Marine strategic area
NTNU is Norway’s centre for technological education and research, with a solid foundation in the natural sciences. With more than 20,000 students, seven faculties and 53 departments, NTNU educates 80% of Norway’s graduate engineers, and many alumni hold senior positions in industry and the public sector.

NTNU aims to create the basis for the development of knowledge and to create value – economic, cultural and social. The university’s main profile in science and technology gives it a particular responsibility to develop the technological foundation for the society of the future. Making best possible use of this profile, of its academic breadth, and of its interdisciplinary expertise, NTNU will contribute to solving complex problems and to increase the understanding of relationships between technology, society and environment. These qualifications will also promote innovation and develop the knowledge base for sustainable value creation and a competitive business sector.

As a university, NTNU has a particular responsibility for long-term basic research and academic development. Research-based education is offered at all levels, emphasizing professional study at master’s degree level and doctoral degrees.

It is anticipated that the answers to the complex questions of the future must be searched for through interactions across the classical disciplines. Among the university’s strengths are its strategic areas, described below, offering international-calibre interdisciplinary research and education:

- Energy and petroleum – resources and environment
- Information and communication technology
- Marine and maritime technology
- Materials
- Medical technology
- Globalization

NTNU Marine Strategic Area will create knowledge for a sustainable coastal development through holistic and interdisciplinary research and education.

The Marine Strategic Area has two main pillars:

1. Centre for Ships and Ocean Structures (CeSOS), Centre of Excellence, funded by the Research Council of Norway and NTNU
2. NTNU Marine Coastal Development (NTNU MCD)

Visit us at www.ntnu.edu/marine
This report is a compilation of activities, events, programmes and projects that have been performed by members of NTNU Marine Strategic Area in 2011. Its objective is to indicate the type of scientific expertise, research opportunities and educational focus available within the marine field. If any more detailed information is required, please contact Alexandra.Neyts@ntnu.no

**MARINE THEMATIC RESEARCH AREA – CORE ACTIVITIES**

The Marine Strategic Area covers the technological and scientific disciplines across the marine value chain:

- **Marine technology**
- **Marine science**
- **New tools for marine management**
- **Social science, economics, humanities**

**OCEAN SPACE RESEARCH**

Monitoring of the marine environment and its resources through observations and measurements has evolved into a new scientific era with the generation of multiple data of high accuracy. NTNU has contributed to this development through research on surveillance technology and communication systems. Mounted on sub-sea installations or mobile platforms like the Gunnerus research vessel, remote operated vehicles, autonomous underwater vehicles and gliders offer complete marine observation systems. New tools become hence available both to marine ecologists and archaeologists. A sustainable management of the marine ecosystem also requires a better knowledge of the marine processes, such as species diversity, genetic resources, biology, hydrodynamics, chemistry and ecology, and of societal issues related to coastal zone development. The understanding of the effects of marine food web exposure to toxic compounds and CO₂, in particular in polar areas, has received special attention.
Applied Underwater Robotics Laboratory (AUR-Lab)

On 23 August 2011, the AUR-Lab was officially opened by Norway’s Minister of Trade and Industry, Trond Giske. He maneuvered Minerva, one of NTNU’s remote-controlled underwater vehicles, and inaugurated the new lab by remotely cutting the ribbon with the snip of its claw. During the opening ceremony, the Minister said: “The AUR-Lab will strengthen NTNU’s position as a world-leading centre of expertise in subsea technology. Top-quality research and education in this field will be decisive in the ability of several of Norway’s most important industries to create jobs and add value to the country’s economy in the future”.

The AUR-Lab has already been proven to be a success. One of the major success factors is the collaboration of MSc and PhD students across scientific and technological disciplines. Their supervisors from different departments enhance the quality of cross-disciplinary research-based education. A strong relationship to industry and research institutions internationally is another driver in this process.

Contact:
Prof. geir.johnsen@bio.ntnu.no; Prof. asgeir.sorensen@ntnu.no;
www.ntnu.edu/news/aur-lab

CeSOS

CeSOS is the national Centre of Excellence for Ships and Ocean Structures, located at the Marine Technology Centre in Trondheim. Research at CeSOS aims at developing fundamental knowledge about how ships and other structures behave in the ocean environment, using analytical, numerical and experimental studies. This knowledge is vital, both now and in the future, for the design of safe, cost effective and environmentally friendly structures as well as in the planning and execution of marine operations. The engineering research carried out is inspired by the technology outlook, in a 20-25 years perspective, and involves topics within hydrodynamics, structural mechanics and automatic control relevant for the design and operations planning of ships as well as offshore structures for oil and gas, ocean renewable energy and aquaculture.

