1. Networking: ARICE will develop strategies to ensure the optimal use of the existing polar research vessels at a European and international level. The aim is to establish an International Arctic Research Icebreaker Consortium which shares and jointly funds ship time for scientists on the available research icebreakers.

2. Transnational access: ARICE will provide transnational access to four European and two international research icebreakers. Access is granted based on scientific excellence of the research proposals, which researchers need to submit during the application process. The participating icebreakers are: PRV Polarstern (Germany), IB Oden (Sweden), RV Kronprins Haakon (Norway), RRS Sir David Attenborough (United Kingdom), CCGS Amundse (Canada) and RV Sikuliala (USA).

3. Joint research activities: ARICE will improve the research icebreakers’ services by working closely together with the maritime industry on a so called “ships and platforms of opportunity” programme. Through this programme, commercial vessels operating in the Arctic Ocean will collect oceanic and atmospheric data on their cruises. At the same time, science and industry will work together to explore new technologies, which can improve ship-based and autonomous measurements in the Arctic Ocean. ARICE will also implement virtual and remote access of data via an innovative 3D Virtual Icebreaker, which will provide anyone with real-time information from the Arctic.

Edelvang, K., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Robertson, O., Project Participant, National Institute of Aquatic Resources
Riisager-Simonsen, C., Project Participant, National Institute of Aquatic Resources

01/01/2018 → 31/12/2021

Keywords: Research area: Oceanography & Observation Technology

Collaborators: National Center for Scientific Research, University of Alaska, Universite Laval, Nordurslodagattin, Swedish Polar Research Secretariat, The Institute of Oceanology of the Polish Academy of Sciences , Alfred Wegener Institute - Helmholtz Centre for Polar and Marine Research, Finish Meteorological Institute, Consiglio Nazionale delle Ricerche, Norwegian Polar Institute, Natural Environmental Research Council, CSIC, World Ocean Council

Project: Research

**Mechanistic approach to ocean ecology (39427)**

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

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

The project is coordinated by DTU Aqua.

The project is funded by Gordon and Betty Moore Foundation.

Kiørboe, T., Project Coordinator, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Visser, A., Contact Person, National Institute of Aquatic Resources
Chakraborty, S., Project Participant, National Institute of Aquatic Resources

01/01/2017 → 30/06/2020

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

Collaborators: Scripps Institution of Oceanography

Project: Research

**Arctic impact on weather and climate (Blue-Action) (39390)**

Blue-Action will provide fundamental and empirically-grounded, executable science that quantifies and explains the role of a changing Arctic in increasing predictive capability of weather and climate of the Northern Hemisphere. To achieve this Blue-Action will take a transdisciplinary approach, bridging scientific understanding within Arctic climate, weather and risk management research, with key stakeholder knowledge of the impacts of climatic weather extremes and hazardous events; leading to the co-design of better services. This bridge will build on innovative statistical and dynamical approaches to predict weather and climate extremes. In dialogue with users, Blue-Arctic will take stock in existing knowledge about cross-sectoral impacts and vulnerabilities with respect to the occurrence of these events when associated to weather and
climate predictions. Modeling and prediction capabilities will be enhanced by targeting firstly, lower latitude oceanic and atmospheric drivers of regional Arctic changes and secondly, Arctic impacts on Northern Hemisphere climate and weather extremes. Coordinated multi-model experiments will be key to test new higher resolution model configurations, innovative methods to reduce forecast error, and advanced methods to improve uptake of new Earth observations assets are planned. Blue-Action thereby demonstrates how such an uptake may assist in creating better optimized observation system for various modelling applications. The improved robust and reliable forecasting can help meteorological and climate services to better deliver tailored predictions and advice, including sub-seasonal to seasonal time scales, will take Arctic climate prediction beyond seasons and to teleconnections over the Northern Hemisphere. Blue-Action will through its concerted efforts therefore contribute to the improvement of climate models to represent Arctic warming realistically and address its impact on regional and global atmospheric and oceanic circulation. The project is coordinated by DMI, Denmark and is funded by EU Horizon 2020 Programme Blue Growth.

Payne, M., Project Manager, National Institute of Aquatic Resources, Section for Oceans and Arctic
Miesner, A. K., Project Participant, National Institute of Aquatic Resources

01/12/2016 → 28/02/2021

Keywords: Research area: Marine Populations and Ecosystem Dynamics & Oceanography
Collaborators: Fundacao Institut Catala De Ciencies Del Clima, Institute For Advanced Sustainability Studies, Rukakeskus Oy, Federal State Budgetary Institution - Institute Of World Economy And International Relations of The Russian Academy of Sciences, Sams Research Services Ltd, Danish Meteorological Institute, The Scottish Association for Marine Science, Marine Scotland, Konsortium Deutsche Meeresforschung, Meopar Incorporated, Woods Hole Oceanographic Institution, Helmholtz Centre for Ocean Research Kiel, Nansen Environmental and Remote Sensing Center, Natural Environment Research Council, CNRS, Hafransomstofnunin, University of Bergen, University of Reading, Havstovan, Stichting Nioz, Koninklijk Nederlands Instituut Voor Onderzoek Der Zee, WOC - World Ocean Limited, Max-Planck-Gesellschaft zur Foerderung der Wissenschaften, University of Lapland, Institute Of Atmospheric Physics of Chinese Academy of Sciences, Stichting Netherlands eScience Center, University of Southampton, Danish Pelagic Producers Organisation, Pelagic Freezer Trawler Association, Organization Of Russian Academy of Sciences, A.M. Obukhov Institute of Atmospheric Physics, Municipality of Almada, University Corporation for Atmospheric Research, Centro Euro-Mediterraneo Sui Cambiamenti Climatici, Foresight Intelligence GBr, Educational Foundation Yonsei University, The Scripps Research Institute, Uni Research AS, Mercator Océan, University of Washington, DNV GL AS, University of Hamburg

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

01/03/2016 → 29/02/2020

Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography & Shellfish and seaweed
Collaborators: University of Hamburg

Project: Research

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

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

The major questions raised in PRIME TRADE OFFS are hence, (i) how the integration of environmentally-driven variability in population and ecosystem dynamics affects short- and long-term predictions of economically important fish species, and (ii) how the inclusion of environmental variability changes our perceptions of tradeoffs between utilization of different resources, including for example fuel cost due to changed resource distributions in space and effects on targeted species, as well as socio-economic efficiency.

There have been several initiatives to improve multispecies and ecosystem modelling in order to make it operational for both tactical and strategic assessment and ecosystem-based fisheries management. PRIME TRADEOFFS is the logical continuation of these initiatives and will make the concepts of multi-species maximum sustainable yield and environmental impact on biological key process such as distribution, growth and recruitment operational for ecosystem-based management of marine resources, as demanded in the Marine Strategy Framework Directive and the reformed Common Fisheries Policy.

This project is coordinated by DTU Aqua and is funded by the EU, COFASP, ERA-NET.
Effects of dispersed oil droplets and produced water components on growth, development and reproduction of Arctic pelagic copepods (PWC-Arctic) (39297)

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

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

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

This project is coordinated by SINTEF, Norway.

The project is funded by the Research Council of Norway.

Collaborative modular underwater robotic system for long-term autonomous operations (REMORA) (39341)

In this project we aim to bootstrap new high-impact underwater robotics activities at DTU. We propose to develop a novel robotic platform, the REMORA1 system, for research, education and innovation. The objectives of the project are to develop the necessary infrastructure, i.e., underwater robotic system, test facilities, educational framework and external collaboration, to perform world-class research and innovation in the area of offshore underwater robotic technology.

