulsen, H., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture. Jokumsen, A., Project Participant, National Institute of Aquatic Resources. Pedersen, P. B., Project Participant, National Institute of Aquatic Resources. 01/01/2012 → 01/01/2015. Keywords: Research area: Aquaculture. Collaborators: FB Aqua Nor, Aquaponics AS, Matorka, Leithbridge College, Hobas AS, Government of Alberta, Norwegian Institute for Agricultural and Environmental Research, Norwegian Institute for Water Research, Icelandic Food Research, Institute of Global Food and Farming. Project: Research.

**Pilot project: Demonstration of possible energy efficiency in a North Sea fishery using the top end technology and having the maximal selectivity and ability to document the activities (38988)**
The aim of the project is to demonstrate how the use of “best ad viable technology” in fishing gear and equipment can increase the earning for the indivial fishing vessel. The project is coordinated bt Thybore Fiskeriforening, Denmark. Larsen, E., Project Participant, National Institute of Aquatic Resources, Public Sector Consultancy. 01/01/2012 → 31/12/2012. Keywords: Research area: Fisheries Management. Collaborators: Thybore Fiskeriforening, Nekse Vodbinderi ApS, Thybøren Trawldoor.dk, Danish Technological Institute. Project: Research.

**On the road to 2020 (38984)**
The goal of the project is to combine the present information systems and documentations systems such as traceability, electronic documentation systems, environmental labeling, economic analyzing tools and different communications methods in the fish sector. The project is coordinated by DTU Aqua. Larsen, E., Project Participant, National Institute of Aquatic Resources, Public Sector Consultancy. 01/08/2012 → 31/12/2013. Keywords: Research area: Fisheries Management. Collaborators: Aalborg University, Icelandic Food Research. Project: Research.

**The Mysterious Lumpfish (Cyclopterus lumpus) (38985)**
The aim of the project is to exchange the knowledge of the lumpfish resources between the Nordic countries. There is no firm knowledge that can surport a sustainable utilization of lumpfish e.g. lumpfish roe. We exchange data of the size and age distribution of the individual fish populations. The project is coordinated by the Institute of Marine Research, Norway. Larsen, E., Project Manager, National Institute of Aquatic Resources, Public Sector Consultancy.
Economically sustainable fishery for Nephrops in Skagerrak and Kattegat (ØBJ-FISK) (38865)

Optimizing the exploitation of the resources of the sea areas Skagerrak and Kattegat is central to promote an economically sustainable development in the region. Norway lobster or Nephrops is one of the economically most important resources for the majority of the commercial fishery in the Kattegat-Skagerrak (KASK)-region where the annual first value was app. 350 million DKR in 2011. Nephrops are mainly caught in bottom trawls (95 % of the total landings), where other species such as cod and sole constitute part of the by-catch. A minor fishery with creels – partly commercial and partly recreational – takes place along the Swedish and Norwegian coast in areas that are generally inaccessible to the trawlers. Taking into account the majority of the Nephorps landings in the KASK region are sold directly to the local fish processing industry or are sold directly in the local areas, the total socio-economic value is much higher than the first value.

In later years, there has been a shift towards an ecosystem-based management e.g. through the NATURA2000 regulations or the Community Action in the field of Marine Environmental Policy. The consequence of this shift is that the focus is no longer on the state of single species but on the entire marine ecosystem. This has led to regulations aiming at reducing discard of unwanted catch as well as reducing the impact of fishing on vulnerable habitats. Regulations that among other things include a discard ban (implemented for Skagerrak by Norway, Denmark and Sweden in 2013), area closures, reductions in number of days at sea, and minimization of unwanted by-catch, have caused uncertainty in the fishing industry and limits the possibilities of exploiting the resource maximally. To ensure an economically sustainable growth of the Nephrops fishery in the KASK region, an increased collaboration between science and industry is needed as is innovation in the design of low impact fishing gears and a reliable stock assessment.

The project aimed at:
- Establishing a platform where the industry, the science, and the managers could work together to identify the challenges that restrain an optimal exploitation of the Nephrops resource
- Establishing a knowledge based collaboration to identify low impact fishing methods that may lead to future economically sustainable growth in the KASK region
- Improving the biological knowledge on which the stock assessment is based - Increasing the reliability of the stock assessment.

The project was coordinated by DTU Aqua.

The project was funded by EU, InterReg (regional collaboration).

Perspective analysis of sustainable aquaculture in the Nordic countries (PABAN) (38986)

A broad description of the status of aquaculture for each of the Nordic countries to form the basis for Nordic perspectives with recommendations to the political government on how to include aquaculture in the picture of obtaining green development, industry development and common synergies and use of comparative benefits. A SWOT analysis was developed for each country/region as basis for the perspectives. The report was presented to the Nordic Ministers of fisheries affairs at the Nordic Ministers annual meeting in Trondheim 2012.


The project was coordinated by SINTEF Fisheries and Aquaculture, Norway.

The project was funded by Nordforsk, Nordic Council of Ministers.

Perspective analysis of sustainable aquaculture in the Nordic countries (PABAN) (38986)
**Eastern-western Baltic cod: Improved management based on stock discrimination of eastern and western Baltic cod (Øst-Vesttorsk) (38989)**

The aim of this project was to improve the management of western Baltic cod by incorporating stock identification routines in order to discriminate between eastern and western Baltic cod stocks.

In recent years, evidence from fishery patterns and otolith structures have indicated an increasing degree of mixing between the two cod stocks which up until 2013 were managed as two separate stocks. Changes in fishing pressure and patterns would therefore result in a risk for local depletion of the smaller western stock.

Stock identification methods were based on established approaches using genetic discrimination and otolith shape analysis, and improved by linking these methods. This method provides a tool to estimate the degree of stock mixing using the existing otolith archives. This approach documented an increase of eastern Baltic cod from 30% to > 80% in the eastern part of the western Baltic Sea management area. As a consequence of this stock mixing, a new procedure incorporating stock mixing on an annual basis was set in place in 2016 with the aim to improve stock exploitation and reduce the risk of local depletion. The knowledge gained also influenced recent management regulations, particularly a prolongation of the spawning closer of the fishery in 2016.

The project was coordinated by Centre for Environment, Fisheries & Aquaculture Science, UK.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Hüssy, K., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
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Meldrup, D., Project Participant, National Institute of Aquatic Resources

27/06/2011 → 29/03/2013

**Keywords:** Research areas: Marine Populations and Ecosystem Dynamics & Marine Living Resources & Population Genetics & Fisheries Management

**Collaborators:** Cefas Weymouth Laboratory

**Project:** Research

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**Development of a sorting grid for the Danish Norway pout fishery (38954)**

The objective of the project was to ensure a sustainable Danish fishery for Norway pout through the development of a sorting grid that minimizes unwanted by-catch.

Through a series of grid designs and tests, the project:
- developed a durable and easy-to-handle grid which can sustain the large strains on gear and decks equipment typical of the Norwegian pout fishery.
- identified an optimal bar spacing for the grid, that reduces by-catch to the extent possible without jeopardizing the rent ability of the fishery through large losses of target species.

As a consequence of the scientific work in the project a sorting grid-system was made mandatory in the Danish trawl fishery for Norway pout to reduce unwanted by-catch (Danish legislation in 2013).

The project was coordinated by Danish Fishermen's Association.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Eigaard, O. R., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Hermann, B., Project Participant
Andersen, H., Project Participant, National Institute of Aquatic Resources

20/09/2011 → 31/12/2012

**Keywords:** Research area: Fisheries Technology

**Collaborators:** Danish Fishermen's Association

**Project:** Research
Reactivity of terrestrially derived dissolved organic matter in aquatic systems - relation to molecular composition and bacterial community structure (38927)

Aquatic systems play a significant role in transforming, remineralizing and sequestering, terrestrially derived organic matter (tDOM). The prevalence of tDOM in aquatic systems is a forcing factor affecting light climate, species distributions, productivity and biogeochemical cycles in freshwater systems and many coastal and marine systems. Despite the significance of tDOM for the function of aquatic systems and global biogeochemical C cycling, we are only beginning to understand the quantitative and qualitative aspects of aquatic tDOM processes. A key to a better understanding of the role of tDOM is compound level information on the distribution and reactivity of tDOM.

The objectives with the project were to:

- examine which molecular size fractions of DOM are available to degradation processes such as flocculation/sedimentation, photooxidation and bacterial utilization and hence how reactivity of tDOM connects to molecular composition.
- determine if bacterial community structure in different systems alter the molecular size distribution of tDOM differently.

In essence, the project addressed if and how the molecular composition of tDOM and the structure of bacterial communities determine the fate of tDOM in aquatic systems.

The project was funded by the Swedish Research Council.

Stedmon, C., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
01/01/2011 → 31/12/2013

Keywords: Research area: Oceanography
Collaborators: Lund University, Uppsala University
Project: Research

Cruise with RV Dana. North Atlantic-Arctic Ocean Coupling: Deep water overflows and surface water outflow (NAAO) (38928)

This cruise was planned as an essential part of the Danish contribution to oceanographic fieldwork as part of the NAACOS project (2011-2014), funded by the Strategic Research Council.

The main objectives of the cruise were to obtain a comprehensive suite of physical, chemical and biological oceanographic measurements across the East Greenland shelf, extending into the Greenland Sea, and to study the deep-water overflow in the Denmark Strait.

The data collected on this cruise formed the basis of validating and improving circulation and ecological models in the region and developing new approaches to tracing freshwater and organic carbon exported from the Arctic.

The project was funded by the Danish Center for Marine Research.

Stedmon, C., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2012

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Copenhagen, Greenland Institute of Natural Resources
Project: Research

Optical properties of Greenlandic coastal waters: modeling light penetration in a changing climate (38931)

The availability and spectral quality of light are key parameters controlling the productivity of Greenlandic coastal waters. Although solar elevation and sea ice cover play an important role, light is also regulated by water constituents (e.g. organic matter, phytoplankton and suspended sediments). Changing ocean circulation patterns and enhanced glacial melt stand to considerably alter the underwater light environment. This project will develop a 1D model for spectral light attenuation based on field measurements planned in two contrasting fjord systems. Results will provide valuable ground-truth data for remote sensing applications and more accurate description of the light environment for hydrodynamic models.

The project is coordinated by DTU Aqua.

Stedmon, C., Project Coordinator, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2011 → 31/12/2012

Keywords: Research area: Oceanography
Collaborators: Aarhus University
Project: Research

Better use of nutrition resources for sustaining aquaculture production in Central Vietnam under climate change condition (SANSIV) (38975)

The main objective of the project is to contribute to the sustainable development of coastal aquaculture in Central Vietnam under climate change condition through better use of available nutrition resources. ARSINC (Aquaculture Research Sub-Institute for North Central (ARSINC), under Research Institute for Aquaculture) No.1 (RIA1) in Vietnam is the applicant and main responsible while DTU Aqua is the Danish partner. The immediate objectives of this project are:

- Better use of nutrition resources by developing cost-effective formulated feeds for permit (Trachinotus falcatus) and by application of non-feed based and improved integrated aquaculture models as adaptive practices in coping with the impacts
of climate change in Central Vietnam.

- Propose and disseminate adapted aquaculture options to farmers, authorities and other stakeholders in response to climate change conditions.

The project management and coordination have so far been in good status. Overall the project made appropriate progress toward achievement of the project’s objectives. Reports on analysis of aquaculture system in Central regions including coastal farmer’s livelihood and vulnerability to climate change were finalized. The reviews on known environmental effects of traditional diets for fish farming are on their final stage. Workshop on adaptive aquaculture techniques and models in response to climate change conditions was proposed and a recommend policy was organized. These are served for proposing both adaptive aquaculture techniques/models and policies for local authorities. Through training courses and study tours adaptive aquaculture techniques/models have been introduced to local farmers and extension workers.

Regarding to development of cost-effective grow-out pellet feed for the selected commercial carnivorous fish species – pompano (Trachinotus falcatus) as case study to replace fish in response to global limitation of fish meal and fish oil, all original planned experiments have been completed. Additional experiments required for PhD student’s study will be carried out and finished within 2016. Experiments/trials on farming techniques for non-feed based species (hard shell clam Meretrix lyrata, macroalgae Kappaphycus alvarezi) and integrated multi-trophic (shrimp and seaweed) have completed.

There have been 5 published articles, of which one article was published in an international peer review journal as the result of joint contribution between Vietnamese and Danish scientists.

All 3 MSc students from Aquaculture Research Sub-Institute for North Central (ARSINC - responsible institute) have finished their education through participation in project experiments by the end of 2015. These MSc staff will contribute to building research capacity and sustainability for ARSINC. Addition, one MSc student from Department of Science and Technology, Nghe An province, was also educated through participation in project experiments. This project was coordinated by Aquaculture Research Sub-Institute for North Central, Research Institute for Aquaculture, Vietnam.

The project was funded by EU, Framework Programme 7.

Lund, I., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Steenfeldt, S. J., Project Participant, National Institute of Aquatic Resources
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources

01/10/2012 → 01/10/2015

Keywords: Research area: Aquaculture
Collaborators: Aquaculture Research Sub-Institute for North Central, Aalborg University
Project: Research

Development and demonstration of Marine Strategy Framework Directive (MSFD) tools for harmonization of the initial assessment in the eastern parts of the Greater North Sea sub-region (HARMONY) (38894)

The HARMONY project has developed and made available a toolbox supporting national MSFD implementation with special focus on issues of a transnational relevance and importance. It builds on cooperation among member states sharing the Greater North Sea sub-region through active involvement in several OSPAR groups. The tools are based on respecting the needs for national flexibility, while ensuring the necessary regional harmonization of key elements under the marine strategies.

The project partnership met these challenges through four development/harmonization activities and a coordination and information activity:

1) To develop and demonstrate a tool supporting an analysis of essential features and characteristics leading towards an integrated assessment building upon the criteria identified in the Commission Decision, while ensuring the necessary linkage to existing work under the Regional Sea Conventions as well as existing EU legislation (WFD, Natura 2000).
2) To develop and demonstrate a tool (a pressure and an impact index) supporting an analysis of the predominant pressures and impacts on the ecosystems, including those impacts of human activities for the Greater North Sea marine sub-region.
3) To provide examples on the linkage of effects and human pressures to informed ecosystem-based marine strategies (based on activities 1 and 2).
4) To establish and support the active cooperation among member states sharing the Greater North Sea sub-region enabling comparisons and harmonization, where relevant and possible, between national efforts in preparing the initial assessment, elaborate the criteria including identification of indicators and target setting, and further on, the preparation of the monitoring program and the program of measures within the Greater North Sea sub-region.

DTU Aqua has focused on biodiversity of fish and fish populations, mapping fishing pressures and ecosystem components of the project working area (North Sea).

The project was coordinated by Department of Bioscience, Aarhus University, Denmark.

The project was funded by the Danish Ministry of Environment.

Sørensen, T. K., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Vinther, M., Project Manager, National Institute of Aquatic Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Hartvig, M., Project Participant, National Institute of Aquatic Resources

01/01/2010 → 01/01/2012

Keywords: Research area: Ecosystem based Marine Management
Collaborators: Swedish Agency for Marine and Water Management, Aarhus University, German Federal Environment Agency, Institute of Marine Research, DHI Water - Environment - Health, Swedish Meteorological and Hydrological Institute, Norwegian Institute for Water Research, Climate and Pollution Agency
**Best available technology applicable to traditional pond farms (38811)**
As a consequence of environmental concerns – also following the Water Framework Directive legislations – traditional Danish pond farms need to install and operate (affordable) technology to reduce environmental impact from fish farming. In this project the best available technology applicable to traditional Danish flow-through pond farms was assessed and defined. Different technologies were installed/evaluated on selected farms and environmental effects were analysed, evaluated and discussed. Based on the study the best available technology and its applicability and effects on traditional farms was established, and the environmental authorities were supplied with details regarding what can realistically be done on this type of farms.

Nutrients (N & P) as well as organics, the pollutants most immediately relevant to the watercourse in such farms, were considered in the assessment.

The project was coordinated by Danish Aquaculture Association, Denmark.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Manager, National Institute of Aquatic Resources

01/01/2011 → 01/01/2013

Keywords: Research area: Aquaculture
Collaborators: Aarhus University, Danish Aquaculture Organisation

**Understanding the mechanisms of stock recovery (UNCOVER) (38104)**
The UNCOVER project has produced a rational scientific basis for developing Long-Term Management Plans (LTMP) and recovery strategies for 11 of the ecologically and socioeconomically most important fish stocks/fisheries in the Norwegian and Barents Seas, the North Sea, the Baltic Sea and the Bay of Biscay and Iberian Peninsula.

UNCOVER's objectives were to:

(i) identify changes experienced during stock depletion/collapses,

(ii) to understand prospects for recovery,

(iii) to enhance the scientific understanding of the mechanisms of fish stock/fishery recovery, and

(iv) to formulate recommendations how best to implement LTMPs/recovery plans.

The project recommends that such plans ideally should include:

(i) Consideration of stock-regulating environmental processes,

(ii) Incorporation of fisheries effects on stock structure and reproductive potential,

(iii) Consideration of changes in habitat dynamics due to global change,

(iv) Incorporation of biological and technological multispecies interactions,

(v) Integration of economically optimized harvesting,

(vi) Exploration of the socio-economic implications and political constraints from existing and alternative recovery plans,

(vii) Investigations on the acceptance of plans by stakeholders and specifically incentives for compliance by the fishery,

(viii) Agreements with and among stakeholders.

UNCOVER has provided imperative policy support underpinning the following fundamental areas:

(i) Evolution of the Common Fisheries Policy with respect to several aims of the ‘Green Paper’;

(ii) Contributing to the Marine Strategy Framework Directive with respect to fish stocks/communities;
The project was coordinated by Institut für Ostseefischerei, Bundesforschungsanstalt für Fischerei, Germany. Köster, F., Contact Person, National Institute of Aquatic Resources
Neuenfeldt, S., Project Manager, National Institute of Aquatic Resources
MacKenzie, B., Project Manager, National Institute of Aquatic Resources
Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Payne, M., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Stettrup, J. G., Project Participant, National Institute of Aquatic Resources
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources

Keywords: Research areas: Marine Living Resources & Fish Biology
Collaborators: Christian-Albrechts-Universität zu Kiel, Federal Research Centre for Fisheries, Instituto Español de Oceanografía, University of Aberdeen, Nikolai M. Knivpich Polar Research Institute of Marine Fisheries and Oceanography, Aalborg University, Cefas Weymouth Laboratory, University of Portsmouth, IFREMER, University of Bergen, Institute of Marine Research, Sea Fisheries Institute, Nederlands Instituut voor Visserij Onderzoek b.v., Marine Laboratory, Marine Research Unit, Marine and Food Technological Centre, University of Hamburg
Project: Research

Implementation of Global Certification (Aquaculture Stewardship Council - ASC) for rainbow trout and assessment of sustainable certification of new species (38809)

Aquaculture is globally the fastest growing food producing sector. However, to continue that trend requires efficient solutions to negative environmental and socioeconomic impacts that may be associated with aquaculture production. This project aimed to support the process of global certification of rainbow trout, i.e. to develop global, measurable, performance-based, and transparent standards that minimize negative environmental and social impacts from farming of trout in fresh water and maintain economic sustainability of trout production. The basis was the current types of production and strategies for farming of rainbow trout in fresh water in Denmark from the embryonic stage to marketable size and broodstock fish. Also included were the principles and the main national and EU regulations related to fish farming as well as issues related to feed, veterinary health conditions, and use of antibiotics and therapeutants. Production facilities included the design and construction, of the various types of fish farms (i.e., traditional farms, model trout farms, and Fully Recirculation Aquaculture (FREA) systems). Finally, farming of organic trout in Denmark and the related regulations affiliated with the organic label were included. The project was part of the Aquaculture Trout Dialogue facilitated by World Wide Fund for Nature (WWF) to develop the certification standards in cooperation with the other partners. Once the certification standards were fixed the Aquaculture Stewardship Council (ASC) became responsible for the certification of the produces.

The project was coordinated by Danish Aquaculture Association, Denmark.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture

01/09/2010 → 01/04/2012

Keywords: Research area: Aquaculture
Collaborators: Aarhus University, World Wide Fund for Nature (WWF), Danish Aquaculture Organisation
Project: Research

North Atlantic - Arctic coupling in a changing climate: Impacts on ocean circulation, carbon cycling and sea-ice (NAACOS) (38888)

Climate change is most pronounced at high latitudes, with rapid and dramatic changes observed in sea-ice coverage, circulation and the ecosystem. These changes have profound effects both at the regional scale as well as globally. The North Atlantic and Arctic Ocean are the headwaters of the thermohaline circulation (THC), the global heat engine responsible, amongst other things, for the relatively mild climate we experience in Denmark. Subtle change in sea-ice formation, deep water circulation, and freshwater supply on a relatively local scale will have repercussions around the world. More subtle still are the feed-back controls these processes have on climate change. Sea-ice coverage and the earth’s albedo is one feed-back, but there is also the draw down and sequestering of atmospheric CO2 in deep waters by physical and biological processes. The whole is an intricate weave of interrelated mechanisms: the scientific challenge to draw together expertise across disciplines to address these issues was accomplished; the strategic outcome was a suite
of knowledge-based tools designed to reduce the uncertainty and contribute to climate policies.
The NAACOS team comprised a number of well-recognized scientists with profound experience and a significant international collaboration. NAACOS developed and refined oceanographic models using remote sensing and observations to evaluate the impact of high latitude climate change on circulation, deep water formation, sea-ice and carbon flux, and their implications at regional scales.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Council for Strategic Research and a DHI student stipend.

Visser, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2014

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources
Collaborators: Aarhus University, Danish Meteorological Institute, DHI Water - Environment - Health, University of Copenhagen, Faroe Research Institute
Project: Research

Arctic plankton in a changing climate (38783)
Climate change impacts the marine arctic environment through changes in ice cover, ice thickness, irradiance, freshwater outflow, concentrations of nutrients and CO2 and the stratification. These factors determine the production, seasonality and fate of the planktonic primary production in the marine ecosystem. Plankton is fueling stocks of fish, marine birds and mammals and through that constitutes the base of the Greenlandic economy.
The aim of the project was to gain knowledge about the interaction between climate, oceanography and plankton in the vulnerable Greenlandic marine ecosystem through field and laboratory experiments. The project was interdisciplinary and closely coordinated with the other projects under the Greenland Climate Research Centre.
The project was funded by the Commission for Scientific Investigations in Greenland (KVUG), Greenland Climate Research Centre, Danish Centre for Marine Research, and Carlsberg Foundation.
The project was coordinated by DTU Aqua.
Nielsen, T. G., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Dutz, J., Project Participant, National Institute of Aquatic Resources
Kjellerup, S., Project Participant, National Institute of Aquatic Resources
Swalethorp, R., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2014
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, Greenland Institute of Natural Resources
Project: Research

Influence of ecological dynamics and climate change on the marine environment in Danish waters (ECODYN) (38136)
The environment in the open Danish waters is controlled by a complex interplay between physical and biological processes, and it is therefore difficult to determine the exact cause of changes in the environment. This is also the situation for hypoxia, which is caused both by nutrients from sources ashore, by ecological dynamics of the waters, and by the flow in Kattegat and the Belts. This project examined the marine environment through three-dimensional numerical models which describe both physical and biological processes. In parallel, laboratory experiments clarified how temperature affects the biological rates at or near the sea floor. This was used to model the response of the ecosystem to the temperature increases which are expected as a result of climate change, and the future consequences for the marine environment were analyzed.
Through model simulations and oxygen measurements from ships and buoys, the biological processes leading to hypoxia were determined with the so far highest resolution in time and space; this contributed significantly to the understanding of the functioning of the ecosystem in this area.
The connection between the state of the marine environment and the abundance of fish was analyzed, focusing on the distribution and spawning regions of cod, in relation to the oxygen conditions in the inner Danish waters and in the Baltic Sea. Thereby, the project provided a description of interconnections between the ecosystem, the water flow, and the effects of a changing climate.
The project was coordinated by Department of Bioscience, Aarhus University, Denmark.
The project was funded by the Danish Council for Strategic Research.
Thygesen, U. H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 01/04/2012
Keywords: Research areas: Marine Living Resources & Oceanography & Marine Populations and Ecosystem Dynamics & Fish Biology
Development of cultural banks to produce mussels in the Limfjord (3418)
The aim of the project is to initiate a targeted research and development of cultivation of blue mussels in bottom cultures, by use of relaying and transplanting techniques, as this area-intensive form of production in the future will be the most productive and sustainable methodology. It will be tested whether bottom cultures can be established by stimulating natural spat fall by improving the substrate. The knowledge generated will partly facilitate the optimization of production methods and partly form the basis for developing a management plan for mussel production, including bottom culture cultivation.

The project was coordinated by DTU Aqua.
Dolmer, P., Project Manager, National Institute of Aquatic Resources
Kristensen, P. S., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2006 → 31/12/2007
Keywords: Research areas: Coastal Ecology & Shellfish and seaweed
Collaborators: Danish Shellfish Centre, Danish Fishermen's Association, Danish Centre for Environment and Energy
Project: Research

Integrated management of agriculture, fishery, environment and economy – a strategic research alliance (IMAGE/MAFIA) (38772)
Background and Objectives
Management of terrestrial and aquatic ecosystems is legally defined in several European directives. The scientific basis for implementing the directives has been limited by insufficient models, deficiencies in terms of uncertainties, local and regional aspects and lack of knowledge on the interplay between agriculture, fishery, environmental qualities in all surface waters, and economy. The project aimed to establish an interdisciplinary and international approach designed to establish a body of knowledge to develop tools, models, scenarios and predictions in order to integrate science and management from agriculture, fishery, aquatic environments and economy into a common platform. The main aims were to link the complex interplay between land use in the drainage basins, the transport of nutrients to water bodies, biogeo-chemistry of freshwater and marine water, marine ecosystem dynamics and the removal of biomass and nutrients in marine fisheries all integrated into a management strategy evaluation (MSE) framework consisting of linked catchment area and river-run-off models, marine bio-geo-chemical models, end-to-end marine ecosystem models, fishery models, economic and cost-minimization models, and ecosystem services assessments models. Such a complex model and MSE framework could be used to assess effects of changing market conditions, changed agricultural and fishery support policies, as well as fulfillments of water related directives.

Tasks and Deliverables
The Danish Strategic Research Council financed project IMAGE was a strategic research alliance between central Danish and international fisheries and marine environment based university institutes. The project integrated, educated, and trained new researchers and private and public end-users to develop and work with a number of empirical and dynamic models and management tools, further developed into cross traditional media and science-based decision support systems, to strengthen national and international environmental management. The results published in a high number of scientific peer reviewed articles have provided major scientific progress. The results and research quality included analyses of novel processes and development of new and improved models, integrated prognoses and scenarios for the interplay between changes in the drainage basins and the ecological and economic consequences, and a number of science-based decision support tools. The work involved (i) identification of key elements and reduction of uncertainties in using complex models, (ii) designing, developing and integrating important new concepts in the models, (iii) linking models and evaluating their ability to detect and follow changes in terrestrial environments into ecological and economic consequences, and (iv) strengthened Danish research in linking science, modeling and management of the environment and economy and thereby consolidating a strong international position. The DTU Aqua has focused on further development, implementation and validation of advanced models and fisheries and ecosystem management evaluation tools: Development, calibration and implementation of the Baltic ATLANTIS end-to-end ecosystem and tropho-dynamic model linked to the HBM-ERGOM physical and bio-geo-chemical models and the FISHRENT fishery economic model; Further development and implementation of the bio-economic and individual vessel based multi-stock-multi-fleet DISPLACE simulation model; Dynamic coupling of the Baltic FLR multi-stock-multi-fleet bio-economic model to the SMS-Multi-Species model. The focus has been on biological interactions and integrated fisheries interactions.

Partners
The project had 12 project partners mainly from Danish universities (AU, DTU, KU, SU) and national fisheries economics and fisheries research institutes (SMHI Sweden), but also from American, Swedish and Finnish universities as well as SMEs (e.g. DHI). The project was coordinated by Aarhus University. DTU Aqua was main project developer, WP4 leader and member of the Project Steering Group.
This project was funded by the Danish Council for Strategic Research.
Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Genetic and genomic approaches to the study of Atlantic eels: Speciation, genetic population structure and footprints of selection (38875)

Anguillid eels, including European (Anguilla anguilla) and American eel (A. rostrata) have fascinated scientists for centuries. At the same time, their geographical distribution and life cycle make them highly suitable study objects to address fundamental issues in evolutionary biology related to speciation and adaptation.

In this project, we made use of unique samples of eel larvae collected in the Sargasso Sea during the Galathea 3 expedition. Novel genomic resources generated by 454 massively parallel sequencing and novel statistical methods were used for:

- testing if the two species represent sympatric speciation.
- analysing the demographic history of the species, comparing present declines to historical population declines.
- testing whether or not European eel is panmictic, despite widespread geographical distribution of adult eels in continental Europe and North Africa.
- testing whether the distribution of both species across subarctic to subtropical environments reflects extreme phenotypic plasticity or footprints of temperature-related selection is evident at the genomic level.

Scientific papers reporting results generated from this project include:

- Als, Thomas Damm; Hansen, Michael Møller; Maes, Gregory E.; Castonguay, Martin; Riemann, Lasse; Aarestrup, Kim; Munk, Peter; Sparholt, Henrik; Hanel, Reinhold; Bernatchez, Louis. 2011. All roads lead to home: panmixia of European eel in the Sargasso Sea. Molecular Ecology, Vol. 20, 1333-1346.

The project was coordinated by Department of Biological Sciences, Aarhus University.

The project was funded by the Danish Council for Independent Research.

Marine protected areas as a tool for ecosystem conservation and fisheries management (PROTECT) (38095)

1) To evaluate the potential of MPAs as a tool to protect sensitive species, habitats and ecosystems from the effect of fishing.

2) To outline and develop monitoring, assessment and management tools for MPAs that can assess: a) the impact of fisheries on marine ecosystems, b) the effect of different levels of protection and c) the impact and socio-economic effects of MPAs on fishing communities.

3) To facilitate linkages between science and management in the areas of: a) MPA design and implementation, b) timing and level of stakeholder involvement and c) management effectiveness and adaptability.

The project was coordinated by DTU Aqua.
Modelling the impact of hydrography and lower trophic production on fish recruitment (MODREC) (38114)
The recruitment of fish stocks is strongly influenced by fluctuations in climate and physical environment leading to strong and seemingly unpredictable year-to-year variations in year class strength. The aim of this project is to develop a model framework for conducting detailed recruitment studies on fish stocks. The framework will be applied for two commercially important fish stocks: sprat and sandeel, in order to improve the understanding of climate effects via bottom-up control and explain the observed high variability in reproductive success in these stocks. The framework will be built on existing hydrographic models by adding descriptions of primary and zooplankton production.

The project is coordinated by DTU Aqua.
Andersen, K. H., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Christensen, A., Project Participant, National Institute of Aquatic Resources
Frisk, C., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
01/01/2007 → 31/12/2009
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, Danish Meteorological Institute
Project: Research

Development of ecological sustainable fisheries practices in the Benguela Current Large Marine Ecosystem (EcoFish) (38847)
EcoFish promotes the ecosystem approach to fisheries (EAF) and is conducted in the Benguela Current Large Marine Ecosystem (BCLME), encompassing fish stocks from Angola, Namibia and South Africa. The objectives are:
1. Adaptation of state-of-art assessments methods and Marine Protected Areas (MPA) planning tools
2. Validation or modification of current assessment practices based on spatially explicit analyses
3. Incorporation of stakeholders’ knowledge in data collection and analysis
4. Strengthening of regional capacity to apply the developed assessment tools on a regular basis.
The project represents a paradigm shift compared to DTU Aqua 20 years of FAO/Danida courses in the 80’s and 90’s, where fish stock assessment was taught in 85 countries by using comparative simple techniques. In contrast EcoFish applies advance stock assessment methodology based on open access, web-based state space (SAM) and geostatistical (GeoPop) tools. Thus the capacity building involved also includes a focus on DTU Aqua because of similar ongoing challenges in the Nordic seas, and two DTU Aqua PhD projects are integrated in EcoFish.
Focus in Ecofish is on hake, horse mackerel and sardinella, coordination to important donor projects in the area such as the Norwegian climate project NansClim and EAF-Nansen is ensured through the leadership of Benguela Current Commission. There are potential synergies to several EU projects (FP6 IMAGE, FP7 MEECE and FP7 FACTS) as well as national projects such as Sunfish (Description of the life cycle and recruitment of cod) and REX/RESOURCE (fishermen-science collaboration on cod in the North Sea). The potential database for BCLME is unique and EcoFish offers the possibility for developing a master example to be used as a generic tool in African Large Marine Ecosystems as well as the large lakes.
The project is coordinated by Benguela Current Commission, Namibia.
The project is funded by EuropeAid.
Beyer, J., Project Manager, National Institute of Aquatic Resources
Köster, F., Project Manager, National Institute of Aquatic Resources
The project was funded by the Danish Council for Strategic Research. The project was coordinated by DTU Aqua.

extrapolations of observed historical trends to predict the likely outcome of climate change on the North Sea ecosystem. The project provided an integrated modelling framework for developing sustainable fisheries management strategies superior to using simple stochastic multispecies fisheries model to make it account for climate effects on fish ecology. The project provided an models. The sustainability of exploitation under changing climate conditions were examined by modifying an existing marine mammals were studied in detail. Their spawning, egg and larval drift, juvenile and adult distribution, growth and feeding, growth and survival of commercially exploited fish at all stages of life. Without improved knowledge about the effect of climate on the basic biological processes involved in fish production, it will be increasingly difficult to separate the effects of fishing from those of environmental fluctuations and change, identify biological reference points, and to develop management strategies for sustainable fisheries. By combining models of the effects of climate on the hydrographical and biological processes important for fish production with models of fish stock dynamics and fishing, the project provided a basis for improved predictions of the effects of climate change on the sustainable exploitation and maximum yield of North Sea fish stocks. The dynamics of cod (a top predator), herring and sandeel (two important prey for fish), seabirds and marine mammals were studied in detail. Their spawning, egg and larval drift, juvenile and adult distribution, growth and survival were investigated through experiments, statistical analyses of collected data and advanced bio-oceanographic models. The sustainability of exploitation under changing climate conditions were examined by modifying an existing stochastic multispecies fisheries model to make it account for climate effects on fish ecology. The project provided an integrated modelling framework for developing sustainable fisheries management strategies superior to using simple extrapolations of observed historical trends to predict the likely outcome of climate change on the North Sea ecosystem. The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Strategic Research.
**Limfjord regime shift (38181)**

The aim of the project was to reveal causes and mechanisms related to a regime shift in the Limfjord, including the relationship with nutrient loading and fish production in the Limfjord. Furthermore management scenarios for ensuring good environmental conditions and sustainable use of the living resources would be examined and discussed. DTU Aqua’s share of the project was through models to demonstrate a regime shift and to explore potential causes of this. The project made it possible to combine different types of data across sub-basins with different physical-chemical conditions and trophic groups and to explore various methods. We chose to use an Integrated Trend Assessment approach and a series of statistical tests were applied (sequential t-test analyses of regime shifts (STARS), principle component analyses (PCA), STARS on PCA scores and Chronological Clustering). A Traffic Light Plot was used to visualize changes in the ecosystem. A regime shift was identified starting in 1990 and fully developed by 1996. It impacted the whole food-chain structure in the fjord. Possible causes were identified as climatic causes (temperature, salinity and wind) and eutrophication (nutrient N, P loadings and bottom oxygen conditions). To a lesser extent fishery of demersal fish species could also have been a contributory factor. The regime shift caused a decrease in the fishery of large demersal fish, whereas there was a general increase in the stock size of pelagic and small demersal fish species, crustaceans (crabs, lobster), echinoderms, starfish and jelly fish. After the regime shift primary production in the water column decreased. In the present project it was not possible to determine if the decrease in large demersal fish stocks was caused by failure in recruitment or by over-fishing. At the management level it was pointed out that it was important to study sub-basins of the fjord due to the high variation of parameters between sub-basins. The fundamental changes that had occurred in the system further suggested that it may not be possible for the system to revert back to its original condition even if the nutrient loadings were brought back to their original levels. However, this needs to be further investigated.

The project was coordinated by DTU Aqua.

**Center for Ocean Life (COOL) - a Villum-Kahn Rasmussen Centre of excellence for the study of life in a changing ocean (38960)**

Our goal is to develop a fundamental understanding and predictive capability of marine ecosystems through the use of novel trait-based approaches and models.

The Centre is organized around three main research activities:
- Identification and mechanistic description of the traits and trade-offs required to characterize the main Darwinian missions (feed, survive, reproduce) of the various life forms in the ocean through experimental and theoretical work, as well as analysis of literature data.
- Models: scaling of individual behavior to population and ecosystem dynamics through the development of trait-based models.
- Testing model prediction by comparing to observed trait patterns in the ocean.

The Centre involves biologists, physicists, chemists, and mathematicians and has a very strong training component through the supervision of master students, and about 30 PhD and postdoctoral fellows as well as by offering PhD summer schools and organizing international workshops. The Centre in addition host many visiting students and scientists.

The Centre is lead by DTU Aqua.

The project is funded by the Villum Kahn-Rasmussen Foundation (Velux Foundations) as well as through various national and European fellowship programs (Research Council, H.C. Ørsted Fellowship programme, Marie Curie, Carlsberg Foundation, etc).
Fehmarn Belt science provision project: Fehmarn Belt fish and fisheries and related environmental investigations (38669)

Objectives and Background
The purpose of the project was to investigate the main exploited fish stock and fisheries dynamics in relation to the marine environment with focus on the Fehmarn Belt area in the Western Baltic Sea, and to provide science and research based investigations and results, as well as reports and scientific peer reviewed journal papers on this. The work was associated to the scientific baseline investigations (2009-13) and impact assessment of the projection of the Fehmarn Belt Fixed Link between Denmark and Germany involving a science cooperation between DTU Aqua, Thünen-Institute and Femern Bælt A/S in order to generate knowledge on potential impacts of establishment of the fixed link. Focus was on the most important commercial fisheries and fish stocks in the area (cod, herring, and sprat, but also flatfish and eels).

Tasks and Deliverables
The work covered WP0: Prospecting, planning and development of the investigations, producing outline and main contents of the science provision contract and coordination of tasks hereunder with DTU Aqua as inter-national project coordinator; WP1: Review of knowledge: Review, provision of data, and analyses of selected historical data on fish stock and fisheries dynamics; WP2: Extension of existing, standard research surveys and linking to standardsurvey time series to detect potential effects on important fish stocks; WP3: Evaluation of potential integrated effects on important fish stocks and fisheries; WP4: Evaluation of potential effects of change and variability in hydrographic features and conditions on recruitment for important fish stocks (cod, herring, sprat); WP5: Evaluation of occurrence and migration as well as separation of spring and autumn spawning herring stock components in the area.
WP1 included provision of state of the art knowledge from historical surveys and review of quality of survey indices, commercial fisheries data, and information on recruitment dynamics with emphasis on fluctuations in distribution and productivity with respect to environmental and anthropogenic drivers of change including species interactions and fisheries.
WP2 included extension of existing standard surveys in the near field area and analyses of both the standard and extended time series with respect to variability in distribution, density and abundance patterns of relevant stocks, as well as developing advanced scientific survey evaluation models and methods for doing this.
WP3 analyzed stock and fisheries dynamics by use and development of complex multi-fleet-multi-stock bio-economic management evaluation models performing analyses on a very high spatial and temporal resolution scale using integrated fisheries, stock and survey data. The models evaluated different management options and scenarios relevant for the establishment of the fixed link.
WP4 evaluated variability in recruitment and important spawning areas according to hydrographic features and in relation to impact of the fixed link among other by use and further development of complex hydro-dynamic models.
WP5 evaluated herring stock occurrence and migration patterns in the Baltic areas based on use of genetic identity markers, otolith micro-structures and information from fisheries and research surveys in order to evaluate impact of the fixed link. The project has besides a long row of project reports produced around 30 scientific peer reviewed journal papers where DTU Aqua are first author on more than half and co-author on more than 20 of the papers.
The project was coordinated by DTU Aqua.
The project was funded by the 3 partners with external Funding from Femern Bælt A/S.
Improvement of aquaculture high quality fish fry production (IMPAQ) (38904)

IMPAQ aims at increasing the sustainability of the Danish marine aquaculture farms producing high value fish through the development of large-scale cultures of copepods as start feed for larval fish. Copepods represent an important alternative food to present classical live feed organisms in marine fish hatcheries. Their use is known to improve survival, growth, and development of fish larvae.

The specific aims of DTU Aqua contributions to the project have been (i) to describe copepod behaviors that are mediated through water-borne chemical cues (pheromones, grazing attractants); (ii) to chemically characterize these chemical cues and develop bioassays that can facilitate the identification of water fractions containing active substances; and (iii) to test the quality of developed live feeds in pilot-scale fish larval cultures.

IMPAQ is built on knowledge transfer and direct collaboration between fundamental and applied scientists and private enterprises (SMEs and industries) and has devoted substantial effort into PhD and Postdoc training. External partners of the project are Roskilde University (coordinator), University of Copenhagen, Aarhus University, universities in France and Taiwan and four Danish private enterprises.

The project is funded by the Danish Council for Strategic Research.

Nørrefjord: A case study of coastal habitat status and restoration possibilities (38171)

Nørrefjord has been used as a case study to study to analyze Danish coastal habitats and their fate and ecological function for fish. As many other Danish coast areas the fjord has undergone dramatic changes in its biological structure and function due to human activities and influences. The fjord is nutrient loaded and eutrophication has led to reduction in the photic zone and frequent hypoxia in fjord deeper parts (>10 m). In addition, there has formerly been extraction of gravel and sand in shallow areas of the fjord.

Management plans and Danish fishery (2245)

The objectives of the project were with reference to the EU Commissions proposals on multi-annual management plans, to deliver high quality advice on management of the fishing effort in Danish fisheries in the Baltic Sea, the North Sea, the Skagerrak and the Kattegat.

To be able to deliver the advice the project addressed the need for detailed and accurate data on catches, effort and economical performance in the main demersal Danish fisheries in the concerned areas and the need for accurate stock assessment of the economically most important fish and shellfish stocks. The project also developed a systematic method to give a qualified prediction of the selectivity of a trawl based on information on the trawl design.

The project included seven work packages: (i) Description of development in catches, fishing effort and economical performance of the main demersal Danish fisheries including creation of a single database; (ii) Develop a reference fleet system to collect detailed information on catches and fishing effort; (iii) Development of a software to be used to simulate trawl selectivity; (iv) Establish a fisheries independent monitoring survey on Norway lobster in the Skagerrak and the Kattegat; (v) Provide advice on a fishing effort management system for the demersal fisheries in Kattegat including proposal for enhancement of the cod selectivity in trawl fisheries; (vi) Provide advice on fishing effort in form of days at sea.
by métier; and (vii) Evaluate the impact of the effort management system in the Baltic Sea on the Danish fishery and the stocks.