Contact:
coe@marin.ntnu.no
www.cesos.ntnu.no

Characterization of seabed properties

This project is developing several approaches for extracting dispersion curves of seismic interface waves and estimating shear wave velocity profile as function of depth in the sediments. The research in this area is directed towards use in site survey for underwater construction and geohazard assessment since the shear wave velocity is a direct measure of the stability of the sediments.

Contact:
Prof. Hefeng.Dong@iet.ntnu.no

Effects of ocean acidification and climatic stress on Calanus finmarchicus

The aim of this Norwegian Research Council project (2010 - 2014) is to reveal if Calanus finmarchicus may be sensitive to predicted ocean acidification scenarios and potential additive effects from raising seawater temperatures and oil spills. To address these questions a dedicated CO2-wetlab has been installed at NTNU SeaLab. The sophisticated experimental setup has been designed to allow controlled manipulation of CO2-concentration, temperature, light and feeding regime over long term. The project is run in collaboration with SINTEF. Results from the experiments will be implemented in a model to be used for prediction of effects on population levels along the coast of Norway.

Contact:
Dr. Sindre.Pedersen@bio.ntnu.no

Effects of oil dispersions in the marine environment

At SeaLab, several experiments were carried out in 2011 related to the following research projects:

• Contribution of oil droplets to the uptake and toxicity of oil dispersions in copepods: investigates effects on marine crustaceans of other oils than North Sea oils

Contact:
Prof. Hefeng.Dong@iet.ntnu.no
SINTEF Materials and Chemistry; funded by BP Exploration & Production Inc.).

- Effects of dispersed oil in the water column: addresses its biological effects in near-shore waters, especially with regard to filtrating organisms [in collaboration with SINTEF Materials and Chemistry, Aquaplan Niva – Tromsø; funded by Statoil petroleum ASA, Shell Technology Norway AS and ENI Norge AS].

- Understanding fitness-related effects of dispersed oil on *Calanus finmarchicus*: addresses its possible biological, physiological and genetic effects, using tools such as metabolomics and genomics [in collaboration with SINTEF Materials and Chemistry, SINTEF Fisheries and Aquaculture, Altins BioTrix, NIVA and Stockholm University; funded by Norwegian Research Council].

- Decision support tool for marine oil spills: evaluates the fate of spilled oil in near-shore waters after treatment with dispersing agents. Involved mechanical, chemical and biological mechanisms are considered, whereas numerical modeling is based on general environmental information [in collaboration with SINTEF Materials and Chemistry, Statoil petroleum ASA, Shell Technology Norway AS, ENI Norge AS; funded by Norwegian Research Council and participating oil companies].

**Contact:**
Dr. Anders.Olsen@bio.ntnu.no

---

**EUR-OCEANS**

EUR-OCEANS considers the relevance and impacts of climate and global change on the oceans. NTNU is one of 26 partners contributing financially and scientifically to the European consortium. The scientific topics that have been dealt with include the changing biogeochemical cycles of the oceans, the loss of biodiversity as a consequence of increasing temperature and acidification or harvesting, the role of small-scale interactions in energy transfer and in carbon export, the widening of sub- and anoxic ocean regions, and the links between ecology and genomics, evolutionary and life history. The EUR-OCEANS 2011 Council meeting was hosted by NTNU, at the Museum of Natural History and Archaeology in Trondheim. The first day was devoted to scientific presentations and discussion of the scientific strategy of the Consortium, whereas the second day focused on organisational matters and formal decisions.

**Contact:**
Prof. Egil.Sakshaug@bio.ntnu.no
www.eur-oceans.eu

---

**HARVEST**

The goal of HARVEST is to assess stocks of plankton and quantify ecological consequences of harvesting at lower trophic levels. The contribution from NTNU to this project is to clarify biological mechanisms and variables as input to mathematical models. One of the matters of dispute is whether *Calanus finmarchicus* selects algae or ciliates as their main food source. During 2011, the results from two food selectivity experiments resulted in one master thesis completed in collaboration with the University of Kiel and a submitted paper. During 2009-2011 a number of experiments to clarify the dependence of food quality and food quantity on production rates of *Calanus finmarchicus* have been performed and the results will be published during 2012.