With this project we aim to eventually strengthen the Danish maritime sector in dealing with the high cost and technical challenges of inspections and maintenance in increasing amount of offshore installations. The project is a collaboration between DTU Electrical Engineering, DTU Mechanical Engineering and DTU Aqua who have complementary expertise within development and innovation of robotic technology and applications of underwater robotics.

This project is coordinated by DTU Electrical Engineering.

The project is funded by A/S Dampskibsselskabet Orients Fond.

Supporting the national monitoring of Marine Strategy Framework Indicators (39304)

In support of the national implementation of EUs Marine Framework Strategy Directive, the project assembles a one-off monitoring of indicators of the following aspects:
- Quality of sandeel habitat
- Proportion of large top predatory fish
- Biomass of planktonic secondary producers
Pressure on the seabed from towed fishing gear

Marine macro-litter

Marine micro-litter in the food chain

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

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

This project was coordinated by DTU Aqua.

The project was funded by the Danish Nature Agency.

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

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

Mortensen, L. O., Project Participant, National Institute of Aquatic Resources

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

15/05/2015 → 31/12/2015

Keywords: Research areas: Ecosystem based Marine Management & Oceanography

Collaborators: Danish Fishermen's Association

Project: Research

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

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

The project is coordinated by DTU Aqua.

Funding

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

MacKenzie, B., Project Coordinator, National Institute of Aquatic Resources, Section for Oceans and Arctic

dev Deurs, M., Project Participant, National Institute of Aquatic Resources

Jonasdottir, S., Project Participant, National Institute of Aquatic Resources

01/04/2015 → 01/04/2018

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources

Collaborators: National Institute for Marine Research and Development, Marine Research Institute Reykjavik, Institute of Marine Sciences, Central Fisheries Research Institute

Project: Research

COLUMBUS (39239)

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

This project is coordinated by AquaTT UETP Ltd.

The project is funded by EU, Horizon2020.

Mariani, P., Project Participant, National Institute of Aquatic Resources

Thøgersen, T. L., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography

Larsen, E., Project Participant, National Institute of Aquatic Resources

01/03/2015 → 28/02/2018

Keywords: Research areas: Oceanography & Observation Technology

Underwater time of flight image acquisition system (UTOFIA) (39240)
This project offers a compact and cost-effective underwater imaging system for turbid environments and will fill the current gap between short-range, high-resolution conventional video and long-range low-resolution sonar systems. The camera system utilizes high frequency laser pulses synchronized with rapid shutter operations on nano second time scales to radically reduce the interference of back scatter on visual images. Using this range-gated imaging technology, the system will extend the imaging range by factor 2 to 3 over conventional video systems. At the same time, the system will provide video-rate 3D information. UTOFIA offers a new modus operandi for the main targeted domains of application: marine life monitoring, harbour and ocean litter detection, fisheries stock assessment and aquaculture, seabed mapping, offshore industry and civil security.
The project is a collaborative effort between engineering companies producing the laser components, the camera systems, the software control and processing systems as well as the deployment platforms. The project also involves companies charged with integrating the system and its commercialization into the market place. The role of DTU Aqua is twofold; it is responsible for a series of field and laboratory trials to demonstrate the proof-of-concept and to feed back into the engineering design process, and it is responsible for the exploitation and dissemination dimension of the project, particularly with respect to marine science, fisheries and aquaculture applications.
The consortium is coordinated by SINTEF, Norway.
The project is funded by EU, Horizon2020.
Visser, A., Contact Person, National Institute of Aquatic Resources, Section for Oceans and Arctic
Mariani, P., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Stage, B., Project Participant, National Institute of Aquatic Resources
Bridda, J., Project Participant, National Institute of Aquatic Resources
Thegersen, T. L., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
01/02/2015 → 30/04/2018
Keywords: Research areas: Oceanography & Fish Biology & Observation Technology
Collaborators: Odos Imaging Ltd., SINTEF, Subsea Tech, AZTI-Tecnalia, Fraunhofer-Gesellschaft, Bright Solutions Srl

Fluorescence analysis and monitoring of recirculating aquaculture systems (FAMoRAS) (39177)
FAMoRAS aimed to investigate fluorescence spectroscopy for potential utilization within 3 main areas of recirculating aquaculture system operation:
(1) system “health” monitoring
(2) treatment performance
(3) feed utilization.
Using sensitive lab-scale spectroscopic analysis and mathematical modeling, the project aimed to identify single wavelengths for future use as online, in-situ aquaculture system sensors.
This project was coordinated by DTU Aqua.
The project is funded by EU, Marie Curie.
Hambly, A., Project Coordinator, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources
Stedmon, C., Project Coordinator, National Institute of Aquatic Resources
Pedersen, P. B., Project Participant, National Institute of Aquatic Resources
Pedersen, L., Project Participant, National Institute of Aquatic Resources
16/06/2014 → 16/06/2016
Keywords: Research areas: Oceanography & Aquaculture
Project: Research

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.

Svendsen, J. C., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Stenberg, C., Project Coordinator, National Institute of Aquatic Resources
01/01/2014 → 31/12/2019

Keywords: Research areas: Coastal Ecology & Oceanography
Project: Research

EUROMARINE Consortium (39185)

EuroMarine is a European, marine science network launched in 2014. It represents the scientific communities of three former European Networks of Excellence: EUR-OCEANS, Marine Genomics Europe, and MarBEF. It was designed by the EuroMarine FP7 preparatory project (2011-13) as a bottom-up organization and meant to be a voice for the European marine scientific community. It is intended as a durable structure and was established as a consortium for an initial duration of 10 years. A legal entity will be established in 2016 as a support structure under the control of the consortium.

As of 2016 EuroMarine counts 72 member organisations (MOs), 57 of which are 'full voting' members contributing to the budget.

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

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

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

This project is coordinated by French Research Institute for Exploitation of the Sea & The National Center for Scientific Research, France.

The project is self-funded.
Mariani, P., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2014 → 31/12/2017

Keywords: Research area: Oceanography
Collaborators: National Center for Scientific Research, L'Institut Français de Recherche pour l'Exploitation de la Mer
Project: Research

Investigation of causes for declines in fish abundance in coastal areas (Kystfisk 2) (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 and is funded by the Danish Ministry of Food, Agriculture and Fisheries through a special governmental Funding for sustainable fisheries ("Bæredygtighedspuljen").

Støttrup, J. G., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Munk, P., Project Participant, National Institute of Aquatic Resources
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Stenberg, C., Project Participant, National Institute of Aquatic Resources
01/01/2014 → 31/12/2016

Keywords: Research areas: Coastal Ecology & Marine Living Resources & Oceanography
Project: Research

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

The overall objective of COCOA is to identify the major pathways of nutrients and organic material (simply referred to as nutrients in the following) across the diversity of coastal ecosystems and assess management implications. Specifically, COCOA will investigate four different types of coastal ecosystems: 1) river- dominated estuaries, 2) lagoons, 3) archipelagos, and 4) embayments with restricted water exchange to:

- Understand the changing nutrient (C/N/P/Si) cocktail across the land-sea continuum.
- Quantify processes that transform and accumulate nutrients.
- Estimate nutrient retention across coastal ecosystems.
- Investigate potential feedback processes sustaining alternative stable states.
- Analyse how these process rates may have changed over time.
- Evaluate consequences of altered nutrient pathways on ecosystem services
- Identify possible management responses for present and future projections.

