**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.

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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

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**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
Pedersen, E. M., Project Participant, National Institute of Aquatic Resources
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
Nielsen, M. M., 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
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01/02/2018 → 31/01/2020

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

**Project:** Research

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**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.

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01/10/2017 → 01/09/2018

**Keywords:** Research area: Coastal Ecology

**Collaborators:** Aarhus University, University of Southern Denmark, Geological Survey of Denmark and Greenland

**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.

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Nielsen, M. M., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre
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01/03/2018 → 30/06/2019

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

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.

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01/01/2008 → …

Keywords: Research areas: Coastal Ecology & Shellfish and Seaweed
Project: Research
Mapping of fish habitats with Øresund as a case study (FISKEHAB) (39206)
Mapping of fish habitats in the Danish part of Øresund, based on existing data on fish and habitats, interviews with gillnet fishermen, anglers and workshop participants. The project was commissioned as a response to widespread protest over sand extraction activity in several designated sites in the area. Øresund is a relatively data poor sea area that is fished primarily by fishermen with vessels below 12 meters, i.e. vessels without satellite location data. The project succeeded in creating maps indicating the distributions of 7 key commercial fish species within Øresund with direct association to benthic habitats. This project was coordinated by DTU Aqua. The project was commissioned directly by the Danish Ministry of Food, Agriculture and Fisheries.
Sørensen, 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
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03/12/2014 → 31/08/2015
Keywords: Research area: Ecosystem based Marine Management & Coastal Ecology
Collaborators: University of Copenhagen
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
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Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
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Sørensen, 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

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
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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

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
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 ("Bæredygtighedsplanen").

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).

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 priorities 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
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 fisheries 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.

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 Resolution 812/2004 and the EU Action Plan for reduction of seabird bycatch.<br><br>The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the Danish Fisheries Agency.

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
Food, Agriculture and Fisheries and Vækstforum Region Nordjylland.

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 the European Fisheries Fund (EFF).

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

15/04/2013 → 31/05/2015

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

Project: Research

**The macroalgae biorefinery - Sustainable production of 3G energy carriers and fish feed from macroalgae (MAB3) (39165)**

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.

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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

**Oyster care in Limfjorden (39120)**

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).

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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.
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.

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 flour -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).
Local strenght - 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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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, macroalgae and benthos but also using input from the local municipalities, environmental NGOs, mussel fishermen and other stakeholders like e.g. anglers, sailors, canoeists, kayakers 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 Vejle 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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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 macroalgae. 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 macroalgae, 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 leaves 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).
**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).

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**Keywords:** Research areas: Coastal Ecology & Observation Technology & Marine Living Resources

**Project:** Research

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

**Collaborators:** BioMar A/S, STMI, Bioneer A/S, Billund Aquaculture Service Aps, North Sea Science Park, Danish Aquaculture Association

**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.
This project is coordinated by Leibniz-Institute for Baltic Sea Research (IOW). The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.
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01/04/2015 → 31/03/2018
Keywords: Research areas: Coastal Ecology & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management
Collaborators: Swedish University of Agricultural Sciences, Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Klaipėda University, University of Latvia, Tallinn University, Polish Academy of Sciences
Project: Research

Investigation of causes for declines in fish abundance in coastal areas (Kystfisk II) (39164)
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. The project is funded by the Danish Ministry of Food, Agriculture and Fisheries through a special governmental Funding for sustainable fisheries ("Bæredygtighedsfuldten").
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01/01/2014 → 31/12/2016
Keywords: Research areas: Coastal Ecology & Marine Living Resources & Oceanography
Project: Research

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).
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Stenstrup, J. G., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Investigation of causes for declines in fish abundance in coastal areas (KYSTFISK-I) (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 fishers 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. The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

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).

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).
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.

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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

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.

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Keywords: Research area: Coastal Ecology
Collaborators: Aarhus University
Project: 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 (&gt;10 m). In addition, there has formerly been extraction of gravel and sand in shallow areas of the fjord (Stenberg, C., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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01/01/2011 → 31/12/2013
Keywords: Research areas: Coastal Ecology & Observation Technology
Collaborators: Local fishermen associations, University of Southern Denmark, Danish Nature Agency, Local Municipalities (Fåborg and Assens)
Project: Research
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.

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FP7 Contract ID: 226661
01/01/2009 → 31/12/2013

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

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.

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01/01/2010 → 31/12/2012

Keywords: Research area: Coastal Ecology

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.

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 Nørrefjord). 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. The project is coordinated by DTU Aqua.

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.

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
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, Nordshell IS, Faaborg Recreational Fishery Association
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: Oricon
Project: Research

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 larval 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 area 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
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 to 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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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.

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01/01/2009 → 31/12/2010

Keywords: Research areas: Coastal Ecology & Shellfish and seaweed
Collaborators: Danish Shellfish Centre
Project: Research
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.
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01/01/2009 → 31/12/2011
Keywords: Research area: Coastal Ecology
Collaborators: Vattenfall Wind Power A/S, Krog Consult ApS, Danish Fishermen's Association
Project: Research

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
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. Focus of PRO-EEL project was on the primary bottlenecks in a controlled reproduction of eels, which concern deficiencies in knowledge about eel reproductive physiology and methods applied to induce and finalize gamete development. During a 4-year period, the project significantly expanded current knowledge on the eel reproductive mechanisms and hormonal control of sexual maturation. The consortium developed standardized protocols for assisted production of high quality gametes (egg and sperm) and artificial fertilization, thereby obtaining a stable production of viable embryos. Furthermore, egg incubation procedures and culture of yolksac larvae were established for the first time for European eel, leading to the first feeding stage. The project disseminated novel literature on early life stages, including their ontogeny and requirements thereby describing egg and larval stages still unknown in nature and providing important information for future development of larval diets and rearing technology. Methodology and technology was established using small scale tests and validated in full scale experimental facilities managed by DTU. The project was an international, EU-funded research project characterized by an integrative and multidisciplinary approach. The consortium brought together leading 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.

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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).

Sørensen, 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
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.

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01/01/2011 → 31/12/2012

Keywords: Research areas: Population Genetics & Coastal Ecology
Collaborators: Northwest Jutland Recreational Fishermen’s Association
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.

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Kristensen, L. D., Project Participant, National Institute of Aquatic Resources
Kristensen, K., Project Participant, National Institute of Aquatic Resources
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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
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-Oresund (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

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 (Stettrup 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 (Stettrup 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. Stettrup, J. G., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management 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

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 fishermen 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; Sparrevohn 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.

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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