The project was coordinated by DTU Aqua.
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01/01/2006 → 31/12/2008
Keywords: Research areas: Fisheries Management & Fisheries Technology
Collaborators: University of Copenhagen
Project: Research

Operational evaluation tools for fisheries management options (EFIMAS) (38094)
Existing models in fisheries management advice (FMA) only consider effects of overall fishing on single fish stocks, while not taking broader ecosystem, social and economic impacts of management decisions into account. Mixed fisheries aspects where several fishing fleets fish on several stocks in the same fishery, spatial planning, and long-term management strategy evaluation are also not considered adequately.

In response to this situation, managers launched EFIMAS aiming to develop alternative management evaluation tools and management strategies that have broader, multi-disciplinary and long-term perspectives. These include social and economic impacts and ecosystem impacts (e.g. by-catch and discards), besides biological consequences on single stocks.

This is a new way of thinking international fisheries research and FMA, by developing conceptual and comprehensive multi-fleet and multi-stock bio-economic simulation tools and management evaluation frameworks (MEF), being spatial and seasonal explicit. A successful implementation of ecosystem, social and economic dynamics and factors on a spatial scale in the advisory process is a major leap towards more holistic and sustainable management within EU waters and fisheries. MEFs enable higher degree of participatory management evaluation by involving various stakeholders in FMA.

EFIMAS, and sister projects, develop and integrates a set of new and existing software tools and simulation models (especially FLR – Fisheries Library in R), generating a more robust Management Strategy Evaluation (MSE) framework, that allows testing plausible hypotheses about dynamics of fish stocks, fisheries and fleets.

The MEF contributes to a conceptual change and paradigm shift in generating advice and management with entire fleets and fisheries as the central units. Here the basic management instrument is the input, i.e. the capacity of fishing fleets, the vessel efficiency, and the effort (activity). This differs from the traditional output based ICES approach, providing advice on single fish stock catch limit from rather uncertain terminal year stock assessments and under strong assumptions on future total stock fishing mortality (F) without much consideration on factors, creating and controlling F and partial Fs by fleet.

The developed frameworks allow simulating and evaluating, respectively, the biological, social and economical
consequences of a range of proposed management options and objectives within different management regimes. They can evaluate fleet and mixed fisheries interactions and fisheries behavior, uncertainties in stock and fisheries dynamics, data collection, assessment, modelling, as well as the advisory management and implementation processes. Being capable of evaluating the relative performance of multiple alternative options the MEFs possess strong capacity in performing sensitivity and risk analyses of consequences.

Managing fisheries in a virtual environment provides more reliable scientific advice to stakeholders: In the same way that a pilot might fly in a simulator before flying for real, the simulation tools evaluates the robustness of alternative strategies and virtual regimes to give more holistic FMA in broader context before implementation. This provides managers and stakeholders a better idea of the consequence of a given strategy or intervention before opting for a particular management approach.

The overall evaluation comprises process evaluation (PE) and technical evaluation (TE). PE focuses on participatory management. Here participatory and iterative scenario-based MEF modelling is used to obtain input and cyclic feedback from multiple stakeholders for different options, and to test the general utility of the operational MEF.

Participants: 30 European universities and national fisheries research institutes with biological and economic expertise as listed under www.efimas.org.

The project was coordinated by DTU Aqua.
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01/01/2004 → 31/12/2009
Keywords: Research area: Fisheries Management
Project: Research

Bridging the gap between science, stakeholders and policy makers (GAP 1 & GAP 2) (38133 & 38860)
Stakeholders and scientists involved in GAP1 initiated cooperative research by making plans to combine knowledge in participatory research through a series of European and regional workshops. GAP1 represented phase 1 of a three-phase program that aimed to explore the complementary nature of alternative knowledge and investigate how to combine it in ways that will enhance understanding and management of natural resources. Tied to knowledge, GAP1 was an evidence-based approach that used participation as the vehicle to improve understanding of fisheries research and management issues of common concern to stakeholders, scientists and policy makers. Through initiation of cooperative research and facilitating the building of the capacity of stakeholders to engage in participatory research, GAP1 contributed towards the wider aspiration of the Science in Society program. In particular, enhancing the democratic debate with a more engaged and informed public, thus providing better conditions for collective choices on scientific issues relating to sustainable management, conservation of ecosystem integrity and biodiversity of the marine environment.
GAP2 was about making a difference to an issue of significance to the whole of society; the well-being of the marine environment and the sustainability of fisheries upon which society depends for food. It continued the relationships, processes and plans made in GAP1 by enabling Mobilization and Mutual Learning (MML) actions that promoted stakeholder participation in the debate and development of research knowledge and structures relevant to emerging policy on fisheries and the marine environment. The aims were to promote and enable processes for open and effective participation of stakeholders in research and management, demonstrate through specific examples and critical evaluation the role and value of stakeholder driven science in the governance of fisheries and the marine environment. DTU Aqua was the case study leader of one of the selected cases of GAP2.
Find full list of participants at the website of GAP2.
These projects were coordinated by the Centre for Environment, Fisheries and Aquaculture Science, UK.
The projects were funded by EU, Framework Programme 7.
Operational ecology: Ecosystem forecast products to enhance marine GMES applications (OPEC) (38864)
The primary goal of OPEC was to improve the quality of operational services for biogeochemical and ecological parameters and hence, improve our ability to project the future status of European marine ecosystems, by delivering a suite of error quantified indicators which describe changes in ecosystem function suitable for implementation in operational centers.
In order to advance our understanding and predictive capacities for the response of marine ecosystems to global change, OPEC employed a combination of numerical simulations, data assimilation of satellite and in situ data, observational strategy evaluation and cross-disciplinary synthesis. The MSFD takes a regional approach to the development of strategies for environmental status, identifying four main regions: NE Atlantic, Baltic, Mediterranean and Black Seas. The MSFD also identifies a number of high level descriptors of environmental status (e.g. biodiversity, commercial fish, eutrophication, food webs, and invasive species) each of which has a defined set of indicators. Using the regional approach as framework we implemented and tested a suite of indicators in each region. These descriptors along with the ECVs provided a framework for the definition of new environmental applications (e.g. habitat for biodiversity, oxygen depletion/eutrophication, fisheries and marine climate change research).
A common set of descriptors with associated GES indicators and ECVs were defined across the four regions, to ensure commonality of approach and the development of a consistent capacity across Europe. Auditable quality is essential for GMES environmental applications, and OPEC emphasized the assessment of predictability of key indicators. The R&D of the project included development of coupled end to end ecosystem models, where DTU Aqua implemented the coupling between the SMS model for higher trophic levels and HBM-ERGOM for physics and biogeochemistry. The project had nine partners from the EU and was coordinated by Plymouth Marine Laboratory, UK. The project was funded by EU, Framework Programme 7.
A coast to coast network of protected areas: From the shore to the deep sea (CoCoNet) (38863)
The project targeted design and implementation of marine protected areas, as well as advancement of the scientific basis for optimal design and implementation. The project focused on two pilot studies in the Mediterranean and Black Sea for establishing a network of MPAs. DTU Aqua participated in developing the scientific basis for optimal design of MPA networks by developing spatial size-based models to describe biodiversity as appropriate scales, as well as habitat connectivity from trait-based modelling, and procedures for analyzing habitat connectivity. DTU Aqua also contributed to governance issues relating to establishment of MPA networks. The project had 39 partners from the EU and Eastern Europe and Near Asia. The project was coordinated by Universita del Salento, Italy. The project was funded by EU, Framework Programme 7.
Maximizing yield of fisheries while balancing ecosystem, economic and social concerns (MYFISH) (38850)
The European Common Fisheries Policy has made a commitment to direct management of fish stocks towards achieving Maximum Sustainable Yield (MSY) by 2015 (or no later than 2020 in special cases). Attaining this goal is complicated by lack of common agreement on the interpretation of both ‘sustainability’ and ‘yield’, and because achieving MSY for one stock may affect the possibility of achieving MSY for other stocks and compromise ecological, environmental, economic,
or social aims.

The objective of MYFISH was to face these difficulties and provide definitions of MSY variants, evaluations of the effect on ecosystems, economy and social aspects of attaining these variants, their social desirability and an operational framework for their implementation.

This was achieved through cases addressing a range of fisheries in all European regional areas. The cases cover situations ranging from data-poor to the most studied and well-understood marine ecosystems in EU waters. The suggested implementation of MSY builds on the existing ecosystem and fisheries models in the cases, modified to perform the maximization of the relevant yield measure operationally. Social aspects were integrated throughout the project by active involvement of stakeholders in the definition and evaluation of MSY variants. Global experience was engaged through associated partners and communication of results was enhanced through two major events, a dedicated MYFISH/ICES symposium in 2015 and a targeted policy meeting in 2016. More details can be found at www.myfishproject.eu.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

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01/01/2012 → 29/02/2016

Keywords: Research areas: Ecosystem based Marine Management & Fisheries Management & Marine Living Resources
Project: Research

MyOcean 2 (38862)
The project advanced and coordinated European scientific and technical infrastructure in the European operational oceanography community, for collecting and distributing ocean observations and ocean forecasts, being a continuation of MyOcean. DTU Aqua was reference intermediate user (RIU) in WP3 aimed at integrating MyOcean products into national systems and services and foster downstream exploitation of MyOcean information especially at a regional level.
The project had 61 partners from the EU and was coordinated by Mercator Ocean, France.
The project was funded by EU, Framework Programme 7.

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01/01/2012 → 30/09/2014

Keywords: Research areas: Marine Living Resources & Oceanography
Project: Research

Cardio-respiratory adaptations in cod feeding under hypoxic conditions (CarlsbergTorsk) (38851)
Employment of DataStorage Tags on individual Atlantic cod (Gadus morhua) in the Bornholm Basin has shown that some fish migrate towards the deeper basin centre, presumably to feed. During these voluntary dives, fish expose themselves to oxygen saturations as low as 10% and many individuals spend a third of their total time at oxygen saturation.

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01/01/2009 → 31/05/2012

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Marine Living Resources
Collaborators: University of Gothenburg
Project: Research

Automated fish ageing (AFISA) (38111)
Most of European fish stocks are assessed using age-based models, the cost of the acquisition of age data from otolith readings raises several million euros annually. Low uncertainty in age estimation is however reached for only 25% of fish stocks under ICES advising process. The impact of ageing errors on stock assessment is obvious though obscure. In this context, automated ageing systems would provide a mean to standardize ageing among laboratories and to control ageing consistency while reducing the cost of the acquisition of age data. No such system is currently available, although preliminary results provide the basis for such developments.

This two-year project aims at developing fully automated and robust systems for routine ageing. It will comprise four work
packages in addition to project management (WP0): the collation of the otolith material and the creation of bases of annotated otolith images (WP1), the development of algorithms for fish ageing automation from otolith features (WP2), the implementation these automated ageing modules in a software platform dedicated to otolith imaging (WP3), the cost-benefit analysis of the proposed automated ageing systems (WP4).

The whole processing chain from the acquisition of otolith data to the actual ageing issue using pattern recognition or statistical inference will be coped with. The demonstration component will include the demonstration of the degree of automation of the proposed systems and a cost-benefit analysis of these automated solutions for three case studies: cod from Faeroes, North Sea and North East Artic, plaice from the Eastern English Channel (VIId) and Iceland, and anchovy from the Bay of Biscay. The focus will be on demonstrating the consistency of automated age estimation with respect to the major steps of the processing chain and to the joint analysis of ageing precision and acquisition costs with respect to stock assessment objectives.

The project is coordinated by Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER), France.
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Christensen, A., Project Participant, National Institute of Aquatic Resources
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01/01/2007 → 31/12/2009
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: Marine Research Institute Reykjavik, Marine and Food Technological Centre, Institute of Marine Research, Polytechnic University of Catalonia, Cefas Weymouth Laboratory, IFREMER
Project: Research

**Establishment and testing of area-based management models for North Sea sandeel fisheries (ETOMTOBIS) (38588)**
The goal of this project is to investigate the effects of area-based management for sandeel stocks and the fisheries. Objectives include developing for optimal area-based management of sandeel fisheries in the North Sea. The tools will first be tested through computer simulations and the experience gained will be used to develop a revised management model at the end of the project.

The project will also help fisheries managers to act proactively to other marine management initiatives. In connection with the implementation of the EU Habitat Directive in the North Sea, EU coastal states appoint Natura 2000 areas by 2010. Area based analysis of population dynamics is therefore necessary to quantify the effect of fishing at the local level, and subsequently assess whether fisheries are affecting the habitat. Additional field-based analysis will be valuable in assessing interaction of the sandeel fishery with potential Natura 2000 areas. Spatial management is not only intended to restrict fishing. A description of the consequences for fisheries and sandeel population dynamics are important in assessing the benefits and drawbacks of introducing area-based management of sandeel fisheries in the North Sea.

Currently the sandeel fishery is managed under the assumption that there is one population of the sandeel (Ammodytes marinus) in the North Sea, in spite of this, the North Sea sandeel stock can be divided into several sub-populations. Based on recent research there is now a strong wish from ICES (see eg. ICES 2007 and 2008) and from the EU (see eg. STECF 2005), to introduce area based management of the sandeel fisheries, in order to adjust fishing to a level defined as sustainable for each of the local sub-populations.

Sandeel stocks in the North Sea will be divided into separate management units, each of which can be regarded as sub-populations who have little or no mutual exchange of both sand eel fry and adult sandeels, as presented in the final report of the project TORTN (project 38128). An assessment model will be developed to analyze sandeel population dynamics for each of the identified management units. A forecast model based on the relevant scientific surveys will predict the actual size of the sandeel recruitment in each of the management areas. Finally a tool will be developed that calculates the catch of sandeels in each of the management areas in a number of scenarios that include output of maximum sustainable yield, the most stable catches, and optimal fisheries management.

The project also includes a field sampling module, using two different methods, pelagic larval and demersal 0-group sampling, associated with a tool technological module for this collection to measure the size of the sandeel recruitment.
The purpose of the field collection is to continue and analyze existing time series of field data to further develop area based recruitment indices. Field data should also be used as a fishery independent index of the sandeel stock size in the developed assessment model.

The project is coordinated by DTU Aqua.
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01/01/2008 → 31/12/2010
Keywords: Research area: Marine Living Resources
Collaborators: Danish Fishermen's Association
Project: Research

**Improved methodology for cod age estimation (DECODE) (38120)**
The objective of this project is to develop and implement an objective method for the age-determination of Eastern Baltic cod. The assessment for Eastern Baltic Cod (Sub-divisions 25-32) has presented a number of problems in recent years. The key problem is the severe inconsistencies in age determination which affect both the catch-at-age and the survey data. The methods to be developed within this project are based on the use of otolith biometrics. This procedure has proven successful in other stocks with age-reading problems. The data series on commercial and survey catch length distributions, otolith biometrics and biological parameters (collected for ICES Study Group on Ageing Issues in Baltic Cod (SGABC)) will be extended back as far as 2000. Mixture and conditional models to estimate age structure for a given component in stock assessment will be developed as statistically robust approaches to age-determination. Based on this new method, the historic catch and survey data will be reconstructed. The primary focus is on data for routine single-species assessments, but data for multi-species assessments will also be updated where possible.

The project is coordinated by DTU Aqua.
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01/01/2007 → 31/12/2009
Keywords: Research area: Marine Living Resources
Collaborators: Federal Research Centre for Fisheries, Morski Instytut Rybacki w Gdynia, Latvian Fish Resources Agency, Swedish National Board of Fisheries, Cefas Weymouth Laboratory
Project: Research

**Bank resolved prognoses of sandeel fishing potential in the North Sea (38563)**
Sandeel stocks in the North Sea have experienced successive recruitment failures within the last 5 years. There is an urgent need to develop management tools that may contribute near and long term planning of the sandeel fishery and understand the reasons behind recent recruitment failures.

The project has three main goals:

(i) To fill some of the current knowledge gaps in the biology of North Sea sandeels and evaluate the North Sea sandeel stock via monitoring programs;

(ii) To demonstrate by combining advanced modelling with biological knowledge, that it is possible to generate fishing potential prognoses for sandeel spatially resolved at bank levels, just like ubiquitous whether forecasts, which at sight may be incorporated in the fishery management process;

(iii) To develop the collaboration with the Danish Fishermen's Association (DF) and foster a sustainable sandeel fishery based on increased self regulation within the fishery.

The scientific activities in this project relate developing the necessary components, which are a premise for generating fishing potential forecasts. This encompasses computer model code writing and data collection. The efforts have been
very successful and a first generation fishing potential forecast has been generated as final products of this project. On the modelling side two model components has been developed. The first is the larval module that describes hydrodynamical transport of sandeel larvae which is determining next year’s recruitment. The second component is the population model which combines the hydrodynamical transport output with available biological data and knowledge into a spatially explicit sandeel stock model. Two fishing vessels take part in the project.

The project is coordinated by DTU Aqua.

Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Jensen, H., Project Participant
01/01/2005 → 31/12/2007
Keywords: Research area: Marine Living Resources
Collaborators: Danish Meteorological Institute, Danish Fishermen’s Association
Project: Research

Conservation of diversity in an exploited species: Spatio-temporal variation in the genetics of herring (Clupea harengus) in the North Sea and adjacent areas (HERGEN) (5512)

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Mosegaard, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Worsøe Clausen, L., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Ruzzante, D., Project Manager
01/01/2002 → 31/12/2005
Keywords: Research area: Population Genetics
Collaborators: Stockholm University, Wageningen IMARES, University of Hull, Institute of Marine Research, University of Gothenburg, Marine Laboratory
Project: Research

MyOcean (38134)
The project advanced and coordinated European scientific and technical infrastructure in the European operational oceanography community, for collecting and distributing ocean observations and ocean forecasts. DTU Aqua contributed by developing an integrated system for forecasting of sandeel fisheries in WP3 and in WP18 as reference intermediate user (RIU), for integrating operational oceanography products in marine resource management.
The project was coordinated by Mercator Ocean, France and had 52 partners from the EU.
The project was funded by EU, Framework Programme 7.
Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 15/05/2012
Keywords: Research areas: Marine Living Resources & Oceanography
Project: Research

Development and performance test of method for establishing an area based recruitment index for North Sea sandeels (TORTN) (38128)
The project’s overall objective is to establish a recruitment index for sandeel in the North Sea, for use in preparation of the scientific advice for North Sea sandeel fisheries. It is also an objective that this index should be developed in collaboration with the fishing industry. This is partly to increase the transparency and credibility of the scientific work but also to reduce the cost of setting up the necessary information to as low as possible.

It is of significant interest to be able to subdivide North Sea sandeel habitats based on well-founded biological and physical principles in order to provide spatial explicit stock assessment and advice on local fishing potential. Using hydrographic modeling and field sampling during the fishing season the coupled larval drift and population model (SPAM) will be validated.

The North Sea wide collection of winter hibernating sandeels from the seabed with the modified scallop dredges will be continued and the time series of abundance data will be analyzed. The project will further create a database of VMS, data corresponding to Danish vessels fishing for sand eels (defined by logbook database). From this data fishing effort, a fishing ground level will be estimated through the use of VMS and log book data. Using sandeel samples from the fishery area-based age-length keys will be developed using a continuation logit statistical approach. Combining recruitment data from population analysis and fisheries independent data on 0-group, the project will further develop, test and optimize a method for calculating the recruitment of 0-year-old sandeels to the North Sea stock. Real-time Monitoring of the sandeel
fishery, which is the present basis for in season advice on fishing opportunities (applied 2004-2009), earliest establish the same basis by May i.e. in the middle of the fishing season. The new procedure developed in the project makes it possible to provide the scientific advice used in fisheries management in January, more than 2 months before the start of fishing season. Thus the procedure will allow the development of area based recruitment indices to manage the sandeel fishery in accordance with principles that ensure a more optimal utilization of sandeel stock and also reduces the risk of local overfishing.

The project is coordinated by DTU Aqua.
Mosegaard, H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Rindorf, A., Project Manager, National Institute of Aquatic Resources
Jensen, H., Project Manager
01/01/2007 → 31/12/2008
Keywords: Research area: Marine Living Resources
Collaborators: Danish Fishermen's Association
Project: Research

Danish Network for Aquaculture and Fisheries Research (FISHNET) (38082)
FISHNET is a network of Danish Fisheries and Aquaculture scientists. It was established to foster cooperation in aquaculture and fisheries research and research education in Denmark.

From the start it functioned as an umbrella over four independent thematic research schools and networks in fisheries biology (SLIP), Fisheries and Aquaculture Management and Economics (FAME), Fish Food, Biochemistry and Physiology (FIBP) and Sustainable Control of Fish Diseases in Aquaculture (SCOFDA). In 2001 a research school in Maritime History and Marine Environmental Research (MARINERS) was added to the network.

FISHNET aims to enhance the visibility and quality of Danish fisheries and aquaculture research through improved collaboration and communication, improving the recruitment and training of PhD students through networks and research schools, thus providing high quality courses, seminars and workshops.

FISHNET has organised a large number of joint courses, seminars, workshops and conferences connecting more than 100 fisheries and aquaculture scientists from Danish universities and sectoral research institutions.

In 2004 Fishnet received funds to embed the network through a number of postdoc grants and co-funded professorships in Fisheries Oceanography, Fisheries Management and Fish Physiology.

The merger of the Danish Universities and Sectoral Research Institutions and various changes in Danish marine research made it necessary to extend the second phase of the project from 2008 to the end of 2012.

The project is coordinated by DTU Aqua.
Gislason, H., Project Manager, National Institute of Aquatic Resources
MacKenzie, B., Project Manager, National Institute of Aquatic Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
van Deurs, M., Project Participant, National Institute of Aquatic Resources
01/01/2000 → 31/12/2012
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Southern Denmark, University of Copenhagen
Project: Research

Analysis of biological key parameters, population structure and population dynamics of the lesser sandeel (Ammodytes marinus) in the North Sea, based on detailed information about the sandeel fishery (AHA.DOT) (2167)
The overall goal is to establish the scientific basis for a management system for the North Sea sandeel fishery that will prevent local depletion of sandeels due to fishing and improve the yield of the fishery.

Stock assessment of sandeels in the North Sea is based on the assumption that there is one stock of sandeels in the North Sea and one stock in the Shetland area. However, recent investigations suggest that sandeels in the North Sea can be divided into several stock components or sub-stocks. Further, growth and fecundity seem to vary significantly between the different stock components. This project will analyse spatial trends in key biological parameters (emergence behaviour, growth and fecundity) and the distribution of the lesser sandeel Ammodytes marinus in the North Sea. Additionally the drift pattern of sandeels larvae between the spawning areas will be analysed by use of a hydrographical model. Information about distribution, biological parameters and the drift of larvae will be used to define the stock components of sandeels to be assessed as separate population units.

Besides the lack of information about the spatial heterogeneity on the biology of sandeels, the possibility to carry out regional assessments is hindered by a lack of information about the sandeel fishery and the catches of sandeels, where the main problem being the level of aggregation of the data. To carry out assessments for each of the stock components separately, more detailed information about the fishery and the catches of sandeels is needed. The data available about the fishery can only be allocated to ICES rectangles. However, data will have to be allocated to fishing grounds. Effort and catch data as well as biological samples has since 1999 been collected on a by haul basis for 15-20 Danish vessels representing the existing vessel categories and fishing pattern in the Danish North Sea sandeel fishery. During this project satellite data for all Danish vessels fishing sandeels in the North Sea will together with the detailed data from the 15-20 vessels, be used to disaggregate data on effort and catches of sandeels, from being on a trip and ICES rectangle level to being on a haul and fishing ground level.

The information about the biology and population structure of sandeels and the detailed data about catches and effort will be used to carry out separate assessments of each of the stock components of sandeels. Furthermore, a model that was developed at DTU Aqua (THEMAS) will be used to simulate the effect of different management scenarios on the fishing fleet and the sandeel populations.

The project was coordinated by DTU Aqua.
Mosegaard, H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Rindorf, A., Project Manager, National Institute of Aquatic Resources
Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Jensen, H., Project Manager
01/01/2003 → 31/12/2007
Keywords: Research area: Marine Living Resources
Collaborators: Krog Consult ApS, Marine Scotland Science, Danish Fishermen's Association, University of Hamburg
Project: Research

Advanced modelling tool for scenarios of the Baltic Sea ecosystem to support decision making (ECOSUPPORT) (38733)
The Baltic Sea is subject to several major human impacts, and three of the most important are fishing, eutrophication and climate change. Understanding and projecting how these impacts will affect the food web and its fish populations in future is therefore challenging, and requires modelling approaches which include climatic-hydrographic forcing, nutrient loading scenarios and likely fishing intensities.
ECOSUPPORT was a project whose objective was to develop an advanced modelling tool for conducting scenario simulations of how these human impacts affect the marine ecosystem and fish populations. The project coupled several different types of models so that end-to-end ecosystem models were developed which to understand how human impacts could influence the Baltic food web and fish populations. The models to be linked included regional climate models, oceanographic-lower trophic level ecosystem models (Nutrient-Phytoplankton-Zooplankton-Detritus) and fish population models. Key project results included new scenario simulations how regionally downscaled global climate model outputs would affect the development of Baltic cod populations under scenarios of climate change and seal (predator) population growth, and under different combinations of eutrophication, exploitation and climate change. These simulations included all key elements of the foodweb via an Ecopath model which included competitive and predatory interactions between the major fish species in the Baltic. The results demonstrated the vulnerability of the cod population to successful implementation of key ecosystem management policies for the Baltic Sea, including those related to exploitation and nutrient loading. Additional model scenarios focused on the sprat population which is a key intermediary link in the Baltic foodweb as prey and predator for cod and of zooplankton. These scenarios illustrated the range of future biomass and yields under assumed ranges of climate change and natural mortality. One of the major novelties of the project was the availability of 3 different NPZD models, which enable estimation of output uncertainties to different model parameterizations and assumptions in the lower trophic levels and physical oceanographic
The fisheries on the other hand are distributed geographically and seasonally. Furthermore, the differences in both historic data. This very crude procedure can be refined with more detailed information on how the stocks on one hand and that is caught in area IIIa, and the fraction of the catches by the area IIIa fleets that consist of WBSS based on recent precautionary exploitation of WBSS. This procedure used two kinds of information about the fishery, the fraction of WBSS used a simple procedure in 2004 to find the highest total catch by fleet in area IIIa that would be compatible with a catch by these fleets. The recommendation for the NSAS was guided by the need to rebuild that stock. By now, the recommendations for the North Sea Autumn Spawners (NSAS), raised according to the historical fraction of NSAS in the area, have been decided by managers according to advice applicable for the stock components in area IIIa due to limited resources to explore on the matter intersessionally. The ICES working group on Herring Assessment for the Area South of 62°N (HAWG) has not been able to provide an benchmark in 2012 the developed model was accepted.

Another primary objective of the project was to improve the current assessment of the Skagerrak shrimp stock by developing a new length-based analytical model. DTU Aqua was in charge of this part of the project and in an assessment interview schemes in all three countries.

The fisher information collected in the project was not only focused on shrimp biology but also addressed economical and technical aspects of the shrimp fishery. In this way, scientists have gained an understanding of both how shrimp populations are structured and distributed in the Skagerrak and of the economic importance. The exchange of knowledge between researchers and fishers was an important aspect of the project and was facilitated by regular meetings and interview schemes in all three countries.

The main objective of the Norwegian-Swedish-Danish research project “Sustainable shrimp fishery in the Skagerrak” was to clarify whether there are one or more shrimp stocks in the Skagerrak. The management of shrimp fishing in the Skagerrak and Norwegian Deep is based on the perception of the shrimp resource as one large population. However, biological differences between shrimps (e.g., the size at sex change) indicate that there may be several stocks in the area. The question of one or more stocks was answered by collecting and genetically analyzing several thousand shrimp from Skagerrak and northern Kattegat, Norwegian Channel and the Norwegian fjords. The analyzed shrimps came both from research cruises and commercial fisheries. The kinship of the collected shrimp was examined with modern DNA technique and the results compared with existing knowledge of the biology of the species. This knowledge was obtained from scientific sources as well as from the fishing industry in terms of skipper interviews. The genetic analyses revealed that shrimps in Skagerrak and Norwegian Deep all belong to the same stock, but also that some of the fjord-populations are genetically distinct (can be considered separate stocks). These results are published in ICES Journal of Marine Science in 2015.

The fisher information collected in the project was not only focused on shrimp biology but also addressed economical and technical aspects of the shrimp fishery. In this way, scientists have gained an understanding of both how shrimp populations are structured and distributed in the Skagerrak and of the economic importance. The exchange of knowledge between researchers and fishers was an important aspect of the project and was facilitated by regular meetings and interview schemes in all three countries.

The project was coordinated by Institute for Marine Research, Norway. The project was funded by EU, InterReg (regional collaboration). Eigaard, O. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Eero, M., Project Participant, National Institute of Aquatic Resources

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Andersen, B. S., Project Participant

Holm, N., Project Participant, National Institute of Aquatic Resources

01/01/2009 → 31/12/2011

Keywords: Research areas: Fisheries Management & Marine Living Resources

Collaborators: Norwegian Directorate of Fisheries, Lund University, Norwegian Fishermen’s Association, Ministry of Environment and Food of Denmark, Institute of Marine Research, University of Gothenburg, Danish Fishermen’s Association

Project: Research

Improved advice for the mixed herring stocks in the Skagerrak and Kattegat (ICES area Illa) (2011)

The ICES working group on Herring Assessment for the Area South of 62°N (HAWG) has not been able to provide an advice applicable for the stock components in area Illa due to limited resources to explore on the matter intersessionally. In previous years, the TAC for the fleets fishing herring in area Illa have been decided by managers according to recommendations for the North Sea Autumn Spawners (NSAS), raised according to the historical fraction of NSAS in the catches by these fleets. The recommendation for the NSAS was guided by the need to rebuild that stock. By now, the NSAS stock has recovered and the main concern is for the Western Baltic Spring Spawners (WBSS) stock. The HAWG used a simple procedure in 2004 to find the highest total catch by fleet in area Illa that would be compatible with a precautionary exploitation of WBSS. This procedure used two kinds of information about the fishery, the fraction of WBSS that is caught in area Illa, and the fraction of the catches by the area Illa fleets that consist of WBSS based on recent historic data. This very crude procedure can be refined with more detailed information on how the stocks on one hand and the fisheries on the other hand are distributed geographically and seasonally. Furthermore, the differences in both...
distribution and fishing pattern both in terms of season and stock components suggest a scope for a fishery management
that is more fishery and stock oriented, allowing for more directed stock-wise exploitation. The primary goal of the project
is to improve the assessment and advice of the mixed stock in area Illa by elaborating fleet- and stock-based
disaggregation on the existing projection method. The advice would so take into account both stocks and all fleet
components in area Illa. Temporal and spatial distribution of the different stock components and fleet exploitation patterns
will form the basis for the elaboration.

The project was coordinated by DTU Aqua.
Worsøe Clausen, L., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Ulrich, C., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Dalskov, J., Project Participant, National Institute of Aquatic Resources
Andersen, B. S., Project Participant, National Institute of Aquatic Resources
Tarp, B. G., Project Participant
01/01/2005 → 31/12/2007
Keywords: Research area: Marine Living Resources
Collaborators: Institute of Marine Research
Project: Research

Marine fish atlas of Denmark (38852)
This project will produce an atlas of all the marine fish species found in waters around Denmark. The species occurrence
data for the atlas will be based on all types of observational data, such as; fisheries research surveys, commercial fish
landings data, recreational fishermen’s landings and diver observations. Users and target audience of the atlas are
university and high school students and instructors, scientists, government officials, private companies, NGOs, and the
wider Danish public. The atlas will be a reference for scientific outreach product and is a collaboration between DTU Aqua,
the Zoological Museum of the Natural History Museum of Denmark and a small private consulting company operated by
the former biologist of the Danish Fishermen’s Association. The atlas will contain photographs and maps of the
distributional area each species and a short (3-5 page) text describing current knowledge of species’ biology and life
history in Danish waters.

The project is coordinated by DTU Aqua.
MacKenzie, B., Contact Person, National Institute of Aquatic Resources, Centre for Ocean Life
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
Hoffmann, E., Project Participant, National Institute of Aquatic Resources
01/01/2009 → 31/12/2013
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: University of Copenhagen, Krog Consult ApS
Project: Research

Statistical aspects of heterogeneous population dynamics (38102)
A variety of ‘indices’ of distribution are often considered: occurrence, aggregation and geographical range. However, the
estimators of these indices are frequently biased and the results often do not reflect changes in distribution, often due to
effects of non-random sampling in space and time. Another type of bias in many existing methods results from the
assumption that the individual observations of abundance in an area are all independent and spatial correlation is ignored.
Methods that do take spatial correlation into account, such as kriging, are often inappropriate because they do not handle
the high frequency of zero observations, which are typical of survey data. During this task we will develop new types of
models using the so-called “Log Gaussian Cox Process” (e.g. Lewy and Kristensen 2009; Kristensen 2008), which
account for spatial correlation and better involve the information from zero observations. These models will further
strengthen our ability to detect changes in distribution and provide useful indices of biological aggregation or ‘clumping’
based on the degree of spatial correlation.

24 research institutes and 14 universities are partners in the project.

The project is coordinated by Plymouth Marine Laboratory, UK.
Gislason, H., Project Manager, National Institute of Aquatic Resources
Lewy, P., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Centre for Macroeecology, Evolution and Climate (CMEC) (38784)
This project investigated large scale patterns and variations of life in the ocean, focussing primarily on fishes. The theme used fishes to investigate how processes associated with climate change and human impacts (e.g., fishing and eutrophication) influence fish life histories, biodiversity and the dynamics of populations and species over large time and space scales. Studies have focussed on key processes affecting life histories and distribution of populations and species, including reproduction, mortality, and migration.

The project had one full-time PhD student, and 5 postdoctoral scientists. The relatively high number of postdocs in a short period was due to their success at finding permanent jobs as tenure-track assistant professors, or as research scientists or managers in either industry or academia.

Key results by DTU Aqua colleagues in the project include the following:
- A pan-Atlantic analysis and discovery of how temperature affects reproductive timing in cod, with evidence for local adaptation of cod thermal physiology and counter-gradient evolution. Our ongoing work is now investigating the consequences of this adaptation for match-mismatch of cod larval production with the timing of the peak production of major zooplankton prey species (e.g., Calanus finmarchicus, Pseudocalanus sp.)
- New estimates of the numbers, locations and volumes of the mesopelagic provinces of the world's oceans, and based for the first time on the dynamics of ocean primary productivity, C sedimentation and photic zones. These new habitat descriptors of the mesopelagic ocean will provide new contexts for studies of ocean biodiversity, and the distribution and productivity of mesopelagic fishes and other biota.
- New models of fish lifetime reproductive output which demonstrated that a fish’s annual reproductive output was strongly related to maximum body size. Moreover, indeterminate spawners had ca. 10-fold higher reproductive output per unit weight than determinate spawners suggesting possible differences in survival rates among the early life history stages between these two groups of fishes.
- Estimates of how climate change will affect the spawning locations and timing for herring in the North Sea, based on climate change scenarios, lab studies of temperature effects on egg survival rate and substrate requirements for herring egg deposition
- Global patterns in taxonomic and functional descriptors of fish biodiversity and how these are inter-related and affected by ocean conditions (e.g., primary production, ecosystem size). Ongoing work is relating these patterns to biodiversity protection (e.g., MPA coverage). The project was coordinated by University of Copenhagen, Denmark.

The project was funded by the Danish National Research Foundation.

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Mantzouni, I., Project Participant, National Institute of Aquatic Resources
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Hartvig, M., Project Participant, National Institute of Aquatic Resources
Reygondeau, G., Project Participant, National Institute of Aquatic Resources
Tsoukali, S., Project Participant, National Institute of Aquatic Resources

The History of Marine Animal Populations (HMAP) (38156)
The History of Marine Animal Populations (HMAP) is the historical component of the Census of Marine Life program (CoML), which is an international, multi-disciplinary project which will investigate biodiversity in the world’s oceans. HMAP’s long-term aim is to improve our historical understanding of ecosystem change and our ecological understanding of man’s role in changing marine ecosystems.

The long data series and time-specific snapshots of marine ecological conditions that are being generated are being used to provide input to contemporary ecological modelling in order to characterize and visualize variations in past ecosystems. Such visualizations and testing of ecological hypotheses will enhance the disciplines of history and ecology in seeking to explain long-term changes in marine animal populations and their ecosystems, especially those changes resulting from man’s activities.

Some key results from our earlier historical ecology work include reconstructions of extended time series of cod and sprat biomasses in the Baltic Sea which have enabled us to document how the relative importance of different ecosystem drivers (e.g., fishing, hydrographic variability, mammal predation, eutrophication) of biomass dynamics change and interact over time, and how eutrophication has affected forage fish production in the Baltic Sea. Ongoing work is evaluating and documenting the causes of long-term declines of a local herring population in the Baltic Sea and swordfish fisheries in coastal New England, Nova Scotia and Italy. Another key result is a recent consensus article by an ICES expert group on how historical ecology can contribute to fisheries and ecosystem management.

Because HMAP and CoML have ended, DTU Aqua’s work in this area continues with support from other projects and as contributions to new successor fora established in 2013-2015. These include the Oceans Past Initiative, ICES Study Group on the History of Fish and Fisheries and the EU COST program Oceans Past Platform (2015).
will contribute to the development of new management and conservation policies by demonstrating the species compositions, sizes and distributions of animals that lived in the ocean during periods with less human impact than today, and how these biological properties have changed over time.

The project was coordinated by Trinity College, Ireland.
The project was funded by Trinity College, Dublin, Ireland.
MacKenzie, B., Contact Person, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Eero, M., Project Manager, National Institute of Aquatic Resources
01/01/2011 → 01/03/2012
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: University of Cambridge, University of Copenhagen, Trinity College Dublin, University of Tartu
Project: Research

**Comparative evaluations of innovative solutions in European fisheries management (CEVIS) (38105)**

CEVIS is an FP6 project that assessed potential innovations for European fisheries management regimes with respect to four general management objectives: biological robustness, economic efficiency, the cost effectiveness of management activities, and social robustness. CEVIS examines four types of regime-level innovations: the use of participatory approaches to fisheries governance, rights-based regimes, effort-control regimes and decision rule systems. These innovations are assessed in respect to four general management objectives: biological robustness, economic efficiency, the cost effectiveness of management activities, and social robustness. The four regime level innovations measured against the four general management objectives define the CEVIS research’s conceptual framework. The conceptual framework is tested against four European test cases. However, before these case studies begin, the research will take a close look at international cases of innovative fisheries management in other developed countries. Visits will be made to four places outside the EU that have similar fisheries and have implemented these four types of innovations.

The project has built further on the networks and platforms produced under EU FP6 EFIMAS project (38094) which DTU Aqua coordinated, and the DTU Aqua team associated to the project has produced several peer reviewed journal papers under CEVIS and been co-authors to a book published by Elsevier in relation to CEVIS. Besides this, CEVIS has two final products. The first is an Innovation Evaluation Framework made up of indicators of inputs and outcomes in relation to the four general management objectives. This is an aid to fisheries managers wishing to assess the suitability of possible changes in EU fisheries management practice. The second is a report based on the case studies that evaluates this specific set of potential regime-level innovations for use in EU fisheries management. The developed framework makes it possible for managers to evaluate the extent to which any given management system will contribute positively to attaining Common Fisheries Policy objectives. A range of options for implementing cost-effective and participatory management systems have been provided and finally, the CEVIS project helps fishery managers to be better informed about the ecological, social and economic consequences of implementing any particular management regime.

The project was coordinated by Innovative Fisheries Management (IFM), Aalborg University, Denmark.
Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Ulrich, C., Project Participant, National Institute of Aquatic Resources
Baodrun, A., Project Participant
Sparre, P. J., Project Participant
01/01/2005 → 31/12/2009
Keywords: Research area: Fisheries Management
Collaborators: Netherlands Institute for Fisheries Research, European Commission - Joint Research Center, Institute of Marine Research, Sea Fisheries Institute, Marine and Food Technological Centre, University of Copenhagen, Marine Scotland, UIIT The Arctic University of Norway, Aalborg University, Luleå University of Technology, Öko-Institut
Project: Research

**Development of fisheries with minimized emission of greenhouse gases (38686)**

Identification of methods and prioritization of areas for actions of minimizing greenhouse gas emissions, optimizing fuel consumption and, thus, improve the economy and reducing the environmental effects of fishing on marine habitats. The focus is on fishing with trawls. Two different strategies (work packages) are considered in the project:

1) Development of new and more energy efficient trawls: This work package targets the development of trawl design with improved relationship between capture efficiency and/or catch value in relation to energy use for towing the gear. In this work package we apply an internationally developed computational model based on fluid mechanics and finite element methods and models to predict the capture efficiency of trawl. Through computer simulations we investigate the predicted ratio between catch value and fuel consumption for different trawl designs. These simulations are accordingly applied to
identify the most favorable trawl design with optimized value of the catch in relation to the fuel consumption to tow the trawl. Through international cooperation, we also experimentally examine the consequences on catch efficiency of applying high strength thin twine netting with low drag in sections of trawls.

2) Fisheries tactics and management in relation to energy efficiency in fisheries effort allocation for different fisheries: This work package analyze management options for different types of fisheries, to investigate opportunities and incentives to achieve the same value (and catch) in fisheries with less effort or re-allocation of effort and consequently less fuel consumption. Advanced computer based bio-economic fisheries simulation models are developed and used in fleet and stock-based scenario analyses for energy efficiency in fishery by integrated evaluation of fishing effort, catch, catch composition and utilization, economics, and fuel consumption under given effort allocation schemes. This involves development and implementation of a generic bio-economic Individual Based Model (IBM) that works on individual vessel basis and which can simulate multi-stock-multi-fleet (mixed) fisheries and evaluate on a scale of very high resolution in time and space. This computer based management evaluation tool and simulation model can evaluate economic cost-benefits, biological impacts according to fish stock sustainability, as well energy efficiency according to catch in weight and value per fuel volume consumed and/or in relation to total fuel costs for different management scenarios. The implementation of the IBM model involves additionally development of advanced statistical and computer based models and methods for coupling information from logbook databases with information from VMS tracking (satellite monitoring) databases on vessel and fishing trip basis. Furthermore, it involves development of a web-based questionnaire and platform to obtain information from the Danish fishery on cost dynamics with focus on fuel costs and effort allocation.