The project is coordinated by Aarhus University, Denmark.

The project was funded EU; BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

Stedmon, C., Project Participant, National Institute of Aquatic Resources, Section for Oceans and Arctic
01/01/2014 → 31/07/2017

Keywords: Research area: Oceanography

Collaborators: Klaipeda University, Russian Academy of Sciences, Finnish Environment Institute, University of Gdansk, Åbo Akademi University, Leibniz Institute for Baltic Sea Research, Stockholm University, Aarhus University, Lund University, Utrecht University, University of Helsinki, University of Gothenburg, Swedish Meteorological and Hydrological Institute

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).

Stenberg, C., Project Coordinator, National Institute of Aquatic Resources
Støttrup, J. G., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Christoffersen, M., Project Manager, National Institute of Aquatic Resources
van Deurs, M., Project Manager, National Institute of Aquatic Resources
Nielsen, A., Project Manager, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources
01/12/2013 → 01/02/2015

Keywords: Research areas: Coastal Ecology & Marine Living Resources & Oceanography

Collaborators: Aarhus University, DHI Water - Environment - Health

Project: Research

The early life of eel in the Sargasso Sea – Influence of oceanography and climate (SARGASSO-EEL) (39107)
The recruitment of the European eel has been in dramatic decline during the last 30 years, and is at a severe low of only 3-5 % of earlier magnitude. This change and its influence on the eel fishery have led to an intensified research in the oceanic phase of the European eel.

In order to contribute to further understanding of the life cycle of eel the Danish eel expedition set out in 2014 for the eel spawning grounds in the Sargasso Sea. Here a consortium of Danish scientists and international collaborators focused on the linkages between oceanography, biological production, eel spawning and the growth and drift of eel larvae.

During the expedition, a wide range of organisms was collected: From the smallest plankton of less than a millimeter to very large fish. A number of research groups are now working on samples and data from the expedition and assembling information on key processes in the early life of eels. Preliminary findings indicate that biological and physical changes have taken place in the spawning areas that may affect the eel larvae’s chances of survival and their journey to Europe.
The project was coordinated by DTU Aqua.
The project is funded by the Carlsberg Foundation and Danish Centre of Marine Research (cruise).

Munk, P., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Nielsen, T. G., Project Manager, National Institute of Aquatic Resources
Ayala, D. J., PhD Student, National Institute of Aquatic Resources
Thomsen, H. A., Project Participant, National Institute of Aquatic Resources
Serensen, S. R., Project Participant, National Institute of Aquatic Resources
Bekkevold, D., Project Participant, National Institute of Aquatic Resources
Malanski, E., Project Participant, National Institute of Aquatic Resources
Jaspers, C., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Christoffersen, M., Project Participant, National Institute of Aquatic Resources
Hansen, S., Project Participant, National Institute of Aquatic Resources
01/08/2013 → 01/08/2016
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Fish Biology & Oceanography
Collaborators: Leibniz-Institute of Freshwater Ecology and Inland Fisheries, University of Alaska Fairbanks, Aarhus University, University of Copenhagen, Université de la Méditerranée Aix-Marseille II, Pierre and Marie Curie University - University of Paris VI, Sir Alister Hardy Foundation for Ocean Science (SAHFOS), University of Rhode Island, International Council for the Exploration of the Sea
Project: Research

**Linking the optical properties of DOM to its characteristics and origins (LOCO) (39110)**

The majority of organic carbon in the ocean exists as dissolved organic matter (DOM). A fraction of DOM absorbs ultraviolet (UV) and visible light, while a specific subset of this subsequently exhibits a natural fluorescence. These spectroscopic properties can be used as markers for the turnover of different DOM fractions in the ocean. This project will link the UV-visible characteristics (optical properties) of DOM to its chemical structure. The results will lead to the capacity for widespread proxy measurements of DOM chemical properties estimated from its optical properties, and the ability to trace the production of both new “reactive” DOM and the humification processes that lead to the production of the bio-refractory DOM pool.

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

The project is coordinated by DTU Aqua.

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

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

**North Atlantic climate (NACLIM) (38945)**

The North Atlantic Ocean is one of the most important drivers for the global ocean circulation and its variability on time scales beyond inter-annual. Global climate variability is to a large extent triggered by changes in the North Atlantic sea surface state. The quality and skill of climate predictions depends crucially on a good knowledge of the northern sea surface temperatures (SST) and sea ice distributions. On a regional scale, these parameters strongly impact on weather and climate in Europe, determining precipitation patterns and strengths, as well as changes in temperature and wind patterns. Knowledge of these factors, and of their development in the years to come, is of paramount importance for society and key economic sectors, which have to base their planning and decisions on robust climate information.

NACLIM will contribute to this goal.

DTU Aqua is the leader of work package developing such climate services for marine ecosystems, pioneering the
translation of decadal-scale forecasts of the ocean’s physical environment to forecasts of the biological environment. There are 18 project partners in total. See http://naclim.zmaw.de/Consortium.2126.0.html
The project is coordinated by University of Hamburg, Germany.
The project is funded by EU, Framework Programme 7.
Payne, M., Project Manager, Section for Marine Ecology and Oceanography, National Institute of Aquatic Resources, Section for Oceans and Arctic
MacKenzie, B., Project Participant, National Institute of Aquatic Resources
Miesner, A. K., PhD Student, National Institute of Aquatic Resources
01/11/2012 → 31/01/2017
Keywords: Research areas: Marine Populations and Ecosystem Dynamics & Oceanography
Project: Research

A coast to coast network of protected areas: From the shore to the deep sea (CoCoNet) (38863)
The project targeted design and implementation of marine protected areas, as well as advancement of the scientific basis for optimal design and implementation. The project focused on two pilot studies in the Mediterranean and Black Sea for establishing a network of MPAs.
DTU Aqua participated in developing the scientific basis for optimal design of MPA networks by developing spatial size-based models to describe biodiversity as appropriate scales, as well as habitat connectivity from trait-based modelling, and procedures for analyzing habitat connectivity. DTU Aqua also contributed to governance issues relating to establishment of MPA networks.
The project had 39 partners from the EU and Eastern Europe and Near Asia.
The project was coordinated by Universita del Salento, Italy.
The project was funded by EU, Framework Programme 7.
Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Sørensen, T. K., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Kiørboe, T., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/01/2016
Keywords: Research areas: Marine Living Resources & Oceanography & Ecosystem based Marine Management
Project: Research

Aqua Fingerprint - Early warning for contamination of drinking water (38966)
The majority of Danish drinking water supplies to some extent have at some point been troubled with periods of decline in water quality. For the majority of instances the contamination event is discovered by the routine microbiological control grab sampling and occurs in conjunction with extreme events, such as intense rain, where contaminated water enters the network as a short pulse with high concentration. For most cases the actual source of the contamination cannot be traced as the event has already passed through the network and this hinders progress in improving the network.
Some events could have been avoided if an early warning system indicating the occurrence of such a pulse was available. This project was focused on developing such an on-line sensor using organic matter fluorescence. Proof of concept was proved and a prototype online sensor was built to prove the feasibility of the technology.
This project was coordinated by Krüger AS, Denmark.
The project was funded by the Danish Environment Agency.
Stedmon, C., Project Participant, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
01/01/2012 → 31/12/2012
Keywords: Research area: Oceanography
Collaborators: Technical University of Denmark, Krüger Veolia Water Technologies, TREFOR Vand A/S
Project: Research

