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.

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 blue mussel and flat European oysters. 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 interest such as the flat European oyster, the blue mussel or the cockle.

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 interest such as the flat European oyster, the blue mussel or the cockle.

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 out 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 interest such as the flat European oyster, the blue mussel or the cockle.

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

Collaborators: Aarhus University
Project: Research
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.

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.
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.

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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
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Nielsen, N., Project Participant, National Institute of Aquatic Resources, Danish Shellfish Centre

Keywords: Research area: Shellfish and seaweed: Biology, production and management
Collaborators: Swedish University of Agricultural Sciences, Leibniz Institute for Baltic Sea Research Warnemünde (IOW), Aarhus University, Institute of Oceanology of the Polish Academy of Sciences, Hjarne Havbrug A/S, University of Gothenburg, GRAIN Wood A/S, The Coastal Union Germany
Project: Research

Mussel farming—mitigation and protein source for organic husbandry (MUUMIPRO) (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.

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Keywords: Research area: Shellfish and seaweed: Biology, production and management
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

**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

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01/03/2016 → 29/02/2020

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Shellfish and seaweed

Collaborators: University of Hamburg

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 sediment sampling 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-Vergès, P., Project Participant, National Institute of Aquatic Resources

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

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26/01/2016 → 14/07/2018

Keywords: Research areas: Coastal Ecology & Shellfish and Seaweed

Collaborators: National Space Institute

Project: Research

**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

Veicherts, M., Project Participant, National Institute of Aquatic Resources

18/01/2016 → 04/08/2018

Keywords: Research area: Shellfish and seaweed

Collaborators: Association of Mussel Producers, Aarhus University, Danish Meteorological Institute, Limfjorden Fishermen Organization
**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-ostysters 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.<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.

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Nielsen, M. M., Project Participant, National Institute of Aquatic Resources
11/01/2016 → 14/07/2018
Keywords: Research area: Shellfish and seaweed
Collaborators: Fiskeriselskabet Cardium A/S
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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Nielsen, C. F., Project Participant, National Institute of Aquatic Resources
Boesen, 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

**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, Legater municipality, Orbicon, Lemvig municipality, Aalborg municipality, Limfjordsrådet
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
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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

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 (“Bæredygtighedsfonden”).
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
Canal-Vergés, 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
Andersen, L. K., Project Participant, National Institute of Aquatic Resources
Nielsen, C. F., Project Participant, National Institute of Aquatic Resources
Nielsen, P., Project Participant, National Institute of Aquatic Resources
Møller, L. F., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre
01/01/2014 → 31/12/2016
Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Collaborators: Foreningen Muslingeerhvervet, Aarhus University, Agro Korn A/S
Project: Research

Oyster hatchery (39313 & 39085 & 39233)
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”.
Fitridge, I., Project Participant, National Institute of Aquatic Resources
Tørring, D. B., Project Participant, National Institute of Aquatic Resources
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources, Danish Shellfish Centre
01/01/2014 → 30/06/2016
Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Collaborators: Foreningen Muslingeerhvervet, Aarhus University, Agro Korn A/S
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 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 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).

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).

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.

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 Bredts 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 oyster 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).

Keywords: Research areas: Shellfish and seaweed & Coastal Ecology
Collaborators: OysterBoat, The Mussel Industry Association
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, 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 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).

Keywords: Research areas: Shellfish and Seaweed & Coastal Ecology
Collaborators: Aarhus University, Vilsund Blue
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.

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
**Macroalgae - Technical support for new principles of management in mussel fishery (39090)**

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).  
Canal-Vergés, P., Project Manager, National Institute of Aquatic Resources, Danish Shellfish Centre  
Petersen, J. K., Project Coordinator, National Institute of Aquatic Resources  
01/01/2012 → 31/01/2015  
Keywords: Research area: Coastal Ecology & Shellfish and Seaweed  
Project: Research

**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 fords 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  
01/01/2012 → 31/05/2012  
Keywords: Research areas: Coastal Ecology & Shellfish and seaweed  
Collaborators: DHI Water - Environment - Health, Danish Shellfish Centre, Danish Aquaculture Association  
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 Narrefjord). 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.  
Stenberg, C., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management  
Poulsen, L. K., Project Participant, National Institute of Aquatic Resources  
Stettrup, J. G., Project Participant, National Institute of Aquatic Resources  
Dolmer, P., Project Participant, National Institute of Aquatic Resources  
01/01/2011 → 31/12/2013  
Keywords: Research area: Coastal Ecology & Danish Shellfish Centre  
Collaborators: Aarhus University, Danish Nature Agency, Local fishermen associations  
Project: Research

**Local strength - strengthening the rural areas, by adding competencies (38086)**

The overall aim 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
Production of mussels: Mitigation and feed for husbandry (MUMIHUS) (38790)

The concept of the MUMIHUS project 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 bioenergetics studies; v) to develop management tools for and economic analysis of extraction cultures as a mitigation measure; vi) 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.

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01/01/2010 → 30/09/2013

Keywords: Research areas: Shellfish and seaweed & Coastal Ecology

Collaborators: Foreningen Muslingeerhvervet, Centrafondning for Limfjorden, Seafood Limfjord ApS, Muslingestrempes

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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Kristensen, P. S., Project Participant, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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Project: Research
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.

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.

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.
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.

Keywords: Research area: Shellfish and Seaweed

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.

Keywords: Research area: Coastal Ecology & Danish Shellfish Centre