The project is coordinated by DTU Aqua.
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Krag, L. A., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Andersen, B. S., Project Participant, National Institute of Aquatic Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Madsen, N., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2012
Keywords: Research area: Fisheries Technology & Fisheries Management
Collaborators: Technical University of Denmark, Thunen-Institut, IFREMER
Project: Research

Development of fishing gears with reduced effect on the environment (DEGREE) (38222)
The DEGREE project main objectives were to (i) develop new gears and fishing techniques with a lower impact on benthic habitats, (ii) to quantify the potential reduction of the physical impact as well as the negative effects on benthic communities caused by the innovations and (iii) to weigh the socioeconomic consequences of these changes against those of alternative management measures, such as the closing of areas. The project consisted of six work packages (WPs), focusing on management and coordination, modelling and quantification of benthic impacts, otter trawl modifications, beam trawl and dredge modifications, economics, dissemination and implementation of knowledge. The DEGREE project fulfilled its primary objectives and combined expertise of the technology, biology and economy sectors.

A number of alternative fishing gears and gear modifications were developed, with the potential to lower mortality of benthic invertebrates and non-target demersal fish. The bottom impact of the new gear designs and practices were assessed by modelling effects on sediments, comparative fishing experiments, observing tracks made on the sea bed. The economic consequences of using the new gear were analyzed for a number of cases. Among the gears tested and demonstrated to have reduced seabed impact were otter trawls with light weight doors and low impact ground gear, pulse trawls, light beam trawls and low impact oyster dredges. It was recommended to further work on the project findings through the development of innovative tools to enable an integrated evaluation of ecosystem effects of the developed alternative fishing gears, which were designed to decrease the impact on marine ecosystems and contribute to sustainable fisheries.

The project was coordinated by IMARES, Wageningen UR, The Netherlands.
Eigaard, O. R., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Frandsen, R., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Monitoring and evaluation of spatially managed areas (MESMA) (38871)
The MESMA project focused on marine spatial planning and aimed to produce integrated management tools (concepts, models and guidelines) for monitoring, evaluating and implementing Spatially Managed Areas (SMAs). The main tasks in the project were information analysis, the development of a generic framework, the testing and evaluation of this framework through case-studies and the development of a toolbox. A significant proportion of the effort was centered on the case studies within five geographical regions: the North Sea, Baltic, Mediterranean, Atlantic, and Black Sea. This approach made it possible to compare pressures on an inter-regional level (e.g. offshore wind farms in the North Sea, Black Sea and Baltic), or a multi-pressure level for a specific region (e.g. SMA in fishing, wind-energy, geo-hazards and tourism in the Black Sea).
The project was coordinated by IMARES, Wageningen UR, The Netherlands.
The project was funded by EU, Framework Programme 7.

Eco-certification of Danish fisheries (38885)
Danish Fishers PO had decided that all commercial fisheries in Denmark should, where possible, operate at the standard necessary to obtain MSC certification by 2012. This project was the third of a suite of EFF-financed projects supporting this challenge.
Of particular focus was the absence of management plan for plaice and sole in Kattegat-Skagerrak area, which is one of the prerequisite for certification. Sole stock is regularly assessed by ICES, implying that a management plan could potentially be established on a standard basis. But the situation was more problematic for plaice, which assessment suffered from a number of uncertainties and issues which could not be solved through a standard benchmark process. DTU Aqua was thus involved in order to clarify the biological knowledge base for this stock and contributed to suggestions for a more tailored approach to the assessment and management of plaice in Skagerrak.
The project resulted in significant changes in the perception of plaice population dynamics in the Skagerrak-Kattegat. An ICES workshop was convened in 2012 (WKPESTO) on the basis of the project, and a new basis for scientific advice was agreed. The scientific and advice outcomes of the project have been disseminated in a scientific publication by Ulrich et al. (2013), DOI: 10.1016/j.seares.2013.04.007
The research underlying this project was continued in project 39025 in 2013-2014.

Survey of existing bio-economic models (38569)
The project “Survey of existing Bio-Economic Models (S12.507729)” is an EU Lot-5 project under studies for carrying out the common fisheries policy (No MARE/2007/07 Lot5) which reviews and evaluates a long row of the most important European bio-economic fisheries evaluation models. In particular the models reviewed are: EIAA, TEMAS, MOSES,
BEMMs, BIRD (Including Aladym), MEFISTO, AHF, EMMFID, SRRMCF, COBAS, ECOCORP, ECONMULT and FLR under EFIMAS. The review is done in two parts. Firstly a revision framework based on some specific and general tables is created in order to facilitate the comparison as well as the selection of the model for completing a specific task. Secondly a report of each model including model generalities, specific issues and implementation details, is produced. The structure of the review as well as the revision framework is based on the existing literature (reports and scientific papers including EFIMAS ECOKNOWS work and platforms), and after a feedback process among the group.

BEMs are used to understand the feedback between human activity and natural resources. When a model is built initial attention must be given to the fishery management problem. The simulation of fisherman behavior is not extensively included in the models. A trade-off between simplicity and usefulness emerges when integrated models are used. New research questions will stimulate the development of new models. The lessons learned from a review of thirteen existing European bio-economic models used in the evaluation of EU policies are produced. How these models compare and differ in terms of their biological and economic components, the integration between the components, which indicators are selected and how they are used, are described and analyzed. The publications from the project conclude that the multitude of construction differences reflects the necessity of adapting the modelling approach to answer different questions. Since real life questions in fisheries are so diverse, answering them requires a diversity of models.

The project has built further on the networks and platforms produced under EU FP6 EFIMAS Project coordinated by DTU Aqua, including the EFIMAS ECOKNOWS (Economist Knowledge System). The DTU Aqua team associated to the project has produced 1 peer reviewed journal paper, 1 conference proceeding and a consolidated report under the Lot5 project.

The project is coordinated by Marine and Food Technological Centre (AZTI), Spain.
Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Andersen, B. S., Project Participant
01/01/2008 → 31/12/2010
Keywords: Research area: Fisheries Management
Collaborators: Istituto Ricerche Economiche Pesa e Aquacoltura, Wageningen IMARES, Marine and Food Technological Centre, University of Copenhagen, Cefas Weymouth Laboratory
Project: Research

Fish larvae and recruitment to fish stocks (38150)
Processes related to fish reproduction and the recruitment to fish stocks are key elements in stock dynamics. Both annual variability and long term changes in recruitment have great influence on the fishery. Hence, further insight into these processes is important for ecosystem understanding and management of fish stocks. A wide range of projects related to the early life of fish are carried out at DTU Aqua. These investigate eggs and larvae through laboratory experiments and studies in the field, focusing on the ecological and oceanographic context of the early life. The present project is set up to accumulate and cross-analyze information from these projects and prepare new research initiatives, ensuring a consistent effort towards improved understanding of larval ecology and recruitment processes. The project follows a hypothesis-oriented, comparative approach identifying key processes in larval biology and analyzing linkages between fish reproductive strategies and major oceanographic patterns, specifically frontal zones. Comparisons cover both coastal and oceanic areas and include all latitude zones: temperate, tropical and arctic. Major traits of apparent universal importance have been identified and these findings guide further research into bio-physical linkages and structuring of fish larval communities in relation to oceanographic features. Subsequently the findings are used in model-based evaluations of recruitment variability and the potential influence of climatic changes. A range of internal and external partners are part of the project.

The project is coordinated by DTU Aqua.
Munk, P., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/01/2002 → 01/01/9999
Keywords: Research area: Oceanography
Project: Research

Study for the revision of the plaice box (PBox) (38647)
This project has attempted to evaluate the effectiveness of the fisheries management, measure known as the “Plaice Box” (PB) for the conservation of plaice and other species of marine organisms in the south-eastern North Sea. The study provides an inventory of existing information and collects new material on the effects of the PB on the conservation of
plaice and the impact of the PB on various components of the commercial fishing fleets.

Based on an analysis of key processes that affect the impact of the PB, modifications were explored to improve the positive effect on the conservation of plaice and other species of marine organisms, including catches and bycatches of other marketable fish. An economic assessment of the consequences of those modifications, in terms of their cost-effectiveness, and implications for profitability of the activity was presented. Finally, the data requirements for future evaluations on the effects of the PB on conservation were discussed.

Stakeholder interest in the project has been high and they made extremely useful contributions to a workshop held in October 2009.

The project is coordinated by IMARES, Wageningen UR, The Netherlands.
Ulrich, C., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Blæsbjerg, M., Project Participant
01/01/2009 → 31/12/2010
Keywords: Research area: Fisheries Management
Collaborators: Wageningen IMARES, Alfred Wegener Institute, Thunen-Institut
Project: Research

Interaction in coastal waters: A roadmap to sustainable integration of aquaculture and fisheries (COEXIST) (38789)
The project aims to provide a roadmap towards improved integration, sustainability and synergies among different activities in the coastal zone.

The project will study interactions between capture fisheries and aquaculture, and evaluate mutual benefits and possible bottlenecks for concomitant development of these activities in the coastal zone within the context of the ecosystem approach to management.

The project will also develop and evaluate different forms of coastal aquaculture and fisheries at different scales and exploit mutual opportunities within a concept of competition for space by multiple users.

Furthermore, the project will address differences in acceptance of activities by society and develop a strategy for communication and involvement of stakeholder as well as for dissemination of results to general and targeted audiences. Six case studies are involved. Individual processes and their interaction will be investigated in each case study using spatial management tools and an array of models.

The project is coordinated by Institute of Marine Research, Norway.
Dolmer, P., Project Manager, National Institute of Aquatic Resources
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Stenberg, C., Project Participant, National Institute of Aquatic Resources
Sørensen, T. K., Project Participant, National Institute of Aquatic Resources
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2012
Keywords: Research area: Coastal Ecology
Collaborators: University College Cork, National Institute of Biological Resources, Finnish Environment Institute, Wageningen IMARES, Aqua TT UETP Ltd, Consiglio Nazionale delle Ricerche, Thunen-Institut, Institute of Marine Research, Denmark, Wageningen University & Research, Finnish Game and Fisheries Research Institute, Cefas Weymouth Laboratory, IFREMER
Project: Research
**Sustainable smolt production – an integrated approach (SMOLTPRO) (38876)**

Salmonid fish is an important natural resource in Scandinavia. Anadromous salmon and brown trout are important natural resources for recreation and fishing and are a part of our cultural heritage. Human activities however, have impaired the natural production of salmonids considerably. Large numbers of hatchery salmonids are therefore released, to compensate losses in natural production caused by hydroelectric power exploitation and other environmental impact. However, conventionally reared hatchery fish have difficulties adapting to natural conditions and therefore perform poorly after release.

New research shows that modifications of the conventional hatchery environment can have positive effects on the development of hatchery reared fish, but their long-term effects on performance in nature are poorly known. Previous research in this area has been too scattered and limited by insufficient infrastructure to conduct large scale experiments over the full life cycle. SMOLTPRO integrated the competence and resources in this field of research using a multidisciplinary approach. We evaluated the effects of modified rearing methods on smolt migration and survival, and its socioeconomic value.

Experiments were conducted in a series of full-scale model systems to evaluate the generality of effects across the climate zones in the Baltic Sea, Kattegat and the North Sea. Following a dialogue with relevant stakeholders, the results will have been used to produce new guidelines for sustainable smolt production.

The project was coordinated by University of Gothenburg, Sweden.

The project was funded by the Swedish Research Council FORMAS.

**Aarestrup, K., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology**
**Boje, J., Project Participant, National Institute of Aquatic Resources**
**Jørgensen, O. A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic**

The scientists are also engaged in formulation of advice to the Greenland Government in several ICES Expert Groups such as North Western Working Group (NWWG) and Working Group for Widely Distributed Stocks (WGWIDE), North East Atlantic Fisheries Commission (NEAFC) and North West Atlantic Fisheries Organization (NAFO). ICES and NAFO are further the platforms where important assessment issues such as stock ID, assessment methods and survey techniques are discussed and applied in the advisory service.

Further scientists acts as appointed experts at the Self-Governments bilateral fisheries meetings and costal state meetings.

During the years DTU has recruited eight scientists from GINR while one scientist has been recruited from DTU Aqua to GINR.

The project is coordinated by DTU Aqua.

The project is funded by the Greenland Institute of Natural Resources.

**Jørgensen, O. A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic**

Cooperative agreement between Greenland Institute of Natural Resources and DTU Aqua (38085)

DTU Aqua supports the Greenland Institute of Natural Resources (GINR) within general fisheries biology, assessment, survey planning and evaluation and education and support of young scientists.

The scientists are also engaged in formulation of advice to the Greenland Government in several ICES Expert Groups such as North Western Working Group (NWWG) and Working Group for Widely Distributed Stocks (WGWIDE), North East Atlantic Fisheries Commission (NEAFC) and North West Atlantic Fisheries Organization (NAFO). ICES and NAFO are further the platforms where important assessment issues such as stock ID, assessment methods and survey techniques are discussed and applied in the advisory service.

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**Jørgensen, O. A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic**

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The project is coordinated by DTU Aqua.

The project is funded by the Greenland Institute of Natural Resources.

**Jørgensen, O. A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic**

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The project is coordinated by DTU Aqua.

The project is funded by the Greenland Institute of Natural Resources.

**Jørgensen, O. A., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic**

Predator fish populations: The impact of behavioural and physical-biological parameters (38267)

Some of the mechanisms guiding the interactions of fish species in clear water lakes seems to act differently in turbid water, thus more knowledge of these relationships are essential. Both in order to understand how the fish population in a lake will develop when the lake is about to change to a clear water state, but also in order to understand the stability of predator fish populations under various environmental conditions. One of the important related issues can be the capability of predator fish, to hunt in turbid water and the interactions of more predator fish species. The capacity of pike and large perch to hunt in turbid water was tested in extensive pond experiments with different clay turbidity, including also the importance of prey fish density. The experimental approach was supplemented by parallel radio telemetry field studies of both predator species, in order to explain the role of behaviour and the importance for the natural composition of fish populations in turbid and clear water lakes. Pond experiments showed that pike were perfectly able to hunt in turbid water, backed up by the field findings of higher activity levels for some pike in the turbid lake, however in general with a larger variation in behavioural strategy in turbid water. Surprisingly, perch were also capable of hunting in very low turbidity at least in high prey fish densities. The telemetry study showed two alternative behavioural patterns of perch in clear water and turbid water, perch being more active in the turbid water on a diel basis including at night and not showing any sunrise and sunset peaks in activity as was seen in the clear water lake. The alternative strategy in the turbid lake might be interpreted as a means of allocating more time for hunting due to visual constraints. Contemporary studies on prey fish behaviour in the study lakes also revealed different behaviours on a diel basis dependent on turbidity, which can be linked to predator fish behaviour.
Two peer-reviewed papers and a master thesis were published on pike-behaviour as well as two peer-reviewed papers on perch behaviour. Results were presented on international and national conferences. The project was coordinated by DTU Aqua. The project was funded by the Danish Rod and Net Fishing License Funds. 

Jacobsen, L., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Andersen, M., Project Participant, National Institute of Aquatic Resources
Berg, S., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Skov, C., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Baktoft, H., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

The project was coordinated by DTU Aqua.
Aarestrup, K., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

01/01/2005 → 30/06/2016

Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Lund University
Project: Research

Marine behaviour of Atlantic salmon (38825)
The last years of development of the salmon stocks in western Jutland has been a success. This is achieved through specific management focus on removing the constraints identified in freshwater and coastal areas, as well as a modified release practices. One of the major challenges for the continued successful management is knowledge of the salmon's marine life. This is the project's overall objective, to obtain more knowledge about this part of the salmon's life, so as to describe the salmon's marine life. So far it has not been possible to make more specific behavioural studies of Danish salmon marine life for two reasons. First: there were very few salmon, and second: there has simply not been technology available to get behavioural data from the fish, apart for the very expensive marine expeditions.

Especially with the development of electronic tags, such as data storage tags (DST) and pop-up satellite tags (PSAT) it is now possible. DST tags are passive tags that records information about the fish's environment and store them. Upon retrieval the data can be offloaded to a computer. The tag is labelled providing an address and information about the reward by for return of the tag. A PSAT tag is essentially the same type of tag, but also contains a satellite device that can send the recorded information to the ARGOS satellite system and a release mechanism. At a predetermined time, the tag detaches from the animal and rises to the surface sending stored information to the satellites. These new types of tags allow you to record information about the fish's environment with an unprecedented accuracy and both types of labels have large application possibilities (Neuenfeldt et al. 2009, Aarestrup et al. 2009). Currently, the limitation is the size of the transmitters and attachment method. Both types of tags are (still) too big for smolt, so kelts will be the most obvious group of salmon to tag. Another way to examine the salmon's movements in the sea is to investigate the chemical fingerprints of fish's scales (Svendsen et al. 2009). The method is a consequence of the fact that a number of stable compounds from the fish food items are incorporated in the fish scales and otoliths. By analysing the fish's scales or otoliths a "chemical fingerprint" depending on where the fish were and what they have eaten can be obtained. Scale samples will be taken from the tagged salmon and the "chemical fingerprint" from these Danish salmon will be compared with "chemical fingerprint" of scales from other population where salmon has been tagged with PSAT tags.

The project is coordinated by DTU Aqua.

The Living North Sea project aims to promote free fish migration from sea to source to keep our waters alive. It addresses three essential aspects about the management of migratory fish:

1) Migration routes
2) Threats such as man-made barriers and fish migration measures
3) Influencing future policy at a regional, national and international level and informing the general public.

The work on migratory routes will focus on sea trout, eel and salmon, but will be applicable to many other species. The partnership will carry out analysis and visualization of migratory routes, populations and consequences of management actions. New communication and mapping tools for working and sharing data between partners will be explored.
The second part involves the innovation of fish migration measures. In the North Sea Region some deltas and estuaries are closed to fish and many more have barriers such as dams and sluices throughout their system. This means that many fish species like the eel, salmon and sea trout cannot reach their spawning and breeding grounds. The partnership focuses on the development of better and innovative migration measures, such as passages or sluice management and the implementation of these in demonstration projects.

Last but not least, communication and the dissemination of our findings to policy-makers, local decision-makers and the public. The Living North Sea Project will place emphasis on promotion and publicity because the effect of barriers on fish populations is often not considered when dealing with flooding, drainage, or renewable power generation. Yet healthy fisheries are critical to sustainable development and good ecological status. Intensive communication actions intended to influence regional, national and European policies will be carried out. Creating new partnerships, sharing knowledge and achieving greater awareness and involvement are key elements in this project.

The project is coordinated by Association of River Trust, UK.
Aarestrup, K., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/01/2009 → 28/09/2012
Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Association of Rivers Trust
Project: Research

Survival and growth of eel in coastal habitats (38830)
Very little is known about settling, habitat utilization and survival of European eel (Anguilla anguilla) in coastal areas (fjords and estuaries). We don’t know what proportion of elvers take residence in the coastal zone. For eels stocked in fjords and estuaries, only little is known about survival and growth. In Denmark it has been suggested that the main production of eel takes place in the coastal areas and not in freshwater. Thus, it is very important to obtain some information about this to enhance our management of this threatened species.

The overall objective is to investigate the importance of various marine habitats for settlement, density, survival and growth of eel. In relation to survival, the importance of fishing and cormorant predation will be sought estimated.

In the first stage (pilot) new sampling methods are being tested in order to be able to generate data about the juvenile eel in the coastal habitats. This is not trivial as no methods have proved effective in sampling small (Jepsen, N., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Pedersen, M. I., Project Manager, National Institute of Aquatic Resources
Aarestrup, K., Project Manager, National Institute of Aquatic Resources
Mikkelsen, J. S., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2016
Keywords: Research area: Freshwater Fisheries and Ecology
Project: Research

Silver eel biomass and non-fishing mortality (38845)
The EU-plan for restoring the European eel population, requires for each MS to issue a national Management Plan and report status of the eel population to the EU Commission in 2012 (and 2015, 2018). Among other things, the report must include estimates of the total production of silver eels (from freshwater), the magnitude of non-fisheries mortality and the reduction of this due to management measures.

This project aimed at providing solid estimates of mortality and biomass. This was be done by trapping silver eels in a number of representative river-systems and extrapolate the results to a national level. The mortality in association with hydropower passage has already been measured (and published), but the mortality of silver eels migrating pass fish farms (with weirs) was measured using radio-telemetry. Sixty migrating silver eels will be radio tagged (surgical implants) and followed on their way downstream in the river Kongeå, where they had to pass 3 fish farms to reach the sea. The results revealed massive loss and delay of silver eels at fish farms.

This project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries.
Jepsen, N., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Pedersen, M. I., Project Manager, National Institute of Aquatic Resources
Effects of new-developed lowland lakes on salmonid populations (38265)

Development of artificial lakes is a management tool to reduce nutrient runoff to coastal waters. Denmark has restored more than 10,000 ha of wetlands and lakes in the last 14 years in consequence of “Action Plans for the Aquatic Environment”, that aim to meet the demands of the European Union’s Water Framework Directive. Juvenile, seaward migrating salmonids (smolts) are highly affected by impounded waterbodies, as they are subjected to extraordinary high mortalities due to predation and altered habitat. Pike and birds have been demonstrated to be major predators on brown trout and salmon smolt in rivers and reservoirs. Migration delay of smolts in lakes may cause desmoltification. The objective of this project is to evaluate the effect of lake development on the salmonid smolt run in restored rivers and wetlands. This knowledge is important not only from a scientific perspective, but also in relation to DTU Aqua’s ongoing recommendations and advice given to counties and Ministry of Foods, Agriculture and Fisheries of Denmark on restoration projects.

The project is coordinated by DTU Aqua.
The project is funded by the Danish Rod and Net Fishing License Funds.

Production of mussels: Mitigation and feed for husbandry (MUMIHUS) (38790)

The concept of MuMiHus was to develop and document mussel farming as a means of mitigating effects of eutrophication of the coastal zone. Specific objectives of the project were i) to adapt known mussel farming techniques to production of maximal biomass at lowest possible costs; ii) to assess environmental impact of blue mussel extraction culture with special focus on benthic effects; iii) to integrate the results in an ecosystem based management model in order to make an overall assessment of environmental impact; iv) to assess effects of low salinity and cyanobacteria occurrence on growth of blue mussels through bioenergetic studies; v) to develop management tools for and economic analysis of extraction cultures as a mitigation measure; vii) to assess bioaccumulation of contaminants in blue mussels as a prerequisite for future use of mussels as feed in husbandry.

MuMiHus demonstrated that mussel farming may be an efficient means of mitigation in terms area efficiency and it was shown that more biomass could have been produced per area unit. Environmental impact studies and modelling showed that in highly eutrophic areas like Skive Fjord, negative environmental impact of mussel farming on the benthic environment are difficult to detect due to the already high organic loading to the sediment. It was further demonstrated that mussel farming might have a relatively higher effect on environmental quality indicators like water transparency compared to load reduction. Based on physiological studies and assessment of environmental conditions a number of coastal areas in Danish waters were appointed as suited for mitigation culture of mussels. Costs of nutrient removal through mussel farming were calculated and cost effectiveness of mussel farming was shown to be compatible to most of the remaining available land based abatement measures. Concentration of hazardous substances in the mussels was shown not to be in conflict with use of the produced mussels for feed or human consumption.

The project was coordinated by Danish Shellfish Centre.
The project was funded by the Danish Council for Strategic Research.
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre

Genetic mapping of Danish trout populations (38828)

The objective of this project is to map the genetic structure of Danish trout populations and to develop genetic tools for use in management of Danish trout populations. This tool will be used for identifying indigenous populations of trout, and to identify causes for maintenance of genetic differentiation between populations. In the longer term we aim to map the geographical distribution of genetic diversity of most Danish trout populations. The genetic database will also be used to establish a molecular testing system allowing the determination of the river origin of individual sea trout, thereby describing
migration patterns. This is done by developing genetic stock identification methods specifically targeting sea trout in Danish waters.

A genetic map with more detail (both geographically and genomic) compared to previous genetic studies will become an important tool for conservation and restoration of natural trout. It will be applied for identifying trout populations that are locally adapted or differs genetically from other populations and therefore are particularly important for maintaining genetic diversity. This tool will be used to define management units and assessment of evolutionary potential. A genetic map provides an overview of indigenous populations and conservation units, and will thus have important implications in counselling practical restoration efforts.

The identification of local adaptations of specific populations, and knowledge of whether individual stocks are adapted to life in their particular environment can be applied in identifying causes for maintenance of genetic differentiation between populations, e.g. whether certain populations are genetically adapted to spawn under certain environmental conditions or at certain times.

Individuals from approx. 50 rivers are selected in a manner that ensures a good coverage of Danish trout populations. These are genotyped for 6000 candidate SNPs (Single Nucleotide Polymorphisms) on an Illumina iSelect bead array. The SNP chip is developed in another DTU Aqua project (Living North Sea Project). Results from the 6000 SNPs will be used to identify a subset of SNPs that are particularly well suited to distinguish between Danish trout populations. These SNPs will be used as a genetic tool in the future and it is therefore extremely important to get proper coverage of Danish trout populations in the mapping of the genetic diversity.

The projects was coordinated by DTU Aqua. The project is funded by the Danish Rod and Net Fishing License Funds.

**Keywords:** Research areas: Population Genetics & Freshwater Fisheries and Ecology

**Project:** Research Evaluation of the National Salmon Management Plan (38257)

A National Management Plan (MP) for the (endangered) remaining Danish populations of Atlantic salmon was issued in 2004. The plan includes stocking, fishing regulations and massive habitat/connectivity improvements, but no monitoring plan to evaluate the effect and assess the current status of the populations/runs in the 4 rivers covered by the MP. This project will seek to close the information gap and provide basic information on the salmon runs to enable proper management decisions. Every year monitoring will be carried out in one or two of the 4 rivers covered by the MP, so each river will be surveyed every 2 or 3 years.

**Number of spawners**

Intensive electrofishing from boat is carried out just after the season closure (October) in the main river and in some tributaries, where all salmon are measured (TL, sex) and PIT tagged. In November during the regular electrofishing for broodstock, the proportion of tagged individuals gives a measure of the sampling efficiency and provides basis for an estimation of population size. The composition in terms of size, sex and origin (stocked fish are fin-clipped) can also be estimated.

**Spawning areas**

In each of the 4 rivers the most important/preferred spawning areas were identified using radiotelemetry. Both present and potential spawning and rearing habitat will be assessed by standard monitoring and electro-fishing for juveniles in order to judge the present production in relation to the potential production. Naturally spawned fry will be genetically analyzed to assess the number of families present on each spawning area (redd). The presence of several families indicate a well-functioning and well-visited spawning area, whereas few or single families indicate lack of spawners.

Annual reports from the project are used for adaptive management measures like quota setting, season and stocking.

The project is coordinated by DTU Aqua. This is funded by the Danish Rod and Net Fishing Licence Funds.

**Keywords:** Research areas: Freshwater Fisheries and Ecology & Population Genetics

**Collaborators:** Danish Center for Wild Salmon

**Project:** Research Monitoring of glass eel recruitment to Danish inland waters (38263)

The objectives are to collect data on the glass eel recruitment from the ocean to Danish inland waters, to be used in national and international advice on fisheries and stocks.

A decline in recruitment of glass eel to the Danish coast and elsewhere in Europe has been persistent through several decades. The yield in fisheries has also declined and the stock is considered by ICES to be outside safe biological limits.
Several hypotheses have been proposed for the decline, but no unambiguous cause has been identified. Monitoring of the stock is traditionally a national task, though coordinated international monitoring is needed, especially to evaluate if any change in management have the intended effect on the size of recruitment.

In Denmark the monitoring is currently taking place at two hydropower stations where ascending eels are monitored in bypass traps, where personnel at the hydropower stations are doing the daily monitoring. The distance from the ocean to the hydropower dams are 5 and 35 km and the ascending eels do not directly reflect the annual size of the glass eel recruitment, but consist of several age groups (0-5 years).

Glass eels recruitment directly from the ocean is also quantified by electro fishing in four small brooks on the west coast of Denmark. Sections of each brook are electro fished three times a year allowing for calculation of numbers and fluctuations in the recruitment to the brooks. The monitoring data are used in the ICES stock assessment group on eel WGEEL.

Keywords: Research area: Freshwater Fisheries and Ecology
Project: Research

The development of the fish community in lakes after biomanipulation: key factors in the development of a good population of piscivorous fish species (38264)
The objectives of the project are to strengthen the ability of DTU Aqua to consult authorities and stakeholders in the management of the fish community in lakes through (i) building time series on the development of the fish population in lakes, which has been subject to biomanipulation, (ii) make a cross analysis on a large data set containing information on standardized investigations of the fish community in more than 100 Danish lakes. Target species in lake fisheries in Denmark are the piscivorous species, which will be the focus of this project as well.

1) Biomanipulation has been applied to more than 50 Danish lakes with the objective to restore eutrophicated lakes to a state with clear water, extensive distribution of submerged macrophytes, a higher degree of biodiversity compared to turbid lakes, and a fish community dominated by piscivorous fish species. It is possible to apply biomanipulation to almost any eutrophic lake, but this restoration tool will only have a long lasting effect in lakes with an intermediate or low content and load of nutrients. In lakes where the improved environmental conditions last for several years, changes in the fish community can still be observed many years after the biomanipulation. Thus we want to describe the long term (10-25 years) development of the fish community, to be able to correctly answer what the end product of a biomanipulation is, regarding fish, on both community structure and population dynamics of the piscivorous species.

Beginning in 1990 we have built time series of the development on the fish population in 10 Danish lakes, where biomanipulation has been applied as a restoration tool. We use a standardized investigation method, which allows both within and between lakes analysis. Under the project 38826 (Handbook for management of lake fish and fisheries) a status report will be prepared in fall 2011.

2) The cross analysis of the more than 100 lake data set aims at developing models to describe the relation between population density and size distribution for important piscivorous species and factors like food availability, distribution and types of vegetation, nutrient levels and water clarity. This analysis is also done within the frame of the project 38826 (Handbook for management of lake fish and fisheries).

Population dynamics of stocked eel in a river system (38261)
The objectives are to evaluate the effect of stocking eel in a river system, and examine how anthropogenic factors such as weirs, trout farms and ponds in a river system may delay or hinder the downstream migration of silver eel.
A few studies have previously been performed to assess the biological value of stocking elvers in small to medium size streams. The studies however showed, that the eels either suffer high mortality or disperse to downstream sections of the streams where monitoring by electrofishing is not possible. Thus, only limited information on the fate of the stocked elvers is available. This project seeks to alleviate this shortcoming.

No, or only very little, natural recruitment occurs to the upper part of River Gudenå. Therefore, the area is excellent for eel stocking experiments, and all migrating fish can be monitored in a downstream fish trap.

During 1987, 1988 and 1992 the area was stocked with 1.6 million elvers. In 2001 and 2002 coded wire tagged eels of size 3.5 gram and 10 gram were stocked. The size and age composition of the silver eel run at Vestbirk fish trap suggest that most males from these stockings have by now, left the feeding areas during the spawning runs, whereas older females are immigrating in these years. All eel passing the trap are being recorded and measured. The population parameters; growth rate, numbers, sex and age at silverying are used to describe the yield of the stockings.

Silver eels leaving the upper reaches of the River Gudenå have to pass several weirs and lakes when migrating towards the sea. How these obstructions influence the migration is largely unknown, but a delay and possibly a higher mortality may be expected. Migrating silver eels are equipped with telemetric tags (PIT) and the progression rate of downstream migrants will be recorded by automatic listening stations and manual tracking.

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Population dynamics of eel (38260)

The project has 3 main goals:

1) Evaluation of the feasibility of eel stocking
In compliance with the National eel MP, 1.3 million pre-fed eel are stocked annually in lakes and rivers. In coastal areas 0.2 million are stocked. Very little is known about the feasibility of these stockings. Due to the long life cycle of eels, both short and long term experiments are carried out.

Short-term: Wild and cultured (pre-fed) eels of similar size (2-5 gram) are stocked in a number of large open ponds (old trout farm) and their growth and survival is recorded during their first year. Similar experiments are performed with wild glass eels stocked in different densities in the ponds.

Long-term: Small CW-tagged eel were stocked in the river Gudenåen in 2001, 2002 and 2011. The return from these stockings in the form of migrating silver eels are monitored by scanning eel caught in a trap (at a hydropower station), operating every autumn from 2006-2013. Furthermore the silver eels caught in the trap are PIT tagged and recorded when reaching the lowermost obstacle in the river (Tange HPS). In Ribe Å, in Vester Vandet lake and in Karrebæk estuary CW-tagged eel were stocked in 2011 and 2012. The monitoring of catches for tagged eel started in 2015 and will continue for several years to get an estimate of how much the stocked eel contribute to the fisheries and how the ratio wild/stocked is, giving an indication of the natural recruitment.

2) Monitoring of recruitment/elvers
The recruitment of eel has been continually declining since early 80’s and is now at a historical low. Monitoring of the number of elvers/glass eels arriving every year is therefore very important for the whole of EU. In DK we have two stations, where upstream migrating elvers are caught and recorded on a daily basis. Both stations are on the Danish East Coast. On the Westcoast the immigration is monitored by electric fishing/sampling in small streams in early summer.

3) Monitoring of the prevalence of the swim bladder parasite Anguillicola in Danish eels
The swim bladder worm Anguillicola crassus was introduced to Europe from the far east in the beginning of the 1980’s. The parasites are thought to be one of the causes of the decline of the European eel population. Therefore the colonisation of Anguillicola in Denmark has been monitored in fresh and marine water bodies to assess the abundance of parasites and the general health of parasitized eels. The geographical distribution and the stability of the parasite abundance are of international interest due to the decline of the eel stock, but also because large effort is done to secure that the 1.5 million annually stocked eel are free of parasites.

This project is coordinated by DTU Aqua.

This project is funded by the Danish Rod and Net Fishing Licence Funds.

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Salmonid freshwater habitats (38256)
The procurement of knowledge in this project aims at improving the basic available knowledge for advising on restoration and stream maintenance activities. Realizing that the question of stream restoration is huge, focus is on selected issues often in cooperation with external partners whenever relevant. Regular cooperation has been done with other Danish universities (Roskilde University, Aalborg University, Aarhus University), local authorities, Environmental centers and anglers associations.

In the coming years it is expected that several issues will be particularly relevant, such as stream restoration (removal/sanitation of barriers and restoration of spawning areas), implementation of EU Water plans, fine sediments and sand transport in streams. Realizing that erosion and transport of fine sediment (sand) is a major problem in many Danish streams, several methods to mitigate this have been tested. One attempt to prevent the embedment of excessive amounts of fine sediment in spawning gravel, has been placing tubes below the gravel in order to allow the sediment transported by the stream to be transported past the area with spawning gravel. Investigations on artificial spawning areas constructed with tubes will be carried out by measuring the content of fine sediment in the gravel on comparable artificial gravel areas with and without tubes.

A database with ongoing and previous stream restoration projects has been created. This is continuously being updated, to enable meta-analysis on relevant variables with the purpose of providing advice on restoration projects. Focus will be on the identification of factors influencing restoration effects towards fish populations.

A number of restoration projects (addition of spawning gravel) are being followed over a longer time span (years). Habitat parameters such as depth, water velocity, substrate composition and vegetation cover was initially measured before the restoration together with fish species and size composition. The same variables are measured annually to register effect from and durability of the restoration.

In a stream where approximately half of the productive area was previously inaccessible to migrating trout, all obstacles are being removed in a major restoration project. Habitat parameters are measured for the entire system, aiming at modelling the effect of the removal of barriers on trout production (cooperation with project 38259).

In a study on brown trout population dynamics and effects on the population from sports fishing, two sections (total length approx. 8 km) have been mapped for habitat quality. All fish with sufficient size for tagging inside the two sections have been tagged (PIT tags) and migrations in and out of the experimental section is monitored. A controlled fishing pressure is being applied to one of the sections in order to evaluate the effect on trout population from sport fishing.

The project is coordinated by DTU Aqua.
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01/01/2011 → 31/12/2016
Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Aalborg University
Project: Research

Marine habitats and restorations methods (MaHaR) (38817)
Restoration of habitats in marine areas is a new research area. DTU Aqua has in recent years worked to develop and restore biogenic reefs (mussel) (project BioReef), boulder reefs (project BlueReef), habitat complexity (project Vejle Fjord), effects and solutions of coastal areas affected by suction dredging (Project Narreford). The project will compile and review these projects and gather knowledge on how to further develop the concept of area "marine habitat restoration methods". Focus will be on the areas structures and functions as nurseries, refuge and feeding opportunities for fish and shellfish.
Fisheries management in NATURE 2000 areas (38797)
Approximately 17% of the Danish sea territory is appointed as Nature 2000 areas. Many of these areas are also very important for fishery. To allow fishery to continue in Nature 2000 sites, it must be demonstrated that the fishery does not negatively impact the basis for appointment for the site. The project aims to establish the science base for development of a concept for Environmental Impact Assessments (EIA) for fishery and aquaculture in Nature 2000 areas, as well as establish interactions between the mussel fishery and the basis for appointment of Nature 2000 areas. The results generated will provide input to the EIA conducted by DTU Aqua and to other advisory issues related to mussel fishery, and to improve the environment in Nature 2000 areas. The approach is a combination of field experiments, model development and theoretical work. Through the project, knowledge will be generated on eelgrass, macrophyte and blue mussel ecology and abundance and interactions with mussel fishery. Development of the oyster fishery in the Wadden Sea will be developed with focus on the Nature 2000 site N89. Seabed mapping of the stone reefs in the Little Belt Sea will include an analysis of the impact of blue mussel fishery on these habitats. Finally the project will establish knowledge base for interactions between aquaculture and Nature 2000 areas.

Bottom culture project with relaying of mussel seed collected at Smart Farm System (38796)
Commercial production of mussels has a number of challenges whose solution requires a focused research and development effort. Requirements for nature conservation, including implementation of Natura 2000 and Water Framework Directives, restrict exploitation of wild populations of mussels in many areas. A reduction of concentrations of nutrients in the inner Danish fjords can over time be expected to reduce fishing of mussels further. A solution to this problem is the development of new area-intensive forms of production, as the cultivation of mussels on longlines or in bottom cultures. Another challenge in the production of mussels is a growing competition from Chilean producers of cooked or frozen mussels. A development strategy for Danish mussel production is an increased focus on the production of high quality mussels for fresh consumption, where competition is restricted to European producers. Important parameters of competition in this market are quality and supply continuity. The overall aim is to optimize a 500 tons production concept, where mussel seed is farmed in the water column on Smart Farm Systems, harvested and laid in bottom culture for future harvesting as mussels for fresh consumption.

The project milestones are:
- To document the optimal harvesting and relay size.
- Study if sizing before relaying in bottom cultures can improve the end-product.
- Documenting the growth and survival of relayed mussel seed as a function of layout density.
Comparison of growth rates of mussels on longlines and in bottom cultures.

Establish 3-D model of biological production in the area near the east coast of Jutland, and implement a survey of the best areas for culture bank cultivation.

Analyze the management and operation of economic prospects for production concept.

The project is coordinated by DTU Aqua.

Dolmer, P., Project Manager, National Institute of Aquatic Resources
01/01/2011 → 31/05/2012

Keywords: Research areas: Coastal Ecology & Shellfish and seaweed
Collaborators: DHI Water - Environment - Health, Danish Shellfish Centre, Danish Aquaculture Association
Project: Research

Restoration of fish habitats by recreation of biogenic reefs in Nørrefjord (blue mussel reefs) (38788)
The aim of the project was to improve fish habitats and fish populations in Nørrefjord by restoring blue mussel reefs in the fjord. This was based on the assumption that blue mussel reefs would provide complex habitats for fish, and improve the conditions and availability of prey organisms and hiding places for both juvenile and adult fish in the fjord.

Blue mussels (~ 44 ton) were produced on ropes in the fjord from the indigenous mussel larvae stock in 2 years, 2010 and 2011. Harvested mussels were distributed on sandy-muddy seabed in a study area in the southern part of the fjord mainly by use of volunteer, local fishermen. The mussel reefs were laid out as small patches (3 m in diameter) with 5 to 7 m in between to increase the complexity of the fjord substrate and covered in total an area of 121,000 m². The design mimicked the observed distribution of existing mussel beds in the fjord. Different approaches for production of the mussels and deployment of the reefs were investigated to minimize costs and labor.

The production of blue mussels on suspended long lines/on hemp sacks was a more ecologically sustainable method compared to transplanting blue mussels by destructive dredging. Crowdsourcing allowed us to conduct the experiments cost-effectively although it did cause challenges in the planning and implementation processes.

A scientific monitoring program monitored the distribution of fish populations and prey organisms in the study area and a control area in 2010 and 2011, before and after the restoration of the mussel reefs in the study area. The establishment of blue mussel beds increased the abundance and diversity of fish on the mussel structures (Kristensen et al. 2015). Video observations revealed the presence of gobies were around the structures for extended periods but also larger fish such as cod, trout and flatfish were observed near the established mussel beds.

The project relied on a strong stakeholder involvement and cooperation with the local fisheries association and local users of the fjord. Field work, including mussel production and deployment of the mussel reefs was carried out by volunteers from the local Fisheries Association supervised by the Nordshell consultant and DTU Aqua staff.

The project was coordinated by DTU Aqua.

The project was funded by the Fishery LAG Funen (established under the Rural District Program in EU Fisheries Development Program) and the Danish Ministry of Food, Agriculture and Fisheries.

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01/01/2010 → 14/04/2012

Keywords: Research area: Coastal Ecology
Collaborators: University of Southern Denmark, Nordshell IS, Faaborg Recreational Fishery Association
Project: Research

Reporting tagging experiments (38250)
The project 1) manages expenses (rewards) and databases with results from tagging experiments and 2) elaborates results on selected previously not reported issues from former tagging experiments.

1) Handling incoming reports on recaptures of tagged fish comprises payment of rewards and registering of recaptures. Reports from previous experiments are normally received over a longer period of time and it is practical to locate expenses in one continuous project. Dating back to the 1970’s and until recent years numerous tagging experiments have been conducted on salmon and trout at DTU Aqua. The use of tags and tagging has been and remains a key method in fish studies. Results from tagging experiments has previously been stored in separate databases, but one objective of the project is to assemble results in a single database accessible using GIS software in order to facilitate access to conducted experiments, being relevant both for research and advisory activities.
Two The elaboration of results from former tagging experiments, where results may already have been used for their primary purpose, aims at extracting as much as possible the information available in the results. Information from the experiments are extracted ad hoc for various purposes, and elaborated for reporting on selected issues.

Presently work is being carried out on a series of tagging experiments on wild and reared sea trout (smolt and adults) in river Kolding Å, as well as on catch pattern of salmon in the Baltic Sea in relation to fishing effort and environmental variables for a selected time series. It is the intention to analyze results on data from several countries around the Baltic Sea in corporation with relevant national institutes.