Center for Ocean Life (COOL) - a Villum-Kahn Rasmussen Centre of excellence for the study of life in a changing ocean (38960)
Our goal is to develop a fundamental understanding and predictive capability of marine ecosystems through the use of novel trait-based approaches and models.
The Centre is organized around three main research activities:
- Identification and mechanistic description of the traits and trade-offs required to characterize the main Darwinian missions (feed, survive, reproduce) of the various life forms in the ocean through experimental and theoretical work, as well as analysis of literature data.
- Models: scaling of individual behavior to population and ecosystem dynamics through the development of trait-based models.
- Testing model prediction by comparing to observed trait patterns in the ocean.
The Centre involves biologists, physicist, chemists, and mathematicians and has a very strong training component through the supervision of master students, and about 30 PhD and postdoctoral fellows as well as by offering PhD summer schools and organizing international workshops. The Centre in addition host many visiting students and scientists. The Centre is lead by DTU Aqua.
The project is funded by the Villum Kahn-Rasmussen Foundation (Velux Foundations) as well as through various national and European fellowship programs (Research Council, H.C. Ørsted Fellowship programme, Marie Curie,
Carlsberg Foundation, etc).
Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Gislason, H., Project Participant, National Institute of Aquatic Resources
Payne, M., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
MacKenzie, B., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2017
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Marine Living Resources & Ecosystem based Marine Management
Collaborators: Michigan State University, University of Bergen, Kiel University, University of Copenhagen, Massachusetts Institute of Technology, University of Oxford, Roskilde University
Project: Research

**Cruise with RV Dana. North Atlantic-Arctic Ocean Coupling: Deep water overflows and surface water outflow (NAAO)**

(38928)
This cruise was planned as an essential part of the Danish contribution to oceanographic fieldwork as part of the NAACOS project (2011-2014), funded by the Strategic Research Council.
The main objectives of the cruise were to obtain a comprehensive suite of physical, chemical and biological oceanographic measurements across the East Greenland shelf, extending into the Greenland Sea, and to study the deep-water overflow in the Denmark Strait.
The data collected on this cruise formed the basis of validating and improving circulation and ecological models in the region and developing new approaches to tracing freshwater and organic carbon exported from the Arctic.
The project was funded by the Danish Center for Marine Research.

Stedmon, C., Project Coordinator, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 31/12/2012
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: Aarhus University, University of Copenhagen, Greenland Institute of Natural Resources
Project: Research

**MyOcean 2 (38862)**
The project advanced and coordinated European scientific and technical infrastructure in the European operational oceanography community, for collecting and distributing ocean observations and ocean forecasts, being a continuation of MyOcean. DTU Aqua was reference intermediate user (RIU) in WP3 aimed at integrating MyOcean products into national systems and services and foster downstream exploitation of MyOcean information especially at a regional level.
The project had 61 partners from the EU and was coordinated by Mercator Ocean, France.
The project was funded by EU, Framework Programme 7.

Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources
01/01/2012 → 30/09/2014
Keywords: Research areas: Marine Living Resources & Oceanography
Project: Research

**Climate change on marine ecosystems and resource economics (NorMER) (38898)**
Marine ecosystems are under pressure from both anthropogenic climate change and high exploitation rates. A major challenge to managers and scientists is to identify ways that oceans can provide food and other services in a sustainable way under changing climatic and socioeconomic conditions. As physical, biological and socioeconomic factors interact at several levels, cross-disciplinary approaches are needed to meet this challenge.
This Nordic project has
(1) evaluated climate effects on Nordic marine ecosystems,
(2) Build new tools for predicting biological consequences of climate change,
(3) quantified impacts on profit, employment, and harvesting of cod.
This has been achieved through the work of 16 PhDs, 4 postdocs, 1 climate scientist, and the combined expertise of 45 senior scientists located at 10 institutions in 8 Nordic countries.
The project was coordinated by University of Oslo, Norway.
The project was funded by Nordforsk, Nordic Council of Ministers.
Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Visser, A., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Eg Nielsen, E., Project Participant, National Institute of Aquatic Resources
Mackenzie, B., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/12/2015
Keywords: Research areas: Oceanography & Marine Population and Ecosystem Dynamics & Population Genetics
Collaborators: Stockholm University, University of Bergen, University of Oslo, University of Helsinki, Greenland Institute of Natural Resources, Åbo Akademi University, University of Iceland, Swedish Meteorological and Hydrological Institute, University of the Faroe Islands
Project: Research

History of marine animal populations (HMAP) (38156)
The History of Marine Animal Populations (HMAP) is the historical component of the Census of Marine Life program (CoML), which is an international, multi-disciplinary project which will investigate biodiversity in the world’s oceans. HMAP’s long-term aim is to improve our historical understanding of ecosystem change and our ecological understanding of man’s role in changing marine ecosystems.
The long data series and time-specific snapshots of marine ecological conditions that are being generated are being used to provide input to contemporary ecological modelling in order to characterize and visualize variations in past ecosystems. Such visualizations and testing of ecological hypotheses will enhance the disciplines of history and ecology in seeking to explain long-term changes in marine animal populations and their ecosystems, especially those changes resulting from man’s activities.

Some key results from our earlier historical ecology work include reconstructions of extended time series of cod and sprat biomasses in the Baltic Sea which have enabled us to document how the relative importance of different ecosystem drivers (e.g., fishing, hydrographic variability, mammal predation, eutrophication) of biomass dynamics change and interact over time, and how eutrophication has affected forage fish production in the Baltic Sea. Ongoing work is evaluating and documenting the causes of long-term declines of a local herring population in the Baltic Sea and swordfish fisheries in coastal New England, Nova Scotia and Italy. Another key result is a recent consensus article by an ICES expert group on how historical ecology can contribute to fisheries and ecosystem management.

Because HMAP and CoML have ended, DTU Aqua’s work in this area continues with support from other projects and as contributions to new successor fora established in 2013-2015. These include the Oceans Past Initiative, ICES Study Group on the History of Fish and Fisheries and the EU COST program Oceans Past Platform (2015). DTU Aqua’s work will contribute to the development of new management and conservation policies by demonstrating the species compositions, sizes and distributions of animals that lived in the ocean during periods with less human impact than today, and how these biological properties have changed over time.
The project was coordinated by Trinity College, Ireland.
The project was funded by Trinity College, Dublin, Ireland.
Mackenzie, B., Contact Person, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Eero, M., Project Manager, National Institute of Aquatic Resources
01/01/2011 → 01/03/2012
Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: University of Cambridge, University of Copenhagen, Trinity College Dublin, University of Tartu
Project: Research

Improvement of aquaculture high quality fish fry production (IMPAQ) (38904)
IMPAQ aims at increasing the sustainability of the Danish marine aquaculture farms producing high value fish through the development of large-scale cultures of copepods as start feed for larval fish. Copepods represent an important alternative food to present classical live feed organisms in marine fish hatcheries. Their use is known to improve survival, growth, and development of fish larvae.
The specific aims of DTU Aqua contributions to the project have been (i) to describe copepod behaviors that are mediated through water-borne chemical cues (pheromones, grazing attractants); (ii) to chemically characterize these chemical cues and develop bioassays that can facilitate the identification of water fractions containing active substances; and (iii) to test the quality of developed live feeds in pilot-scale fish larval cultures.
IMPAQ is built on knowledge transfer and direct collaboration between fundamental and applied scientists and private enterprises (SMEs and industries) and has devoted substantial effort into PhD and Postdoc training.
External partners of the project are Roskilde University (coordinator), University of Copenhagen, Aarhus University, universities in France and Taiwan and four Danish private enterprises.
The project is funded by the Danish Council for Strategic Research.
Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Støttrup, J. G., Project Participant, National Institute of Aquatic Resources
01/01/2011 → 31/01/2016
Keywords: Research area: Oceanography
Project: Research

Integration of European marine research networks of excellence (EUROMARINE) (38903)
EuroMarine seeks to integrate three major European marine FP6 networks of excellence (EUR-OCEANS, MarBEF and Marine Genomics Europe) into one organization, “The EuroMarine Consortium” with a road map for joint programming,
creating synergies between different scientific fields, towards a common research strategy and a shared vision for the oceans of tomorrow. EuroMarine will bring together leading European marine scientists to create a major internationally competitive network.