**Contact:**
Oystein.Leiknes@bio.ntnu.no

---

**HYDRALAB IV**

HYDRALAB is a unique European network in the hydraulic research community and has large experience in co-operating since its start in 1997. Currently, 30 partners and associated partners from 15 countries participate in Hydralab IV (2010-2014), aiming at structuring the access to unique research infrastructures for studying interactions between water and environmental elements, sediment, structures and ice. NTNU offers transnational access and full-scale field research opportunities at the land-locked bay of Hopavågen in Mid-Norway. Here, an interdisciplinary team of ecologists, sedimentologists and marine engineers are brought together to bridge the gap between field observations of benthic algae and physical models of plants and animals. By comparing the results obtained from the environmental simulator at the University of Hull with the field data from the coastal bay, a better practice for experimental modeling is to be developed. From 13 to 16 September 2011, the first Hydralab IV large event was organised in Trondheim, gathering almost 80 persons from the entire consortium as well as invited experts, and representatives from the European Commission.

**Contact:**
Alexandra.Neyts@ntnu.no
www.hydralab.eu/
Impact of oil discharges on light- and temperature-adapted behaviour in the marine calanoid copepod *Calanus finmarchicus*

The project is aimed to investigate the vision ability of *Calanus finmarchicus* with regard to sensitivity, wave-length range and response pattern, and whether or not petrogenic oils may affect the vision or visual response. Light clues are believed to be involved in diel and annual vertical migrations in copepods, but there is still much debate regarding the mechanisms governing the migrations. Vertical migrations are assumed to be vital for growth and maintenance in copepod populations. The work is a laboratory study carried out in a custom-made exposure system at Sealab. In 2011 several experiments with copepod stage five (CF) and adults were carried out, included oil exposure experiments. The project is run at NTNU, with assistance from SINTEF Materials and Chemistry, and Biotrix. The project is funded by VISTA.

**Contact:** Prof. Bjorn.Munro.Jenssen@bio.ntnu.no, Dr. Anders.Olsen@bio.ntnu.no

---

**Innovation in Global Maritime Production - 2020 (IGLO-MP2020)**

IGLO-MP 2020 is a knowledge-building project with user involvement (KMB) with collaboration between NTNU, Marintek and the industrial partners Ulstein International AS, Pon Power AS, Siemens AS and Fiskerstrand Verft AS. The project draws on the expertise in international institutions, on Roll Royce Maritime and the Norwegian Center of Expertise Maritime in Ålesund (NCE Maritime). The overall focus of this KMB is to strengthen the competitive capabilities of the Norwegian maritime industry in order to improve competitiveness. IGLO-MP 2020 has identified a few key areas and themes, which the consortium members perceive as critical for future development and sustainability of the maritime industry in Norway. These are elements which are believed to provide Norwegian ship owners, ship designers, ship consultants and maritime equipment suppliers with competitive advantages in years to come.

**Contact:** Prof. Annik.Fet@iot.ntnu.no www.iglo-mp2020.no

---

**MaRIT**

The Marine Research Infrastructure platform in Trondheim is a collection of ocean space research facilities in the Trondheimsfjord region. The consortium was established in 2011 aiming at building an integrated platform for multidisciplinary marine research, development and education. An agreement between the partners makes the infrastructure components more easily available within the consortium, thus providing a stronger basis for collaborative ocean space research. Facilities which have been made available so far are research vessels, experimental and analytical laboratories, field facilities and instruments, owned by NTNU, NINA and ACE. In 2012, the consortium will be further broadened.