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01/01/2011 → 01/01/2009
Keywords: Research area: Freshwater Fisheries and Ecology
Project: Research

Marine invasive species impact on ecosystem structure and function (MARINVA) (38716)
The project aims to investigate the structural and environmental impacts of invasive benthic fauna and algae in Danish waters. Focus is on three species: a macrophyte from Asia, a group of polychaete species from North America/Arctic and an oyster species from Japan. All three species are more or less well established in Danish waters and co-existing in the western Limfjord. Knowledge on these species is sparse, including their physiological and habitat requirements. We will study how and to what extent these species influence the community they have become a part of with particular focus on ecosystem nutrient and energy turnover. The approach is a combination of field and laboratory experiments at different scales (individual to population). DTU Aqua focuses on coexistence of Pacific oyster and blue mussels in relation to competition for food and space, and research include lab and field experiments, and observation of small and large scale distribution.

The project is coordinated by University of Copenhagen.
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01/01/2009 → 31/12/2011
Keywords: Research areas: Coastal Ecology & Ecosystem based Marine Management
Collaborators: University of Southern Denmark, University of Copenhagen, Roskilde University
Project: Research

Development of a lighter mussel dredger for blue mussel fishery (38692)
Mussel fishery has been identified as a possible treat to fulfilling the aims of habitat protection in specific sites. Also in the Limfjord during the last 10-15 years, the mussel population together with the landings has declined significantly. An explanation for this decline has been that the fishery removes stone and hard substrate reducing recruitment potential for newly-settled mussels. The project’s aim was to develop a lighter gear for blue mussel dredging that may have lower impact on removal of hard substrate, and be more in line with requirements for habitat protection. The development of this gear will be based on experience and technological innovation in connection with the development of a box-dredger for oyster fishery and by modification of existing gear. International experience from other mussel fisheries will also be incorporated. This aim was achieved and the lighter gear implemented by mussel fishers. Further, the project documented the environmental impact of the new gear and showed that the lighter mussel dredge had an increased catch efficiency of mussels when compared against the Dutch mussel dredge, whilst the amount of mud stirred was considerably lower. The report concluded that the lighter dredge was therefore less detrimental to the environment than the Dutch dredge, whilst maintaining a high catch per unit effort for mussel fishery.

The project is coordinated by DTU Aqua.
Dolmer, P., Project Manager, National Institute of Aquatic Resources
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01/01/2008 → 31/12/2010
Keywords: Research area: Shellfish and Seaweed
Collaborators: Danish Shellfish Centre, Danish Fishermen’s Association, Central Association for the Limfjord
Project: Research

Incorporating extrinsic drivers into fisheries management (IN EX FISH) (38188)
The overall aim of the IN EX FISH project is to increase the responsiveness of fisheries management to a range of anthropogenic and non-anthropogenic forcing factors. This will be achieved through a systematic review of the factors
influencing fish stock dynamics in European Seas and by developing a suite of management tools. These management tools will use robust metrics of ecosystem state, and will provide varied management responses depending on the ecosystem state compared to a historic reference condition. The framework will be developed specifically to be integrated into European fishery management processes and will be based on the geographical areas defined by the regional advisory councils (RACs).

A holistic ecosystem approach will be used to assess the effects of anthropogenic and non-anthropogenic factors on the main functions of the biological cycle of exploited fish species and the ecosystem that supports them. The IN EX FISH project recognizes that humans are part of the marine ecosystem and that some are dependent upon it for their livelihoods. The project will validate its management recommendations through consultation with stakeholder groups and incorporate their feedback into the project outputs.

The IN EX FISH project has four specific and verifiable scientific and technical objectives. These are (i) To provide a state of the art review of the impact of anthropogenic and non-anthropogenic factors on the dynamics of fish stocks; (ii) To develop a framework for the systematic evaluation of the impact of anthropogenic and non-anthropogenic factors on the dynamics of exploited fish species; (iii) To develop criteria for the selection of appropriate metrics, to review available metrics of ecosystem status, to select those that match the criteria and establish reference levels in four geographic regions for these metrics and (iv) To incorporate IN EX FISH knowledge of anthropogenic and non-anthropogenic effects into fisheries management.

The project is coordinated by School of Biological Science, University of Liverpool, UK.

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01/01/2006 → 31/12/2008
Keywords: Research area: Ecosystem Based Marine Management
Collaborators: Stockholm University, Marine Research Institute Reykjavik, Wageningen IMARES, Heinrich-Heine-Universität Düsseldorf, Sea Fisheries Institute, University of Liverpool, University of Bari, Instituto Português do Mar e da Atmosfera
Project: Research

**Effect of the Horns Rev 1 offshore wind farm on fish communities (38734 and 38735)**

The present project focuses on the fish community at the Horns Rev 1 Offshore Wind Farm. The objective of the present study was to document possible refuge effects or changes in local fish communities, seven years after the establishment of the wind farm at a time where wind farm effects on the physical and biological environment could be assumed to have stabilized. Fish communities and sandeel assemblages were compared inside and outside the wind farm area, with the null-hypothesis that the introduction of an offshore wind farm does not affect species composition, temporal or spatial distribution of species or relative abundance.

The project is coordinated by DTU Aqua.

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01/01/2009 → 31/12/2011
Keywords: Research areas: Coastal Ecology & Marine Populations and Ecosystem Dynamics
Collaborators: Orbicon
Project: Research

**RESTOCK (38566) (38400 pre-project)**

The aim of the pre-project was to explore the potential for restocking the cod stock in the eastern Baltic. A theoretical study was conducted to explore the potential for restocking bringing together scientists from the aquaculture sector, fisheries managers, ecological scientists and scientists with a background in stock enhancement. The ecology, biology
and fisheries biology of the eastern Baltic was reviewed and provided the basis for the study. The results indicated a good potential for restocking with first-feeding cod larvae (Støttrup et al. 2008). This was the first example of a study to examine the potential for large-scale restocking prior to the release of fish. A 2-3 month delay in the spawning period compared to 20-30 years ago has altered feeding conditions and predation susceptibility in a way that may have exacerbated the decline in recruitment. Producing and releasing cod larvae during spring would mimic the spawning period recorded in previous times and would coincide with the spring peak in copepod production. An evaluation of 3 different release scenarios showed that a release of 474 million first-feeding larvae over 5 months (covering the historic and present day spawning period) would enhance the average population of 2 year old by 10% and be biologically and economically the most feasible scenario.

Three years of a six year follow up project (RESTOCK) to verify the theoretical findings was funded, but due to political changes, funding for the final three years was not possible and the project was unable to empirically ascertain the potential for restocking. During the three years, 3 cod broodstocks were established with different photoperiods and subsequent spawning periods, together with the development of a technique to determine fish gender non-invasively (McEvoy et al., 2009). Egg and larval incubation techniques were developed and several investigations on temperature, salinity and food impacts on first feeding cod larvae to define the “window of opportunity” for release (i.e. time when the larvae were ready to start feeding when they began to be too poor in condition to feed) (Støttrup et al., 2008; Overton et al. 2010; Meyer et al 2011a). A release strategy was developed and the first successful release of first-feeding fish larvae at 23 m depth was conducted, but needed further adjustments (Støttrup et al., 2008). An extensive disease monitoring program was established (Støttrup et al., 2008) and the presence of a protistan endoparasite generated a further study (Skovgård et al., 2010). Studies were also conducted to determine explore marking techniques for identification of released fish (Meyer et al., 2011b) and explore growth characteristics in cod larvae (Meyer et al., 2011a).

The project was coordinated by DTU Aqua.

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Möllmann, C., Project Participant
Sichlau, M., Project Participant
01/01/2005 → 31/12/2007
Keywords: Research area: Coastal Ecology
Collaborators: University of Caen Normandy, University of Copenhagen, Danish Fishermen’s Association, University of Hamburg
Project: Research

Environmental impact assessment of mussel dredging (38691)

EU Habitats Directive Article 6 requires that if an activity in a habitat area or a nearby area can be expected to have an effect on habitat area, an environmental impact assessment (EIA) has to be conducted before permission is given. This Natura 2000 legislation was implemented in the Danish Fisheries Act at the last change which came into force on 1 July 2008. The Directorate of Fisheries, which is responsible for carrying out EIA’s, has requested DTU Aqua to conduct EIA’s of the fisheries.

The project aims to:

1) Develop a basic concept for use in future EIA’s of fishing activities in Natura 2000 areas

2) Prepare EIA’s of mussel fisheries in the Limfjord, Jutland’s east coast, Isefjord and the Wadden Sea

3) Implement monitoring systems of mussel stocks in the Limfjord, Jutland’s east coast, Isefjord and the Wadden Sea as input to EIS’s of mussel fishery.

The project is coordinated by DTU Aqua.

Dolmer, P., Project Manager, National Institute of Aquatic Resources
Offshore wind farms and possibilities for aquaculture/farming of shellfish (38641)

Large areas of the sea across Denmark and rest of Europe expanded these years with offshore wind farms (OWF). OWF are more or less closed to fishing and have restriction in access. OWF has been proposed for multiple use, e.g. aquaculture and sea farming for shellfish. OWF often have reduced environmental requirements and utilization of these areas for aquaculture and sea farming for shellfish cannot be expected to be in conflict with nature conservation considerations.

This project aim is to investigate whether the production of shellfish can be combined with the operation of OWF. The Danish waters offer very different physical/biological environmental aspects, mainly because of a salinity gradient from the relative fresh Baltic Sea to the North Sea salts. Three OWF along this gradient are used as cases (Horns Rev 1 OWF, Anholt OWF and Nysted OWF) thus allowing general assessment of options for production of shellfish in OWF in Denmark.

The project is coordinated by DTU Aqua.

ERFA-MUS (38615)

Within the last 8 years a number of mussel farms have been established. A significant growth and development in the seafood industry can be expected if the industry offers support in relation to research and development. The research is primary focused on testing different farming methods in collaboration between a number of research institutions and aquaculture organizations. Also at the level of individual mussel farms, methods are developed to improve growth by adapting cultivation techniques to local environmental conditions and to improve harvest techniques. These developments which take place in individual farms promote diversification of methods. The aim of the project is to collect and compile this body of information, in order to disseminate the knowledge to other farmers. The farms will thus have the opportunity to evaluate and use the best possible production methods in relation to the production conditions their production area offers.

The project is coordinated by DTU Aqua.

Coastal habitats (3117)

The aim of the project was to characterize coastal habitats based upon their function as optimal areas for stock enhancement projects, where artificially reared individuals are released with the purpose of increasing local stock sizes.
Towards this aim, the basic criteria for stocking were reviewed and discussed (Støttrup & Sparrevohn, 2007). Habitat suitability was examined (Carl et al. 2008) and methods for estimating mortality of newly released fish were developed together with means of securing the highest possible survival after release (Sparrevohn & Støttrup, 2007).

The potential of linking available prey items to growth of released individuals was examined together with potential for this linkage as a parameter to identify areas suitable for stock enhancement (Sparrevohn & Støttrup, 2008). Predation impact was explored through field experiments (avian predators; Sparrevohn & Støttrup, 2007; Støttrup & Sparrevohn, 2007) and theoretically using ecosystem modeling (Dalsgård et al. 2008 and Nielsen et al., 2008 (both reports).

The project was coordinated by DTU Aqua.

Støttrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Sparrevohn, C. R., Project Participant, National Institute of Aquatic Resources

Nicolajsen, H., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Nielsen, A., Project Participant, National Institute of Aquatic Resources

01/01/2005 → 31/12/2010

Keywords: Research area: Coastal Ecology & Danish Shellfish Centre

Collaborators: Aarhus University, Local fishermen associations, Danish Organization for Amateur Fishermen, Wageningen IMARES

Project: Research

Science and policy integration for coastal systems assessment (SPICOSA) (38180)
The objective of SPICOSA was to develop a self-evolving, holistic research approach, for integrated assessment of Coastal Systems so that the best available scientific knowledge could be mobilized to support deliberative and decision-making processes towards improving the sustainability of Coastal Systems by implementing Integrated Coastal Zone Management policies. Based on a System Approach, a multidisciplinary assessment framework was developed with a balanced consideration of the Ecological, Social and Economic (ESE) sectors of Coastal Systems. The System Approach Framework (SAF) developed in the project was then used to explore dynamics of Coastal-Zone Systems and potential consequences of alternative policy scenarios in 18 different Study Sites. We demonstrated that achieving this objective required a restructuring of the science needed to understand the interactions between complex natural and social systems at different spatial and temporal scales including the overall economic evaluation of alternative policies. The software used for the modeling was furthermore developed with the aim to support transfer of scientific products to policy decision-makers, stakeholders and end-users. The SAF Portfolio consisted of generic assessment methodologies, specific tools, models and model blocks and new knowledge useful for ICZM provided in a user-friendly manner and updateable for future CZ researchers and professionals. In addition SPICOSA generated new training curricula, training modules and training opportunities for academics and professionals involved in Sustainability Science and ICZM implementation.

The project was organized into 5 Nodes with DTU Aqua leading one of these 5 Nodes. In total the project had 54 partners from 22 EU countries.

The project was coordinated by University of Western Brittany, France, Institute of Coastal Marine Environment of CNR, Italy and French National Institute of Marine Research (IFREMER), France.

The project was funded by EU, Framework Programme 6.

Støttrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Dinesen, G. E., Project Participant, National Institute of Aquatic Resources

Geitner, K., Project Participant, National Institute of Aquatic Resources

01/01/2007 → 31/12/2011

Keywords: Research areas: Coastal Ecology & Ecosystem based Marine Management

Project: Research

Energy efficiency in the aquaculture sector (38802)
The increased implementation of technologies for water recirculation and the purification, oxygenation and degassing of water used in aquaculture production, has caused the energy costs associated with fish production to dramatically increase. The current energy consumption for the production of 1 kilogram of rainbow trout is estimated at 1.7 kWh. This represents a challenge for the aquaculture industry because national and international ambitions strive for a general decrease in carbon dioxide emissions. The aim is to reduce the energy requirements for trout production to 1 kWh per kg. With an annual production of 35,000 tons, this corresponds to an annual reduction in CO2 emissions of 33,400 tons, and a financial saving of DDK 17.1 million. The purpose of the project is to identify the most energetically efficient methods to oxygenate, degas and move water, or how to improve the efficiency of currently used methods, without compromising water quality parameters. Currently, the primary method for aeration, degassing and water movement is by use of air,
using the so-called air lift pumps aka mammoth pumps.

The project will collect data on annual energy consumption from 4-8 selected recirculating aquaculture facilities and compare these values with feed use and fish production. The energy consumption is considered with reference to the technologies in use at a given facility and the construction of the facility. The primary purpose is to evaluate energy efficiency of air blowers currently in use, air delivery per unit of effect, efficiency in aeration and degassing, and variations in the requirement for aeration and degassing over the daily cycle. These results will enable the documentation of any correlations between energy efficiency, technology in use, methods of operation, and will serve in the further development of alternative solutions to aeration and degassing. Emphasis will be on the physical properties and placement of air diffusers in airlift pumps and the feasibility of using trickle towers for aeration, aeration with liquid oxygen or other alternatives. Experiments to determine energy use and efficiency of alternate oxygenation and degassing devices will allow the project to determine whether more suitable technologies exist and make an estimate of potential energy savings.

The project will terminate in a final report and a workshop where the results will be presented to stakeholders in the aquaculture industry (fish farmers, feed manufacturers and equipment suppliers). Suitable alternative technologies and methods for aeration and degassing will be presented in practice.

The project is coordinated by Danish Aquaculture Association, Denmark.
Skov, P. V., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/01/2010 → 01/10/2012
Keywords: Research area: Aquaculture
Collaborators: BioMar A/S, Nielsen Consult, Lokalenergi A/S, Danish Aquaculture Organisation, Danish Technological Institute, AquaCircle
Project: Research

Local raw materials for production of fish feed for aquaculture (38840)
The aquaculture industry is the fastest growing food production industry in the world and approximately 50 % of all fish consumed by humans comes from aquaculture. The main cost factor in aquaculture is the cost of feed. Furthermore, high amounts of feed ingredients from marine sources have been of concern both environmentally and economically. Thus, it is of importance for the aquaculture industry to aim for the development of new locally-produced, cost-effective, beneficial and eco-friendly ingredients for innovative practical feed production. Food production, not least in the marine sector and aquaculture, is one of the main fundamental industries in the Nordic countries. Wild fisheries have stagnated or even declined and the aquaculture in other continents has been increasing substantially. It is therefore essential for these industries to implement innovative solutions to maintain the competitiveness of the region in this field. New opportunities for sustainable aquaculture production are emerging providing the tools.

The main objectives of the project were to test new local raw materials for aquaculture feed and to implement those into the production chain, with the purpose to:
- Move the Nordic aquaculture industry towards a more competitive and sustainable production with focus on efficient and responsible use of local feed sources.
- Lowering carbon footprint of aquaculture production
- Identify novel fish feed ingredients and optimizing use of marine raw materials
- Create added-value of feed sources like seaweed, microalgae and mussel meal.
- Decrease dependency of fish meal and fish oil as fish feed ingredients
- Establish a user driven diversified "green growth" aquaculture production of high quality fish products.

The specific role of DTU Aqua in the project was to evaluate mussel meal as a protein source in fish feed. For this purpose a series of digestibility and growth trials at different inclusion levels of mussel meal, with fishmeal based diets as reference, were successfully performed. DTU Aqua also examined potential environmental effects (nitrogen excretion) of replacing fishmeal with mussel meal. Furthermore, the trials provided tissue and blood-samples for closer examination of physiological effects of mussel meal on gut epithelia as well as effects on various hormones. The latter was performed by partners from University of Gothenburg.

The project was coordinated by Islensk Matorka ehf, Iceland.
The project was funded by Nordforsk, Nordic Council of Ministers.
Larsen, B. K., Project Participant, National Institute of Aquatic Resources, Section for Aquaculture
01/01/2011 → 31/08/2014
Keywords: Research area: Aquaculture
Collaborators: Matorka, University of Gothenburg, Nord University
Project: Research
Enzymes in fish feed: Optimization of protein digestibility in fish production (38396)

The demand for aquaculture products is increasing globally and is expected to keep increasing in proportion with the growth in the global human population. A limiting factor for the expansion of the aquaculture industry is the dependency of fish meal, which is the primary protein source in feed for carnivorous fish (trout, salmon, turbot, cod etc.). Increasing world market prices on quality fish meal is reflected in the price of fish feed, and has intensified the international competition for finding ways to optimise the use of alternative plant-based proteins in fish feed.

Enzymes are catalysts that increase the speed of the processes in which they are involved. A high degree of specificity makes enzymes an excellent tool for increasing specific reactions, e.g. the degradation of complex feed ingredients to digestible nutrients. The addition of enzymes to fish feed has the potential of improving the nutritional value of the feed, reducing production costs and loss of valuable nutrients to the environment. Enzymes are already widely used in feed for broilers and pigs, while only phytases have been approved for commercial fish production.

The objective of this project was to promote the use of industrial enzymes in fish feed as a means to improve the utilization by the fish of existing and/or alternative protein sources. The project consisted of four work packages: 1) Identification of relevant enzymes and feed ingredients; 2) Feed production; 3) Test of feed quality in a digestion model; 4) Data analyses, reporting and preparing publications. Low-grade soybean cake, sunflower cake and rapeseed cake were chosen as alternative plant-based protein sources in three diets. The effects of three exogenous enzymes in liquid form (Ronozyme®VP (β-glucanase, pectinase), Ronozyme®WX (xylanase) and an experimental protease) on nutrient digestibility was examined. The study showed that Ronozyme®VP and the experimental protease were able to significantly improve the nutrient digestibility primarily in the soybean cake diet at doses of 150-300 mg kg⁻¹. No clear effect of RONOZYME®WX on nutrient digestibility was observed with any of the ingredients tested. The overall conclusion of the project was that Ronozyme®VP and the experimental protease have potential to increase the nutritional and energetic value of proteinaceous plant-based feed ingredients in fish feed.

The project was coordinated by DTU Aqua.

Dalsgaard, A. J. T., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Poulsen, E., Project Participant, National Institute of Aquatic Resources
Larsen, O. M., Project Participant, National Institute of Aquatic Resources
Sproegel, U., Project Participant, National Institute of Aquatic Resources
Frandsen, D., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2010
Keywords: Research area: Aquaculture
Collaborators: BioMar A/S, Novozymes AS, DSM Food Specialties
Project: Research

Further development of Danish organic aquaculture (ØKOAKVA-1) (38806)

The first Danish organic rainbow trout with the Danish red Ø label was introduced to the market in 2005. The demand for organic trout is increasing and Danish trout farmers are currently converting to organic production. However, the development of organic trout production in Denmark has been challenged by a very strict national legislation for organic aquaculture production. However, by the coming into force of the EU regulation for organic aquaculture by 1 July 2010, equality was established between the European organic fish farmers, but new challenges were faced by the Danish organic farmers. Therefore, further development and establishment of sustainable organic fish production in Denmark required strengthened research efforts, i.e. nutritional and environmental aspects, farming conditions, health, green energy and water consumption to improve the competitiveness and efficiency in production. The project aim was to facilitate the implementation of the EU regulation on Organic Aquaculture for the production of rainbow trout in fresh and sea water, organic production of line mussels and sea weed.

The project was coordinated by Danish Aquaculture Association, Denmark.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/01/2010 → 31/03/2013
Keywords: Research area: Aquaculture
Collaborators: Danish Aquaculture Organisation, Danish Veterinary and Food Administration
Project: Research

Forage fish interactions (FACTS) (38781)

Removal of a forage fish has consequences for both predators and prey of forage fish. As everything is connected, every management action has a price which goes beyond the apparent, direct effect on the target species. The fishery on forage fish can therefore not be seen in isolation, as the immediate gain in profit from the fishery has to be discounted by the
lowered potential for production of large piscivorous fish. Management actions on other species also influences forage fish, i.e. conservation efforts on marine mammals or sea birds have direct consequences for the predation pressure on forage fish.

The objective of the project was to provide insight and quantitative advice on the ecosystem wide consequences of management actions directly or indirectly related to forage fish.

The two overarching questions were:
- What are the consequences of forage fish fisheries on (a) predator growth and abundance, (b) economic output of fisheries on piscivorous species, and (c) ecosystem stability and the risk for regime shifts?
- What are the consequences of changes in predator populations on forage fish populations and fisheries?

The method was a combination of ecosystem models, of process studies aimed at feeding into the models, of economic models, and of data-analysis of existing data sources.

The project covered four ecosystems in detail: Norwegian-Barents Sea, Baltic Sea, North Sea and Bay of Biscay. FACTS brought together leading European fisheries and university institutes working on creating the tools for ecosystem based management. The active involvement of the institutes in the current management has provided a means for the results of the project to feed into management. The project furthermore included a network component which has ensured a wider dissemination of methods and results within the marine scientific community.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

Neuenfeldt, S., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography  
Haslund, O. H., Project Manager, National Institute of Aquatic Resources  
Andersen, K. H., Project Participant, National Institute of Aquatic Resources  
Rindorf, A., Project Participant, National Institute of Aquatic Resources  
01/01/2010 → 31/12/2012  
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Ecosystem based Marine Management

Collaborators: Christian-Albrechts-Universität zu Kiel, Centre National de la Recherche Scientifique, Wageningen IMARES, Marine and Food Technological Centre, University of Copenhagen, Spanish Institute of Oceanography, Cefas Weymouth Laboratory, IFREMER, University of St Andrews, Leibniz Institute for Baltic Sea Research Warnemunde (IOW), University of Southern Denmark, Institute of Marine Research, Finnish Game and Fisheries Research Institute, University of Hamburg

Project: Research

North Denmark Region as strategic development platform for offshore sea farming technology (38805)
The development of offshore aquaculture has reached a point where the next step forward is to physically move the last step from off coast to off shore. This is a challenge though, and will be a multidisciplinary task only to be carried out by a consortium of private sector partners, research institutions and government authorities. The project launches the concept of describing such a development platform based at the North Sea Science Park. This will place the North Denmark Region in the center of a coming national R&D activity and be the foundation for a coming Danish offshore aquaculture production.

The project is coordinated by DTU Aqua.

Steenfeldt, S. J., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture  
01/10/2010 → 31/03/2012  
Keywords: Research area: Aquaculture

Collaborators: North Sea Science Park

Project: Research

Strategies to improve health and welfare in rainbow trout farming (38193)
The main aim of the project is the developing of sustainable strategies for improving the health, welfare and quality of cultured rainbow trout by implementing three interrelated approaches: management, immune prophylactics, and selective breeding. The management approach determines how increased water current at given rearing densities and water temperatures can reduce the stress of trout. The immune prophylactic approach determines the relationship between immune response profiles and induction of protective immunity at different water temperatures and hereby establishing efficient strategies for use of vaccination and feed stimulants in prevention of diseases. The selective breeding approach determines how physiological and immunological traits can improve the genetically basis for resistance of trout to stress and disease.

The project is coordinated by DTU Aqua.

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture  
Höglund, E., Project Participant, National Institute of Aquatic Resources  
Larsen, B. K., Project Participant, National Institute of Aquatic Resources

Project: Research
The blue revolution: Perspectives for sea based food production (38804)
The project will conduct an investigation of the possibilities for use of a larger part of the Danish sea territory for aquaculture of food as well as non food products.
The project will review the current state of world sea based aquaculture with focus on offshore activities of fish, shellfish and algae. The project will also review the national state of sea based culture of fish shellfish and algae before conducting an analysis of potential transfers of technology to support the Danish development of the sector.

The project will initiate the formation of a national Blue Revolution Network that will link the different activities on sea based production in a network to support exchange of knowledge and cooperation between the different activities on the subject.

A set of recommendations on the future development of Danish sea based production will be outlined and serve as guidelines for the coming development of the sector.

Steenfeldt, S. J., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/10/2010 → 30/06/2012
Keywords: Research area: Aquaculture
Project: Research

**Improvement of energy efficiency of fishing gear (38886)**
The project's aim is to demonstrate the best available technology in fishing gear and equipment, to lower the energy consumption and increase the profit of the vessels economy.

A typical fishing vessel from the Baltic area is used as demonstration platform. Change of trawl gear, doors and the additional rigging will be done. The trawl is constructed to give less water resistance. The doors to be used are pelagic doors, in contrast to the present doors that are typical bottom trawl doors. The lines and ropes are changed to the Dyneema material which has a higher braking point with a smaller diameter. Dyneema® is an UHMwPE fiber, DSM invented it 20 years ago and it's been in production since 1990, the fiber is incredibly versatile with virtually limitless applications. The fiber is manufactured by means of a gel-spinning process that combines extreme strength with incredible softness. High strength/low weight – Dyneema® is 15 times stronger than steel, and 40 % stronger than aramids on a weight-for-weight basis.

It is expected that the effect will reduce the energy consumption within 30-40 %. The results until now indicate that this goal can be reach.

Additional partners than the above mentioned: Five subcontractors.

The project is coordinated by Gemba Seafood Consulting, Denmark.
Larsen, E., Project Manager, National Institute of Aquatic Resources, Public Sector Consultancy
01/01/2010 → 31/12/2011
Collaborators: Espersen A/S, Fishermen’s Association of Bornholm and Christianse, Danish Fishermen's Association, Gemba Seafood Consulting
Project: Research

**Catch quota project 2011 (38823)**
The aim of the project is further development and test of Catch Quota Management (CQM) systems in Danish fisheries by the use of electronic monitoring systems. Furthermore, to test whether electronic monitoring – video and sensor recordings – can provide the necessary documentation to support a CQM system. In addition the project will illustrate whether full documentation of catches can support implementation and certification and traceability solutions which requires linkage to project dealing with these issues.

As the Danish Government has worked intensively for the implementation of CQM in the new Common Fisheries Policy (to be implemented from 2013 and onwards) the project should also facilitate international cooperation on European level to
set up common standards for CQM data collection, data processing, data exchange and base development.

The project is coordinated by DTU Aqua.
Dalskov, J., Project Manager, National Institute of Aquatic Resources, Public Sector Consultancy
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Jensen, R., Project Participant, National Institute of Aquatic Resources
Kirkegaard, E., Project Participant, National Institute of Aquatic Resources
Håkansson, K. B., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 30/09/2012
Keywords: Research area: Fisheries Management
Collaborators: Ministry of Environment and Food of Denmark, Archipelago Marine Research Ltd., Gemba Seafood Consulting
Project: Research

Electronic monitoring on smaller fishing vessels fishing with gillnets (38773)
The aim of the project is to examine whether electronic monitoring by the use of CCTV and sensor recordings can ensure full documentation of the fisheries carried out by smaller gillnetters, and whether the use of "pingers" (acoustic deterrent devices) can be more operational.

Furthermore, the project has the aim to proof that:

- A total recording of all catches of quota managed species and a reduction of “high-grading”
- Involvement of the fishing industry in collection of detailed data and thereby ensure industry involvement for joint responsibility for the collection of data to be used as the basis for the scientific advice
- An adequately documentation that can ensure that the fishery could be carried out sustainably in sensitive marine areas such as NATURA 2000 sites
- An improved economy for vessels that participate in fully documented fishery
- A documentation that can provide the basis for the marked to be able to evaluate sustainability of the fisheries.

The project is coordinated by DTU Aqua.
Dalskov, J., Project Manager, National Institute of Aquatic Resources
Kindt-Larsen, L., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Larsen, F., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Jensen, R., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2011
Keywords: Research areas: Fisheries Management & Observation Technology
Collaborators: Archipelago Marine Research Ltd.
Project: Research

Catch quota project 2010 (38787)
The aim of the project is further development and test of Catch Quota Management (CQM) systems in Danish fisheries by the use of electronic monitoring systems. Furthermore, to test whether electronic monitoring – video and sensor recordings – can provide the necessary documentation to support a CQM system.

In addition the project will illustrate whether full documentation of catches can support implementation and certification and traceability solutions which requires linkage to project dealing with these issues.

From January 2010 the European Council has adopted possibilities for EU Members States to conduct trials on catch quota management on cod in the North Sea, the Skagerrak and the Kattegat.
As the Danish Government has worked intensively for the implementation of CQM in the new Common Fisheries Policy (to be implemented from 2013 and onwards) the project should also facilitate international cooperation on European level to set up common standards for CQM data collection, data processing, data exchange and data base development.

The project is coordinated by DTU Aqua.
Dalskov, J., Project Manager, National Institute of Aquatic Resources, Public Sector Consultancy
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Jensen, R., Project Participant, National Institute of Aquatic Resources
Kirkegaard, E., Project Participant, National Institute of Aquatic Resources
Håkansson, K. B., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2011
Keywords: Research area: Fisheries Management
Collaborators: Danish Directorate for Fisheries, Archipelago Marine Research Ltd.
Project: Research

Monitoring and modelling vertical movements of Greenland halibut in Disko Bay (38795)
The project measured and parameterized Greenland halibut behaviour in terms of vertical movement patterns by means of data storage tags. The tags were released (and recaptured) prior to the project period under another project, so that data was available at start of the project.

Previous measurements using Data Storage tags on halibut tagged in Disko Bay have shown that the halibut undertake distinct vertical migrations of several hundred meters at a time during a few hours.
The findings in the project from analyses of the previous tagging’s gave important biological information on the seasonal migration patterns for Greenland halibut in the West Greenland Fjords; icefjords are mainly preferred as wintering habitat for the fish while the outer parts of the fjord systems are summer habitats. Further, the study showed that halibut are fast vertical swimmers most likely when chasing pelagic prey fishes.
The project was coordinated by DTU Aqua.
The project was funded by the Commission for Scientific Investigations in Greenland (KVUG).
Boje, J., Project Manager, National Institute of Aquatic Resources, Arctic Section
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2013
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: Greenland Institute of Natural Resources
Project: Research

European eel: Investigation and assessment of their decline (EELIAD) (38410)
The EELIAD project was a research initiative to investigate the ecology and biology of European eels during their marine migrations, and how these relate to eel condition and population of origin. The information has been integrated into models to determine the most important factors that influence silver eel production and migration success. The fulfillment of this objective will provide a means to evaluate the likely success of the EU eel recovery plan, to enable management actions to be most effectively directed to enhance and conserve eel stocks across Europe, and to determine the dynamics of eel population structure and reproductive success.

To achieve this aim we undertook a large-scale field program to determine the migration routes and behavior of silver eels during their spawning migration, and to determine ecological factors that influence the number and quality of silver eels leaving river catchments.
These field studies were supported by the use of cutting edge biotechnological analyses to determine population structure and innovative modeling approaches aiming to incorporate these data into fishery management models. In addition, these different studies were linked to studies and observations undertaken in other cooperative projects such as INDICANG which is a network of monitoring programs that report on the status and the development of eel populations over a large area (e.g. Atlantic Area).
The knowledge gained from the EELIAD research, aside from its scientific significance, have been of direct use to the conservation of eel stocks because it helps to clarify the reasons for the recent decline in the stock. This information will then be used to change and improve the way that eel fisheries and habitats are managed across Europe, and to help ensure that enough silver eels migrate to their spawning grounds to reproduce and sustain the species.
The project was coordinated by Centre for Environment, Fisheries and Aquaculture Sciences (CEFAS), UK.
The project was funded by EU, Framework Programme 7.
Aarestrup, K., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/01/2008 → 31/12/2012
Keywords: Research areas: Freshwater Fisheries and Ecology & Observation Technology
Collaborators: Norwegian Institute for Nature Research, Consejo Superior de Investigaciones Cientificas, Marine Institute, Centre for Agricultural and Environmental Engineering Research, Swedish National Board of Fisheries, Universite de Pau et des Pays de l'Adour, Cefas Weymouth Laboratory, IFREMER, Museum National d'Histoire Naturelle, Laboratoire de
The overall objective was to set up the basis for more appropriate data collection and analysis programs in order to support existing and emerging fishery management issues. The present data and advisory structures have developed by a process of evolution and involve considerable commitment of human and financial resources. In general these resources are in short supply and may be declining. It is no longer clear whether present systems can be maintained or whether they are appropriate for emerging issues, notably those relating to a more holistic approach to fishery management.

The first objective of the concerted action was to understand the current balance between resources devoted to data collection and value of these data in the provision of advice. This required the evaluation of the range of advice requested on fishery management and the data needs to perform the science to support it. Of particular importance is the basic fisheries data on catch composition according to species, size or age and commercial catch per unit of effort (CPUE) according to fleet since these are used in almost all analyses. However other types of necessary data have also been included, e.g. research vessel CPUE, stock structure according to size or age, weight and maturity at age.

The second objective was to quantify the quality of the scientific outputs derived from the data inputs. Since much advice is qualitative and relies on expert judgement, this objective was focussed to quantifying the reliability of routine annual stock assessments upon which advice is formulated.

The third objective was to identify alternative uses of data and alternative analytical methods which could support present fishery management needs as well as those which could address new and emerging issues, such as multi-annual decision rules and mixed fisheries issues.

The fourth and final objective was to analyse ways of re-deploying existing resources in order to support a modern fishery management system. With focus on where data collection should be improved and rationalisation of the deployment of current resources to improve efficiency scope for re-deployment of resources to address emerging management advisory needs, such requirements of effort management systems and the implementation of the ecosystem approach to fisheries management.

The project was coordinated by DTU Aqua.

Köster, F., Contact Person, National Institute of Aquatic Resources
Nielsen, J. R., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2002 → 31/12/2006

Keywords: Research area: Fisheries Management

Collaborators: Netherlands Institute for Fisheries Research, Instituto Español de Oceanografía, Federal Research Centre for Fisheries, Marine Institute, Swedish National Board of Fisheries, Marine Scotland Science, Fisheries Research Station, Instituto Português do Mar e da Atmosfera, Cefas Weymouth Laboratory, IFREMER, Marine Research Institute Reykjavik, Institute of Marine Research, Ecole Nationale Supérieure Agronomique, Finnish Game and Fisheries Research Institute

Project: Research

DTU centre for recirculation technology (38159)

Despite the obvious scientific relationship and correlation between recirculation technology, specifically biofiltration, and municipal waste-water treatment only limited scientific knowledge has been interchanged between these two areas.

DTU Environment has for many years been an internationally renowned actor within biofiltration processes and kinetics in waste water treatment. Combining this stronghold with the DTU Aqua expertise in recirculating systems is the basis for this project. Through project cooperation, student interchange and common research set-ups knowledge is exchanged and new insights developed.

In recirculation systems feed is the major input to the system, and the linkage between feed, water quality and system
operation is important, yet missing knowledge, which will also be addressed by the group through a combined experimental and modeling approach.

Pedersen, P. B., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, L., Project Manager, National Institute of Aquatic Resources
Suhr, K. I., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/12/2015
Keywords: Research area: Aquaculture
Project: Research

Reproduction of European eel: Towards a self-sustained aquaculture (PRO-EEL) (38793)
Reproduction of European eel (Anguilla anguilla) in culture has become a research priority area due to a severe decline of natural stocks and an increasing interest to breed eels for a self-sustained aquaculture. As eels do not reproduce naturally in captivity, development of methodology and technology was needed for production of viable eggs and larvae from broodstock in a regular and predictable way.

The project was an international, EU-funded research project characterized by an integrative and multidisciplinary approach. The consortium brought together experts in eel reproduction complemented by expertise in disciplines filling gaps in knowledge and technology. The consortium included 15 partners, comprising European research institutes and industry partners as well as an international collaboration partner country (ICPC). Within DTU, the project involved DTU Food, Research Group for Bioactives – Analysis and Application, and several DTU Aqua research areas including Fish Biology, Aquaculture, Marine Populations and Ecosystem Dynamics, and Coastal Ecology.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

Tomkiewicz, J., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Munk, P., Project Manager, National Institute of Aquatic Resources
Butts, I., Project Participant, National Institute of Aquatic Resources
Krüger-Johnsen, M., Project Manager, National Institute of Aquatic Resources
Stetttrup, J. G., Project Participant, National Institute of Aquatic Resources
Sørensen, S. R., Project Participant, National Institute of Aquatic Resources
Skov, P. V., Project Participant, National Institute of Aquatic Resources
Steenfeldt, S. J., Project Participant, National Institute of Aquatic Resources
Hornum, I., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 31/07/2014
Keywords: Research areas: Fish Biology & Aquaculture & Marine Populations and Ecosystem Dynamics & Coastal Ecology
Collaborators: Leiden University, Wageningen IMARES, University of Copenhagen, Demokritos National Centre for Scientific Research, Billund Aquaculture Service Aps, National Institute of Sciences and Technologies of the Sea, Norwegian University of Science and Technology, BioMar A/S, Institute of Marine Research, Polytechnic University of Valencia, National Institute for Agronomic Research, Nofima, Ghent University
Project: Research

Bycatch and discards: Management indicators, trends and location (BADMINTON) (38714)
In the EU there is intensive data collection of by-catch and discard onboard commercial vessels, but until now there have been few attempts to describe the general patterns in these data, and still less to understand the factors that determine what and how much is discarded. However, the latter step is key if we are to develop operational indicators and propose mitigation tools for fisheries management. There is especially a need to investigate the effectiveness of mitigation methods that have been implemented in the past, primarily as technical regulations, including gear modification. This has to be done at the scale of the fishery: many gear modifications showed to make a difference in field trials, however there have been few studies about the way fishers used these modified gears, and the real impact it had on catch and discards on the fleet scale.

The project developed along five main steps:
- A descriptive analysis of total catch in terms of species and size composition, based on the data collected onboard EU vessels under the Data Collection Regulation. This included a quantification of spatial and temporal distribution and abundance of discards.
- The development of indicators of discard issues: indicators of discard state (amounts and characteristics of discards), of the pressures that determine discards (selectivity of fishing), and of the management responses to this issue.
- An analysis of the factors that determine discard amounts, including environmental settings, year-class strength,
community composition, and fishing practices. This included an examination of the efficiency of technical regulations currently in force, and retrospective analyses of the efficiency of such measures in the past.
- An analysis of socio-economic and institutional drivers and incentives that influence fishers' behaviour in regard to selectivity and discard.
- Based on all previous steps, the elaboration of potential mitigation measures. Beyond technical measures, integrated approaches that will remove or at least reduce incentives to discard were explored.

The project was coordinated by Hellenic Centre for Marine Research, Greece.
The project was funded by EU, MariFish, ERA-NET.
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2010 → 01/04/2013
Keywords: Research area: Fisheries Technology
Collaborators: Instituto Español de Oceanografía, Wageningen IMARES, Hellenic Centre for Marine Research, Aalborg University, Cefas Weymouth Laboratory, IFREMER
Project: Research

Development and test of a sorting grid for the fishery on Norway lobster (38742)
Goal of the project was to develop and test a sorting grid for the Norway lobster fishery in Kattegat and Skagerrak, with the aim to improve both the size selectivity for Norway lobster and allow high escapement of cod. A second requirement was, that the sorting can be deployed from smaller vessels and is easy to handle.

Within the project, a flexible sorting grid was developed which can be hauled directly on the net-drum and can be handled on small fishing vessels. The grid was designed and tested with different set-up of bars and colors.

As an alternative for a sorting grid, a sorting frame was developed to be inserted in the upper panel of the cod end was tested in comparison.

The project is coordinated by DTU Aqua.
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2010 → 31/12/2011
Keywords: Research area: Fisheries Technology
Collaborators: SINTEF, Different net producers
Project: Research

Selective trawls for the North Sea (38740)
The goal of the project was to design, develop and test a selective trawl, which reduces the by-catch of cod, while still retaining high catch rates of flatfish, Norway lobster and anglerfish. A second requirement was that the trawl should be simple and fast to deploy and recover.

The project tested different possibilities to improve the selectivity of a cod end with a 140 mm sorting panel, as implemented in the fishing regulations. This included changes in mesh size of the panel and changes in panel position.
For different combinations of panel mesh sizes and panel positions, size selectivity functions were determined, to allow for designing the optimal configuration for different mixed fisheries.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2010 → 31/12/2011
Keywords: Research area: Fisheries Technology
Collaborators: Cosmos Trawl A/S, SINTEF, Danish Fishermen's Association
Project: Research

Innovative practices and technologies for developing sustainable aquaculture in the Baltic Sea region (AQUABEST) (38924)
In opposite to the global trend, aquaculture production in the Baltic Sea region had stagnated. It is widely accepted that aquaculture had great potential to feed the growing human population in the era of declining wild stocks ("Blue Revolution"), but new production has to be built on sustainable practices and technologies. The European Union has identified this challenge and has adopted aquaculture as a flagship project in the EU strategy for the Baltic Sea region.
Firstly, AQUABEST demonstrated that Baltic Sea region aquaculture was capable of becoming a nutrient neutral food production system. This was assessed to be achieved by replacing oceanic feed ingredients and plant products harvested at other continents with regional feed ingredients. Potential regional ingredients included Baltic Sea fish catches and Baltic Sea grown mussels not used for human consumption, as well as plant proteins and single cell proteins produced and
processed in the region. Secondly, AQUABEST adapted lessons from maritime spatial planning projects, developed them into guidelines and by regional testing demonstrated that spatial planning tools can be adapted to create environmentally, economically and socially sustainable aquaculture. Spatial planning activities were completed by activities that could support farmers to move fish cages offshore and which could support mussel farmers to adapt technologies that tolerated harsh winter conditions in the northern Baltic Sea.