The goal is to exploit the knowledge created within the consortium to address questions related to the functioning of marine ecosystems and the needs of society. This project also wishes to engage the European marine data management and scientific communities in shaping the long-term integration of data, historical, present and future. Moreover, EuroMarine aims to create a 21st century marine scientist, with deep knowledge in one discipline and basic "fluency" in several others, as well as a natural ability and desire to work as part of a team.

The project is coordinated by University of Gothenburg, Sweden.
Mariani, P., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
MacKenzie, B., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2011 → 31/01/2013
Keywords: Research area: Oceanography
Collaborators: Environmental & Marine Project Management Agency, Centre National de la Recherche Scientifique, Centre of Marine and Environmental Research, University of Groningen, Stazione Zoologica Anton Dohrn, Ministero dell'Istruzione dell'Università e della Ricerca, Netherlands Institute of Ecology, Centro de Ciências do Mar do Algarve, L'Institut Français de Recherche pour l'Exploitation de la Mer, Marine Biological Association of the United Kingdom, Station Biologique de Roscoff, Max Planck Institute, University of Gothenburg, University of Bremen, Centre de Recherche Halieutique Méditerranéenne et Tropicale, Institut de recherche pour le développement, Royal Netherlands Institute for Sea Research - NIOZ, Flanders Marine Institute, Ghent University
Project: Research

**Match and mismatch in the ocean (38897)**
Only a very small fraction of the enormous amount of eggs that a fish population spawns survives the larval stage and enters the population as young fish: the majority die as larvae. The synchronicity between the timing of the plankton blooms and the food requirements of larval fish is thought to be one of the most important factors for the survival of larvae. This "match-mismatch" hypothesis will be tested using data from fish populations across the planet and global satellite observations of plankton dynamics. The results will increase our understanding of why fish populations vary throughout time and thereby contribute to their sustainable management.

The project is coordinated by DTU Aqua.
Payne, M., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2011 → 01/04/2012
Keywords: Research area: Oceanography
Collaborators: Swiss Federal Institute of Technology
Project: Research

**North Atlantic - Arctic coupling in a changing climate: Impacts on ocean circulation, carbon cycling and sea-ice (NAACOS) (38888)**
Climate change is most pronounced at high latitudes, with rapid and dramatic changes observed in sea-ice coverage, circulation and the ecosystem. These changes have profound effects both at the regional scale as well as globally. The North Atlantic and Arctic Ocean are the headwaters of the thermohaline circulation (THC), the global heat engine responsible, amongst other things, for the relatively mild climate we experience in Denmark. Subtle change in sea-ice formation, deep water circulation, and freshwater supply on a relatively local scale will have repercussions around the world. More subtle still are the feed-back controls these processes have on climate change. Sea-ice coverage and the earth's albedo is one feed-back, but there is also the draw down and sequestering of atmospheric CO2 in deep waters by physical and biological processes. The whole is an intricate weave of interrelated mechanisms: the scientific challenge to draw together expertise across disciplines to address these issues was accomplished; the strategic outcome was a suite of knowledge-based tools designed to reduce the uncertainty and contribute to climate policies. The NAACOS team comprised a number of well-recognized scientists with profound experience and a significant international collaboration. NAACOS developed and refined oceanographic models using remote sensing and observations to evaluate the impact of high latitude climate change on circulation, deep water formation, sea-ice and carbon flux, and their implications at regional scales.
The project was coordinated by DTU Aqua.
The project was funded by the Danish Council for Strategic Research and a DHI student stipend.
Visser, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Stedmon, C., Project Participant, National Institute of Aquatic Resources
Optical properties of Greenlandic coastal waters: modeling light penetration in a changing climate (38931)
The availability and spectral quality of light are key parameters controlling the productivity of Greenlandic coastal waters. Although solar elevation and sea ice cover play an important role, light is also regulated by water constituents (e.g. organic matter, phytoplankton and suspended sediments). Changing ocean circulation patterns and enhanced glacial melt stand to considerably alter the underwater light environment. This project will develop a 1D model for spectral light attenuation based on field measurements planned in two contrasting fjord systems. Results will provide valuable ground-truth data for remote sensing applications and more accurate description of the light environment for hydrodynamic models.

The project is coordinated by DTU Aqua.

Reactivity of terrestrially derived dissolved organic matter in aquatic systems - relation to molecular composition and bacterial community structure (38927)
Aquatic systems play a significant role in transforming, remineralizing and sequestering, terrestrially derived organic matter (tDOM). The prevalence of tDOM in aquatic systems is a forcing factor affecting light climate, species distributions, productivity and biogeochemical cycles in freshwater systems and many coastal and marine systems. Despite the significance of tDOM for the function of aquatic systems and global biogeochemical C cycling, we are only beginning to understand the quantitative and qualitative aspects of aquatic tDOM processes. A key to a better understanding of the role of tDOM is compound level information on the distribution and reactivity of tDOM.

The objectives with the project were to:
- examine which molecular size fractions of DOM are available to degradation processes such as flocculation/sedimentation, photooxidation and bacterial utilization and hence how reactivity of tDOM connects to molecular composition.
- determine if bacterial community structure in different systems alter the molecular size distribution of tDOM differently. In essence, the project addressed if and how the molecular composition of tDOM and the structure of bacterial communities determine the fate of tDOM in aquatic systems.

The project was funded by the Swedish Research Council.

Response of pelagic food webs to warmer, acidified oceans (Pelagic foods) (38923)
Atmospheric CO2 is projected to double by 2100, resulting in increased global temperature, ocean acidification (OA) and changes in the balance of marine ecosystems. A general lack of multifactorial studies means very limited knowledge on the combined effects of these pressures on ecosystem structure and function. Preliminary mono-factorial data indicate important but little studied appendicularians (pan-global pelagic urochordates) may be strongly impacted, directly and indirectly via altered phytoplankton growth and chemical composition. Effects on other key plankton such as copepods may depend on phytoplankton size. Appendicularians repetitively secrete and discard filter-feeding houses. Discarded houses with trapped particles make a significant contribution to global vertical carbon flux. We will study combined effects of temperature and CO2 on these dominant zooplankton by manipulating natural plankton in mesocosms. We hypothesize climate change will impact the important zooplanktonic trophic level through top down altered predation fields and bottom up changes in prey type and size. Copepods are size-selective feeders and recent data suggest appendicularians are bottom up regulated by large and spiny particles. We will test these hypotheses in mesocosms by generating blooms of diatoms (large) or flagellates (small) and evaluate subsequent zooplankton population dynamics. Under these different conditions, we will also examine competitive predatory interactions between copepods and appendicularians, leading to models of projected effects of p(CO2) and temperature on appendicularians and copepods through alterations in phytoplankton community structure and uni-directional predatory pressure. Both appendicularians and copepods are
important in oceanic carbon sequestration, but do so via different pathways. Data from these experiments should also have important predictive value on the nature and extent of future carbon sequestration in marine pelagic communities.