**Contact:** Alexandra.Neyts@ntnu.no www.ntnu.edu/marine/marit

---

**Ocean Space Centre (OSC)**

In September 2011, the documentation for the concept evaluation of the Ocean Space Centre was submitted to the Ministry of Trade and Industry. Various alternatives to meet the overall vision were studied, among which the Board of MARINTEK suggested building of a new research infrastructure at Tyholt in Trondheim combined with an innovation centre for ocean space technology in the harbour district of the city. Ocean Space Centre is a new world-leading cross-disciplinary knowledge centre for development of ocean space science and technology that can contribute to global food, energy and environment challenges. In particular, OSC aims to contribute to:

- educate the future specialists within ocean space technology,
- make sure industry and society have access to leading edge expertise and infrastructure related to harvesting, use and management of ocean space,
- the effective utilization of national expertise and knowledge through

---

**NORUS**

NORUS or "Technology Development for Marine Monitoring and Ocean Observation” is a joint North America – Norway educational program for higher education. In 2011, several practical workshops were organised with student teams and staff members of NTNU, the University at Svalbard, California Polytechnic State University and Rutgers University. In the Arctic Ocean, autonomous underwater vehicles were run into the ice as well as under polar night conditions for environmental measurements and for vehicle performance testing under extreme circumstances. The program supported several students to travel to the Arctic attending specialized courses and cruises. From NTNU, 5 MSc students graduated before the official finalization of the NORUS program on 31 December 2011. However, the educational activity will continue through the AUR-Lab.

NORUS was also presented during the Transatlantic Science Week in Berkeley (October 2011).

**Contact:** Prof. Geir.Johnsen@ntnu.no www.norus-science.com
cooperation with Norwegian and foreign institutions and businesses,
- increased innovation within ocean space technology.
The OSC project is now subject to independent quality assurance by the Ministry of Finance before final decision concerning which alternative that will be further developed and built. A final decision is expected late 2012.

Contact: Atle.Minsaas@marintek.sintef.no

Seismic noise and fishing

The project for the Norwegian Petroleum Directorate was completed in 2011 with the development of a computer model for the propagation of airgun signals to large distances in the water column. The model has been tested and validated using field measurements of airgun noise in connection with a regular seismic survey at the Nordland VII conducted in June 2009. Figure 1 shows the Vesterålen area and the seismic line, and Figure 2 shows the modeled sound field from an airgun at 6 m depth out to distance of more than 30 km.
The problem of how fish may react to sound was the subject for a new Norwegian Research Council project named CollPen - Collective reaction of penned fish. This is a basic research project with international participation. The project leader is the Institute of Marine Research, whereas the marine acoustics team of NTNU is responsible for the acoustic modeling and instrumentation. The field experiments, scheduled for the summer of 2012 will expose and study the reactions of a school of herring (ca. 1000 fish) to waterborne acoustic signals and noise of various types.

Contact: Prof. Jens.Hovem@iet.ntnu.no

ShipSoft
ShipSoft is a pre-project where the opportunities for integrating system analysis in marine systems design is explored. By investigating the informational, computational and analytical requirements for assessing marine design, opportunities and barriers for adopting such methods in the industry is identified. The project is connected to IGLO-MP 2020 with partners from Ulstein Design and Solutions, Pons Power, Fiskerstrand Shipyard and Fjord1. The project period spans from 2011 to 2012.

Contact: Prof. Annik.Fet@et.ntnu.no

Underwater Acoustic Monitoring and Communication
The objective of this national project is to develop new acoustic methods and technologies for observation and monitoring of the marine ecosystem. In 2011, several experiments were carried out in the Trondheimfjord, leading to an optimised underwater acoustic transmission and transfer of data.

Contact: Prof. Hefeng.Dong@iet.ntnu.no

University Technology Centre (UTC)
The UTC “Performance in a Seaway” is a co-operation between Rolls-Royce Marine, MARINTEK and NTNU. The centre aims at promoting research with a commercial potential, in particular development of propellers, propulsion systems, ship designs, and various types of ship equipment. In 2011 Hamid Amini and Bingjie Guo graduated with a PhD from the UTC, on side forces and bending moments on propellers of azimuthing thrusters and added resistance of ships due to waves. The Second International Symposium on Marine Propulsors (smp11), www.marinepropulsors.com, was held in Hamburg in June 2011 as a result of the UTC collaboration.

Contact: Prof. Sverre.Steen@ntnu.no
There is a clear trend that, whereas catches from the wild are stagnating, any future increases in seafood provision are to come from sea-based aquaculture. Although the situation for the fisheries and aquaculture industries is very different, both sectors need to focus on environmental sustainability and consumer attitude when developing further.