New farming technologies using recirculating water have been developed especially in Denmark. The third solution of AQUABEST was to transfer these technologies to other regions and further develop them to adapt to brackish water conditions of the Baltic Sea. Furthermore, although recirculation farms already released much less nutrients in the effluent than conventional farms, nitrogen release of these farms could be further diminished.

As the final outcome, AQUABEST carried out regional self-evaluation of current environmental regulation models in aquaculture. A novel ecosystem-based regulation needed new approach, environmental policy instruments and economic incentives. Concrete improvements were proposed after dialogue between major stakeholders.

The project was coordinated by Finish Game and Fisheries Research Institute, Finland.

The project was funded by EU, InterReg (regional collaboration).

Jokumsen, A., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Suhr, K. I., Project Participant, National Institute of Aquatic Resources
Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources
Pedersen, L., Project Participant, National Institute of Aquatic Resources

01/01/2011 → 31/12/2014

Keywords: Research area: Aquaculture
Collaborators: Association of Marine Aquaculture Ltd, Jämtland County Council, Lund University, University of Helsinki, Belarusian State Agricultural Academy, Danish Aquaculture Organisation, The Government of Åland, Institute of Food Safety Animal Health and Environment BIOR, Thunen-Institut, Finnish Game and Fisheries Research Institute, University of Tartu, Swedish Board of Agriculture, Polish Trout Breeders Association
Project: Research

Scientific advice concerning the impact of the gears used to catch plaice and sole (GUPS) (38115)

The aim of the project was to:

- collect information on the fishing fleets that target plaice and sole in the North Sea
- collect information on the main fish stocks and ecosystems impacted by these fleets
- evaluate the performance of these fleets in terms of economic, ecological and social sustainability
- list the problem fisheries-list alternatives that reduce adverse impacts
- estimate the improvement in economic, ecological and social terms caused by adopting these alternatives.

The work program was structured into four tasks:

In Task 1, basic data were collected on fleets and effort, fish stocks, discards and selectivity. The scientific and grey literature, project reports and existing databases was consulted to collect the basic information. This information was aggregated along a common methodology. Sub-fleets or métiers were defined and an evaluation was made of the performance of the different fleets in economic, ecological and social terms.

In Task 2, the critical effects on the marine environment was identified for the different fisheries evaluated in Task 1. Based on comparative indicator tables, the problem areas were listed in order to best focus the review and selection of alternative gears and vessels.

In Task 3 a review was made of possible ways to reduce the adverse effects by fisheries selected in Task 2. These were technical alterations to existing gears, alternative fishing methods for vessels designed for a specific method or fishing methods not yet applied on a large scale in the North Sea.

In Task 4, predictions were made on the effects of a possible modification of existing sole and plaice fisheries in the North
Sea based on the following criteria:

- possible reduction in discards through an improved selectivity-benefits for the spawning stock biomass and the landings
- reduction in the environmental impact of the fishing activity
- improvement of the socio-economic performance of fishing fleets.

Based on the results obtained in Task 4, conclusions and recommendations were formulated on the feasibility and effectiveness of the alternatives for existing fisheries targeting sole and plaice in the North Sea.

The project was coordinated by Institute for Agricultural and Fisheries Research (ILVO), Belgium.
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management 01/01/2007 → 31/12/2009
Keywords: Research area: Fisheries Technology
Collaborators: Wageningen IMARES, Agricultural Economics Research Institute, Cefas Weymouth Laboratory, Institute for Agricultural and Fisheries Research
Project: Research

**Nephrops and cetacean species selection information and technology (NECESSITY) (38623)**

The project objectives were to develop effective and acceptable:

- gear modifications (by-catch reduction devices) and alternative fishing tactics in cooperation with the fishing industry to reduce the by-catch and mortality of non-target fish species in European Nephrops fisheries, and determine the biological effects and socio-economic repercussions of using these.

- gear modifications (by-catch reduction devices and acoustical deterrents) and alternative fishing tactics in cooperation with the fishing industry to reduce the by-catch and mortality of cetaceans in European pelagic fisheries, and determine the biological effects and socio-economic repercussions of using these.

With specific objectives:

- To develop novel species-selective gear prototypes and alternative fishing tactics in cooperation with the fishing industry for use in the European Nephrops fisheries.

- To review the current status of knowledge of cetacean by-catches in pelagic fisheries, using existing data sources and oncoming data collection programmes, and to collect additional biological data (age, year of maturity, causes of death) of landed cetaceans.

- To develop novel species-selective gear prototypes and alternative fishing tactics in cooperation with the fishing industry for pelagic trawl fisheries where cetaceans by-catch may occur (pair trawling on bass, pair trawling on albacore, single boat and pair pelagic trawling on herring, mackerel and horse mackerel, fishery with high opening bottom trawls and midwater pair trawls on hake).

- To compare the effectiveness of commercial available acoustic deterrents (pingers) on cetaceans.-To develop an interactive pinger in cooperation with a manufacturer.

- To evaluate the potential biological and economic impacts of the technologies and tactics developed above.

- To disseminate the results to relevant sectors in the fishing industry, and contribute to implementation of the technologies and tactics developed above.

In total there are 22 partners in the project. The project is coordinated by Wageningen University, The Netherlands.
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management 01/01/2004 → 31/12/2007
Keywords: Research area: Fisheries Technology
Project: Research
An assessment of mortality in fish escaping from trawl cod ends and its use in fisheries management (SURVIVAL) (4305)

The survival of fish escaping from towed fishing gears is essential if selective devices are to be used as a practical conservation tool. Several studies have attempted to test this principle and assess the mortality of escaping fish. Unfortunately, these early endeavours have been shown to be fundamentally flawed in methodology so there are currently no reliable estimates of escape mortality. This project developed methods for accurate assessment of escape mortality. The work covered development of techniques to sample fish escaping from a trawl cod end, without introducing biases into the mortality estimates. These techniques were then applied in the field to estimate mortality in cod and haddock under various circumstances including escape at depth and surface, in high intensity fisheries and at different times of the year.

The objectives of the project were:
- to develop sampling techniques that overcome current biases in escape mortality estimation
- to test these techniques directly against previous protocols in order to establish the validity of the new methods
- to develop a methodology to compare the cod end selectivity, and survival, of gadoid fish escaping at the surface in a side-trawler fishery with that of fish escaping at depth
- to estimate the number of repeated encounters with trawls on intensively fished grounds
- to study the effect of repeated gear encounters on escape mortality
- to determine if gadoid escape mortality varies throughout the year and identify its cause
- to report the project work and results to the fishing industry, the public and the European Commission.

The contribution of DTU Aqua centered around:
- testing the validation of the new cover design against previous designs
- investigating the seasonal variation in escape mortality of gadoids trough surface selectivity
- investigating the seasonal variation in total escape mortality.

The project was coordinated by Institute of Marine Research, Norway.
Madsen, N., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2002 – 31/12/2006
Keywords: Research area: Fisheries Technology
Collaborators: Institute of Marine Research, Marine Scotland Science, North Sea Museum
Project: Research

Towards an integrated marine and maritime science community (MARCOM+) (38881)
The Aberdeen plus interest group joined forces with the Venice Platform group to take further steps in integrating the marine, maritime and coastal research sectors in Europe. The goal is to establish a sustainable and long-lasting partnership forum (European Marine and Maritime Science and Technology Forum), based on shared interests and shared leadership, and to test it on regional seas and pan-European basis. The process will contribute to developing interactions between partners (the research community, industry, regional authorities, civil society and other stakeholders) starting from regional scales to broader issues shared with EU-neighboring countries.

In the project DTU Aqua is representing the European Fisheries and Aquaculture Organization (EFARO).

The project is coordinated by International Council for the Exploration of the Sea (ICES).
Köster, F., Project Participant, National Institute of Aquatic Resources
Development of selective trawls for important Danish fisheries (4313)
The project was structured in following sub-projects:

1) Development of a North Sea haddock trawl: to design a trawl with reduced by-catches of cod.

2) Improved size-selection of the Norway lobster trawl used in Kattegat: to reduce the catch of undersized Norwegian lobster.

3) Improved species-selection in Norway lobster trawl used in Kattegat: to design a trawl that selectively catches Norway lobsters while letting cod and other unwanted by-catch escape.

4) Improved size selection in Baltic cod trawls: test of T90 meshes in the cod end in comparison to BACOMA trawl.

The cod stock in the North Sea is on a low level, with little signs of recovery during the most recent 20 years. By-catch of cod in different fisheries is a problem at this low stock size and therefore technological modifications of gears used in fishing fleets with significant by-catch of cod are requested. Sub-project 1 aimed at the development of a haddock trawl with reduced catchability of cod. Making use of the different behavior of haddock and cod during the catching process, modifications of the trawl groundrope were tested for their effect on cod catchability.

The Norway lobster population in the Kattegat is doing well, and the Norway lobster fishery is the most economically important fishery in the Kattegat. However, there is a substantial catch of undersized Norway lobster in the fishery and improving the size selectivity of the trawl in use was the goal of sub-project 2. This included designing and testing of different mesh sizes and sorting mechanisms.

In contrast to Norway lobster, the cod population in Kattegat has declined severely in the last 20-30 years. Without reducing the by-catch of cod through a more selective trawl, the Norway lobster fishery would have to be reduced significantly in order to protect the cod. Within sub-project 3, the aim was to develop a trawl with significantly improved selectivity, allowing enhanced escapement of cod. The traditional round cod end was replaced with a cod end shaped like a square mesh box. This box proved to be more stable in the water enabling to take advantage of the different behavior of cod and Norway lobster. While cod tend to move up-wards in the tunnel of a cod-end, Norway lobster remains passive at the bottom. Placing a 180 mm escape panel into the upper panel of the box, allowed to improved escapement of cod.

A simple way to increase the mesh opening in a cod-end is to turn the mesh 90° (T-direction, henceforth T90) because the knots will determine the initial mesh bar angle. A T90 cod end was introduced in the legislation for the Baltic Sea cod fishery and the aim of sub-project 4 was to test for differences in cod selectivity in comparison to the standard BACOM (having a sorting window in the top-panel of the cod end).

The project was coordinated by DTU Aqua.

Integration of European marine research networks of excellence (EUROMARINE) (38903)

EuroMarine seeks to integrate three major European marine FP6 networks of excellence (EUR-OCEANS, MarBEF and Marine Genomics Europe) into one organization, “The EuroMarine Consortium” with a road map for joint programming,
creating synergies between different scientific fields, towards a common research strategy and a shared vision for the oceans of tomorrow. EuroMarine will bring together leading European marine scientists to create a major internationally competitive network.

The goal is to exploit the knowledge created within the consortium to address questions related to the functioning of marine ecosystems and the needs of society. This project also wishes to engage the European marine data management and scientific communities in shaping the long-term integration of data, historical, present and future. Moreover, EuroMarine aims to create a 21st century marine scientist, with deep knowledge in one discipline and basic “fluency” in several others, as well as a natural ability and desire to work as part of a team.

The project is coordinated by University of Gothenburg, Sweden.
Mariani, P., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
MacKenzie, B., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2011 → 31/01/2013
Keywords: Research area: Oceanography
Collaborators: Environmental & Marine Project Management Agency, Centre National de la Recherche Scientifique, Centre of Marine and Environmental Research, University of Groningen, Stazione Zoologica Anton Dohrn, Ministero dell'Istruzione dell'Università e della Ricerca, Netherlands Institute of Ecology, Centro de Ciências do Mar do Algarve, IFREMER, Marine Biological Association of the United Kingdom, Station Biologique de Roscoff, Max Planck Institute, University of Gothenburg, University of Bremen, Centre de Recherche Halieutique Méditerranéenne et Tropicale, Institut de recherche pour le développement, Royal Netherlands Institute for Sea Research - NIOZ, Flanders Marine Institute, Ghent University
Project: Research

Handbook for management of lake fish and fisheries (38826 & 39189)
This project has developed a web based handbook in lake fisheries management. The end goal was to provide local anglers and lake managers (which are often not biologists) with knowledge about the biology of focal species as well as a tool box on how to manage these with regards to both environment and fisheries. A central part of the handbook focus on compiling thorough descriptions of species and their ecology, environmental requirements etc. based on existing knowledge from our own research and the literature. Focus is also on a description of different measures that can be used to protect or enhance abundance of specific fish species. The handbook incorporates existing legislation on freshwater fisheries and management as well as a description of angling techniques. In addition we give advice on how anglers specifically and citizens in general can participate in the process, i.e. by practical help or cooperation with the municipalities or other authorities that may be responsible for the lake management.
The handbook covers all types of lake fishery preferences (species, sizes, quantity, etc.), with due consideration to authenticity and environmental conditions. All pages include FAQ’s to answer the most common inquiries, as well as email addresses of the authors of the text which facilitates that users of the handbook easily can interact with the researchers.
The lake handbook was published on line in 2013 as an integrated part of the existing homepage www.fiskepleje.dk. It is continuously updated when new knowledge is available, always providing latest knowledge on fisheries management to a broad audience of users.
Lake ecology and fish population dynamics is complex and often very lake specific. Unfortunately knowledge on the environment and fish populations of specific lakes is often scarce or lacking, making fisheries management difficult. A part of the project has focused on how to use citizen science to increase our knowledge. Hence, we explore the use of anglers log book as a method to get knowledge on fish populations and we initiated a nation-wide anglers log book for pc and cellphones (which in 2013 became an independent project expanding from lakes to cover all freshwater and marine habitats). The project also explores the use of citizens reporting on environmental parameters in lakes. We have by now recruited a corpse of citizens ("Water Environment Agents") who measure Secchi depths and presence of the invasive zebra mussel in various lakes on a regular basis. We continue recruitment of citizens for this purpose.
Another part of the project has been aimed at establishing a web-based platform, named The Knowledge Base, where citizens and authorities can find knowledge about specific lakes. The cornerstone is a web-library, where close to 1000 reports on lake environment or fish covering the last ca. 75 years can be found in pdf-format. Some reports has never been published before, others has been very hard to find (only paper-versions in The National Library). A large collection (1000+) of historic (1915-1960) photos of Danish lakes and rivers taken by former employees of the department (C. V. Otterstrøm and Knud Larsen) has been digitalized and will be available online in fall 2016. The primary search method is via a GIS-based map. This will be supplemented with a more traditional database search option fall 2016.
The project is coordinated by DTU Aqua.
The project is funded by the Danish Rod and Net Fishing License Funds.
Jacobsen, L., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Skov, C., Project Manager, National Institute of Aquatic Resources
Berg, S., Project Manager, National Institute of Aquatic Resources Nielsens, J., Project Manager, National Institute of Aquatic Resources
Sivebæk, F., Project Participant, National Institute of Aquatic Resources
Optimal sustainable exploitation of Nephrops norvegicus in Kattegat and Skagerrak (38909)
The scientific advice on management of fisheries is primarily aiming at avoiding overfishing of the fish and shellfish stocks and only to a very limited extent addresses how the utilisation of the resources can be optimised within a sustainable ecosystem framework. An example is the regulation of the demersal trawl fisheries in the Skagerrak and the Kattegat which to protect the cod stock is sub-optimal in relation to the utilisation of the Norway lobster (Nephrops) stocks. The project takes a new approach to the management and aims at optimising the utilisation of Nephrops stocks without compromising the protection of cod.

The Nephrops fishery is one of the economically most important fisheries in Denmark. In the Kattegat and Skagerrak, Nephrops catches accounted in 2010 for 53 % and 25 % of the total value of fish and shellfish, respectively, landed by Danish fishermen. Cod is taken as by-catch in the Nephrops fishery and it has been necessary to introduce measures to limit the by-catches of cod, which is currently below agreed reference points for stock size. These measures have had a negative impact on Nephrops catches.

The project addressed four objectives: (i) development of advice on the fishing mortality for the Nephrops stocks, which is consistent with maximum sustainable yield; (ii) mapping of the distribution of Nephrops in Skagerrak and Kattegat; (iii) development of a new trawl concept optimising the catchability on Nephrops while limiting the by-catches of cod and impact on the sea bed; and (iv) evaluating alternative fishing methods for Nephrops including fishing with pots.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and Demonstration Program (GUDP).

Improving the selectivity for cod in Danish trawl fisheries (38887)
The aim of the project was to develop and test more selective fishing gear for three major Danish fisheries:
- The demersal trawl fishery in the North Sea (120 mm)
- The demersal trawl fishery in Kattegat and Skagerrak (90 mm)
- Improve the selection range (SR) in the BACOMA codend used in the Baltic Sea

The new and more selective fishing gears were developed under consideration of the economy in the fishery. The project delivered three new selective gear solutions of which two were tested during experimental fishery. Technical descriptions of the new designs were delivered. Furthermore, an economical model to quantify the economic consequences of using the new selective fishing gears compared to existing standards was developed.

Experiments were conducted in the Baltic Sea cod fishery demonstrating that the selection range (SR) could be reduced by using a larger diamond mesh in the lower sheet of the BACOMA design. Further the project demonstrated the efficiency of legal selective escape panels in Skagerrak/Kattegat and the effect of varying design parameters in both the panel section and the trawl body. Finally the project demonstrated that active stimulating fish behavior around selective escape panels significantly can improved the escape panels’ selectivity.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Ministry of Food, Agriculture, and Fisheries and the European Fisheries Fund (EFF).

Keywords: Research area: Fisheries Technology & Marine Living Resources
Collaborators: Danish Fishermen's Association
Project: Research
**Response of pelagic food webs to warmer, acidified oceans (Pelagic foods) (38923)**

Atmospheric CO2 is projected to double by 2100, resulting in increased global temperature, ocean acidification (OA) and changes in the balance of marine ecosystems. A general lack of multifactorial studies means very limited knowledge on the combined effects of these pressures on ecosystem structure and function. Preliminary mono-factorial data indicate important but little studied appendicularians (pan-global pelagic urochordates) may be strongly impacted, directly and indirectly via altered phytoplankton growth and chemical composition. Effects on other key plankton such as copepods may depend on phytoplankton size. Appendicularians repeatedly secrete and discard filter-feeding houses. Discarded houses with trapped particles make a significant contribution to global vertical carbon flux. We will study combined effects of temperature and CO2 on these dominant zooplankton by manipulating natural plankton in mesocosms. We hypothesize climate change will impact the important zooplanktonic trophic level through top down altered predation fields and bottom up changes in prey type and size. Copepods are size-selective feeders and recent data suggest appendicularians are bottom up regulated by large and spiny particles. We will test these hypotheses in mesocosms by generating blooms of diatoms (large) or flagellates (small) and evaluate subsequent zooplankton population dynamics. Under these different conditions, we will also examine competitive predatory interactions between copepods and appendicularians, leading to models of projected effects of p(CO2) and temperature on appendicularians and copepods through alterations in phytoplankton community structure and uni-directional predatory pressure. Both appendicularians and copepods are important in oceanic carbon sequestration, but do so via different pathways. Data from these experiments should also have important predictive value on the nature and extent of future carbon sequestration in marine pelagic communities.

The project is coordinated by University of Bergen, Norway.

Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Koski, M., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life

01/01/2011 → 31/12/2011

**Keywords:** Research area: Oceanography

**Collaborators:** University of Bergen, Uni Research AS, Russian Academy of Sciences, University of Gothenburg, Leibniz Institute of Marine Sciences, Skidaway Institute of Oceanography

**Project:** Research

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**Socio economic effects of management measures of the future CFP (SOCIOEC) (38940)**

**Objectives and Background**

The main aim of the SOCIOEC FP7-KBBE-2011-5 project under KBBE.2011.1.2-10 (Socio-economic effects of the main management principles of the future CFP: impact of new policy framework and opportunities for the fishing sector) was to evaluate innovative fisheries management measures and develop self- and co-management. It has been important that the project focused on the interpretation of overarching (i.e. EU) objectives in local and regional contexts.

**Deliverables and Tasks**

In the first step the project developed a coherent and consistent set of objectives for fisheries management, which addressed ecological, economic and social sustainability targets. The objectives were consistent with the aims of the CFP, MSFD and other EU directives, but also understandable by stakeholders and the community and engaged their support. This leaded to the proposal of a number of innovative management measures, based on existing or new approaches. The second step was to analyze the incentives for compliance provided by these measures through examination of fisher’s responses to and perceptions of measures based on historical analysis, direct consultation and interviews, and how the governance of the measures operated.

Finally, the project examined the impact of the measures that emerge from this process, particularly in terms of their economic and social impacts on the industry and the wider community. All this was done through a generic analysis of the wide range of current and emerging measures in the current CFP and possible measures introduced in the future. This required and has resulted in interdisciplinary work across a range of scientific disciplines (economics, social and natural sciences).

DTU Aqua was involved in the North Sea and Baltic Sea case studies and in the project Steering Group. For the North Sea, DTU Aqua focused on analyses of catch quotas compared to landing quotas in mixed consume fisheries including related discard processes. Also, small meshed pelagic fisheries in the North Sea were addressed for efficient management of those. For the Baltic Sea, DTU Aqua focused on evaluation of spatial management measures among other in relation to NATURA 2000 areas and implementation of windmill farms, and larger marine constructions. This resulted in evaluation of success and failures of several management measures, and enabled us to draw conclusions on which measures are best introduced in which circumstances, possibly on a regional basis. On this basis DTU Aqua has produced several peer reviewed journal papers under SOCIOEC. In the CFP we need to distinguish between the basic, overarching regulations of the EU or regional seas level and the specific and local management by Member States in sea areas where self- and co-management schemes are often already informally in place. Here the cooperation with the ACs was essential to derive objectives applicable for the CFP based on the ecological, economic and social drivers and to reconsider management at more regional or local levels. This process involved: (i) investigation of how the objectives regarding ecological, economic and social sustainability could be defined in the short term and ensures the long-term sustainability and viability of fisheries; (ii) analyzing which management measures and at what organization level, created the right incentives to tackle structural failings in the CFP with focus on technical measures, command and control
Fish welfare aspects of individual variation in cognition, physiology and behaviour (Cope Well) (38813)
The project targeted welfare aspects of individual variability fish. Such differences include both behavioural and physiological traits, which are often clustered in separate stress coping styles. These stress coping styles seem to be coupled to fundamental differences in how information is processed. The aim of this project was to develop methods for separating fish with respect to stress coping styles, and investigate how fish with contrasting stress coping styles differs in cognitive evaluation of challenges. Moreover, the neural mechanism separating fish with contrasting stress coping styles was investigated. The project was part of a large scale collaborative project, funded by the European Commission FP 7 (Cope Well), aiming to establish, evaluate, and further develop, a new scientific framework for the understanding and application of the concept of animal welfare in farmed fish.
The project was coordinated by Havforskningsinstituttet (IMR), Norway.
The project was funded by EU, Framework Programme 7.
Högland, E., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Moltesen, M., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2015
Keywords: Research area: Aquaculture
Collaborators: Stichting Dienst Landbouwkundig Onderzoek, Havforskningsinstituttet, University of Stirling, University of Oslo, Uppsala University, Autonomous University of Barcelona, University of Patras, Centro de Ciências do Mar
**Vectors of change (VECTORS) (38907)**

Marine life makes a substantial contribution to the economy and society of Europe. VECTORS aimed at elucidating the drivers, pressures and vectors that cause change in marine life, the mechanisms by which they do so, the impacts that they have on ecosystem structures and functioning, and on the economics of associated marine sectors and society. VECTORS particularly focused on causes and consequences of invasive alien species, outbreak forming species, and changes in fish distribution and productivity. New and existing knowledge and insight was synthesized and integrated to project changes in marine life, ecosystems and economies under future scenarios for adaptation and mitigation in the light of new technologies, fishing strategies and policy needs. VECTORS also evaluated current forms and mechanisms of marine governance in relation to the vectors of change. Based on its findings, VECTORS outlined solutions and tools for relevant stakeholders and policymakers during the lifetime of the project. The VECTORS consortium included a mixture of natural scientists with knowledge of socio-economic aspects, and social scientists (environmental economists, policy and governance analysts and environmental law specialists) with interests in natural system functioning.

DTU Aqua contributed to VECTORS by developing new statistical models of fish species distributions, by further developing spatially resolved bio-economic models of fishing, and by analyzing fish species richness and distribution in the north Atlantic and the general relationship between changes in fish stock abundance and distribution area. We coordinated the Baltic WP where we implemented the ATLANTIS end-to-end model and performed initial scenario testing. We also analyzed the most important drivers of fish population dynamics in the Baltic, and contributed to the study of invasive species.

VECTORS comprised a total of 37 European Universities, research institutions and professional associations dealing with applied maritime and marine research. The project included marine environmental scientists, fisheries scientists, conservation biologists, sociologists and economists from across the European scientific community providing expertise in marine ecosystems, management, fisheries, maritime transport, tourism and coastal development.

The project was coordinated by Plymouth Marine Laboratory, UK. The project was funded by EU, Framework Programme 7.

Gislason, H., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Eero, M., Project Manager, National Institute of Aquatic Resources
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Köster, F., Contact Person, National Institute of Aquatic Resources
Lewy, P., Project Participant, National Institute of Aquatic Resources
Rindorf, A., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Kristensen, K., Project Participant, National Institute of Aquatic Resources
Huwer, B., Project Participant, National Institute of Aquatic Resources

01/01/2011 → 31/01/2015

Keywords: Research areas: Ecosystem based Marine Management & Fisheries Management & Marine Living Resources

**Trait based plankton ecology (38996)**

Plankton is the dominating life-form in the ocean. It is mainly invisible and lives in a viscous world that is not part of our sensed experience. As a consequence, important properties of life in the oceans remain poorly understood. This project has aimed to further a cross-disciplinary research activity to promote an understanding of the dynamics of marine pelagic ecosystems that is based on mechanistic descriptions of the functioning of and interaction between its individuals. We provided trait-based descriptions of the key functions of plankton, formulate their associated trade-offs, and develop trait-based models of plankton ecosystem that we will test against observations.

The core activity of the project was the development of mechanistic descriptions of key plankton traits and their trade-offs and development of trait-based models of pelagic systems. The immediate goal of the project was to achieve fundamental insights in the functioning of pelagic ecosystems but ultimately the models to examine effects of environmental changes and human impact. The project was a ‘precursor’ for the Centre for Ocean Life.

The project was coordinated by DTU Aqua.

The project was funded by the Danish Council for Independent Research.

Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources

01/01/2011 → 31/12/2013

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics

Collaborators: Aarhus University, Roskilde University

Project: Research
EURO-BASIN: European basin-scale analysis, synthesis and integration (EURO-BASIN) (38899)

EURO-BASIN was designed to advance our understanding on the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on the structure, function and dynamics of the North Atlantic and associated shelf sea ecosystems as well as the key species influencing carbon sequestering and ecosystem functioning. Like the entire biosphere, marine ecosystems such as the North Atlantic and its associated shelf sea ecosystems can be characterized by emergent properties controlled by a dynamic network of interactions and relationships and not static entities. This system complexity is what Martin Luther King Jr. called "an inescapable network of mutuality" scientists today define as complex adaptive systems (CASs).

EURO-BASIN has represented the first attempt of creating future prognosis of marine ecosystem states sensitive to CAS dynamics using as its test case the North Atlantic. Long-term prediction of the status of these CAS systems, population dynamics of key species and hence management of marine systems requires the implementation and advancement of an ecosystem approach for the management of marine resources sensitive to CAS dynamics. What is the ecosystem approach? Unlike a single species approach, the ecosystem approach takes into account population and ecosystem responses to changes in the Earth's climate, fisheries, and interactions between them. In EURO-BASIN not only did we monitor and assess how North Atlantic marine ecosystems behaved in the past, but also predict how they will respond under possible future climate change scenarios. Hence, the results of this project have provided important recommendations for better marine resource management in the European Union.

The project had participants from 23 European universities and research institutions as well as collaborations with key institutions and Universities in the US and Canada.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

St. John, M., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Köster, F., Project Manager, National Institute of Aquatic Resources
MacKenzie, B., Project Manager, National Institute of Aquatic Resources
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Kiærboe, T., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Stæhr, K., Project Participant, National Institute of Aquatic Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources
Grigorov, I., Contact Person, National Institute of Aquatic Resources

FP7 Contract ID: 264933
01/01/2010 → 31/12/2014
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Marine Living Resources

Project: Research

Traceability in the Danish fish sector (SIF) (38883)

The development of an operative system to have full traceability in the Danish fish sector, started in 2009, with the first project SIF 1. This was a specification of what an IT program should contain to meet the demands of the sector. The actual software development took place in the next project SIF 2. Due to some political implications to finance SIF 2 it was divided in SIF 2.1 and SIF 2.2. SIF 3 had to start before SIF 2.2 was finished and some elements were transferred between the two projects.

SIF 3 has the Danish title of “Dataopsamling af sporbarhedsdata” (collection of traceability data). The main activities are to specify and build the access points to the database constructed in SIF 2.1 and extend the use to the processing industry and wholesalers. The overall aim is to construct a “single string system” that collects all relevant data. This last expansion has been done to meet the challenge from the EU Regulation 1224/2009 and the Commissions Regulation 404/2011, to have valid traceable data.

DTU Aqua’s part in SIF 3 has been concentrated on constructing a software program to be used on the fishing vessels to communicate with the fishery inspections IT based Logbook (E-Log) and the SIF-database. This has been done in close cooperation with DTU IMM (Institute for Mathematical Modeling), which have a software development group, originally coming from DTU Aqua. The developed program has been built partly on a previous program with the name of PIP – developed for the pelagic sector.

The project is coordinated by Danish Fishermen's Producers' Organisation, Denmark.
**Larsen, E., Project Manager, National Institute of Aquatic Resources, Public Sector Consultancy**  
01/01/2010 → 31/03/2012  
*Keywords: Research area: Fisheries Management*  
*Collaborators: Pack & Sea A/S, Danish Fishermens Producers Organization, Ministry of Environment and Food of Denmark, Danish Seafood Association, Lyngsoe Systems A/S*  
*Project: Research*

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**Match and mismatch in the ocean (38897)**  
Only a very small fraction of the enormous amount of eggs that a fish population spawns survives the larval stage and enters the population as young fish: the majority die as larvae. The synchronicity between the timing of the plankton blooms and the food requirements of larval fish is thought to be one of the most important factors for the survival of larvae. This “match-mismatch” hypothesis will be tested using data from fish populations across the planet and global satellite observations of plankton dynamics. The results will increase our understanding of why fish populations vary throughout time and thereby contribute to their sustainable management.

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The project is coordinated by DTU Aqua.  
*Payne, M., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life*  
01/01/2011 → 01/04/2012  
*Keywords: Research area: Oceanography*  
*Collaborators: Swiss Federal Institute of Technology*  
*Project: Research*

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**EU preparatory action on maritime spatial planning in the North Sea (MASPNOSE) (38895)**  
Several EU member states had been working on spatial plans for their part of the North Sea. However, most marine spatial planning was carried out on a national level and largely ignored the possible benefits of cross-border cooperation. Joining forces with neighboring countries could have been an efficient way forward. A first step in this direction was the EU MASPNOSE project that brought together spatial planning practitioners, stakeholders and researchers in order to deal with these bottlenecks. MASPNOSE was an EU project on ecosystem based Maritime Spatial Planning (MSP) in the North Sea, focusing on cross-border areas. The project focused on the southern North Sea with Belgium, Denmark, Germany and the Netherlands as target countries.  
To achieve this aim, MASPNOSE explored possibilities for cooperation among North Sea countries; established elements for a common agenda for cooperation of countries around the North Sea; tested the 10 key principles on Maritime Spatial Planning set up by the European Commission; and identified potential barriers and opportunities for cross border Maritime Spatial Planning.  
The MASPNOSE project acknowledged the overarching importance of national authorities and other stakeholders (e.g. industries, NGO’s) in Maritime Spatial Planning. National governments had an advisory role in the project.  
Stakeholder participation was one of the focus points of the project and took place in the different case studies on a local scale. MASPNOSE could be seen as an experiment on how cross-border Maritime Spatial Planning could be carried out.  
This was based on two cross-border case studies in the North Sea: the Dutch-Belgian border and the Dogger Bank.  
The project was coordinated by Wageningen University, The Netherlands.  
The project was funded by EU, Call for tender (Preparatory Action for Maritime Spatial Planning).  
*Serensen, T. K., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management*  
*Dinesen, G. E., Project Participant, National Institute of Aquatic Resources*  
*Egekvist, J., Project Participant, National Institute of Aquatic Resources*  
01/01/2010 → 31/05/2012  
*Keywords: Research areas: Ecosystem based Marine Management & Marine Living Resources & Coastal Ecology*  
*Collaborators: Wageningen IMARES, Wageningen University & Research, Thunen-Institut, Deltares, Ghent University*  
*Project: Research*

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**Geographical distribution of fish resources and optimizing of fishery practice in the north-eastern North Sea (RESOURCE) (38878)**  
RESOURCE is a collaborative fishermen-scientist project in direct continuation of the REX projects in the north-eastern North Sea conducting small-scale scientific surveys, but only with one commercial trawler, encompassing also geographical distributional aspects as in OSKAR.  
The REX project showed that changes in the biomass densities of cod differ between bottom types (and may depend on stock size) and the proportion of the cod population found on smooth bottoms is not constant. However, due to scaling problems and too short a time series the achieved results have so far had no impact on the assessment procedure or any (measurable) effect on the TAC’s (but the RAC discussions may have affected decisions by the European Commission). Continuation of the field work with the trawler in 2010-12 in the RESOURCE project should produce a sufficient time series
for supplementing the abundance indices for the older ages in the assessment, which at present are based only on the
catch rates in the international scientific surveys (IBTS). This total REX-RESOURCE time series will be used in the state
space assessment of North Sea cod (SAM) and various other approaches applied to document how commercial CPUE
may be used in the tuning procedure. Particular attention will be given to evaluate the size of the spawning stock of cod.

Mechanistic knowledge on vital rates together with REX, RESOURCE, OSKAR and IBTS (and possibly also UK) survey
data will be used as input to the geostatistical tool GeoPop to estimate the temporal and spatial dynamics of the size
distribution of the cod stock. This part of the project will represent a direct continuation of OSKAR principles including
considerations to how to design an operational fishery-forecast system for North Sea cod.

The project is coordinated by DTU Aqua.
Beyer, J., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Wieland, K., Project Manager, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and
Oceanography
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
Andersen, B. S., Project Participant, National Institute of Aquatic Resources
Hüssy, K., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Kristensen, K., Project Participant, National Institute of Aquatic Resources
Nielsen, A., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Christensen, A., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Madsen, N., Project Participant, National Institute of Aquatic Resources
01/01/2010 → 30/09/2012
Keywords: Research area: Marine Populations and Ecosystem Dynamics
Collaborators: Danish Fishermen’s Association
Project: Research

The shore crab and its parasites in Limfjorden. A model study of a marine invasive species in its home range (38870)
The purpose of the DTU Aqua part of the project is to collect and analyze data for a quantitative description of the
population and parasite structure of the shore crab (Carcinus maenas) in Limfjord in Denmark. This includes quantitative
information on the species’ geographical distribution in the Limfjord as well as estimates of abundance. The abundance
estimates will be based on mark-recapture experiments and trawl survey data. Geographical distribution and year to year
fluctuation in abundance of the shore crab will be related to key parameters such as salinity, depth and temperature.

The project is coordinated by University of Copenhagen, Denmark.
Hoffmann, E., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine
Management
Munch-Petersen, S., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine
Management
01/01/2009 → 31/12/2011
Keywords: Research areas: Ecosystem Based Marine Management & Marine Living Resources
Collaborators: University of Bergen, University of Copenhagen, Danish Shellfish Centre
Project: Research

Marine model trout farms (38816)
Based on the success with the development and implementation of Danish model trout farms in freshwater, a somewhat
similar concept was developed for sea water farming of large trout and potentially also salmon in land-based, recirculating
systems. Design and technology for the recirculation unit as well as for end-of-pipe treatment were developed and tested
in 3 consecutive seasons.
During the project, design and operation were optimized and documented. End-of-pipe treatment, especially related to
nitrogen removal and sludge hydrolysis were also investigated.
Based on the concept and the results achieved in the major unit in commercial scale at DTU Aqua premises in Hirtshals, it
can be concluded that there is potential for such open land-based sea water farming units and that they can be operated
commercially sustainable. Major issues related to reducing/preventing (toxic) algal blooms and supersaturation in
seawater needs to be addressed before commercial operations should be initiated, though.
The project was coordinated by North Sea Science Park, Denmark.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries through the Green Development and
The Atlantic cod (Gadus morhua) in Greenlandic waters – past and future under climate change (38873)

This project aimed at understanding and predicting the population dynamics of Atlantic cod (Gadus morhua) in Greenlandic waters in response to climate change. This was achieved through biological, chemical and genetic analysis of unique cod otolith collections, generating historical time series on growth, food composition and genetic population structure. Relationships between environmental changes and the historical distribution, size and growth of individual cod populations was elucidated and used to predict their dynamics under different climate scenarios. The project generated fundamental insights, but also contributed significantly to proactive management of cod in Greenland.

The project was coordinated by DTU Aqua.

The project was funded by the Greenland Climate Research Centre.

Recirculation technology for future aquaculture (REFA) (38843)

An Innovation Consortia with many industrial partners. In the project, basic and applied research was performed by several partners to support the development of new and energy-efficient technologies for recirculation systems. Some of the research issues were:

- to develop new filter technologies and energy-efficient aeration systems
- to develop process- and CFD models to improve our understanding and insight into dynamic variation in water quality parameters
- to determine the importance of particulate matter for biofilter operation (this was the DTU Aqua research package)
- to develop tools and instruments for advanced regulation and control of recirculating aquaculture systems
- to develop technologies for waste management

Twelve larger Danish companies were further partners in this project.

The project was coordinated by Danish Hydraulic Institute, Denmark.

The project was funded by the Danish Agency for Science, Technology and Innovation and the participating companies.

Population genetics of flounder in Danish waters (38819)

Knowledge about population structure and local adaptation is central for successful management of both freshwater and marine fisheries. For instance, recently accumulated knowledge about the geographical scale and extent of local adaptation in anadromous fishes has resulted in the abandonment of fish transplants and releases of foreign fish into natural populations, because such activities threaten the survival of natural populations. In coastal habitats, local fishermen have expressed interests in moving marine fish between geographically distant areas, but until now a lack of scientific knowledge about the scale and extent of local adaptation has prevented any detailed advice on the scale that such movements may be possible. In one particular case, it was proposed to move European flounder from the western parts of the Limfjord to the Bay of Aarhus in order to support a fishery in the bay where the species had reached very low abundances. Since these two areas are both geographically distant and environmentally different, it is possible that fish are also adapted to local environmental conditions. However, although earlier work has strongly suggested that populations of European flounder may be locally adapted, no study had directly compared samples from these areas. In this project, we aimed to use a combination of genetic markers previously found not to be affected by selection (so-called “neutral markers”) and markers situated in or close to genes which may be important for local adaption. The application of such a combination of genetic markers may allow the assessment of geographical patterns and scales of both population structure and local adaptation in natural populations. The first stage of the project was the development of new genetic markers through screening candidate genes, identified as differentially expressed in relation to various
stressors in laboratory experiments, for the presence of suitable genetic markers. Genetic markers were subsequently analyzed in individuals collected from the target as well as reference populations in 2011 and in additional reference samples available from 2003/2004. Results showed markedly different levels of genetic variation in putatively neutral and candidate gene associated markers throughout the species’ distribution. Furthermore, different frequencies of genetic variants near the stress response candidate gene, Hsc70, were observed between the Limfjord and the Bay of Aarhus, suggesting local adaptation to the two areas. Consequently, it was advised that fish were not moved between these two regions. In addition to providing information about the specific case, these results could also be important for guiding future research on finer geographical scales in this and other marine fishes.

The project was coordinated by DTU Aqua. The project was funded by the Danish Rod and Net Fishing License Funds. Hansen, J. H., Project Manager, National Institute of Aquatic Resources Meldrup, D., Project Participant, National Institute of Aquatic Resources Støttrup, J. G., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management Sparrevoehn, C. R., Project Participant, National Institute of Aquatic Resources Nicolajsen, H., Project Participant, National Institute of Aquatic Resources 01/01/2011 → 31/12/2012

Keywords: Research areas: Population Genetics & Coastal Ecology Collaborators: Northwest Jutland Recreational Fishermen's Association

Predation from birds and mammals and the significance for populations of freshwater fish (38829)

It is a well-known fact that predation can be a key factor for many fish populations and in some areas predation may even be the most important regulating factor for fish stocks of major recreational importance. Several species of predators were earlier persecuted, but are now protected and have experienced high population growths recently. This includes species like: cormorant, grey heron, seals and otter. Thus, the protection of these species has been a conservation success, but has also caused severe conflicts between various user-groups. To handle and mitigate these conflicts, scientific documentation is severely needed.

During a long period, DTU Aqua has carried out a number of projects that directly or as side-results have assessed the magnitude of predation and its impact on various fish stocks. This has provided some insight in when, where and by whom the important recreational fish species are being eaten. This project gathered and synthesized this knowledge to provide an overview of the significance of predation.

Outputs:
- Synthesis and analyses of existing knowledge/results.
- Method evaluation for scanning for PIT tags in cormorant/heron colonies.
- Investigations of possible causes for the recent drastic decline in grayling (Thymallus thymallus) populations.

The project was funded by the Danish Rod and Net Fishing License Funds. Jepsen, N., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology Skov, C., Project Participant, National Institute of Aquatic Resources Aarestrup, K., Project Participant, National Institute of Aquatic Resources Pedersen, S., Project Participant, National Institute of Aquatic Resources 01/01/2011 → 31/12/2013

Keywords: Research area: Freshwater Fisheries and Ecology

Scaling from individuals to populations (SLIP) (38726)

The research school SLIP (Scaling from Individuals to Populations) focuses on how individual behavior and mutual interactions generate the dynamics observed at the population level. This topic forms the link between the basic and applied marine ecological research environments in Denmark and requires input from biology, mathematics and statistics. SLIP is one of the five research networks and research schools under the Danish Network for Aquaculture and Fisheries Research (Fishnet). SLIP has arranged a number of national and international PhD courses and workshops and has served to focus the interest on size and trait-based modeling, as well as on improved understanding of the physiology, genetics and behavior of marine organisms, in particular fish.