The project is coordinated by University of Bergen, Norway.

Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Koski, M., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life

01/01/2011 → 31/12/2011

Keywords: Research area: Oceanography

Collaborators: University of Bergen, Uni Research AS, Russian Academy of Sciences, University of Gothenburg, Leibniz Institute of Marine Sciences, Skidaway Institute of Oceanography

Project: Research

Trait based plankton ecology (38896)

Plankton is the dominating life-form in the ocean. It is mainly invisible and lives in a viscous world that is not part of our sensed experience. As a consequence, important properties of life in the oceans remain poorly understood. This project has aimed to further a cross-disciplinary research activity to promote an understanding of the dynamics of marine pelagic ecosystems that is based on mechanistic descriptions of the functioning of and interaction between its individuals. We provided trait-based descriptions of the key functions of plankton, formulate their associated trade-offs, and develop trait-based models of plankton ecosystem that we will test against observations.

The core activity of the project was the development of mechanistic descriptions of key plankton traits and their trade-offs and development of trait-based models of pelagic systems. The immediate goal of the project was to achieve fundamental insights in the functioning of pelagic ecosystems but ultimately the models to examine effects of environmental changes and human impact. The project was a ‘precursor’ for the Centre for Ocean Life.

The project was coordinated by DTU Aqua.

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

Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Nielsen, T. G., Project Participant, National Institute of Aquatic Resources
Thygesen, U. H., Project Participant, National Institute of Aquatic Resources
Mariani, P., Project Participant, National Institute of Aquatic Resources

01/01/2011 → 31/12/2013

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

Collaborators: Aarhus University, Roskilde University

Project: Research

Arctic plankton in a changing climate (38783)

Climate change impacts the marine arctic environment through changes in ice cover, ice thickness, irradiance, freshwater outflow, concentrations of CO2 and stratification. These factors determine the production, seasonality and fate of the planktonic primary production in the marine ecosystem. Plankton is fueling stocks of fish, marine birds and mammals and through that constitute the base of the Greenlandic economy.

The aim of the project was to gain knowledge about the interaction between climate, oceanography and plankton in the vulnerable Greenlandic marine ecosystem through field and laboratory experiments. The project was interdisciplinary and closely coordinated with the other projects under the Greenland Climate Research Centre.

The project was funded by the Commission for Scientific Investigations in Greenland (KVUG), Greenland Climate Research Centre, Danish Centre for Marine Research, and Carlsberg Foundation.

The project was coordinated by DTU Aqua.

Nielsen, T. G., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Dutz, J., Project Participant, National Institute of Aquatic Resources
Kjellerup, S., Project Participant, National Institute of Aquatic Resources
Swalethorp, R., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources

01/01/2010 → 31/12/2014

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

Collaborators: Aarhus University, Greenland Institute of Natural Resources

Project: Research

Centre for Macroecology, Evolution and Climate (CMEC) (38784)

This project investigated large scale patterns and variations of life in the ocean, focussing primarily on fishes. The theme used fishes to investigate how processes associated with climate change and human impacts (e.g., fishing and eutrophication) influence fish life histories, biodiversity and the dynamics of populations and species over large time and space scales. Studies have focussed on key processes affecting life histories and distribution of populations and species,
including reproduction, mortality, and migration.

The project had one full-time PhD student, and 5 postdoctoral scientists. The relatively high number of postdocs in a short period was due to their success at finding permanent jobs as tenure-track assistant professors, or as research scientists or managers in either industry or academia.

Key results by DTU Aqua colleagues in the project include the following:
- A pan-Atlantic analysis and discovery of how temperature affects reproductive timing in cod, with evidence for local adaptation of cod thermal physiology and counter-gradient evolution. Our ongoing work is now investigating the consequences of this adaptation for match-mismatch of cod larval production with the timing of the peak production of major zooplankton prey species (e.g. Calanus finmarchicus, Pseudocalanus sp.)
- New estimates of the numbers, locations and volumes of the mesopelagic provinces of the world’s oceans, and based for the first time on the dynamics of ocean primary productivity, C sedimentation and photic zones. These new habitat descriptors of the mesopelagic ocean will provide new contexts for studies of ocean biodiversity, and the distribution and productivity of mesopelagic fishes and other biota.
- New models of fish lifetime reproductive output which demonstrated that a fish’s annual reproductive output was strongly related to maximum body size. Moreover, indeterminate spawners had ca. 10-fold higher reproductive output per unit weight than determinate spawners suggesting possible differences in survival rates among the early life history stages between these two groups of fishes.
- Estimates of how climate change will affect the spawning locations and timing for herring in the North Sea, based on climate change scenarios, lab studies of temperature effects on egg survival rate and substrate requirements for herring egg deposition.
- Global patterns in taxonomic and functional descriptors of fish biodiversity and how these are inter-related and affected by ocean conditions (e.g., primary production, ecosystem size). Ongoing work is relating these patterns to biodiversity protection (e.g., MPA coverage).

The project was coordinated by University of Copenhagen, Denmark.

The project was funded by the Danish National Research Foundation.

MacKenzie, B., Contact Person, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Lindegren, M., Project Participant, National Institute of Aquatic Resources
Mantzouni, I., Project Participant, National Institute of Aquatic Resources
Neuheimer, A., Project Participant, National Institute of Aquatic Resources
Hartvig, M., Project Participant, National Institute of Aquatic Resources
Reygondeau, G., Project Participant, National Institute of Aquatic Resources
Tsoukali, S., Project Participant, National Institute of Aquatic Resources

01/01/2010 → 31/12/2015

Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: University of Copenhagen
Project: Research

**EURO-BASIN: European basin-scale analysis, synthesis and integration (EURO-BASIN) (38899)**

EURO-BASIN was designed to advance our understanding on the variability, potential impacts, and feedbacks of global change and anthropogenic forcing on the structure, function and dynamics of the North Atlantic and associated shelf sea ecosystems as well as the key species influencing carbon sequestering and ecosystem functioning. Like the entire biosphere, marine ecosystems such as the North Atlantic and its associated shelf sea ecosystems can be characterized by emergent properties controlled by a dynamic network of interactions and relationships and not static entities. This system complexity is what Martin Luther King Jr. called “an inescapable network of mutuality” scientists today define as complex adaptive systems (CASs).

EURO-BASIN has represented the first attempt of creating future prognosis of marine ecosystem states sensitive to CAS dynamics using as its test case the North Atlantic. Long-term prediction of the status of these CAS systems, population dynamics of key species and hence management of marine systems requires the implementation and advancement of an ecosystem approach for the management of marine resources sensitive to CAS dynamics. What is the ecosystem approach? Unlike a single species approach, the ecosystem approach takes into account population and ecosystem responses to changes in the Earth’s climate, fisheries, and interactions between them. In EURO-BASIN not only did we monitor and assess how North Atlantic marine ecosystems behaved in the past, but also predict how they will respond under possible future climate change scenarios. Hence, the results of this project have provided important recommendations for better marine resource management in the European Union.