Aquaculture at NTNU has its main focus on aquaculture engineering of production systems, the sustainability of these systems, and the fundamental biological sciences of aquaculture engineering. By taking full advantage of the knowledge and developments made in other sciences and industries, such as the offshore oil industry, considerable technological progress can be obtained within this young industry. A better understanding and control of environmental impacts is crucial both from a production and a consumer perspective.

The goal of fisheries research at NTNU is to promote active multi-disciplinary problem-solving research, through close interaction among engineering, natural science and social sciences. Through the development of low energy catching technology, improved fishing gear, on board catch handling and flexible logistic - and distribution systems fisheries can gain efficiency. At the same time, it is important to counteract over-fishing problems through improved management strategies, catch monitoring, and sustainability documentation. Scientific approaches for the maintenance of sustainable coastal communities is also a focus area for fisheries research at NTNU.

AQUAEXCEL
AQUAEXCEL (AQUAculture infrastructures for EXCELence in European fish research) is a EU-funded project under the 7th Framework Research Infrastructures programme. It provides the aquaculture research community with a platform of top class research infrastructures. The objective of AQUAEXCEL is to integrate, on a European scale, key aquaculture research infrastructures, in order to promote their coordinated use and development. In total, 17 partners collaborate to offer access to 23 experimental facilities, and to provide better tools for aquaculture research. NTNU provides access to the CodTech laboratory. This automated start-feeding rig is one of the most advanced cultivation hatchery units in Europe. The facility is equipped with automatically controlled feeding, water exchange and online measurements and control of live feed density and environmental variables. AQUAEXCEL operates with approximately 2 calls for access proposals each year until 2014.

Contact:
Assoc. Prof.
Jo.Arve.Alfredsen@itk.ntnu.no
www.aquaexcel.eu

Aqua-tnet
Aqua-tnet is the European Thematic Network in the field of aquaculture, fisheries and aquatic resources management. The network is funded under the European Commission Lifelong Learning Programme, running from 2008-2011, and aims at reaching a greater compatibility and comparability of the systems of higher education in Europe. The Aqua-tnet web portal contains databases on mobility opportunities, course databases, and innovative teaching resources. Aqua-tnet submitted successfully a new application for continued activity through the proposal Aqua-tnet 3 (phase 2011-2014).

Contact:
Prof. Elin.Kjorsvik@bio.ntnu.no
www.aquatnet.com
Carbon footprint of seafood

This activity was initiated by Standards Norway together with researchers from NTNU and SINTEF Fisheries and Aquaculture. Experts from the university are involved in the process collaborating with colleagues from institutions like the Norwegian Seafood Export Council, DNV, the Ministry of Fisheries and Coastal Affairs, Aker Seafoods, Nofima. The goal is to establish requirements for Product Category Rules (PCR) and obtain an approved PCR by the end of 2013.

Contact:
Prof. Elin.Kjorsvik
www.uib.no/rg/mdb/projects/code-

Characterisation of microbiota in the digestive system of wild cod (Gadus morhua)

By using amplikon pyro sequencing the aim of this project is to characterise the microbiota composition in different parts of the digestive system of cod, and to characterise the variation in stomach and gut biota between individuals.

Contact:
Dr. Ingrid.Bakke@biotech.ntnu.no

CODE – Cod Development

CODE is a national knowledge platform for studies of the development of biological processes in early stages of Atlantic cod, linked to nutritional, environmental and management aspects. CODE brings together a broad mass of leading Norwegian scientists from nine partner institutions and several international partners, and is funded by the Research Council of Norway (2010-2014).

Contact: Prof. Elin.Kjorsvik@bio.ntnu.no
www.uib.no/rg/mdb/projects/code-
cod-development

CSR – Competence network for innovation

The CSR competence network aims to increase the competence on Corporate Social Responsibility (CSR) in the intersection between education, research and the industry. The network is a collaborative project between companies and knowledge partners from Mid-Norway. Seminars, lectures and workshops were used to share and create new knowledge within this field. The network was established in 2011 and will last until the end of 2012. Core partners are Sparebank 1MN, Fokus Bank, the Norwegian Center of Expertise – Maritime, Pharmaq, NTE.