The project is coordinated by DTU Aqua.
Gislason, H., Project Manager, National Institute of Aquatic Resources Kiørboe, T., Project Manager, National Institute of Aquatic Resources Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources Höffle, H., Project Participant Gürkan, Z., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources Therkildsen, N. O., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources Sichlau, M. H., Project Participant, National Institute of Aquatic Resources Mosgaard, T., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
The population of whitefish (Coregonus lavaretus) in Ringkøbing Fjord: Effects of fishery, stocking and natural reproduction (38827)

Objectives of the project are to improve our knowledge on the whitefish population in the Ringkøbing Fjord Lagoon and its effects associated with the commercial exploitation of the population, i.e. to what extent the traditional gill-net (46 mm monofil nets) fishery for whitefish affect both the whitefish population and other species of fish in the lagoon. Another goal is to establish how much natural reproduction and stocking of hatchery reared fry contributes to the adult population. These results will provide a much better basis for the management of whitefish populations in Denmark in general and in Western Jutland in particular.

The natural population of whitefish in the Ringkøbing Fjord Lagoon has been the subject of an extensive fishery for more than 100 years. The fishery is primarily performed by commercial fishermen, but estimated from the number of recreational fishers in the area, a substantial amount is caught by this group as well. The lagoon holds the largest population of whitefish in Denmark. The official landing statistics (only covering the commercial catches) shows that the catch through the 20th century typically has varied between 10 and 60 tons per year (e.g. mean 1990-2000 25.1 tons per year). Since 2001 the landings have increased to a mean of 55 tons per year (range 14-94 t), with a mean value of 1.2 m DKK. This constitutes 75-95% of the total Danish whitefish fishery.

Since 1986 ca. 4 million hatchery reared fry has been stocked in the lagoon each year. 3.6 million are stocked as newly hatched larvae in April. 0.4 million are reared to a size of 3-4 cm before stocking in late May. The population of sea trout (Salmo trutta) in the main tributary of the lagoon, the River Skjern, is much smaller than expected, considering the environmental conditions of both the river and the lagoon and the size of the river. One possible reason is by-catch in the whitefish fishery. The landing of sea trout and the endangered salmon (Salmo salar) from the lagoon is prohibited and the discard mortality for sea trout is considered to be very high. Investigations on the subject of by-catch in gill-nets set for whitefish in the Baltic Sea supports this hypothesis.

In the project we estimate the catch of whitefish and the by-catch of other fish species in the whitefish gill-net fishery, with special emphasis on salmonids, by a combination of experimental fishery, monitoring selected commercial fishing trips and a questionnaire the fisher men on their effort. A number of different approaches re time and place of fishing and net construction is tested to describe how much by-catch can be minimized.

The result of natural spawning in River Skjern is investigated by a combination of catching newly hatched larvae with drift-nets and e-DNA analysis of water samples from the river. The latter method is a very novel approach.

The results show that catching is unavoidable, but also that the by-catch can be reduced substantially by employing specific gears and methods. The by-catch of salmon is insignificant while the by-catch of other species, especially flounder is substantial. These results will be reported in autumn 2016. Their investigation on natural reproduction in the River Skjern is still ongoing and will be reported in 2017.

This project is coordinated by DTU Aqua. The project is funded by the Danish Rod and Net Fishing License Funds.

Project: Research

Collaborators: Aarhus University, University of Copenhagen, Roskilde University

Keywords: Research areas: Marine Populations and Ecosystem Dynamics

01/01/2000 → 31/12/2008

HPLC and amino acids uptake patterns in fish fed plant-based protein (38803)

One of the issues of the rapidly growing aquaculture sector is to find fish meal substitutes. The main focus has been on plant proteins as a substitute for fish meal in the diet formulation. However, significant incorporation of plant proteins in the fish diet often results in reduced growth and/or impaired feed efficiency. Recent trials performed at our lab have shown that the profile of amino acid uptake (timeline) varies between rainbow trout fed plant based diet and fish meal diet. This difference in amino acid availability might well influence the protein synthesis and could add to the explanation of reduced performance of fish fed plant based diets and also the observed increased ammonia excretion.

Following these initial observations made in 2011 the project will perform a series of experiments to further examine how and why amino acid uptake patterns differ. Correlations between amino acid profile in the diet and amino acid in the blood following feeding will be made for different plant protein sources and added crystalline amino acids.
The concomitant effects on liver enzyme activity and protein synthesis will be examined and relevant indicators for protein synthesis (i.e. growth) hopefully determined. Specific digestibility and nitrogen excretion studies as well as traditional growth studies will be performed to support the findings.

The project is coordinated by DTU Aqua.
Larsen, B. K., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Skov, P. V., Project Participant, National Institute of Aquatic Resources
Dalsgaard, A. J. T., Project Participant, National Institute of Aquatic Resources
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Rolland, M., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2015
Keywords: Research area: Aquaculture
Collaborators: BioMar A/S
Project: Research

The biological pump in the Nordic seas: Copepods and appendicularians as producers and consumers of sinking particles (BIOPUMP) (38757)
BIOPUMP is a research network investigating the vertical flux, its production and consumption, and how it is affected by the climate change. The main activities of the network are annual research workshops concentrating on diverse aspects of vertical flux, such as the role of different zooplankton groups in producing and degrading of sinking particles, and how will the changing temperature and CO2 concentrations of the ocean influence the dynamics of these groups. BIOPUMP is also involved in organizing a Nordic PhD course on vertical flux and factors influencing it.

The project is coordinated by DTU Aqua.
Koski, M., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Kierboe, T., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2008 → 01/05/2013
Keywords: Research area: Oceanography
Collaborators: University of Bergen, Stockholm University, University of Oslo, University of Copenhagen, University of Gothenburg, Greenland Institute of Natural Resources, UiT The Arctic University of Norway, Danish Centre for Environment and Energy
Project: Research

Fish populations and traceability (FishPopTrace) (38283)
The underlying rationale of FishPopTrace was to assess and address challenges arising from the development of traceability tool within a forensic framework for four judiciously chosen target species: cod (Gadus morhua), hake (Merluccius merluccius), herring (Clupea harengus) and sole (Solea solea). Previous information on levels of population structuring in traits such as life histories, morphometrics, genetics and physiology was used to inform sample choice. Thenew data was restricted to markers at two levels:
- Routine screening: selection of markers that exhibit maximal discriminatory power to identify populations, though with discrete and controlled variance enabling validation (single nucleotide polymorphisms (SNPs) and otolith microchemistry and morphometrics). Data from DNA based methods provided a mechanism for traceability throughout the food supply chain (“fish to fork”) and indicated discrete spawning populations, whereas otoliths aimed at providing an independent onboard traceability system of fish provenance.
- Testing of novel tools: additional tools were tested on a selection of populations to assess validity and potential for traceability and validation, including fatty acid analysis, proteomics, gene expression analysis and the generation of high-throughput microarray platforms for SNP genotyping. Thus, FishPopTrace provided information relating to geography (“population tag”), as well as regional signatures that indicate biological differentiation in relation to spawning identity.

The project was coordinated by University of Wales Bangor, UK.
The project was funded by EU, Framework Programme 7.
The project was funded by EU, Framework Programme 7.
Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Bekkevold, D., Project Manager, National Institute of Aquatic Resources
Hansen, J. H., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2011
Keywords: Research area: Population Genetics
Collaborators: University of Padova, Wildlife DNA Services Ltd., Département Sciences & Techniques Alimentaires Marines, Spanish National Foundation of Fish and Seafood Processors, Bangor University, University of Bergen, European Commission - Joint Research Center, Aarhus University, University of Bologna, The Centre of Molecular
Genetic Identification, VNIRO, National Agricultural Research Foundation, Stichting Katholieke Universiteit, University of Bremen, Complutense University

Project: Research

**Physical oceanography in Greenland waters under climate change (38767)**

Chasing climatic conditions will have considerable effects on the seas around Greenland. Melting glaciers, the formation of sea ice, large scale circulation of the Atlantic Ocean as well as more local changes in weather patterns will have direct impact, with cascading effects to biological processes and sustainable harvesting of marine resources. The aim of this project is to prepare modeling tools and analyses to describe expected oceanic conditions around Greenland under climate change. Particular focus will be on coupling these models and process studies to biology, biogeochemical cycling, and sea ice processes, with eventual feed backs to climate itself.

The project is coordinated by DTU Aqua.
Visser, A., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Koski, M., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2010 → 31/12/2014
Keywords: Research area: Oceanography
Collaborators: Aarhus University, VitusLab, Danish Meteorological Institute
Project: Research

**Monitoring effective population sizes of North Sea houting using genetic markers (38272)**

This project was aimed at providing basic information on the genetic structure of lake whitefish and North Sea houting, species where population genetic data are needed in order to improve conservation and management efforts, including principles for stocking.

The project focused on North Sea houting within the framework of the EU LIFE project Urgent Actions for the endangered houting (Coregonus oxyrhunchus). It was investigated if there are other remaining indigenous populations than that in the Vidaa River, which is currently assumed to be the last remnant of this species/form. Moreover, effective population size was estimated in order to assess if it was below the threshold where inbreeding and loss of genetic variation is an immediate concern. A paper was published on genetic monitoring of effective population size in North Sea houting, showing that the described methods are useful for monitoring purposes. All analyses were based on microsatellite DNA analysis of contemporary and historical samples. In addition, the results were used in the context of a US-based working group, aimed at defining and developing the emerging field of genetic monitoring, i.e. the use of genetic markers for monitoring populations.

The project was coordinated by the Nature Agency, Danish Ministry of the Environment, Denmark.
The project was funded by EU LIFE.
Bekkevold, D., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
01/01/2005 → 31/12/2011
Keywords: Research areas: Population Genetics & Freshwater Fisheries and Ecology
Collaborators: Ministry of Environment and Food of Denmark
Project: Research

**Test and demonstration of a selective topless trawl (38699-1)**

The cod stock in Kattegat was at a critical level and ICES recommended a 0-TAC for cod. In the economically important fishery for primary Nephrops and flatfish in Kattegat cod were caught as by-catch.

The aim of the project was to develop and test a cod selective topless trawl design in the Nephrops directed fishery in Kattegat to allow an economically feasible fishery with a minimal by-catch of cod. The design idea was based on utilizing behavioral differences between the species, specifically that most fish stay low in the trawl, whereas gadoids like cod raise further aft in the gear and therefore can escape above the cut-back headline. The top of the trawl was cut 10-20 meters back, which allowed cod to escape above the headline. The catch of flatfish and Nephrops were not expected to be affected by the change in design due to their strong preference for the lower part of the gear.

The results of the project led to the implementation of a topless trawl design into the technical legislation in Kattegat.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food Agriculture and Fisheries and the European Fisheries Fund (EFF).
Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Madsen, N., Project Participant, National Institute of Aquatic Resources
Jensen, J., Project Participant, National Institute of Aquatic Resources
01/01/2009 → 31/12/2010
Keywords: Research area: Fisheries Technology
Collaborators: Danish Fishermen's Association
Project: Research
Improving the knowledge of the biology and the fisheries of the new species for management (NESPMAN) (38689)
The NESPMAN (New Species for Management) project is meant to improve the knowledge of the biology and the fisheries of the new species for management. Apart from highly priced turbot, brill, striped red mullet and sea bass, these 12 species comprise also 3 gurnard species and 4 flatfishes. This report presents information for these 12 species that are becoming increasingly important for fisheries in NW Europe, partly due to the generally poor state of some of the main commercial fish species.

DTU tasks in the project:
- Danish fishery for witch flounder: compilation of data and description.
- Assessment of the witch flounder stock in the North Sea and Skagerrak.

The project is coordinated by IMARES, Wageningen UR, The Netherlands.
Munch-Petersen, S., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2009 → 31/12/2010
Keywords: Research area: Fisheries Management
Collaborators: Thunen-Institut, Wageningen IMARES, Institute of Marine Research, Marine and Food Technological Centre, Cefas Weymouth Laboratory, Institute for Agricultural and Fisheries Research, IFREMER
Project: Research

Optimizing the exploitation of fishery resources in Skagerrak (OSKAR) (38720)
The purpose of this project was formulated in 2008 to establish knowledge on the geographical distribution of target species in Skagerrak, which enables the fishermen to plan and execute sustainable fisheries on these species with a minimum of discard and unwanted by-catch of cod, and without drastically reductions or unjustified closure of areas. OSKAR was a collaborative fishermen-scientist project building on the experience from the REX-project conducting small-scale scientific surveys with commercial ships.

To separate control issues of the mixed fishery of Skagerrak from the issues of using fishermen’s and scientists’ combined knowledge and experience to produce more selective fisheries, some of the key questions addressed were:
- Is it feasible to predict the size distribution of cod on a small spatial scale (single trawl haul) from surveys?
- How important are the seasonal changes for the spatial distribution of cod in Skagerrak?
- Can fishermen’s anecdotic knowledge on the distribution of cod be used?
- Which role does mechanistic process knowledge play in determining critical spatial dynamics of cod?
- Taking also gear technology into account then how can we best produce e.g. a useful cod avoidance tool?

A new advanced geostatistical tool GeoPop was introduced in order to use all available survey data in the maximum likelihood estimation of temporal and spatial dynamics of the size distribution of the stock. Real time closures, future disallowance of discards etc. put the perspective of OSKAR into focus.

The development of GeoPop in this fishermen-scientist project has proven valuable (see Jansen et al 2016, Fish. Res. 179: 156-167 and refs herein). The method was published in 2013 (Kristensen et al 2013, Can. J. Fish. Aquat. Sci. 99: 1-19). Particular attention in GeoPop is paid to correlation between size classes within each trawl haul due to clustering of individuals with similar size. Extracting this nugget effect produces clearer population signals and allows e.g. following cohorts in space and time and determining stock structures. Although GeoPop today is fully TMB operated it is the present computer capacity which sets the limits to exploring e.g. the impacts of spatial heterogeneity on fishery stock assessment.

The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Beyer, J., Project Manager, National Institute of Aquatic Resources
Wieland, K., Project Manager, National Institute of Aquatic Resources
Andersen, N. G., Project Participant, National Institute of Aquatic Resources
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2011
Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management
Collaborators: Danish Fishermen’s Association
Project: Research

Test and demonstration of a selective topless trawl in the North Sea (38699-2)
The aim of the project was to develop and test a selective topless trawl to improve selectivity of cod in the demersal mixed species fishery in the northern North Sea.
The design idea was based on utilizing behavioral differences between the species, specifically that most fish stay low in
the trawl, and that gadoids, like cod, raise further aft in the tapered section of the gear and can escape above the cut-back
headline. An improved species selectivity of cod in the North Sea can allow and economically feasible mixed fishery
without further exhausting the cod stocks.
In addition to the topless design, a SELTRA sorting box was installed in codend to compare the selective effect between a
relatively large design modification in the forward part of the trawl with a relative small change in codend where the
behavioral differences between species is less expressed.
The project is coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Herrmann, B., Project Participant, National Institute of Aquatic Resources
Karlsen, J. D., Project Participant, National Institute of Aquatic Resources
01/01/2009 – 31/12/2011
Keywords: Research area: Fisheries Technology
Collaborators: Cosmos Trawl A/S, Thunen-Institut, Danish Fishermen's Association
Project: Research

Spatially-explicit management methods for North Sea cod – a Danish fishermen-science collaboration (REX, REX II, REX
III) (38430, 38431, 38541)
The REX project started in 2006 as a protest from the Danish Fishermen Association because fishers had a less
pessimistic perception of the status of the cod stock in the North Sea than ICES, and they considered the agreed TAC
levels far too low. In particular the fishermen considered the scientific surveys as inappropriate due to extremely low
catches of large cod because of wrong gear and fishing on smooth bottom only. This seemed to call for more spatially-
explicit oriented approaches and REX was born with an aim of getting closer to a common understanding of the true
number of adult cod in the North Sea by focusing on communication and collaboration in developing and implementing a
scientifically sound and robust survey strategy with commercial ships in a north-eastern area selected by the Danish
Fishermen Association using three vessels presenting different fishing methods (flyshooter, trawler and gillnetter).
The development of the fishermen-scientists collaboration with mutual respect has increased the understanding on both
sides. In particular the emphasis on defining common goals, facing and solving conflicts immediately and extending
thorough collaboration from survey planning, conducting of field work to interpretation of results during workshops have
contributed to bridging the communication gab.
A better understanding of cod biology has also been a focal point in these projects through the new field studies
incorporating fishermen’s knowledge. This includes distribution and migration, feeding behavior and importance of Hot-
Spots (e.g. ship wrecks). Electronic tags were applied to learn about migration also in the Baltic. Together with the aim of
continuing to obtain better assessments of the stocks such more mechanistically oriented studies are needed to answer
two apparently simple questions “Where are the cod and why?”
The REX projects have strengthened the scientific collaboration with fishermen and produced several results and types of
knowledge that will influence future work on developing spatial explicit management tools. REX also represents capacity
building for DTU Aqua’s interdisciplinary field research and monitoring towards the spatial dynamics of cod.
The project is coordinated by DTU Aqua.
Beyer, J., Project Manager, National Institute of Aquatic Resources
Andersen, N. G., Project Manager, National Institute of Aquatic Resources
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Wieland, K., Project Manager, National Institute of Aquatic Resources
Olesen, H. J., Project Participant, National Institute of Aquatic Resources
Neuenfeldt, S., Project Manager, National Institute of Aquatic Resources
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Kristensen, K., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Berg, C. W., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Storr-Paulsen, M., Project Participant, National Institute of Aquatic Resources
Vinther, M., Project Participant, National Institute of Aquatic Resources
Christensen, P., Project Participant, National Institute of Aquatic Resources
Jensen, R. F., Project Participant, National Institute of Aquatic Resources
Pedersen, J., Project Participant, National Institute of Aquatic Resources
Reproduction of European eel in aquaculture: Consolidation and new production methods (REEL) (38398)

Project aim: Enhance methods and technology applied to produce and culture European eel larvae as basis for the development of a future self-sustained eel aquaculture.

Background: The severe decline of the European eel stock calls for conservation measures including national eel management plans and establishment of a self-sustained eel aquaculture. In 2005, DTU Aqua, University of Copenhagen and the eel aquaculture industry started to build up a research and technology platform for the development of methods to reproduce European eel in aquaculture.

Two major projects: Artificial Reproduction of Eels II and III (ROE II and III) succeeded during 2005-2008 to produce viable eggs and larvae that lived up to 12 days. The larvae thereby accomplished the yolk sac stage and became ready to start feeding. The results were in particular promising because they evidenced that methods successfully applied to Japanese eel have a potential for application also to European eel. ROE II and III LC were supported by the Danish Ministry of Food, Agriculture and Fisheries and the Financial Instrument for Fisheries Guidance (FIFG) and RO III by the Danish Food Research Program 2006.

Results: The REEL project has accomplished through three series of experiments to consolidate previous results and extend the longevity of larvae from 12 to 20 days after hatch in first feeding experiments. Methods to induce maturation were further tested, and farmed and wild eel broodstocks and different treatments were compared. In particular, fertilization procedures to produce fertilized eggs and embryos and monitoring techniques were enhanced. The technology needed to culture embryos and larvae was substantially improved. The potential for new hormonal treatments was explored and recombinant eel hormones have been produced. New broodstock diets were developed with focus on the lipid composition essential for development and survival of fish larvae. In addition, the experimental facility established by DTU Aqua at Lyksvad Fishfarm was enhanced by improving the experimental and laboratory facilities. The REEL project has provided the basis for the establishment of an EU research project: Reproduction of European Eel: Towards a Self-sustained Aquaculture (PRO-EEL) (38793) coordinated by DTU Aqua. REEL included the partners DTU Aqua, the Danish Eel Producers Association, Billund Aquaculture, BioMar, Bioneer and Copenhagen University of which four are integrated in PRO-EEL.

The project was coordinated by DTU Aqua.

Migration and spawning behaviors of brackish water perch and pike (38413)

Brackish water populations of pike and perch have decreased severely along the coasts of the Baltic Sea. In Denmark a drastic decline in catches of brackish water pikes has been recorded during the last 30-40 years. Both brackish water pikes and perch are well estimated in angling and commercial fisheries on the brackish coastlines around the southern part of Zealand and the southern islands. Very little is known about their behaviour and life history, for instance the possible dependence of access to freshwaters to spawn. Obstacles in rivers and hereby blocking of migratory routes can therefore be crucial to reproductive success and survival of brackish fish populations along with deterioration of spawning areas in freshwater. In some areas perch is known to migrate into rivers to spawn in freshwater, but perch are also observed to spawn in brackish waters. In the Gulf of Bothnia perch have different spawning and migration strategies and some perch spawn in the bays with salinities of 6 ppt. whereas the upper limit of salinity tolerance during spawning is not known in Danish areas, where salinity is often 8-10 ppt.

The present project aims to initiate investigations of the dependence of perch for access to freshwater lakes and bogs for spawning. In particular it will be explored if it is possible to enhance brackish water perch recruitment by creating or reopening of access to lakes and bogs along a river system and this way to be able to re-establish or increase the
brackish water perch fishery. This is highly relevant to local authorities that manage restoration of rivers and lakes. For this purpose the perch population of a large number of lakes and bogs along river systems with present or historical migration of brackish water perch will be monitored. Some of the lakes have connection to the river, some not, and in the latter a connection will be created afterwards. The fish population and recruitment of perch will be studied before and after the intervention. Scale chemistry will be explored and possibly this will be able to define whether large perch caught in the lakes and bogs during spawning actually had a brackish water life history. The project also aims to elucidate the salinity tolerance of perch under Danish condition to establish whether it is possible that some perch spawn along the coast and bays of southern Denmark. The project is done in close cooperation with municipalities around southern Zealand.

The project is coordinated by DTU Aqua.
Jacobsen, L., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Berg, S., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Skov, C., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Aarestrup, K., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Municipality of Vordingborg, University of Copenhagen, Municipality of Næstved, Municipality of Guldborgsund, Aalborg University
Project: Research

Inter- and intralake behaviour and migration of fish (38266)
This project supports the research area fishmigration. In many shallow lakes cyprinid fishes like roach (Rutilus rutilus)and bream (Abramis brama) aggregate in inlet- and outlet streams during winter. Up to 85 % the bream and roach may leave the lake and individuals may stay out of the lake for periods up to 7 months during winter. However there is interannual variation in the part of the population that participates in this so-called partial migration. Since 2005 DTU Aqua has investigated patterns of seasonal migrations of cyprinids in three Danish lakes and thereby in combination with international collaborators, furthered our knowledge on the behavior of some of the most common fish species in Denmark. This has resulted in numerous publications/reviews about partial migration. By expanding the investigation period to include 2011-2016 we have increased the length of the time series leading to a better understanding of the annual variation in immigration patterns. In addition we included the effects of seasonal premigration on top predator fitness in the study. Top predators such as pike (E. lucius) are important species in recreational fisheries, and in order to optimize fisheries management its crucial to understand the biology of these predators. Since the migrating cyprinids are important prey for the pike and since previous results have shown that pike do not follow the prey into the stream, the migration of cyprinids are likely to affect seasonal patterns of predator fitness. Overall, this project increases our knowledge on fish behavior and fish population dynamics in lakes and thereby expands our tool box for management of lacustrine fishes. During the project period focus has been on three areas (the last two as part of a PhD project with deadline in 2017):
Mechanisms behind partial migration
The risk of predation from birds and fish as well as the distribution of feeding resources are two very likely explanatory components in spatial ecology of fish in general and partial migration in specific. DTU Aqua have published several studies and reviews focusing on these as well as other mechanisms involved in partial migration such as body morphology, sex, individual variations in boldness and temperature.
The influence of cyprinid partial migration on top-predator pike feeding dynamics
Pike feeding patterns and prey availability in number of open and closed lakes are monitored from early fall to late spring. This could reveal that pike in open lakes where prey abundance fluctuate during the season require more management attention i.e. due to restricted growth and/or increased cannibalism in periods with low prey abundance.
Migration between neighboring lakes
Two of the three focal lakes in which we are monitoring seasonal migrations are situated only 3 km apart and connected by a small stream. So far it has become obvious that from time to time large amount of fish move from one lake to another. By continuing to pit tag and monitor fish migration we are likely to observe more of these mass migration events, which in turn facilitate a better understanding of why and when these mass migrations occur. Clearly, the level of fish exchange between neighboring lakes is an important factor to consider when it comes to management of lakes.
The project is coordinated by DTU Aqua.
The project is funded by the Danish Rod and Net Fishing License Funds.
Skov, C., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Hansen, J. H., Project Participant, National Institute of Aquatic Resources

Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Lund University, Municipality of Viborg
Project: Research

Indicators for fisheries management in Europe (IMAGE) (38225)
The Common Fisheries Policy (CFP) requires the progressive implementation of an ecosystem-based approach to fisheries management (EBFM). To implement effective management, it is essential to develop a framework that allows for the evaluation of different management strategies based on indicators. Indicators can support the decision making
process by (i) describing the pressures affecting the ecosystem, the state of the ecosystem and the response of managers, (ii) tracking progress towards meeting management objectives and (iii) communicating trends in complex impacts and management processes to a non-specialist audience. The aim of this project was to develop an indicator-based operational framework that can support ecosystem-based management, and also show how this can be applied to test and evaluate different management strategies or sampling programs.

The principal objectives of IMAGE were:-To develop an operational framework of candidate indicators (ecological, economic, social) that can support ecosystem-based fisheries management at the regional and pan-European scale-To elaborate these indicators in comprehensive dashboards (e.g. current values, trends, reference levels)-To develop methodology to integrate this information into tools supporting the decision-making process-To develop a framework that can evaluate management strategies based on indicators-To advise on how indicators can be used to support EBFM in selected regional case studies based on the RAC areas.

The project consisted of a conceptual phase where the operational framework was designed. This was followed by a phase of methodology development, an implementation phase consisting of regional case studies linked to the RACs and finally a pan-European evaluation and synthesis of the projects results. The results of this project contribute to the development of an effective EBFM in the context of the CFP, while also contributing to the applied science needed to support the emerging European Marine Strategy and Maritime Policy.

The project was coordinated by Institute for Marine Resources and Ecosystem Studies (IMARES), The Netherlands. Eero, M., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management Nielsen, J. R., Contact Person, National Institute of Aquatic Resources Köster, F., Contact Person, National Institute of Aquatic Resources Jarre, A., Project Participant, National Institute of Aquatic Resources Bastardie, F., Project Participant, National Institute of Aquatic Resources Andersen, K. H., Project Participant, National Institute of Aquatic Resources Sørensen, T. K., Project Participant, National Institute of Aquatic Resources Mosegaard, H., Project Participant, National Institute of Aquatic Resources Thomsen, K., Project Participant, National Institute of Aquatic Resources Tomczak, M., Project Participant Jacobsen, J. B., Project Participant
01/01/2006 → 31/12/2009
Keywords: Research area: Ecosystem Based Marine Management Collaborators: Wageningen IMARES, COISPA Tecnologia & Ricerca, University of Tartu, Aalborg University, Cefas Weymouth Laboratory, IFREMER Project: Research

**Fisheries induced evolution (FinE) (38279)**
The project is set up to investigate the prevalence of fisheries-induced evolutionary changes in life-history traits of exploited fish stocks in European and North American waters. The aims are to unravel the underlying mechanisms of change ranging from the phenotypic to the genetic level, to evaluate their consequences on population and fisheries dynamics, and to provide recommendations for evolutionarily enlightened management. This objective necessitates the development and application of novel methodological tools for investigating field data both at phenotypic and genetic levels, together with the setup of relevant experiments on model species and the careful construction of theoretical models suitable for complementing field data analyses and for evaluating managerial options. Earlier investigations have focused on specific aspects such as the analysis of long-term trends in phenotypic data, the investigation of temporal changes in neutral genetic markers, artificial fishing experiments, or the modeling of fisheries-induced evolutionary changes in life-history traits and their demographic consequences for exploited stocks. However, a comprehensive investigation of fisheries-induced evolution at the phenotypic and genetic level and of consequences on fish stocks dynamics are still largely missing, mostly because of the wide range of scientific expertises and approaches required for tackling these challenges. This project aims at combining fields of expertise as diverse as population genetics and quantitative genetics, life-history theory, population dynamics, evolutionary theory, and fisheries science.

The project is coordinated by International Institute for Applied Systems Analysis, Austria. Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources Hansen, J. H., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources Therkildsen, N. O., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
01/01/2007 → 31/12/2010
The distribution of Danish freshwater fishes (38269)
The objectives of this project are, for the first time in almost 100 years, to produce and in a book present an updated distribution map of all freshwater fishes found in Danish fresh waters. The results will act as a reference point when analyzing both previous and future changes in the distribution of freshwater fishes in Denmark, e.g. related to climatic changes.

Until the beginning of this project the geographic distribution of freshwater fishes in Denmark was not known in detail. For many species we only knew in which part of the country and maybe in which river system they live now or had lived earlier. Thus, our knowledge was incomplete and in general fragmented and consequently hard to find. In addition much of the existing information was old and newly arrived alien species had not been registered correctly. Thus, there was a need for a complete and updated status on the distribution of freshwater fish. Such a status will be a milestone in Danish inland fisheries research and management. Its value in relation to research and management as well as providing public access to correct information will be high. As an example the database has been used to revise the red data list for freshwater fishes in Denmark.

In this project we have 1) collected existing data on the occurrence of freshwater fish from public and private institutions and 2) gathered information from the public on catches and other observations of freshwater fish. As supplement we have 3) made targeted surveys to fill gaps and improve knowledge on rare species. All this information have been 4) combined in a GIS-based database. Finally we have 5) presented the complete set of information on geographical distribution of freshwater fishes in Denmark in a book also containing detailed information on the biology and ecology of all species (native and alien) present in Denmark.

The book was published in 2012 and contains 700 pages. It is written in Danish and illustrated with a large number of high quality photos of all species. It is written by 5 main authors (two of which are from DTU Aqua) and a few guests (one from DTU Aqua). Even though written to a broad audience, it is fully documented with references in the text. Due to private funding it has been possible to distribute the book at a very low price, 399 DKK (ca. 53 €). The revenue from the sale is reserved for a future revision and re-publishing of the book.

The project was coordinated by Natural History Museum of Denmark, University of Copenhagen, Denmark.
Rasmussen, G., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Berg, S., Project Manager, National Institute of Aquatic Resources

Capacity, F and Effort (CAFE) (38100)
The CAFE project was designed to investigate the links between the fleet capacity, the fishing effort of those fleets and the fishing mortality that results from that effort, so as to facilitate the development of a fishing management strategy.

The fishing effort was considered as the amount of time a given fishing capacity was deployed in a fishery. Therefore, engine power could be seen as a capacity measure and kilowatt hours as the expression of the effort from that capacity. This estimate allowed for capacity and effort to be directly linked within the project.

CAFE proved that relating higher capacity and/or effort to higher fish mortality was a common misinterpretation. Thus, the project aimed to test the hypothesis that there was a quantifiable relationship between the capacity and effort by particular fleets and the fishing mortality imposed on the various commercial stocks.

The project covered six different case studies (the North Sea, the Bay of Biscay and the Mediterranean) accounting, both pelagic and demersal fisheries and single and multi-species fisheries.

A combination of models and metrics was subsequently employed to quantify the links between capacity, effort and fishing mortality. External factors which affected the fishers’ choices were also identified. The modelling approach used both
statistical and mathematical modelling techniques.

The models and the understanding gained through them were subsequently used to examine the response of the system to a range of management measures for controlling capacity and effort. A series of simulations were performed to examine the fisheries' response to limitations of capacity, effort or other measures. Several of the models were run using data of different case studies to test the general applicability of the approaches and observe existing differences between individual countries.

The project was coordinated by IMARES, Wageningen UR, The Netherlands.

Andersen, B. S., Project Participant
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

01/01/2006 → 31/12/2009

Keywords: Research area: Fisheries Management

Collaborators: European Commission - Joint Research Center, Wageningen IMARES, Marine and Food Technological Centre, University of Copenhagen, Hellenic Centre for Marine Research, Marine Scotland, Spanish Institute of Oceanography, IRD, Cefas Weymouth Laboratory, Institute for Research in Economics and Business Administration, University of Portsmouth, IFREMER

Project: Research

Flatfish nursery grounds (38176)
The aim of the project is to determine what constitutes a good nursery area for specific flatfish in coastal soft bottom areas in the inner Danish waters using a combination of empirical and theoretical approaches. Field studies on juvenile flatfish feeding, growth and condition use both wild and released fish. One approach is to explore different statistical methods to determine potential nursery grounds for different flatfish based on physical parameters such as wave exposure, sediment type and abiotic variables such as temperature, salinity and depth. This research coupled with the development of tools to map different coastal habitats will provide the basis for advice on management of coastal fish nursery areas.

Implementation of PIT-tag technology in coastal marine waters will be developed in order to build up expertise to sample released individuals in different habitats.

The project was coordinated by DTU Aqua.

The project is funded by the Danish Rod and Net Fishing License Funds.

Støttrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Kristensen, L. D., Project Participant, National Institute of Aquatic Resources
Kristensen, K., Project Participant, National Institute of Aquatic Resources
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Brown, E. J., PhD Student, National Institute of Aquatic Resources

01/01/2011 → 31/12/2013

Keywords: Research areas: Coastal Ecology & Freshwater Fisheries and Ecology & Marine Living Resources

Collaborators: Aarhus University, Danish Organization for Amateur Fishermen

Project: Research

Fatty acids in the marine food chain (38160)
Primary production by autotrophic phytoplankton fuels the marine ecosystem and this energy is passed through the food web by trophic interactions. Understanding how energy flows through these interactions is vital for understanding how marine ecosystems function. The efficiency of energy transfer from primary producers to higher trophic levels depends on the efficiency of secondary producers utilizing the new carbon. This crucial link is still poorly understood and most often we observe that secondary production is not simply correlated with phytoplankton biomass. However, reproduction and growth of secondary producers, such as copepods, depend also on food quality. The goal of this project is to investigate the effect of essential fatty acids on copepod reproduction, growth and survival. Essential fatty acid are the ones the copepod need but has to attain from the food, as it cannot synthesize those de-novo. The project is based on series of laboratory, field and mesocosm studies with the focus on understanding on how food composition, both chemical composition and type affect growth and mortality all contribution to population dynamics of the copepod species. In addition the project has a strong teaching factor for masters and PhD students in form of advanced summer schools.

The project is coordinated by DTU Aqua.
Jonasdottir, S., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Koski, M., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Population development of sea trout after removal of migration obstacles (38259)

Generally, the size of a sea trout population is under the influence of a number of bottlenecks in the life cycle. Reduced spawning- and nursery habitat, as a consequence of sand walk and adjustments of streams, is one of the major obstacles. Another important factor is obstacles in connection with migration. A very important obstacle during migration is the passage of weirs which deny fish access to important habitats, both when it comes to downstream and upstream migration. The weirs’ negative effect on the population of migrating fish is well-documented (Aarestrup et al. 2003; Aarestrup et al. 2006a, b, c; Baktoft et al. 2007). It has lead to a number of model reflections on the impact on the fish stock if the weirs are removed (Olesen & Aarestrup 2006). However, this model has not been validated. The possibility of such a validation now exists in the River Villestrup, where the original model was developed. In this comprehensive restoration project, the plan is to remove all weirs in the main stream. This gives a unique chance to test these models in the stock of migrating fish before and after the removal of the weirs.

The study aims at estimating the spring run of smolt and kelts in a number of defined years before and after the removal of the dams. The restoration project was in 2011. The run has been estimated in 2008 and 2009 before weirs were removed and again in 2015-2017 after the completion of the restoration project and allowing for juvenile cohorts to develop. The estimated smolt run before the removals was around 5000 smolt migrating into Mariager Fiord. In 2015 the smolt run was estimated to app. 20000 smolts. The project provides us with valuable information on the potential for optimizing the fish stocks without releases.

The project is running concurrently with project 38258 “The marine life and survival of sea trout” and with the EU funded project 39301: "Expertise in marine and aquatic ecology and genomics for sustainable management of fish and shellfish in Skagerrak-Kattegat-Øresund (MarGen)”. MarGen is an interregional management project with a specific aim to increase scientific and management competencies of marine resources in Kattegat/Skagerrak including understanding of fish migration.

The project is funded by the Danish Rod and Net Fishing License Funds.

Aarestrup, K., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology

01/01/2008 → …

Keywords: Freshwater Fisheries and Ecology
Project: Research

Advancing understanding of Atlantic Salmon at sea: Merging genetics and ecology to resolve stock-specific migration and distribution patterns (SALSEA-Merge) (38282)

Over the past two decades, an increasing proportion of North Atlantic salmon are dying at sea during their oceanic feeding migration. The specific reasons for the decline in this important species are as yet unknown, however, climate change is likely to be an important factor. In some rivers in the southern part of the species range, wild salmon now face extinction. This is in spite of unprecedented management measures to halt this decline. Arguably the greatest challenge in salmon conservation is to gain insight into the spatial and ecological use of the marine environment by different regional and river stocks, which are known to show variation in marine growth, condition, and survival. Salmon populations may migrate to different marine zones, whose environmental conditions may vary. To date it has been impossible to sample and identify the origin of sufficient numbers of wild salmon at sea to enable this vital question to be addressed.

The aim of SALSEA-Merge was to provide the basis for advancing our understanding of oceanic-scale, ecological and ecosystem processes. Such knowledge is fundamental to the future sustainable management of this key marine species. Through a partnership of nine European nations the program delivered innovation in the areas of: genetic stock identification techniques, new genetic marker development, fine scale estimates of growth on a weekly and monthly basis, the use of novel high seas pelagic trawling technology and individual stock linked estimates of food and feeding patterns. In addition, the use of the three-dimensional Regional Ocean Modeling System, merging hydrography, oceanographic, genetic and ecological data, provided novel stock specific migration and distribution models.

This widely supported project provided the basis for a comprehensive investigation into the problems facing salmon at sea. It also acted as an important model for understanding the factors affecting survival of many other important marine species.

The project was coordinated by Institute of Marine Research, Norway.

The project was funded by EU, Framework Programme 7.

Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

01/01/2008 → 31/12/2011

Keywords: Population Genetics & Freshwater Fisheries and Ecology
Collaborators: Norwegian Institute for Nature Research, North Atlantic Salmon Conservation Organisation, National University of Ireland, Swansea University, University of Oviedo, Marine Institute, University of Exeter, Marine Scotland, Genindex, Institute of Freshwater Fisheries, Queen’s University Belfast, The Faroese Fisheries Laboratory, Institute of Marine Research, Conservatoire National du Saumon Sauvage, Atlantic Salmon Trust, TOTAL Fondation d’entreprise pour la Biodiversité et la Mer, University of Turku, Finnish Game and Fisheries Research Institute, Loughs Agency
Project: Research
The marine life and survival of sea trout (38258)
Considering the importance of the species and the fact that it is spending most of its time in the sea, it is striking that the knowledge on the survival and whereabouts of the sea trout in the marine areas is so limited. This is mainly due to technical barriers. The development within telemetry has made it possible to study the behavior of the sea trout by means of electronic tags. By using the so-called pit tags and acoustic tags it is possible to monitor the fish when it passes a given place - typically at the outlet of the stream, the river or similar. At the same time new types of marks, the so-called DST-marks and the acoustic oxygen transmitter, make it possible to register information about the surrounding environment of the fish with a so far unprecedented accuracy.

In the last few years, DTU Aqua has investigated the behavior and survival of postsmolts and kelts in the initial estuarine phase after exit from the river. The results show that wild fish have a relatively high degree of survival after emigration (Aarestrup et al. 2014; 2015). Meanwhile, further studies of survival and behavior in other systems are necessary in order to make any conclusions - as well as the rest of the survival and behavior of the sea trout in the sea that is not yet clarified. This project aims at obtaining information on the behavior of the marine phase of the sea trout. Besides valuable information on the marine life of the sea trout, the project will also give detailed information on the survival in salt water, survival of spawning, survival of repeat spawners as well as a lot of other information such as the time of entering fresh water to spawn and the time of returning to the sea. In some rivers part of the population are said to have an alternative life history strategy and these fish are called “fjord trout”. Rumor has it that sea trout with this particular life history only wander into the fjord and not to the sea. Furthermore it has a number of morphological differences compared to the sea trout. The project will try to determine if there actually exist two life history strategies in the form of fjord- and sea wandering trout.

The project is running concurrently with project 38259: “Population development of sea trout after removal of migration obstacles” and both collaborates with the EU funded project 39301: "Expertise in marine and aquatic ecology and genomics for sustainable management of fish and shellfish in Skagerrak-Kattegat-Øresund (MarGen)". MarGen is an interregional management project with a specific aim to increase scientific and management competencies of marine resources in Kattegat/Skagerrak including understanding of fish migration.

The project is coordinated by DTU Aqua.
The project is funded by the Danish Rod and Net Fishing License Funds.
Aarestrup, K., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/01/2008 → 01/01/9999
Keywords: Research areas: Freshwater Fisheries and Ecology & Coastal Ecology
Collaborators: Aalborg University
Project: Research

Research on effective cod stock recovery measures (RECOVERY) (4304)
The cod stock in some European waters is at critical levels. The project aimed at developing more selective gears for the three most relevant fisheries that take cod with the highest number of discards and total catches. The otter trawl (and seine) fishery has the highest catches of cod and greatest level of discard of all fisheries, followed by the beam trawl fishery. The Nephrops fishery has a high discard rate and this is a fishery which the fleet often will switch to when fisheries for fish species are restricted. The main objective was to develop novel species-selective gear prototypes for the three prominent mixed-species demersal trawl fisheries in the North and Irish Sea, where cod is an important catch component. The development of novel species selective fishing gears is intended to reduce the fishing mortality rate on cod of all ages/sizes, to enhance the recovery of cod stock, and at the same time permit the continued exploitation of other species taken in the same fisheries as cod.

The project was coordinated by DTU Aqua.
Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Madsen, N., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2003 → 31/12/2007
Keywords: Research area: Fisheries Technology
Collaborators: Queen's University Belfast, Sea Fish Industry Authority, ConStat, Wageningen IMARES, Institute of Marine Research, Marine Scotland, Institute for Agricultural and Fisheries Research
Project: Research

Test and demonstration of a selective Nephrops trawl (4307)
This aim of this project was testing a newly developed and more selective fishing gear onboard a smaller vessel in the Danish Nephrops directed fishery in Kattegat and Skagerrak. The selective effect of different selective devices can vary with the type and size of the vessels using the gear. The Danish fleet operating in Kattegat and Skagerrak covers very different vessels, both with regards to size and type. The aim of this project was to test the applicability of a selective sorting panel, developed and tested on larger vessels using larger trawls, on a small vessel and compare selective effect across different vessel sizes.
The project was coordinated by DTU Aqua.

Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Madsen, N., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Frandsen, R., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
01/01/2004 → 31/12/2005

Keywords: Research area: Fisheries Technology
Collaborators: Danish Fishermen's Association
Project: Research

**Integrative Fish Behavioural Neuroscience Network (BIFINE) (38812)**
The aim of the network was to encourage exchange of ideas and stimulate collaboration across disciplines. A multitude of disciplines were represented, each offering distinct and powerful tools for the study of behavioral neuroscience of fishes. The network included leading groups in Denmark, Norway, Sweden and Finland, representing the following research fields: general fish physiology (both at the phenotypic and genotypic level), genetic modification, genotype-phenotype interactions, molecular biology, biomedicine, evolutionary ecology, stress responses and neurotransmitter mechanisms, neuroanatomy and developmental neurobiology.
The integration of the above mentioned disciplines aimed at meeting the growing need to understand underlying mechanisms of fish behavior and how it is affected by environments change, including anthropogenic disturbance and climate changes and at improving our understanding and tackling of key issues associated with fish aquaculture, welfare, restoration and climate change.
The project was coordinated by DTU Aqua.
The project was funded by Nordforsk, Nordic Council of Ministers.
Höglund, E., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
01/01/2010 → 31/12/2012

Keywords: Research area: Aquaculture
Collaborators: Uni Research AS, University of Bergen, Lund University, Uppsala University, University of Helsinki, University of Gothenburg, Norwegian University of Life Sciences, Norwegian School of Veterinary Science
Project: Research

**Edible-, slaughter- and health quality of exercised rainbow trout (38395)**
In Danish aquaculture the production of rainbow trout (Oncorhynchus mykiss) in intensive, recirculating systems has increased over the years and this tendency is expected to proceed. Intensive systems are characterized by their potential to apply relatively high water velocities that can be of importance to fish farmers since water currents in earlier studies have been shown to stimulate fish growth. A large part of the growth potential of modern trout strains has however been exploited through breeding and this makes it uncertain to what extent and how modern trout strains respond to increased water velocities in terms of growth. Quality is also a significant parameter in that regard. Fast growth in intensive rearing systems may have implications on trout quality through increased propensities to stimulate lipid depositions in edible parts of the fish and in buccal cavities with concomitant effects on sensory parameters and slaughter yields.
The aim of the project is to study how exercise of rainbow trout may influence their growth and quality. Through collaboration with external partners and internal collaboration in DTU Aqua that has been stimulated through the research area “Individual Biology” numerous competences are involved. The project addresses important aspects of muscle physiology, hormonal control, enzymatic activities, fatty acid metabolism, overall fish growth and industrial fish quality. More specifically, by use of different exercise levels, fish growth and feed and protein utilization is monitored by changes in weights and lengths of the fish together with differences in feed intake. Growth rates are evaluated together with blood plasma content of IGF-1. Furthermore, measurements of plasma cortisol levels together with feed shares indicate the impact on fish welfare. Slaughter yields are determined under common production conditions in industry. Changes in chemical proximate composition of fillets are studied together with fatty acid profiles and the particular change in healthy n-3 fatty acids. Muscle fiber growth and other characteristics in the swimming musculature are studied by use of histological techniques involving light microscopy as well as electron microscopy. Changes in gene expression for mTOR (the mammalian target of rapamycin) are studied for their potential role in muscle fiber hypertrophic or hyperplastic growth and proteom analyses considering other key proteins of importance to both growth and quality are also undertaken. Changes in the calpastatin/calpain system measured as gene expression and/or electrophoretic are considered important for development of fillet texture that is measured instrumentally. Fillet texture is additionally considered by a trained sensory panel focusing on taste, odors, texture characteristics and appearance of the fish fillets.

The results obtained so far have proven positive with regards to applying exercise in rearing of modern rainbow trout strains. Negative aspects only seem to manifest when strenuous exercise levels are applied. Exercise has the potential to
stimulate overall growth and reduce size differences within a stock supposedly owing to less aggression when feeding. Through several changes in muscle physiological components brought about by exercise the fillet texture may increase and there are furthermore indications that fish welfare may be improved.

The project is coordinated by DTU Aqua.
Rasmussen, R. S., Project Manager, Section for Aquaculture, National Institute of Aquatic Resources
Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2011
Keywords: Research areas: Aquaculture & Fish Biology
Collaborators: Aarhus University, Danforel A/S, University of Tasmania
Project: Research

Critical interactions between species and their implications for a precautionary fisheries management in a variable environment – a modeling approach (BECAUSE) (38613)
Across Europe, the population of predatory fish has fallen dramatically in recent years. This has reduced the predation rate and the prey species has remained fairly stable. Therefore the balance between predators and prey species has been radically changed. No accurate scientific picture of the exact interactions between these species and their effects on non-commercial top predators is available. To maintain biodiversity and make recovery plans more effective, such an understanding is vital.

The sustainable management of European fisheries requires an adaptive approach that takes into account the long term dynamics of the entire marine ecosystem so as to protect the biodiversity of our seas. BECAUSE investigated the interaction between predator and prey, and the shifts in their relative populations and looked into how fishing affects the balance of the marine food chain. The interactions targeted for investigation included sandeel/predator fish, predators and prey of cod, and hake/prey fish.

Contributions to the policy development aimed at integrating a sustainable ecosystem approach into the EU’s Common Fisheries Policy (CFP) thereby helping the EU to meet its global fishing commitments and underwrite the sustainability of ecosystem services. Multi-species fisheries assessment were improved and enhanced policy and management measures to replenish fish stocks and ensure high yields were proposed.

The was coordinated by Universität Hamburg, Germany.
 Köster, F., Contact Person, National Institute of Aquatic Resources
 Vinther, M., Project Manager, National Institute of Aquatic Resources
 Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
 Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
 Rindorf, A., Project Participant, National Institute of Aquatic Resources
 Christensen, A., Project Participant, National Institute of Aquatic Resources
 01/01/2004 → 31/12/2007
 Keywords: Research area: Marine Living Resources
 Collaborators: University of Rome La Sapienza, Instituto Español de Oceanografía, Marine and Food Technological Centre, Marine Scotland, Cefas Weymouth Laboratory, IFREMER, University of St Andrews, Marine Research Institute Reykjavik, Universität Hamburg, Consejo Superior de Investigaciones Científicas, Institute of Marine Research, National Centre for Marine Research, Sea Fisheries Institute, Leibniz Institute of Marine Sciences, Latvian Fish Resources Agency, Finnish Game and Fisheries Research Institute
 Project: Research

Behavior and recruitment biology of lake trout with special emphasis on the effect of cormorant predation on smolt survival (38271)
The scope of this study is to investigate the movement behavior in brown trout, Salmo trutta. Movements between Lake Hald and its two major tributaries and outlet are monitored by the use of passive telemetry. Juvenile and adult trout, caught in the tributaries, have been tagged with passive integrated transponder (PIT) tags and subsequently their passages at automated listening stations have been registered. The trout population is per definition landlocked, as barriers allow only for out-migration and prohibit the return of anadromous individuals. The movements in this semi-closed system allowed surveillance of general migration patterns and identification of within-population variations in life history strategies (stream resident, lake resident and migratory). A number of trout have been caught, sampled and released and use in retrospective evaluation of physiology. Measured variables from blood and gill samples were used to identify
physiological differences that had discriminatory power between the three identified life history strategies. Additionally, the movements of lake resident spawners will also be looked upon in this study.

The trout population has been in decline for the last decade. This coincides with the establishment and growth of a cormorant colony on the lake shore. Furthermore, a heron colony close by has likewise grown in this period. Hence, trout which reside in tributaries and lake are subjected to predation from nearby cormorant and gray heron. The accumulation of PIT tags has been monitored with high temporal resolution, revealing the periods of peak predation pressure and the overall annual minimum predation. This, combined with PIT records, will reveal the habitat a trout has been predated in and hereby expose temporal vulnerabilities of lake and tributaries.

The project is coordinated by DTU Aqua.
Koed, A., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Boel, M., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/01/2008 → 31/03/2013
Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: Ministry of Environment and Food of Denmark
Project: Research

**Documentation of the selective effect of SELTRA 180 in Kattegat (38917)**
The cod stock in Kattegat was at a critical low level. A selective SELTRA codend concept was developed to reduce the fishing mortality of cod in the Nephrops directed fishery in Kattegat. A version of the SELTRA design, SELTRA 180 was developed directly for the Kattegat situation and optimized through flume tank tests. The aim of the project was to document the selective effect of SELTRA 180 codend, which was made mandatory in Kattegat in 2011, and to compare it with the standard 90 mm gear used in Kattegat. The SELTRA design was developed to getting an efficient selection of cod while retaining Nephrops. Results from an increased commercial onboard monitoring of the catch composition obtained with the SELTRA codends were compared with results obtained from experimental fishing.
The project demonstrated that the 90mm codend with a SELTRA escape panel obtained similar selectivity for cod as a 120 mm standard codend. This documentation led to the implementation of the SELTRA codend in Skagerrak in 2011.
The project was coordinated by DTU Aqua.
This project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Herrmann, B., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2012
Keywords: Research area: Fisheries Technology
Collaborators: Danish Fishermen's Association
Project: Research

**Design optimization of SELTRA 180 (38908)**
After implementation, the industry was concerned that a newly developed selective codend (SELTRA codend) was causing relative large losses of the economically important Nephrops. The aim of the project was to optimize the geometry of a 2-panel and 4-panel version of the SELTRA codend through extensive monitoring of their global geometry in the flume tank in Hirtshals. The global geometry was monitored with optic stereo-system techniques over a gradient of catch weights. The final design was demonstrated in the flume tank for the industry for further discussion. The project delivered detailed design specifications for the Nephrops fishery in Kattegat. Further, the test conducted in the project delivered a detailed understanding of the effect of changing design parameters like panel construction, selvedges, codend construction (number of panels, meshes in circumference, tension lines during the catch build-up.
The changes in the design is today implemented in the technical legislation in the Kattegat and Skagerrak and there were no problems or difficulties raised by the industry during the commercial take-up process.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Krag, L. A., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Herrmann, B., Project Participant, National Institute of Aquatic Resources
Madsen, N., Project Participant, National Institute of Aquatic Resources
Frandsen, R., Project Participant, National Institute of Aquatic Resources
Lundgren, B., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2012
Keywords: Research areas: Fisheries Technology & Observation Technology
Collaborators: Danish Fishermen's Association
Project: Research
Judgement and knowledge in fisheries involving stakeholders (JAKFISH) (38132)

JAKFISH aimed at developing institutions, practices and tools for dealing with scientific support to European Marine policy under high uncertainty. The objectives of JAKFISH are: (i) to examine and develop these institutions, practices and tools that allow complexity, uncertainty and ambiguity to be dealt with effectively within participatory decision-making processes, (ii) to examine how scientific information is used and what types of roles scientists play in the formulation of policies, (iii) to study how the current scientific processes take into account the multi-objective nature of fisheries management, and (iv) to synthesize the obtained views and to redefine the institutional role of science in EU polices to improve the overall governance in CFP.

Two parallel tracks were followed: First, a number of case studies involving participatory modeling processes with stakeholders involvements were developed, for support in policy decision-making: Western Baltic herring, Central Baltic herring, North Sea nephrops and Mediterranean swordfish. Second, sociological analyses of the practices and institutional forms that can most effectively involve the wider community in debates over developing science-based policies were carried in various regions both within Europe (North Sea, Baltic, Mediterranean) and outside (USA, Australia). Ultimately, both tracks were linked into a single synthesis.

The project was coordinated by IMARES, Wageningen UR, The Netherlands.

Ulrich, C., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Worsøe Clausen, L., Project Participant, National Institute of Aquatic Resources
Payne, M., Project Participant, National Institute of Aquatic Resources
Nielsen, A., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Contact Person, National Institute of Aquatic Resources

01/01/2008 → 31/12/2011

Keywords: Research area: Fisheries Management
Collaborators: Wageningen IMARES, Institute of Marine Research, Hellenic Centre for Marine Research, University of Helsinki, Dialogik, University of Tartu, Aalborg University, Cefas Weymouth Laboratory, University of Portsmouth
Project: Research

Management and environmental improvement of recirculating aquaculture systems (38815)

The aim of this project was to identify new applicable measures and management strategies to optimize trout production in recirculating aquaculture systems (RAS), in particular the model trout farms. Model trout farms have gained lots of positive attention since their recent launch, as the rearing concept allows increased production, increased water reuse, and decreased nutrient discharge with obvious advantages for the natural fish fauna. Currently, model fish farms have generally experienced a certain fish mortality related to pathogens and suboptimal water quality. Scopes for improvement have been identified in terms of more focus on chemical and (micro-)biological water quality.

The project included four interrelated work packages:
1) Biological filtration (stable, optimal nitrification, nitrite accumulation issues, biofilter kinetics and management)
2) Denitrification: self-contained, operational end-of-pipe solution to reduce N-total from model trout farms
3) Water disinfection and sanitation: evaluation of UV systems disinfection efficacy, resulting water quality and test of easy degradable disinfectants to replace formalin
4) Gas saturation: consequences and effects of N super saturation and total gas pressure on fish performance in RAS.

Each WP addressed specific issues of concern based on current scientific knowledge and practical experience in dialogue with the aquaculture industry. The investigations included bench and pilot scale experiments conducted under controlled conditions at the research facilities at the Section for Aquaculture, DTU Aqua, Hirtshals. The project also included monitoring campaigns and experiments on commercial model trout farms in collaboration with stakeholders.

The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Pedersen, L., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Suhr, K. I., Project Manager, National Institute of Aquatic Resources
Skov, P. V., Project Manager, National Institute of Aquatic Resources
Pedersen, P. B., Contact Person, National Institute of Aquatic Resources

01/01/2011 → 31/12/2012

Keywords: Research area: Aquaculture
Collaborators: Danish Aquaculture Organisation, UltraAqua, Model fish farmers
Project: Research
Management of the fish population in lakes under heavy human influence (38268)
The objectives of this project are to improve our understanding of how the physical conditions of lakes can affect spawning
and fry mortality and growth for the most important piscivorous fish species. We will especially focus on the conditions of
the littoral zone. This knowledge can be used to insure that the demands of these species in relation to spawning and
YOY development are met. The results will be used as part of the web-based “Handbook on the Management of Lake
Fish”, which is under development.

The majority of Danish lakes are strongly influenced by human activity, partly in the form of increased nutrient load, but
also direct physical alterations are common, e.g. by regulation of the water level, consolidation of the banks or the
consequences of heavy boat traffic. These types of physical alterations are often most common in lakes situated in or
close to urban areas. In these kinds of lakes, lake restoration by biomanipulation might prove to be insufficient to achieve
the improved environmental conditions expected, including a good population of piscivorous fish. Thus, the lakes
environmental quality, as well as the possibility to use the lake for recreational activities including recreational fisheries,
might be negatively influenced.

During the project, several activities related to this subject have been conducted:

1) An experiment demonstrating the importance of water depth for the mortality of 0+ pike.

2) Another experiment, which showed that it is possible to build an artificial spawning habitat for pike in an urban, artificial
lake without a natural littoral zone and that the pike did use it for spawning and that the pike fry used it as nursery habitat.

3) A stocking experiment with 0+ pike to find out if stocking is a possible way to enhance a very low population density of
pike in a lake with heavy boat traffic and extensive angling. During this experiment we demonstrated that it is possible to
tag 0+ pike of 6-8 cm with PIT tags without mortality, but also that the tagging has a negative effect on growth of the
tagged pike.

4) An investigation on the spawning habitat choice and spawning behavior of pike in a small natural lake (in cooperation
with project no 39270).

The use of specially designed “egg traps” has been used successful in two of these experiments.

The project is coordinated by DTU Aqua.
Berg, S., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Skov, C., Project Manager, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
Baktoft, H., Project Participant, National Institute of Aquatic Resources, Section for Freshwater Fisheries Ecology
01/01/2003 → 31/03/2013
Keywords: Research area: Freshwater Fisheries and Ecology
Collaborators: City Council of Copenhagen
Project: Research

Behaviour of lake-dwelling fish: natural and fishery induced impacts (38270)
The project focuses on establishing new and comprehensive knowledge on behavior of lake dwelling fish and the impact
of human activities, which can eventually enhance management of freshwater fish populations. The study is based on an
acoustic telemetry system, which facilitates fine scale 3D positioning of fish several times a minute with sub meter
accuracy. The system has been deployed in a small lake for five consecutive years and has generated data sets on pike,
perch and roach behavior with unprecedented details, e.g. activity levels and habitat choice on a diel and seasonal basis
coupled to environmental factors such as establishment and break of thermoclines. For instance, studies on pike winter
behavior during ice cover have generated new insights and added to the increased consciousness of the importance of
year-round knowledge on lake ecology processes. The remote sensed monitoring of the tagged fish without presence of
personnel has allowed for comparison of fish behavior in situations with and without human disturbances, e.g. fishery-
related activities. This way a distinct and instantaneous impact of boating on fish behavior has been revealed and the
impact of catch and release angling has been addressed. Finally, the system has facilitated studies extending laboratory
findings to behavior in the field. For instance, findings of physiological (metabolic rates) and behavioral properties of
individual fish in the lab have been linked with behavior of the same individuals in nature by subsequent tagging and
release in the lake.
Several issues have been studied concurrently the last years and will be continued: A principal focus area has been
striving to establish which factors impact and confine natural pike populations. The majority of larger pike in the study lake
have been followed for more than three years, which has provided a detailed picture of pike behavior and individual
variation. The interactions between pike size groups and whether the behavior of smaller pike is controlled by larger individuals has been studied and has revealed differences in both activity patterns and habitat choice ruled by the largest pike, as well as uncovered extensive cannibalism among large individuals. Pike exploitation of various spawning habitats has been assessed and a genetic analysis of pike individuals and pike eggs will be explored, possibly facilitating assessment of the individual contribution to the population and thus enabling a cross-discipline approach to explore how behavior and reproductive fitness is related.

The studies on winter biology are not only covering pike, but are incorporating the entire fish community adding further insights to the limited overall knowledge on winter lake ecology. Further, while simultaneous tracking several species the system allows for studies of predator-prey and species interactions, shoaling etc. in a natural system.

The project was coordinated by DTU Aqua.

Hansen, J. H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

Berg, S., Project Manager, National Institute of Aquatic Resources

Skov, C., Project Manager, National Institute of Aquatic Resources

01/01/2008 → 31/12/2016

Keywords: Research area: Freshwater Fisheries and Ecology

Collaborators: Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Fisheries and Oceans Canada

Project: Research

Analysis of historical and contemporary salmon samples in the world's northermmost salmon population (38835)
The project investigates potential genetic changes in the world’s northermmost population of Atlantic salmon (Salmo salar) from the Kapisillit river in Greenland. The aims are to elucidate whether geographical isolation in concert with overexploitation and habitat degradation has led to loss of genetic diversity and associated loss of evolutionary adaptive potential. By comparing genetic diversity in DNA extracted from historical scale collections from the 1950’s and contemporary samples, migration from other populations, loss of allelic diversity as well as genetically effective population sizes can be estimated. The research will contribute to setting management priorities for this unique and extremely vulnerable Atlantic salmon population.

The project is coordinated by DTU Aqua.

Eg Nielsen, E., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

Hansen, J. H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources

01/01/2011 → 31/12/2012

Keywords: Research area: Population Genetics

Collaborators: Leibniz-Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Fisheries and Oceans Canada

Project: Research

Development of tools for logbook and VMS data analysis (38751)

Objectives and Background

The project “Development of tools for logbook and VMS data analysis” was an EU project under studies for carrying out the common fisheries policy (No MARE/2008/10 Lot2). The aim of the project was to develop a set of standard protocols for coupling and simultaneous analyses of EU fisheries logbook and VMS satellite vessel record data.

Tasks and Deliverables

The process began with the construction of standardized data formats for logbook (EFLALO) and VMS (TACSAT). The software for analyzing the data took the form of a fully documented package called vmstools, built using the freeware package, R (http://cran.rproject.org/). Once the data have been imported into R in the correct format, a series of R programs or ‘functions’, linked by ‘scripts’ enable all tasks necessary to be completed in a single software environment.

The software can ‘clean’ data and format input data, estimate distances between VMS positions, and métiers can be identified objectively from species assemblages in catch data using multivariate statistical techniques.

We have included a range of complimentary methods for determining fishing activity from VMS position registrations. Positions at sea, for example, can be distinguished from vessels in harbor or erroneous positions on land. Position registrations of vessels actually fishing can be separated from those engaged in other activities (e.g. steaming) using their speed in conjunction with other information such as vessel size and gear being used.

Logbook and VMS data can be merged such that high-resolution spatial maps of catches of various commercial species can be generated. Individual vessel tracks can be reconstructed for more realism through different interpolation techniques (both linear and non-linear, i.e. using Hermite spline functions). Further, all the fishing activity indicators required under the Data Collection Framework can be calculated using vmstools. The package can also be used to explore the impact of different spatial (grid size) and temporal aggregations (month, quarterly, annual) which need to be explicitly considered when assessing fishing impact on the sea floor. There are also scripts for displaying results using Google Earth which is a useful aid for dissemination.

The combination of all these routines ‘under one roof’ permitted and permits the construction of ‘Regional’ databases (i.e. FishFrame developed by DTU Aqua - a regional database hosted by one of the project partners) and scripts to produce output suitable for this are included with the vmstools package.

As proof of concept, all analyses performed within each work package have been tested, using the vmstools package, against national datasets with contributions from the French, Danish, Irish, UK and Dutch institutes. As an example,
FishFrame has been populated with Dutch and Danish combined VMS and logbook data for 2005-2009. The project demonstrated emphatically that logbook and VMS data from disparate countries with often different data collection regimens can be combined and compared using generic tools and that the output can be sent to regional databases permitting more holistic assessments of fishing activity. The project has built further on the networks and platforms produced under EU FP6 EFIMAS Project coordinated by DTU Aqua, and the DTU Aqua team associated with the project has produced several peer reviewed journal papers under Lot 2. The project is coordinated by Institute for Marine Resources and Ecosystem Studies (IMARES), Wageningen UR, The Netherlands. This project is funded by EU, Framework Programme 7. Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management Bastardie, F., Project Participant, National Institute of Aquatic Resources Ulrich, C., Project Participant, National Institute of Aquatic Resources Egekvist, J., Project Participant, National Institute of Aquatic Resources Degel, H., Project Participant, National Institute of Aquatic Resources 01/01/2009 → 31/12/2012 Keywords: Research areas: Fisheries Management & Marine Living Resources Collaborators: Wageningen IMARES, Sea Fisheries Institute, Marine Institute, Marine Scotland, Cefas Weymouth Laboratory, IFREMER Project: Research

**MEECE: Marine ecosystem evolution in a changing environment (MEECE) (38131)**

In order to advance our understanding and the predictive capacities necessary to resolve how marine ecosystems will respond to global change MEECE employed a combination of data synthesis, numerical simulation and targeted experimentation to further our knowledge of how marine ecosystems will respond to combinations of these climate change and anthropogenic drivers.

A key objective of MEECE was to advance model coupling across trophic levels and create concepts and infrastructure to enable end-to-end modeling, from physics to fish, which has empirically been difficult due to different space and time scales involved, as well as relative emphasis of statistical and mechanistic aspects. Finally MEECE integrated modeling advancements with fishery management perspectives.

The project was coordinated by Plymouth Marine Laboratory, UK, and had 21 partners from the EU. The project was funded by EU, Framework Programme 7. Christensen, A., Contact Person, National Institute of Aquatic Resources, Section for Marine Living Resources Köster, F., Project Manager, National Institute of Aquatic Resources Vinther, M., Project Participant, National Institute of Aquatic Resources Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources MacKenzie, B., Project Participant, National Institute of Aquatic Resources Nielsen, J. R., Project Participant, National Institute of Aquatic Resources Eero, M., Project Participant, National Institute of Aquatic Resources Andersen, K. H., Project Participant, National Institute of Aquatic Resources Bastardie, F., Project Participant, National Institute of Aquatic Resources Neumann, V., Project Participant, National Institute of Aquatic Resources Grigorov, I., Project Participant, National Institute of Aquatic Resources 01/01/2008 → 15/10/2012 Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management Project: Research

Development of a method for long term spatially resolved management of the herring fishery in the North Sea and IIIa taking the migration of the primary herring stocks, the fishery pattern and by-catch of mackerel into consideration (URSIN) (38731)

The overall objective is to develop a tool to create long-term management plans for the two main herring stocks in the North Sea and Illa, which may allow the industry an optimum use of the population under safe conditions relating to population maintenance and catch of mackerel.

The project will further develop, test and optimize a method for the quantification and prediction of herring stock spatial distribution in relation to life stages that is based on existing methods. This quantification of the migration patterns will provide more solid understanding of population development under various conditions. Moreover, the method will include a modeling of the herring fleet behavior, allowing for merging of herring spatial distribution in relation to life stage and hence potential economic value of fishing pattern. The historical and current behavior of the herring fleets will be quantified in collaboration with the industry. Similarly, mackerel skull occurrence will be mapped as it is of great importance for the herring fleet behavior, due to the economic incentives to minimize this by-catch.
The objective of the project is to generate a scientifically based tool for prediction of utilization of herring that can be used in future scientific advice to management, and information on optimal harvest strategies for the fishery in collaboration with the fishing industry. This is partly to increase the transparency and credibility of the scientific work and increase security in the input data and thus reduce uncertainty in the advice given in the end. Collaboration with industry includes Pelagic PO, Skagen PO and Esbjerg Fishermen and covers all types of fishing for herring (both industrial and human consumption).

The project is coordinated by DTU Aqua.
Worsøe Clausen, L., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Ulrich, C., Project Manager, National Institute of Aquatic Resources
Payne, M., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
Dijkman, T. J., Project Participant, National Institute of Aquatic Resources
Nielsen, A., Project Participant, National Institute of Aquatic Resources, Section for Marine Living Resources
01/01/2009 → 31/12/2011
Keywords: Research area: Marine Living Resources
Collaborators: Danish Fishermen's Association, Danish Pelagic Producers Organisation
Project: Research

Resolving climatic impacts on fish stocks (RECLAIM) (38109)
Climate change will impact fisheries resources and challenge managers to develop sustainable exploitation strategies. Knowledge on the impacts of climate on fisheries resources is still fragmentary.

RECLAIM will summarize current knowledge, test process understanding, improve predictive capacity and formulate future research hypotheses by examining trophic processes, geographical distributions and essential habitat requirements for marine and shellfish in the NE-Atlantic.

A conceptual framework will be developed to distinguish between processes acting on individual (physiology, behavior), population (predation, competition) and ecosystem (physical habitat qualities, biological productivity, trophic coupling) levels. The framework structures a literature review to detects gaps in knowledge and, where possible, distinguishes between climate and anthropogenic influences.

A comparative analysis follows quantifying climate variability and changes in distribution and productivity of (i) individual species, (ii) selected fish and shellfish communities, and (iii) ecosystem structure and functioning.

Target species represent different commercially important resources, ecosystem components (pelagics, demersals), and play key trophic roles (wasp-waist, apex predators) within NE-Atlantic ecosystems.

Changes in ecosystem structure and functioning will be analyzed from fisheries and scientific survey data including planktonic, benthic and fish production and consumption in relation to climate forcing and fishing. Relevant spatial and temporal scales of climate change and variability will be explored using time series analyses, spatial statistics and coupled 3-D hydrodynamic ecosystem models.

Using a variety of approaches, RECLAIM will both hind cast as well as forecast the effects of climate change on the productivity and distribution of fish and shellfish stocks to formulate hypotheses and research needs to be addressed in future EU research.

The project is coordinated by IMARES, The Netherlands, and has nine partners from the EU.
Köster, F., Project Manager, National Institute of Aquatic Resources
Creation of multi-annual management plans for commitment (COMMIT) (2212)
The objective of COMMIT was to provide a sound scientific basis for the long-term planning of fisheries management consistent with sustainable development, while also identifying any short-term biological and socio-economic consequences. This was done through the evaluation of multi-annual management plans that reduce annual fluctuations in exploitation strategy and ensure commitment of the stakeholders to the plan. Strategies were based upon harvest rules and developed explicitly recognizing uncertainty due to process, measurement, estimation, model and implementation error. In particular a socio-economic analysis identified mechanisms affecting the commitment of key stakeholders and hence the level of implementation error. Robust strategies were designed that explicitly took this into account. Stocks chosen are those of interest to the community (Baltic salmon, North Sea flatfish and Northern hake) and in particular those exploited in mixed fisheries, although the methods developed are generic and applicable to other stocks.

The project was coordinated by Centre for Environment, Fisheries & Aquaculture Science (CEFAS), UK.
Ulrich, C., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Sparre, P. J., Project Participant
01/01/2004 → 31/12/2007
Keywords: Research area: Fisheries Management
Project: Research

Artificial reproduction of eels: Phase III (ROE III) (38187)
The steady decline of the European eel stock has adverse consequences for the Danish eel aquaculture as all eel farming is at present capture based relying on wild caught glass eels. In 2005, DTU Aqua, University of Copenhagen and the eel aquaculture industry started to build up a research and technology platform for the development of methods to reproduce European eel in aquaculture.

The focus of ROE III was to follow up the pioneering work on artificial reproduction of European eels performed in the preceding pilot projects ROE I and II. The projects ROE II and III were a collaboration among DTU Aqua, University of Copenhagen and the eel aquaculture industry following up an initial survey ROE I of suited methodology lead by University of Copenhagen.

ROE III comprised the following activities:

(i) Experimental series with different treatment schemes and hormone dosage to improve the maturation process and optimize gamete quality;

(ii) Development of methods to monitor the maturation process on individual level using ultrasound scanning technology and ovary biopsy;

(iii) Analysis of broodstock fishes and improvement of the dietary fatty acid composition;

(iv) Investigation of parameters determining egg quality during incubation;
Three experimental series were completed focusing on methods for broodstock enhancement, maturation and fertilization plus culture of eggs and larvae. Already during the first experimental series, larvae accomplishing the entire yolk sac stage were achieved for the first in history for European eel. The yolk sac larvae developed successfully during the period were they entirely depend on nutrition sources i.e. yolk and lipid of maternal origin. The larvae were ready to start feeding day 12 post hatch. During the second experimental series, larval longevity was extended to 18 days during first feeding experiments. These recent results are a major breakthrough because they show for the first time that artificial hormone treatment can lead to viable offspring in European eel. Eggs and yolk sac larvae were obtained from different hormonal treatments and mass hatchings were regularly obtained. Larval feeding using live and artificial larval feeds developed in collaboration with the food company BioMar were developed towards the end of the experiments and are ready for testing in new and coming projects.

The success of this project on improved methods, quality criteria and larval survival has led to form the basis of the project: Reproduction of European eel in aquaculture: Consolidation and new production methods and later (REEL) (38398) and later the EU FP project: Reproduction of European eel in Aquaculture: Towards a self-sustained aquaculture (PRO-EEL) (38793).

The project was coordinated by DTU Aqua.
Tomkiewicz, J., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Munk, P., Project Manager, National Institute of Aquatic Resources
Stettrup, J. G., Project Manager, National Institute of Aquatic Resources
Tybjerg, L., Project Manager, National Institute of Aquatic Resources
Støttrup, J. G., Project Manager, National Institute of Aquatic Resources
Serensen, S. R., Project Participant, National Institute of Aquatic Resources
Hornum, I., Project Participant, National Institute of Aquatic Resources
Krüger-Johnsen, M., Project Participant, National Institute of Aquatic Resources
Jarlbæk, H., Project Participant
01/01/2007 → 31/12/2009
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: University of Copenhagen, Bioneer A/S, Billund Aquaculture Service Aps, Danish Eel Farmers Association
Project: Research

**A framework for fleet and area based fisheries management (AFRAME) (38110)**
Basing advice on fleets or fisheries requires switching focus from a biological unit (a fish stock) to a social one (a fleet or fishery). This is a major shift away from the current TAC-dominated, stock-based approach. The general objective of the AFRAME project was to develop an operational area- and fleet-based framework that integrates single-species assessment and advice. The framework must be robust to uncertainty caused by, for instance, lack of discard data. Work also included development of indicators as a basis for setting management targets, as well as the analysis of stakeholder perspective in relation to these developments.

Three case studies of mixed demersal fisheries were included focusing on areas where the need for a fleet-based management is particularly urgent: (i) The North Sea, (ii) The Western Waters in ICES areas VII & VIII (Celtic Sea to the Bay of Biscay), and (iii) the Eastern Mediterranean.

The AFRAME project has been particularly successful in developing a simple and operational approach for mixed-fisheries advice. This approach is now integrated as part of the ICES Advice for the North Sea, through the setup of a dedicated working group applying this approach on a routine basis.

The project was coordinated by Marine and Food Technological Centre (AZTI), Spain.
Ulrich, C., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Andersen, B. S., Project Participant
Nielsen, J. R., Contact Person, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Climate change on marine ecosystems and resource economics (NorMER) (38898)

Marine ecosystems are under pressure from both anthropogenic climate change and high exploitation rates. A major challenge to managers and scientists is to identify ways that oceans can provide food and other services in a sustainable way under changing climatic and socioeconomic conditions. As physical, biological and socioeconomic factors interact at several levels, cross-disciplinary approaches are needed to meet this challenge.

This Nordic project has
(1) evaluated climate effects on Nordic marine ecosystems,
(2) Build new tools for predicting biological consequences of climate change,
(3) quantified impacts on profit, employment, and harvesting of cod.

This has been achieved through the work of 16 PhDs, 4 postdocs, 1 climate scientist, and the combined expertise of 45 senior scientists located at 10 institutions in 8 Nordic countries.

The project was coordinated by University of Oslo, Norway.
The project was funded by Nordforsk, Nordic Council of Ministers.

DTU Aqua was mainly involved in habitat modelling (coastal and pelagic fish habitats) and in development of marine spatial planning and management frameworks.

In addition to DTU Aqua, 23 partners were involved in the BALANCE project, i.e. representing governmental and non-governmental organizations and research institutes from the entire Baltic region in the fields of biology/ecology, fisheries.
and geology.

The project was coordinated by DTU Aqua.
Serensen, T. K., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Geitner, K., Project Participant, National Institute of Aquatic Resources
Sparrevohn, C. R., Project Participant, National Institute of Aquatic Resources
Hüssy, K., Project Participant, National Institute of Aquatic Resources
Köster, F., Project Participant, National Institute of Aquatic Resources
Tomkiewicz, J., Project Participant, National Institute of Aquatic Resources
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
Vestergaard, O., Project Manager
01/01/2005 → 31/12/2007
Keywords: Research area: Ecosystem Based Marine Management
Project: Research

Evaluation of harbour porpoise behaviour in relation to acoustic alarms (pingers) (38670)
The project included four sub-projects that were all related to development of methods for mitigation of harbour porpoise by-catch. The first sub-project investigated the effective deterrent range for a commercial pinger and whether the range changed over time (habituation). This is important to know in order to be able to evaluate the effects if pingers are to be used in marine protected areas like the Natura 2000 areas. By deploying automated porpoise click loggers (C-PODs) in a grid around an active pinger, the effective range of the pinger was assessed. The set-up was deployed both in Denmark and in Scotland to also investigate possible regional differences in porpoise reactions to pingers. The second sub-project tested the alerting-hypothesis, i.e. whether it was possible to induce porpoises in the wild to use their biosonar against a target by having the target emit artificial porpoise click trains (alerting signals). Alerting signals have a number of advantages over traditional pinger signals, including that they will not lead to exclusion of porpoises from important habitats, that the risk of habituation is smaller because the porpoises will be able to learn from their experience with the alerting pingers, and that noise pollution will be considerably smaller because the sound level of alerting pingers is much lower than for traditional pingers. The third sub-project tested if pingers emitting alerting-signals could reduce by-catch of harbour porpoises in the commercial gillnet fishery. Alerting pingers were deployed on bottom-set gillnets in a fishery with a high by-catch rates, in a double-blind experiment. The fourth sub-project investigated the behaviour of free ranging harbour porpoises in relation to a gillnet. This included land-based tracking by theodolite of porpoises approaching a bottom-set gillnet to determine detection distances and avoidance behaviour.

The project was coordinated by DTU Aqua.
The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).
Kindt-Larsen, L., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Larsen, F., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Stage, B., Project Participant, National Institute of Aquatic Resources
01/01/2009 → 31/12/2011
Keywords: Research area: Ecosystem based Marine Management & Observation Technology
Collaborators: Fjord & Bælt
Project: Research

Baltic zooplankton cascades (BAZOOCA) (38584)
The alien ctenophore Mnemiopsis leidyi, notorious for wreaking havoc in the Black Sea, was recently introduced to the Baltic, where it thrives. As an enclosed brackish water system where many organisms live close to their tolerance thresholds, the Baltic is very sensitive to such disturbances. We aim to test the overall hypothesis that Mnemiopsis in the Baltic causes cascading effects throughout the pelagic food web, from gelatinous and top predators to microbes. Using field studies, experiments and modeling we will address a specific set of research aims (organized as work packages). We will consider these research aims within the natural spatial (Baltic proper, Bothnian Sea, Bothnian Bay) and environmental (oxygen, temperature, salinity, light, N, P) gradients in the Baltic. Understanding such food web effects and potential cascades is crucial given the overall stress from contemporary environmental challenges, e.g. eutrophication, increased maritime activities, and climate change. The results will be useful for both scientists and policy makers. The current regime shift towards more jellyfish is unprecedented in the Baltic. Its effects on this specific ecosystem cannot be forecast solely on the basis of lessons from other ecosystems.

The project is coordinated by University of Gothenburg, Sweden.
Kierboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Jaspers, C., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2009 → 14/07/2012
BLUE REEF (38179)
The overall project objective was to restore a rare marine habitat at a strategically important locality (Læsø Trindel) with the purpose of conservation of marine biodiversity. The more specific objectives include:
- Stabilization and restoration of a cave-forming stone reef to favorable conservation status.
- Conservation and proper management of a reef donor area (larval dispersal) for the oxygen depleted inner Danish waters.
- Implementation through dissemination and cross-sectoral co-operation among authorities and local stakeholders.
Offshore boulder reefs have a high biodiversity and are a biologically important reef type at national and European level. At national levels these reef types are rare and Læsø Trindel constitutes one of 51 reef areas included in the Danish Natura 2000 network. In Denmark, shallow water boulder reefs have been extensively exploited for about a century, targeted for their easily accessible large boulders for constructing sea defenses and harbor jetties. A cautious estimate is that at least 34 km² of boulders from predominantly shallow cavernous reefs have been extracted from Danish waters and national monitoring programs indicate that only around 5 ha of the total original cavernous reefs have been left untouched.
The field experimental work was based on baseline surveys to be followed up by a survey 4 years after the deployment of the boulders; i.e. a “Before-After” approach. One role that DTU Aqua had in the project was to participate in the design of the restoration together with the other project partners. Based on the results from the multi-beam echo-sounder survey of the area conducted by GEUS in 2005, the reef restoration design was developed through several meetings between engineers and biologists/ecologists (Støttrup et al. in prep.). DTU Aqua’s main role in the project, however, was to document the ecology and biodiversity status of Læsø Trindel with focus on fish and shellfish assemblages before and after the restoration (Støttrup et al. 2014; Kristensen et al. 2 papers close to submission). This work was carried out in close collaboration with Aarhus University who is responsible for monitoring bottom fauna and flora. The baseline study has been carried out in 2007, just before the deployment of the boulders that should stabilize the remains of the original reef and restore its earlier shallow-water cavernous reef function. In 2012 the area was revisited using the same methodology and sampling program as in the baseline study.
The project was coordinated by Danish Nature Agency.
The project was funded by EU LIFE.
Støttrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Stenberg, C., Project Participant, National Institute of Aquatic Resources
01/01/2005 → 01/07/2012
Keywords: Research areas: Coastal Ecology & Marine Living Resources
Collaborators: Aarhus University, Danish Nature Agency, Geological Survey of Denmark and Greenland
Project: Research

Building scenarios for marine ecosystems under anthropogenic and natural forcings (EurOceans Consortium) (38779)
The aim of the EUR-OCEANS Consortium was to favor joint initiatives between key Research Performing Organizations (RPOs) and Research Funding Organizations (RFOs) across Europe, to help the community make significant jumps in marine sciences during the next decades. This was implemented by organizing and sponsoring activities with a clear focus on relevant marine science “hot topics” leading to wider European (FP8, JPI) projects. These activities included Gordon-like conferences, flagship programs, foresight workshops and public outreach. The focus of the Consortium was on the impact of climate/global change on marine ecosystems, and the construction of scenarios relevant to the emerging International Platform on Biodiversity and Ecosystem Services (ipBses).
A number of activities were funded in EUROCEANS with major impacts in term of new scientific publications, international training networks and other EU and Nationally funded projects. The EUROCEANS Consortium merged with similar initiatives in other marine research fields (i.e., MARBEF+ and Marine Genomics) to establish first a Consortium for a Collective Support Action under the FP7 program (called EUROMARINE) and then the integrated European Marine Network : EUROMARINE covering research topics from genes to ecosystems under changing oceans. The Consortium had over 25 European universities and research institutions covering all of Europe and a broad spectrum of marine ecology disciplines.
The project was coordinated by Institut de Recherche pour le Développement, France.
The project was self-funded.
Mariani, P., Contact Person, National Institute of Aquatic Resources
Köster, F., Project Participant, National Institute of Aquatic Resources
01/01/2009 → 31/12/2012
Keywords: Research area: Oceanography
Project: Research
Key fishers project II (38172)
The aim of this project is to collate data on recreational catches of fish around Denmark’s 7,300 km coastline. The objectives are to collate data on species caught in coastal areas and fjords around Denmark. The project is carried out in close collaboration with the Danish Organization for Amateur Fishermen and the Danish Union of Recreational Fishermen, who facilitate and support contact with up to 95 recreational fishers. This project is an extension of a previous project (2005-2007) and an earlier project “Catch Registration” initiated in 2002. Whereas the first project allowed the fishers to fish as they normally did with whatever gear they normally used and register all their catch, including undersized fish or non-edible fish, the Key Fishers projects had a different approach. In the Key Fishers projects, the fishers use standardized gear unanimously agreed upon and supplied by DTU Aqua. They fish at fixed positions during a particular time period each month. Catch data is sent to DTU Aqua for analysis. Information on temperature is provided by each fisher through a temperature data logger placed at the fishing position. General site information is provided by the fisherman through interviews conducted with each fisher. Further environmental data is obtained from other sources for the multivariate analyses to explore potential causes of change or spatial and temporal variations in CPUE. Several reports have been produced from the project (Pedersen et al., 2005; Sparrevoohn et al., 2009, Støttrup et al. 2012; Kristensen et al. 2014). With ten years of data it is now possible, in collaboration with other Baltic Sea countries, to contribute with data to develop fish indicators for the entire Baltic Sea (Helcom 2015). A first peer-reviewed publication on the method for crowd sourcing and citizen science used here is being developed and data analyses looking at spatio-temporal changes have been initiated. The project is coordinated by DTU Aqua. The project is funded by Danish Rod and Net Fishing License Funds. Støttrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management 01/01/2011 → 31/12/2016 Keywords: Research areas: Coastal Ecology & Ecosystem based Marine Management Collaborators: Danish Organization for Amateur Fishermen, Danish Union of Recreational Fishermen Project: Research

Harmonised environmental sustainability in the European food and drink chain (SENSE) (38973)
The food and drink industry in Europe, of which 99% are SMEs, is highly fragmented, and food chains are very complex. Hence, to assess the environmental sustainability of a product there is a need for applying integrated, harmonised and scientifically robust methodologies, together with appropriate communication strategies for making environmental sustainability understandable to the market. SENSE will deliver a harmonized system for environmental impact assessment of food & drink products. The research will evaluate existing relevant environmental impact assessment methodologies, and consider socio-economical, quality and safety aspects, an approach that has been rare up till now, to deliver a new integral system that can be linked to monitoring and traceability data. The concept of harmonized environmental impact assessment system will integrate: (i) (regionalized) data gathering system; (ii) matrix of key environmental performance indicators; (iii) methodology for environmental impact assessment; and (iv) a certification scheme. The methodology will be transferred to food & drink sectors and stakeholders of the food supply chain by means of specific communications strategies. SENSE will validate the new harmonized system in the juice, meat & dairy and aquaculture chains. The methodology and the associated software will be modular allowing its implementation for any food product. In addition, it will be economically viable and acceptable for the consumers, food industry and relevant stakeholders of the food and drink chain. These tools will allow food companies to set realistic environmental sustainability goals and to improve their competitiveness towards a more sustainable production culture for all levels of the production process. The sustainability information collected along the production cycle of any food stuff and reflected into the EID (Environmental Identification Document) will be accessible by the EID-Communication Platform, contributing to make the environmental sustainability part of the usual purchasing behavior of consumers and provide a competitive advantage to those products (and companies) which choose to use the developed concept. External partners are five universities and public research institutions, four national and European organizations and eleven private companies. The project is coordinated by Marine and Food Technological Centre (AZTI), Spain. Larsen, E., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management 01/01/2012 → 31/12/2014 Keywords: Research area: Fisheries Management Project: Research

Animal welfare: social and environmental preferences of reared rainbow trout (38697)
The principle objective of this project is to evaluate the effect of rearing densities, current and cover on animal welfare. We will use preference test to investigate behavioral and environmental needs of farmed rainbow trout. Furthermore, for investigating the effects of not fulfilling these needs we will use neurophysiological and endocrine responses involved in the stress reaction as biomarkers for compromised welfare. The obtained knowledge is expected to contribute to a scientific based governmental guideline for welfare based intensive fish rearing. Höglund, E., Project Manager, National Institute of Aquatic Resources, Section for Aquaculture
Spoilage and safety of cold-smoked fish (EU-FAIR CT95-1207)

In DK the annual export value of cold-smoked salmon is in the order of 150 mill. US$. It is a major problem for the industry that large amounts of products are rejected on the basis of microbiological counts that do not show any relation to the organoleptic quality of the product.