The project had participants from 23 European universities and research institutions as well as collaborations with key institutions and Universities in the US and Canada.

The project was coordinated by DTU Aqua.

The project was funded by EU, Framework Programme 7.

St. John, M., Project Manager, National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography
Köster, F., Project Manager, National Institute of Aquatic Resources
MacKenzie, B., Project Manager, National Institute of Aquatic Resources
Andersen, K. H., Project Participant, National Institute of Aquatic Resources
Jonasdottir, S., Project Participant, National Institute of Aquatic Resources
Kiørboe, T., Project Participant, National Institute of Aquatic Resources
Koski, M., Project Participant, National Institute of Aquatic Resources
Munk, P., Project Participant, National Institute of Aquatic Resources
Physical oceanography in Greenland waters under climate change (38767)

Changing climatic conditions will have considerable effects on the seas around Greenland. Melting glaciers, the formation of sea ice, large scale circulation of the Atlantic Ocean as well as more local changes in weather patterns will have direct impact, with cascading effects to biological processes and sustainable harvesting of marine resources. The aim of this project is to prepare modeling tools and analyses to describe expected oceanic conditions around Greenland under climate change. Particular focus will be on coupling these models and process studies to biology, biogeochemical cycling, and sea ice processes, with eventual feed backs to climate itself.

The project is coordinated by DTU Aqua.

Advanced modelling tool for scenarios of the Baltic Sea ecosystem to support decision making (ECOSUPPORT) (38733)

The Baltic Sea is subject to several major human impacts, and three of the most important are fishing, eutrophication and climate change. Understanding and projecting how these impacts will affect the food web and its fish populations in future is therefore challenging, and requires modelling approaches which include climatic-hydrographic forcing, nutrient loading scenarios and likely fishing intensities.

ECOSUPPORT was a project whose objective was to develop an advanced modelling tool for conducting scenario simulations of how these human impacts affect the marine ecosystem and fish populations. The project coupled several different types of models so that end-to-end ecosystem models were developed which to understand how human impacts could influence the Baltic food web and fish populations. The models to be linked included regional climate models, oceanographic-lower trophic level ecosystem models (Nutrient-Phytoplankton-Zooplankton-Detritus) and fish population models. Key project results included new scenario simulations how regionally downscaled global climate model outputs would affect the development of Baltic cod populations under scenarios of climate change and seal (predator) population growth, and under different combinations of eutrophication, exploitation and climate change. These simulations included all key elements of the foodweb via an Ecopath model which included competitive and predatory interactions between the major fish species in the Baltic. The results demonstrated the vulnerability of the cod population to successful implementation of key ecosystem management policies for the Baltic Sea, including those related to exploitation and nutrient loading. Additional model scenarios focused on the sprat population which is a key intermediary link in the Baltic foodweb as prey and predator for cod and of zooplankton. These scenarios illustrated the range of future biomass and yields under assumed ranges of climate change and natural mortality.

One of the major novelties of the project was the availability of 3 different NPZD models, which enable estimation of output uncertainties to different model parameterizations and assumptions in the lower trophic levels and physical oceanographic processes, and to compare these with uncertainties due to fish population dynamics (e. g., recruitment variability). These comparisons suggest that the biological uncertainty associated with fish population dynamics was larger than that associated with the choice of the oceanographic NPZD model.

Partners in the project are the above mentioned and five other marine research institutes around the Baltic Sea.

The project is funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.
**Baltic zooplankton cascades (BAZOOCA) (38584)**

The alien ctenophore Mnemiopsis leidyi, notorious for wrecking havoc in the Black Sea, was recently introduced to the Baltic, where it thrives. As an enclosed brackish water system where many organisms live close to their tolerance thresholds, the Baltic is very sensitive to such disturbances. We aim to test the overall hypothesis that Mnemiopsis in the Baltic causes cascading effects throughout the pelagic food web, from gelatinous and top predators to microbes. Using field studies, experiments and modeling we will address a specific set of research aims (organized as work packages). We will consider these research aims within the natural spatial (Baltic proper, Bothnian Sea, Bothnian Bay) and environmental (oxygen, temperature, salinity, light, N, P) gradients in the Baltic. Understanding such food web effects and potential cascades is crucial given the overall stress from contemporary environmental challenges, e.g. eutrophication, increased maritime activities, and climate change. The results will be useful for both scientists and policy makers. The current regime shift towards more jellyfish is unprecedented in the Baltic. Its effects on this specific ecosystem cannot be forecast solely on the basis of lessons from other ecosystems.

The project is coordinated by University of Gothenburg, Sweden.
Kiørboe, T., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
Jaspers, C., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2009 → 14/07/2012
Keywords: Research area: Oceanography
Collaborators: University of Bergen, Umeå University, Linnaeus University, University of Helsinki, University of Gothenburg
Project: Research

**Building scenarios for marine ecosystems under anthropogenic and natural forcings (EuroOceans Consortium) (38779)**

The aim of the EUR-OCEANS Consortium was to favor joint initiatives between key Research Performing Organizations (RPOs) and Research Funding Organizations (RFOs) across Europe, to help the community make significant jumps in marine sciences in the next decades. This was implemented by organizing and sponsoring activities with a clear focus on relevant marine science “hot topics” leading to wider European (FP8, JPI) projects. These activities included Gordon-like conferences, flagship programs, foresight workshops and public outreach. The focus of the Consortium was on the impact of climate/global change on marine ecosystems, and the construction of scenarios relevant to the emerging International Platform on Biodiversity and Ecosystem Services (ipBess).

A number of activities were funded in EUROCEANS with major impacts in term of new scientific publications, international training networks and other EU and Nationally funded projects. The EUROCEANS Consortium merged with similar initiatives in other marine research fields (i.e., MARBEF+ and Marine Genomics) to establish first a Consortium for a Collective Support Action under the FP7 program (called EUROMARINE) and then the integrated European Marine Network : EUROMARINE covering research topics from genes to ecosystems under changing oceans.

The Consortium had over 25 European universities and research institutions covering all of Europe and a broad spectrum of marine ecology disciplines.

The project was coordinated by Institut de Recherche pour le Développement, France.
The project was self-funded.
Mariani, P., Contact Person, National Institute of Aquatic Resources
Köster, F., Project Participant, National Institute of Aquatic Resources
01/01/2009 → 31/12/2012
Keywords: Research area: Oceanography
Project: Research

**Influence of ecological dynamics and climate change on the marine environment in Danish waters (ECODYN) (38136)**

The environment in the open Danish waters is controlled by a complex interplay between physical and biological processes, and it is therefore difficult to determine the exact cause of changes in the environment. This is also the situation for hypoxia, which is caused both by nutrients from sources ashore, by ecological dynamics of the waters, and by the flow in Kattegat and the Belts. This project examined the marine environment through three-dimensional numerical models which describe both physical and biological processes. In parallel, laboratory experiments clarified how temperature affects the biological rates at or near the sea floor. This was used to model the response of the ecosystem to the temperature increases which are expected as a result of climate change, and the future consequences for the marine environment were analyzed.

Through model simulations and oxygen measurements from ships and buoys, the biological processes leading to hypoxia were determined with the so far highest resolution in time and space; this contributed significantly to the understanding of the functioning of the ecosystem in this area.