The primary objective of the project is to identify indices of quality of cold-smoked salmon. Secondly methods to measure the indices of quality will be developed and validated on a European basis. Identification of indices of quality will be based on an approach where specific spoilage organisms (SSO) and individual chemical compounds that can be related to product shelf life are studied. At the same time a non-specific approach based on measurements of profiles of volatile compounds and other metabolites will be used in combination with multivariate statistical methods for identification of indices of quality.

Dalggaard, P., Project Manager, National Institute of Aquatic Resources
Jørgensen, L. V., Project Participant, National Institute of Aquatic Resources
Huss, H. H., Project Participant, National Institute of Aquatic Resources

Ukendt: DKK2,200,000.00
01/11/1996 → 28/02/2000
Collaborators: Netherlands Institute for Fisheries Research, Catholic University of Portugal, Leatherhead Food Research, IFREMER
Award relations: Spoilage and safety of cold-smoked fish (EU-FAIR CT95-1207)
Project: Research

The coupling between the dynamics and the biology in the North Sea

In stratified waters there may be a close connection between the dynamics and the biology of the water masses. Recent research suggests that this circumstance is responsible for the fact that the North Sea is among the world's most important with respect to the production of fish. The project aims at studying this possible close connection by considering the course of the thermal stratification in the North Sea and the abundance of cod larvae for the past 40 years.

Nielsen, M. H., Project Manager, Department of Hydrodynamics and Water Resources
St. John, M., Project Participant, National Institute of Aquatic Resources

01/10/1998 → 14/12/1999
Project: Research

Studies of low volatility oxidation products of sensory significance

The aim is to establish the identity and sensory significance of low volatility oxidation products in lipid-rich foods. Methods for isolation of compounds of low volatility are under development. High-vacuum distillation and supercritical extraction (SFE) have been tested for the ability to isolate lipid-derived oxidation products. Method development using SFE will be continued.

Fractionation of fish muscle has been carried out by centrifugation and by HPLC of extracts. Method development along these lines is also continuing.

Studies of protein oxidation in the presence of lipids are the focus in a collaboration project with Dr. Earl Stadtman at NIH (Bethesda, MD USA).

Jensen, B., Project Manager, National Institute of Aquatic Resources
Refsgaard, H., Project Participant, Department of Biotechnology
Holmberg, I., Project Participant, Department of Biotechnology

Ukendt: DKK1,900,000.00
01/01/1998 → 31/12/2000
Award relations: Studies of low volatility oxidation products of sensory significance
Project: Research

Applied multivariate dataanalysis and measurement techniques.

Jørgensen, B. M., Project Manager, National Institute of Aquatic Resources
Berner, L., Project Participant, National Institute of Aquatic Resources
Martens, H., Project Participant, Department of Biotechnology
Munck, L., Project Participant, University of Copenhagen

01/01/1997 → 01/01/9999
Collaborators: University of Copenhagen
Project: Research
TMAO aldolase in fish products. A key to reduction of the quality problems connected with formaldehyde and dimethylamine.

The formation of formaldehyde and dimethylamine are main factors in the reduction in quality of lean fish like cod during frozen storage. They are formed from trimethylamine-oxide, catalysed by the enzyme trimethylamine-oxide aldolase (TMAOase; EC 4.1.2.32) which is situated mainly in the inner organs like gall bladder, spleen and kidney. The presence of the enzyme in other marine species is not thoroughly described, and it is to be expected that TMAOase activity may be the cause of formaldehyde formation and quality deterioration in other products than those formed from lean fish.

Products of commercial importance to the Nordic fish industry were screened for TMAOase activity. TMAOase was almost only found in gadoid fishes. The TMAOase activity concentrations varied much between individuals. Results from the frozen storage experiment showed that the formation of formaldehyde at -10°C was both proportional to the TMAOase activity and the storage time. Therefore TMAOase activity concentration can be used as a selection criteria to sort out individuals less suitable to frozen storage.

Jørgensen, B. M., Project Manager, National Institute of Aquatic Resources
Nielsen, M. K., Project Participant, National Institute of Aquatic Resources
Berner, L., Project Participant, National Institute of Aquatic Resources
Espe, M., Project Participant, Unknown
Poulsen, M., Project Participant, Unknown
Einarsson, S., Project Participant, Unknown

Award relations: TMAO aldolase in fish products. A key to reduction of the quality problems connected with formaldehyde and dimethylamine.

Project: Research

Antioxidative defence

Oxidative defense, mandatory for protection of human health and for maintaining safety and freshness of foods, will be investigated in dietary invention studies in humans. Early stages of oxidation involving protein damage and formation of long-lived protein radicals will be characterized in fish and pig muscle systems which will allow detection of radical damage in tissues in more details than in humans.

Refsgaard, H., Project Manager, Department of Biotechnology
Jensen, B., Project Participant, National Institute of Aquatic Resources
Person, U., Project Participant, University of Copenhagen
Person, U., Project Participant, University of Copenhagen
Dragsted, L. O., Project Participant, VFD
Andersen, H., Project Participant, DJF

Award relations: Antioxidative defence

Project: Research

FAO Fish Oil

The purpose of the project is to obtain preliminary data on the storage stability of a fish oil-enriched, vegetable-based product intended as a supplement to the staple diet in sub-Saharan populations. FAO Fisheries Utilization Division is in the process of setting up a project which involves supplying families in certain African regions with fish oil, rich in docosahexaenoic acid. The role of this pre-project is to follow the development of possible oxidation products during the storage at ambient temperature of the fish oil-enriched tomato-and-onion sauce. The storage stability is assessed through sensory evaluation and chemical measurements of oxidation indices.

Jensen, B., Project Manager, National Institute of Aquatic Resources
Jacobsen, C., Project Participant, National Institute of Aquatic Resources
Vu, T. T. T., Project Participant, National Institute of Aquatic Resources

Award relations: FAO Fish Oil

Project: Research

Collection and Analysis of Research Results and Industrial Experience on the salting and ripening of herring

Salted and marinated herring products are of great importance for the fish industry in the Nordic countries. The background for this production is herring caught in the right season and ripened by salting in barrels for several months according to old experience. Little scientific knowledge is however yet available for understanding the process.

The aim of the project is to retrieve and process existing data from three Nordic laboratories by means of multivariate statistical analysis in order to obtain a better understanding of the main factors (quality criteria) that govern the salting and ripening of herring, with the purpose of improving the economy in the industry and making the industry able to market products with consistently high quality.

Jensen, B., Project Manager, National Institute of Aquatic Resources
Jacobsen, C., Project Participant, National Institute of Aquatic Resources
Vu, T. T. T., Project Participant, National Institute of Aquatic Resources

Award relations: Collection and Analysis of Research Results and Industrial Experience on the salting and ripening of herring

Project: Research
In the project an overview will first be obtained of the results that the three laboratories have already obtained in numerous salting experiments on different herring stocks. Secondly, the scientific results will be pooled together. Thirdly, information will be collectively gathered by interviewing experienced people from the industry on the factors that are important for the salting and ripening of herring. The results obtained by the scientific studies and the experience from industry will be combined using sophisticated statistical methods (multivariate analysis). The final step will be to present the results in a workshop to the industry.

Nielsen, H. H., Project Manager, National Institute of Aquatic Resources
Stefansson, G., Project Participant, The Icelandic Fisheries Laboratories
Skára, T., Project Participant, Norconsv AS
Bro, R., Project Participant, University of Copenhagen

Collaborators: Norconsv AS, University of Copenhagen, The Icelandic Fisheries Laboratories
Project: Research

Leaching of heavy metals from soils
Quality criteria for soils with respect to heavy metals have traditionally focused on the environmental issues related to the land use (ingestion of soil, skin contact, etc.) and very little attention has been given to protection of the groundwater. The complex form of heavy metals in polluted soils makes prediction of leachability difficult and leaching experiments or testing are usually the only way to assess the amount of metal to leach from the soil.

Model scenarios are being developed to evaluate heavy metal leaching in the context of groundwater protection and allow for simplified methods to account for groundwater quality criteria, depth and location of polluted soil, reduction in infiltration and leachable amounts determined in leaching test.

Experimental studies have been performed at actual sites and leaching experiments are conducted in the laboratory.

Christensen, T. H., Project Manager, Department of Environmental Science and Engineering
Kjeldsen, P., Project Participant, Department of Environmental Science and Engineering
Astrup, T. F., Project Participant, Department of Environmental Science and Engineering
Bodum, J. K., Project Participant, Department of Environmental Science and Engineering
Jensen, D. L., Project Participant, Department of Environmental Science and Engineering
Foverskov, A., Project Participant, Department of Environmental Science and Engineering

Holm, P., Project Participant, VKI Water Quality Institute
Hjelmar, O., Project Participant, VKI Water Quality Institute

Ukendt: DKK100,000.00, Ukendt: DKK200,000.00

01/01/1996 → 31/12/1998
Collaborators: VKI Water Quality Institute
Award relations: Leaching of heavy metals from soils, Leaching of heavy metals from soils
Project: Research

Degradation of myofibrillar proteins from herring muscle by herring Cathepsin D
The aim of the project is to investigate the role of the lysosomal protease Cathepsin D in the ripening process of salted herring. The project is part of a larger project "Production of Cathepsin D from Herring" carried out at Biotechnological Institute, Denmark.

The aim of the experimental work is to see whether Cathepsin D is active and able to degrade myofibrillar proteins under conditions corresponding to storage conditions of marinated and salted herring.

Myofibrillar proteins extracted from herring muscle have been incubated with purified cathepsin D from herring muscle at pH (4.5 and 6), temperature (5 C) and salt concentration (10 and 20% NaCl) corresponding to what is found in marinated and salted herring during storage. Changes in the profile of myofibrillar proteins has been study by SDS-PAGE.

Nielsen, H. H., Project Manager, National Institute of Aquatic Resources
Reimers, K., Project Participant, National Institute of Aquatic Resources
Nielsen, L. B., Project Participant, Bioteknologisk Institut

01/04/1997 → 30/04/1998
Collaborators: Bioteknologisk Institut
Project: Research

Advanced methods for identification and quality monitoring of (heat) processed fish
Objectives:
-Development of methods for fish species identification, which are tailored for the various types of heated products.
-Development of a data base containing physical parameters (isoelectric point and/or molecular weight) of proteins for fish species identification. This reference data base will contain data for raw and heated fish and products.
-Testing the suitability of image analysis for interpretation and comparison of electrophoresis gels.
-Testing the suitability of image analysis for interpretation and comparison of electrophoresis gels.
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-Testing the suitability of image analysis for interpretation and comparison of electrophoresis gels.
-Testing the suitability of image analysis for interpretation and comparison of electrophoresis gels.

Jessen, F., Project Manager, National Institute of Aquatic Resources
Stampe-Villadsen, H. L., Project Participant, National Institute of Aquatic Resources

Project: Research
Luten, J., Project Participant, DLO-Metherlands Institute for Fisheries Research
Rehbein, H., Project Participant, Federal Research Centre for Fisheries
Etienne, M., Project Participant, Institut français de recherche pour l'exploitation de la mer
Mendes, R., Project Participant, Instituto Portugues de Investigacao Maritima
Perez-Martin, R., Project Participant, Instituto de Investigaciones Marinas
Craig, A., Project Participant, Rowett Research Institute
Malmheden-Yman, I., Project Participant, National Food Agency
Martinez, I., Project Participant, Nofima
Åkesson, G., Project Participant, Swedish Institute for Food Research
Ukendt: DKK500,000.00
01/11/1996 → 31/01/2000
Collaborators: Netherlands Institute for Fisheries Research, Federal Research Centre for Fisheries, CSIC, Swedish Institute for Food Research, National Food Agency, Institut français de recherche pour l'exploitation de la mer, DLO-Metherlands Institute for Fisheries Research, Instituto de Investigaciones Marinas, Instituto Portugues de Investigacao Maritima, Rowett Research Institute, Nofima, IFREMER
Award relations: Advanced methods for identification and quality monitoring of (heat) processed fish
Project: Research

**Dietary fats: Technology - Quality- Nutrition**
The production of interesterified fats is optimized in laboratory scale as well as in pilot plant. The intestinal absorption of the fats is examined in animal models and the fats are incorporated into food.
Høy, C., Project Manager, Department of Biochemistry and Nutrition
Porsgaard, T., Project Participant, Department of Biochemistry and Nutrition
Jensen, K., Project Participant, Department of Biochemistry and Nutrition
Nielsen, N. S., Project Participant, Department of Biochemistry and Nutrition
Mu, H., Project Participant, Department of Biochemistry and Nutrition
Børresen, T., Project Participant
Jacobsen, C., Project Participant, Unknown Organization
Adler-Nissen, J., Project Participant, Unknown Organization
Xu, X., Project Participant, Unknown Organization
Ukendt: DKK14,300,000.00
01/01/1999 → 31/12/2003
Collaborators: Unknown Organization
Award relations: Dietary fats: Technology - Quality- Nutrition
Project: Research

**Purification and characterization of TMAOase of saithe and hake.**
The intracellular distribution of the enzyme TMAO aldolase (EC 4.1.2.32) is determined from detergent-treated tissue extracts. The enzyme is isolated and purified by chromatography and its properties are studied. Thereby, greater knowledge is gained of the factor that determines the formation of dimethylamine and formaldehyde in frozen fish. This knowledge forms a basis for the possibility of influencing the process that is considered important for quality deterioration during frozen storage.
Jørgensen, B. M., Project Manager, National Institute of Aquatic Resources
Nielsen, M. K., Project Participant, National Institute of Aquatic Resources
Jessen, F., Project Participant, National Institute of Aquatic Resources
Berner, L., Project Participant, National Institute of Aquatic Resources
Rehbein, H., Project Participant, Bundesforschungsanstalt für Fischerei, Hamburg
Gonzalez-Sotelo, C., Project Participant, Instituto de Investigaciones Marinas, Vigo
Ukendt: DKK1,300,000.00
01/04/1995 → 31/03/1998
Collaborators: Federal Research Centre for Fisheries, University of Vigo, Bundesforschungsanstalt für Fischerei, Hamburg, Instituto de Investigaciones Marinas, Vigo
Award relations: Purification and characterization of TMAOase of saithe and hake.
Project: Research

**Thaw-rigor**
The metabolic processes related to rigor mortis in fish during freezing, frozen storage and thawing can be related to quality deterioration. In this project these processes are studied in dependence of time and temperature. A special interest is on the relation between thaw-rigor and quality deterioration during processing of fish.
The project shall determine the extent and importance of gaping as a result of thaw-rigor and investigate the potential for thaw-rigor in frozen industrial cod blocks. Based on these results an optimized thawing procedure will be developed in order to increase quality and yield of thawed raw material.
Jessen, F., Project Manager, National Institute of Aquatic Resources
Cappeln, G., Project Participant, National Institute of Aquatic Resources
Peptides and free amino acids on the quality of salted fish products

Enzymatic degradation of proteins in salted fish products can influence the sensory quality of the products both in a positive and negative way. However, it is today only possible to detect the presence of active proteolytic enzymes but not how active the enzymes actually are under the conditions the products are stored. In order to estimate which proteolytic enzymes that are active in the products during storage, it is necessary to identify the breakdown products, such as peptides and free amino acids, from the protein degradation and correlate this to the presence of active enzymes. Heavy salted and spice salted herring is characterised by a long ripening process where a degradation of proteins in the fillet is considered to be important in order to obtain the correct sensory profile of the product. The enzymatic degradation of the muscle proteins in the herring results in a more soft texture and in the formation of taste-active peptides and free amino acids.

The aim of the present project is therefore to establish a well defined profile of peptides and free amino acids in brine and fillets of spice salted herring during storage. Changes in the profiles will be investigated when the different proteases present in fillet are influenced by inhibitors.

Capillary zone electrophoresis (CZE) will be used to analyse changes in the peptide fraction of spice salted herring during storage. Dominating peptides will be collected and sequenced. Changes in the peptide and amino acid concentrations will be followed during storage.

Nielsen, H. H., Project Manager, National Institute of Aquatic Resources
Engvang, K., Project Participant, National Institute of Aquatic Resources
Reimers, K., Project Participant, National Institute of Aquatic Resources

Sensory analysis at Dept. of Seafood Research

The aim is to strengthen the sensory research area and consumer test at Dept. of Seafood Research in a way that will enable the function to give qualified advice on sensory problems and for participation in planning and doing sensory analysis for various research projects.

The sensory research area will be expanded by building up knowledge about consumer test. For this purpose new methodologies will be introduced at Dept. of Seafood Research. Consumer test can be used for confirming consumer preferences which can be correlated with laboratory tests. The knowledge obtained gives a picture of which specific sensory attributes the consumer prefers. These attributes can be used by selection and training of new assessors. The electronic FIZZ-system will be used as a tool for planning and performing sensory analysis. The results will be analysed by classic and/or multivariate methods. Further research will develop the Quality Index Method (QIM) to a standard analysis by incorporation of more species and fish products. QIM will be introduced to Danish fish companies. The project will also include finding correlations between rheological and sensory properties and characterisation of microstructure of fish and fish products.

Participant, D., PI
30/12/1989 → 01/01/1996
Project: Research

Improved vaccination strategies in marine aquaculture

Lorenzen, N., Project Manager, National Veterinary Institute, Division of Poultry, Fish and Fur Animals, Section of Fish Diseases
Rasmussen, J. S., Project Participant, National Veterinary Institute, Division of Poultry, Fish and Fur Animals, Section of Fish Diseases
Lorenzen, E., Project Participant, National Veterinary Institute, Division of Poultry, Fish and Fur Animals, Section of Fish Diseases
Olesen, N. J., Project Participant, National Veterinary Institute, Division of Poultry, Fish and Fur Animals, Section of Fish Diseases
Dalsgaard, I., Project Manager, National Institute of Aquatic Resources
Pedersen, K., Project Manager, University of Copenhagen
Buchmann, K., Project Participant, University of Copenhagen
Juel Hansen, P., Project Manager, University of Copenhagen
Henriksen, N. H., Project Manager, Danish Aquaculture Association
Høllyck, V., Project Manager, Aller Aqua A/S
Engell-Sørensen, K., Project Manager, Fishlab
Nielsen, T., Project Manager, Aquasearch Ova Aps
Efficient data collection and storage
Development of a database for raw data of various kinds (single values, vectors, matrices) so that they are easily accessible for e.g. multivariate analysis.

Fish Meal Quality assessed by analysis of volatiles
Current methods for analysis of oxidation status of the lipid component (fish oil) in fish meal do not give satisfactory results, possibly due to extraction problems. As oxidation processes result in, i.a., formation of volatile breakdown products, it is hypothesized that the determination of such volatiles may give a better indication of the oxidative deterioration of fish meal.
Fish meals from various sources, processes, and antioxidant treatments were stored for 12 weeks, exposed to light and air. Amounts (arbitrary units) were determined by headspace - gas chromatography (GC), and volatiles were identified by mass spectrometry - GC. The development of volatiles displayed clear differences between meal types. The correlation of these results with the quality estimates of the trade (fish meal manufacturers) remains to be carried out.

Development of multisensor techniques for monitoring the quality of fish.
Physical signals from various instruments like near infrared vision systems, texture meters and electronic noses are correlated to organoleptic and physical/chemical quality parameters by multivariate data analysis (projection methods and neural networks). Based on these results, a multisensor device is designed for at line (or even in line) use in the fish production chain.

Prevalence and growth of Listeria monocytogenes

Quality of water for the production of bivalve molluscs

Fresh Fish with Traceable Quality
Fast instrumental methods.
Development and implementation of near-infrared spectrometry and other fast instrumental methods for prediction of quality parameters for raw material and seafood products. Optimization of multivariate data-analytical applications directed towards these goals.
Jørgensen, B. M., Project Manager, National Institute of Aquatic Resources
Berner, L., Project Participant, National Institute of Aquatic Resources
01/01/1997 → …
Project: Research

Time-temperature integration and shelf life prediction (EU-FAIR-PL95-1090)
The project is a continuation of "Predictive modelling of shelf life of fish and meat products" (EU-AIR CT93-1251). The aim is to evaluate and further develop kinetic and empirical models for prediction of shelf-life of seafoods. Shelf life models will particularly be evaluated with fluctuating temperature conditions. Fresh fish and lightly preserved products, including cold-smoked salmon and brined shrimps, will be studied by empirical or relative rate of spoilage models. An important objective has been to develop the "Seafood Spoilage Predictor" software now available at http://www.dfu.min.dk/micro/ssp. This software allows shelf life of different seafood to be predicted at constant and fluctuating temperatures. The project is financed by EU and carried out in collaboration with Greece and France.
Dalgaard, P., Project Manager, National Institute of Aquatic Resources
Ukendt: DKK2,100,000.00
01/11/1996 → 30/04/2000
Collaborators: ADRIA Developpement, National Technical University of Athens, Agricultural University of Athens, Danish Institute for Fisheries Research
Award relations: Time-temperature integration and shelf life prediction (EU-FAIR-PL95-1090)
Project: Research

Shelf-life prediction for improved safety and quality of foods (EU-COPERNICUS)
The aim of the Concerted Action is to stimulate interest in the complex issue of shelf-life prediction. The work focuses primarily on (i) development of computer modelling techniques, (ii) predictive microbiology, (iii) product specific shelf-life determination.
Dalgaard, P., Project Manager, National Institute of Aquatic Resources
Ukendt: DKK20,000.00
01/05/1995 → 31/12/1997
Award relations: Shelf-life prediction for improved safety and quality of foods (EU-COPERNICUS)
Project: Research

Predictive models of microbial growth in foods (EU-COST 914)
The Concerted Action focused on (i) validation of models (ii) evaluation of instrumental methods for data capture (iii) modelling of mixed microbial populations and (iv) modelling of microbial survival. DIFRES has particularly participated in validation of models in seafoods and in the development of absorbance methods for generation of growth data. DIFRES represents Denmark in the management committee.
Dalgaard, P., Project Manager, National Institute of Aquatic Resources
01/03/1995 → 31/12/1999
Project: Research

Ice quality and pumpable ice.
The aim is to investigate those parameters which possibly can influence the manual handling characteristics of tube ice, the most common type of ice used on danish fishing vessels. Also investigation of parameters, which can lead to production of pumpable ice/water-mixtures based on tube ice will be done.
Olsen, K. B., Project Manager, National Institute of Aquatic Resources
Frederiksen, M. T., Project Participant, National Institute of Aquatic Resources
Johannesen, E., Project Participant, National Institute of Aquatic Resources
Popescu, V., Project Participant, National Institute of Aquatic Resources
Ukendt: DKK567,000.00
01/10/1996 → 01/05/1998
Award relations: Ice quality and pumpable ice.
Project: Research

Traceability of packed and weighed fresh fish onboard vessels
Sapklangsprojektet blev startet i begyndelsen af 1995. I alt fire skibe blev udvalgt som demonstrationsskibe for projektet. Skibene fik udstyr ombord, der muliggjorde skylding/vask, afbledning, størrelsesortering, vejning, pakning, mærkning og

Olsen, K. B., Project Manager, National Institute of Aquatic Resources
Frederiksen, M. T., Project Participant, National Institute of Aquatic Resources
Popescu, V., Project Participant, National Institute of Aquatic Resources
01/01/1995 → 01/08/1997
Project: Research

**Improving Quality Control in the Seafood Industry using an integrated process approach and advanced on-line methods**

By use of multivariate process data analysis and viewing the process as an integrated whole, the aim is to study possibilities for improving the controllability of quality and the quality management in seafood industries

Moe, T., Project Manager, National Institute of Aquatic Resources
Ukendt: DKK2,500,000.00
15/08/1995 → 31/12/1997
Award relations: Improving Quality Control in the Seafood Industry using an integrated process approach and advanced on-line methods
Project: Research

**In vitro protein digestion in fish**

A project has been carried out with the aim of developing a rapid and reliable method for predicting the protein digestibility in fish feed. The method should replace present methods using experimental animals like rats, minks and fish. These methods take up to several weeks until the result is known. The results in the present project show that an in vitro method can give a result after a one day assay only. The project has been successfully ended by submission of a thesis for an industrial ph.d., which has been approved.

Børresen, T., Project Manager, National Institute of Aquatic Resources
Bassompierre, M., Project Participant, National Institute of Aquatic Resources
01/02/1994 → 31/03/1997
Collaborators: Fiskernes Fiskeindustri, Aalborg University
Project: Research

**Biological and technological significance of the fish parasite Ichthyophonus hoferi**

In 1991 an epizootic of ichtyophoniasis in herring was recorded for the first time in waters around Denmark and Norway causing mass mortality. This Ph.D. study demonstrates how continuously successful subculturing of Ichthyophonus hoferi is possible only at alternating pH (between pH 3-4 and pH7). The morphology of I. hoferi at pH 3.5 and 7.0 was studied using light and scanning electron microscopy. At pH 3.5 only hyphal growth was seen while only growth of uni-to multinucleate spherical bodies was seen at pH 7. These findings were used to explain the lifecycle of this parasite. The phylogenetic position of the genus Ichthyophonus was investigated using a combination of molecular analysis of the genomic DNA encoding the small subunit ribosomal RNA, ultra-structural features and biochemical data. These studies indicated that I. hoferi is not a member of the Fungi, but belongs to the protist Kingdom. Feeding experiments with mice showed that I. hoferi is not a pathogen in mammals. However, the technological significance of I. hoferi infected fish fillets entering processing is severe due to soft texture, unfavourable flavour changes and discolorations of the fish products.

Huss, H. H., Project Manager, National Institute of Aquatic Resources
Spanggaard, B., Project Participant, National Institute of Aquatic Resources
01/11/1993 → 01/01/1997
Collaborators: University of Copenhagen
Project: Research

**Improved utilization of low-value fish**

The specific objectives of this project were in three areas:

1. To examine and adapt traditional Asian preservation technologies for fish products.
2. To investigate and optimise the fermentation process used in traditional Asian fish products.
3. To study the composition and stability of lipids from low-value fish species.

The results have identified potential new use of a large number of low-value fish species. The properties of Lactic Acid Bacteria (LAB) isolated from low salt fermented products have been studied and the capacity to ferment inulin from garlic was found to be an important criteria for selection of starter cultures, since garlic is added to most low-salt fermented products. The fatty acid profile from a great number of tropical fish has been determined. The stability of fish oil and the potential of spices as antioxydants has also been investigated.

Huss, H. H., Project Manager, National Institute of Aquatic Resources
Embarek, P. K. B., Project Participant, National Institute of Aquatic Resources
Østergaard, A., Project Participant, National Institute of Aquatic Resources
**NUTRIFISH - Nutritional Studies on Dried Functional Ingredients Containing n-3 Polyunsaturated Fatty Acids**

1998: The project objectives are to define the lowest intake of n-3 PUFA which will exert a positive nutritional effect against biomarkers of chronic diseases in humans; to design high quality bioavailable fish oil-enriched ingredients; to incorporate these novel dried ingredients in a range of consumer food products.

The tasks at FF are to provide fish oil for powder-production, to set up quality specifications for fish oil, to prepare antioxidant formulations and to test their efficiencies, and to study formation and identity of volatile oxidation products formed in spray-dried fish oil powders during storage.

Fish oil was refined and deodorized for production of microencapsulated fish oil and for a storage experiment. The fish oil was protected against oxidation by adding an antioxidant system prepared at FF.

The shelf-life of commercial powders have been compared with the shelf-life of powders produced in this project.

The dynamic headspace method develop at FF, applying analysis of the volatiles by gas chromatography-mass spectrometry (GC-MS), was used to evaluate sensorially significant volatiles formed by lipid oxidation. Compounds with a characteristic and easily detectable odour were selected by GC sniffing analyses. The amount of the volatiles were calculated using calibration curves, that were determined by quantitative GC-MS analysis of standards. The amounts of volatiles were found in levels of microgram volatiles / g powder (ppm).

Schmidtsdorff, W., Project Manager, National Institute of Aquatic Resources

Haahr, A., Project Participant, National Institute of Aquatic Resources

Jensen, B., Project Participant, National Institute of Aquatic Resources

Vu, T. T. T., Project Participant, National Institute of Aquatic Resources

Ukendt: DKK1,834,000.00

01/12/1995 → 01/03/1999

Collaborators: Ytkemiska Institutet, Instituto de la Grasa, University College Cork, Ulster University, TEAGASC, Deutsches Institut für Lebensmitteltechnik, Trinity College Dublin, Golden Vale plc

Award relations: NUTRIFISH - Nutritional Studies on Dried Functional Ingredients Containing n-3 Polyunsaturated Fatty Acids

Project: Research

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**Quality indicators for frozen fish**

An important factor for efficient utilisation of the resources of fish is quality assurance in the chain from catch to consumer. Freezing is an effective method for preserving fat and lean fish. In order to reduce the quality loss during processing, storing and distribution it is necessary to obtain better knowledge of the biochemical shelf life indicators of the different species.

It is important to create a system of traceability of the fish through the chain for the benefit of the consumer. On the background of the obtained knowledge in the project the objective is to construct a model for labelling of quality, prediction of shelf life and utilisation and to obtain a better freezing stability.

The aim is to give guidelines for the optimum handling of fish prior to freezing, the optimum freezing-, storage- and thawing conditions and to collect data necessary for prediction of a production of thawed fish packed in MAP based on raw material frozen-at-sea.

The effect of season, catch handling, cold/chilled storage period and temperature is examined.

Nielsen, J., Project Manager, National Institute of Aquatic Resources

Jensen, H. S., Project Participant, National Institute of Aquatic Resources

Jørgensen, B. M., Project Participant, National Institute of Aquatic Resources

Jessen, F., Project Participant, National Institute of Aquatic Resources

Jensen, K. N., Project Participant, National Institute of Aquatic Resources

Godiksen, H., Project Participant, National Institute of Aquatic Resources

Ukendt: DKK9,994,630.00

01/01/1997 → 01/03/2002

Collaborators: Hoejmarklaboratory

Award relations: Quality indicators for frozen fish

Project: Research

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**Lightly salted lumpfish roe. Composition, spoilage, safety and preservation**

Traditional caviar products are often heavily salted and further preserved by addition of chemical preservatives. This industrial Ph.D. project has studied the problems associated with reducing the salt content and eliminating the chemical preservatives from the product. It was shown that Lactic Acid Bacteria (LAB) dominated the microbial flora after three months of storage at plus 5°C of this lightly salted product (approx. 4% water phase salt (WPS)), but also Enterobacteriaceae was found in high numbers, particularly when WPS was lower than 4%. A number of chemical indicators of spoilage were analysed, but only volatile sulphur compounds were related to sensory spoilage. The presence...
and growth of Listeria monocytogenes was identified as a possible health hazard. Experiments with biopreservation were unsuccessful, but the use of 2.8% (w/w) sodium lactate was found to be a possible alternative.

Huss, H. H., Project Manager, National Institute of Aquatic Resources
Basby, M., Project Participant, National Institute of Aquatic Resources
01/10/1994 → 31/07/1997
Collaborators: Abba Seafood A/S
Project: Research

Oxidation mechanisms in fish oil enriched emulsions
The purpose of the project is to study the oxidation mechanisms in fish oil enriched emulsions in order to develop combined emulsifier and antioxidant systems which are more efficient in protecting fish oil enriched foods against oxidation than existing antioxidant systems.

Results obtained in 1999 have shown that the low pH in mayonnaise is a very important factor for the initiation of the oxidation processes in mayonnaise. This is due to the fact that iron ions are released/loosened from the egg yolk components at the oil/water interface when pH is decreased to 4, which is the normal pH in mayonnaise. The released iron promotes decomposition of peroxides to volatiles, which are responsible for the off-flavour formation in mayonnaise. The metal chelator EDTA was observed to be a very efficient antioxidant in mayonnaise due to its ability to chelate iron. A HPLC method for determination of lipid peroxides has been further optimised and is now fully operational. By the aid of GC-MS a large number of volatiles that correlate to the fishy and rancid off-flavours in oxidised mayonnaise have been identified.

Børresen, T., Project Manager, National Institute of Aquatic Resources
Vu, T. T. T., Project Participant, National Institute of Aquatic Resources
Jacobsen, C., Project Participant, National Institute of Aquatic Resources
Hartvigsen, K., Project Participant, Department of Biochemistry and Nutrition
Lund, P., Project Participant, Department of Biochemistry and Nutrition
Datta, S., Project Participant, Department of Biochemistry and Nutrition
Helmer, G. K., Project Participant, Department of Biochemistry and Nutrition
Meyer, A. S., Project Participant, Department of Biotechnology
Green, E., Project Participant, Department of Biotechnology
Reitz, S., Project Participant, Department of Biotechnology
Adler-Nissen, J., Project Participant, Department of Biotechnology

Ukendt: DKK6,178,065.00, Ukendt: DKK1,050,000.00
01/05/1996 → 31/12/1999
Collaborators: Danisco AS, University of Copenhagen, Association of Danish Fish Meal and Fish Oil Manufacturers
Award relations: Oxidation mechanisms in fish oil enriched emulsions, Oxidation mechanisms in fish oil enriched emulsions
Project: Research

European Quality Fish Net (EQF-Net)
Coordinating project in EU Leonardo Program dealing with training and information dissemination in quality issues. Forty industry and University participants in EU countries
Bremner, A., Project Manager, National Institute of Aquatic Resources
Ukendt: DKK20,000.00
01/01/1997 → 31/12/1998
Award relations: European Quality Fish Net (EQF-Net)
Project: Research

Quality Assurance & Information Technology
Development of QA and IT systems suitable for use in the fishing industry.
Provide leadership to Process Technology group, develop strategies in QA and chain management.
Bremner, A., Project Manager, National Institute of Aquatic Resources
Ukendt: DKK100,000.00
01/06/1996 → …
Award relations: Quality Assurance & Information Technology
Project: Research

Analytical Chemistry
Analytical Chemistry at FF is a basic activity, aimed at maintaining the chemical-analytical know-how, which is necessary for carrying out general analytical tasks, e.g. analyses for salt, crude protein, and TVB-N. In addition, newer instrumental methods may be part of this general project area, though usually such analyses are developed within specific projects (analysis of peptides, proteins, microbial metabolites, autolytic breakdown-products). The available instrumentation include i.a. 4 HPLC-instruments (UV, DAD, ELSD, RI, fluorescence detection), 3 GC instruments (MS, PFD, FID, olfactory detection), 2 scanners for 2-D-gel electropherograms, NIR, low-resolution NMR, differential scanning calorimeter.
The Analytical Quality Group follows up on developments and trends in analytical principles and in analytical quality
control that may be relevant for analytical chemistry at FF. This group carries out updating of standard procedures and method descriptions for the purpose of improving quality assurance and minimizing environmental effects, and occasionally manages participation in national and international inter-laboratory tests. Safety activities have been strengthened by the employment of a safety officer.

Also, within this project area are placed advisory activities towards internal and external questions on analytical problems.

- A central theme of present and planned activities is quality assurance and quality control of standard analytical methods.
- External cooperation in the field of chemical analysis of fish with WEFTA Working Group on Analytical Methods (WEFTA = [West] European Fish Technologists' Association. - The basal chemistry activities, comprising approx. 1 person/year, are financed by the running costs of the department.

Jensen, B., Project Manager, National Institute of Aquatic Resources
Berner, L., Project Participant, National Institute of Aquatic Resources
Stampe-Villadsen, H. L., Project Participant, National Institute of Aquatic Resources
Jørgensen, B. M., Project Participant, National Institute of Aquatic Resources
Olsen, L. R., Project Participant, National Institute of Aquatic Resources
Reimers, K., Project Participant, National Institute of Aquatic Resources
Haahr, A., Project Participant, National Institute of Aquatic Resources
01/06/1989 → 31/12/2013

Project: Research

Lipid Chemistry
Lipid chemistry activities at FF are related partly to projects that are based in the fish oil and fish meal area, and partly to projects studying the formation of lipid-derived aroma and flavours. Lipid oxidation is a central topic.
Lipid analytical methods maintained at FF comprise analysis of lipid content by extraction or occasionally by NIR or microwave methods. Lipid class analysis is carried out using the principle of solid phase extraction. Fatty acid composition is an important parameter in studies both of fish and of fish oil. Capillary gas chromatography, with detection by flame ionization or, occasionally, with mass spectrometric analysis is used. Oxidation parameters are analyzed traditionally (e.g. peroxide value). Polymer formation is analyzed using high performance size exclusion chromatography. Oxidative stability of edible oils, and thereby the effect of various antioxidants, is assessed using accelerated methods (Rancimat, Oxidograph). Formation of volatile products of lipid oxidation is analyzed using headspace chromatography with adsorbent trapping, thermal desorption, and gas chromatography with detection by flame ionization, mass spectrometry or olfactometry (sniffing analysis). - The basal lipid activities are financed by the related projects and by the basic running costs of the department.

Jensen, B., Project Manager, National Institute of Aquatic Resources
Jørgensen, B. M., Project Participant, National Institute of Aquatic Resources
01/06/1989 → 31/12/2013

Project: Research

Proteome analysis of muscle tissues: Two dimensional protein mapping of pig and cod muscle.
Certain aspects of muscle biology such as metabolism, growth and development of muscle cells influence the quality of muscle based foods. In addition, the proteolytic processes that start immediately after slaughter or catch (post mortem metabolism) have major impact on taste and texture of meat from fish and mammals. In order to secure optimal quality, it is important to understand the basic mechanisms of muscle biology as well as to understand the post mortem processes that turn muscle into meat. Hence it is important to characterize the involved proteins and genes, and how they interact with each other and with environmental factors to influence meat quality.
Proteome analysis is a new and powerful tool for characterization of cellular protein expression. This method is based on 2 dimensional (2D) electrophoretic separation of the cellular proteins so that each protein can be identified by its specific coordinates in a 2D protein map from which it can be extracted and identified by micro sequencing and mass spectrometry.

Our aim is to establish and optimize such 2D protein maps of muscle tissues from cod and pork. Existing methods of tissue preparation, 2D gel separation and computer assisted image analysis of the 2D maps will be optimized. The established 2D maps will be used to study proteins that are involved in post mortem changes of muscle tissue, in order to find and identify marker proteins that can be used as assays for quality labeling.

Jessen, F., Project Manager, National Institute of Aquatic Resources
Kjærsgård, I. V. H., Project Participant, National Institute of Aquatic Resources
Stampe-Villadsen, H. L., Project Participant, National Institute of Aquatic Resources
01/07/1999 → 31/05/2003

Collaborators: Danish Institute of Agricultural Sciences
Award relations: Proteome analysis of muscle tissues: Two dimensional protein mapping of pig and cod muscle.

Project: Research

Nutritional Immunology
Licht, T. R., Project Manager, National Food Institute
Wilcks, A., Project Participant, National Food Institute
Bergström, A., Project Participant, National Food Institute
Andersen, J. B., Project Participant, National Food Institute
Metzdorff, S. B., Project Participant, National Food Institute
Frøkiær, H., Project Manager, Department of Systems Biology
Fink, L. N., Project Participant, Department of Systems Biology
Hellgren, L., Project Manager, Department of Systems Biology
Jacobsen, C., Project Manager, National Institute of Aquatic Resources
Nielsen, N. S., Project Participant, National Institute of Aquatic Resources

[Ordinær drift UK 10]: DKK3,250,000.00
04/01/2007 → 31/12/2011
Award relations: Nutritional Immunology
Project: Research