The connection between the state of the marine environment and the abundance of fish was analyzed, focusing on the distribution and spawning regions of cod, in relation to the oxygen conditions in the inner Danish waters and in the Baltic Sea. Thereby, the project provided a description of interconnections between the ecosystem, the water flow, and the effects of a changing climate.

The project was coordinated by Department of Bioscience, Aarhus University, Denmark.
The project was funded by the Danish Council for Strategic Research.
Thygesen, U. H., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
Neuenfeldt, S., Project Participant, National Institute of Aquatic Resources
Behrens, J., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 01/04/2012
Keywords: Research areas: Marine Living Resources & Oceanography & Marine Populations and Ecosystem Dynamics & Fish Biology
Collaborators: Aarhus University, Danish Meteorological Institute, University of Copenhagen
Project: Research

MyOcean (38134)
The project advanced and coordinated European scientific and technical infrastructure in the European operational oceanography community, for collecting and distributing ocean observations and ocean forecasts. DTU Aqua contributed by developing an integrated system for forecasting of sandeel fisheries in WP3 and in WP18 as reference intermediate user (RIU), for integrating operational oceanography products in marine resource management.
The project was coordinated by Mercator Ocean, France and had 52 partners from the EU.
The project was funded by EU, Framework Programme 7.

Christensen, A., Project Manager, National Institute of Aquatic Resources, Section for Marine Living Resources
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01/01/2008 → 15/05/2012
Keywords: Research areas: Marine Living Resources & Oceanography
Project: Research

The biological pump in the Nordic seas: Copepods and appendicularians as producers and consumers of sinking particles (BIOPUMP) (38757)
BIOPUMP is a research network investigating the vertical flux, its production and consumption, and how it is affected by the climate change. The main activities of the network are annual research workshops concentrating on diverse aspects of vertical flux, such as the role of different zooplankton groups in producing and degrading of sinking particles, and how will the changing temperature and CO2 concentrations of the ocean influence the dynamics of these groups. BIOPUMP is also involved in organizing a Nordic PhD course on vertical flux and factors influencing it.
The project is coordinated by DTU Aqua.

Koski, M., Project Manager, National Institute of Aquatic Resources, Centre for Ocean Life
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Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
01/01/2008 → 01/05/2013
Keywords: Research area: Oceanography
Collaborators: University of Bergen, Stockholm University, University of Oslo, University of Copenhagen, University of Gothenburg, Greenland Institute of Natural Resources, UiT The Arctic University of Norway, Danish Centre for Environment and Energy
Project: Research

Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis (META-OCEANS) (38154)
This project was an EU Marie Curie Early Stage Training PhD network. The project was designed to improve and apply meta-analytical methods to oceanographic and fishery research questions. There are significant gaps in knowledge regarding the structure of marine food webs, the ecological roles of taxa of different sizes and the factors controlling linkages between different functional groups. Moreover, marine ecosystems continue to suffer from the impacts of human society superimposed on naturally and anthropogenically induced climate variability. These impacts include exploitation, eutrophication, pollution, species transfers and habitat alteration; they cause changes in the structure, function and biodiversity of marine ecosystems. However, the ability of marine scientists to predict the magnitude and direction of how marine taxa, functional groups and entire ecosystems respond to these changes, remains fragmentary. As a result, when asked by society for advice about how marine ecosystems will respond to different kinds of perturbations (including management actions), the marine science community can often only provide answers with high levels of uncertainty.
Students were trained in the use of meta-analysis techniques for marine ecological problems. The statistical methods were comparative and involved regression analysis, time series analysis, Bayesian analysis and trophic modelling. Students attended seminars organized by network scientists and visited scientists in partner institutes to attain additional training. Meta-analyses approaches make use of existing data, produced in the context of different specific analyses, but which gain new value when assembled and re-analysed in a broader perspective. Meta-analyses involve several stages: (1) data mining; (2) quality control, (3) data analysis, and (4) validation. Students were trained in all these steps.
DTU Aqua had two PhD students involved in the project. These projects used Bayesian and meta-analytical methods to show that standardized estimates of maximum population growth rate for all assessed cod stocks vary spatially across the Atlantic and in a dome-shaped relationship with temperature, and that extremely good or bad recruitment occurs in years
with extreme temperatures. In addition, new time series-based ways of forecasting cod population dynamics under climate change-exploitation scenarios were developed and the role of a trawling ban on a local cod population was shown to override temperature or other climate effects on stock productivity. Both projects produced papers in high impact journals (2 in Proc. Roy. Soc., 1 in PNAS), as well as in other leading fishery-marine ecology journals (MEPS, ICES, JMS, etc.) s in other leading fishery-marine ecology journals (MEPS, ICES JMS, etc.).

This project was coordinated by AZTI Tecnalia, Spain.

This project was funded by EU, Marie Curie.

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Keywords: Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Collaborators: National Center for Scientific Research, CSIC, University of Bergen, AZTI-Tecnalia, Plymouth Marine Laboratory
Project: Research

Fatty acids in the marine food chain (38160)

Primary production by autotrophic phytoplankton fuels the marine ecosystem and this energy is passed through the food web by trophic interactions. Understanding how energy flows through these interactions is vital for understanding how marine ecosystems function. The efficiency of energy transfer from primary producers to higher trophic levels depends on the efficiency of secondary producers utilizing the new carbon. This crucial link is still poorly understood and most often we observe that secondary production is not simply correlated with phytoplankton biomass. However, reproduction and growth of secondary producers, such as copepods, depend also on food quality. The goal of this project is to investigate the effect of essential fatty acids on copepod reproduction, growth and survival. Essential fatty acid are the ones the copepod need but has to attain from the food, as it cannot synthesize those de-novo. The project is based on series of laboratory, field and mesocosm studies with the focus on understanding on how food composition, both chemical composition and type affect growth and mortality all contribution to population dynamics of the copepod species. In addition the project has a strong teaching factor for masters and PhD students in form of advanced summer schools.

The project is coordinated by DTU Aqua.
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Koski, M., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life
Dutz, J., Project Participant, National Institute of Aquatic Resources, Centre for Ocean Life

Keywords: Research area: Oceanography
Collaborators: Uni Research AS, Aarhus University
Project: Research

Fish larvae and recruitment to fish stocks (38150)

Processes related to fish reproduction and the recruitment to fish stocks are key elements in stock dynamics. Both annual variability and long term changes in recruitment have great influence on the fishery. Hence, further insight into these processes is important for ecosystem understanding and management of fish stocks. A wide range of projects related to the early life of fish are carried out at DTU Aqua. These investigate eggs and larvae through laboratory experiments and studies in the field, focusing on the ecological and oceanographic context of the early life. The present project is set up to accumulate and cross-analyze information from these projects and prepare new research initiatives, ensuring a consistent effort towards improved understanding of larval ecology and recruitment processes. The project follows a hypothesis-oriented, comparative approach identifying key processes in larval biology and analyzing linkages between fish reproductive strategies and major oceanographic patterns, specifically frontal zones. Comparisons cover both coastal and oceanic areas and include all latitude zones: temperate, tropical and arctic. Major traits of apparent universal importance have been identified and these findings guide further research into bio-physical linkages and structuring of fish larval communities in relation to oceanographic features. Subsequently the findings are used in model-based evaluations of recruitment variability and the potential influence of climatic changes. A range of internal and external partners are part of the project.

The project is coordinated by DTU Aqua.
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Keywords: Research area: Oceanography
Project: Research