Contact: Prof. Annik.Fet@ot.ntnu.no
www.csr-norway.no and www.csr-region.no

DANTEQ - Development & assessment of technology improving fishing operation & on board processing with respect to environmental impact & fish quality

The main goal of this project is to improve the fishing vessel operation, energy system design and the on board fish processing with respect to fish quality and environmental impact. The project is led by SINTEF Fisheries and Aquaculture, it is funded by the Research Council of Norway (2010 – 2013), with 11 research and industrial partners.

Contact: Prof. Elin.Kjorsvik@bio.ntnu.no

EATiP – European Aquaculture Technology and innovation Platform

EATiP is a European Technology Platform including members from the entire European aquaculture value chain. As an international non-profit association, it is dedicated to developing, supporting and promoting aquaculture technology and innovation in Europe. Its stakeholders, i.e. aquaculture suppliers, producers and processors, along with leading research groups and key representative organisations come together to jointly address and resolve the challenges that lie ahead. The draft EATiP Strategic Research and Innovation Agenda has been the subject of in-depth consultations during 2011:
• Inland Freshwater Aquaculture Workshop (June 2011, Warsaw, Poland)
• Marine Coldwater Aquaculture Workshop (September 2011, Oslo, Norway)
• Mediterranean Aquaculture Workshop (November 2011, Madrid, Spain)

The workshops were used to present, discuss and debate the prioritisation of key research goals issues categorised by theme. NTNU has been strongly involved in the work of the thematic areas on “Integration with the Environment” and “Knowledge Management”.

Contact: Prof. Yngvar.Olsen@bio.ntnu.no
www.eatip.eu

EXACTUS

Insufficient biomass control has been an issue for Norwegian aquaculture during the last decade. The concept of biomass control covers the estimation of biomass through measurements, instrumentations, but also the operations involved in the process regarding control of planning the production at each site according to the maximal carrying capacity, splitting of cages, grading and management of harvest and of advance sales. EXACTUS is to obtain new knowledge and technological basis for future biomass measurement systems with the potential to satisfy accuracy, reliability, and operational requirements for large aquaculture systems. NTNU is responsible for mathematical modeling and model-based estimations. Other research activities involve Instrumentation for biomass measurement; Salmon behavior, cage environment, mortality and size registrations; and Operation
and management, methods, design and user interface. The project is managed by SINTEF Fisheries and Aquaculture, and supported by the Norwegian Research Council and several industry partners.

Contact: Assoc. Prof. Jo Arve Alfredsen @itk.ntnu.no www.sintef.no/Projectweb/EXACTUS

Gemini Centre for Marine juvenile and plankton technology
The main activity of this interdisciplinary Gemini Centre is located at SeaLab, where NTNU and SINTEF have several aquatic laboratories. In 2011, 39 scientists and technicians from six NTNU departments and 20 from three research groups at SINTEF Fisheries and Aquaculture participated in relevant activities, of these were 11 PhD students. The aim is to develop joint strategies and a strong working partnership between biological and technological disciplines to promote a high-level and robust research and educational community within the field of marine fish larval and plankton cultivation and utilisation. The activities in 2011 were concentrated around coordination and policies for joint initiatives for new projects and conferences, joint management of laboratories, and to carry out joint project research and joint supervision of MSc students.

Contacts:
Prof. Elin Kjorsvik @bio.ntnu.no
Assoc. Prof. Jo Arve Alfredsen @itk.ntnu.no
http://www.ntnu.edu/geminicentre/mtp

Gemini Centre for Sustainable Fisheries - GEMINIFISH
A holistic approach is urgently required to face problems in the fisheries sector, such as overexploitation, poor selectivity of fishing gear, large post harvest losses, poor utilisation of by-products, poor working conditions and energy-intensive operations. The Gemini Centre for Sustainable Fisheries, established in 2010, aims to promote problem-solving research involving close interaction among engineering, natural science and social sciences. It focuses on the biological framework for use of marine resources, on marine harvesting technology, and on social and fisheries management strategies.

Contact: info@geminifish.org www.geminifish.org; www.facebook.com/geminifish

LarvaNet
LarvaNet is a European network of researchers and producers working with fish larvae, funded by COST Action FA0801. It intends to integrate knowledge obtained in national and European research projects, as well as practical experience, in order to improve the quality of fish larvae used in aquaculture. It is funded through the European Commission COST action. The network offers training schools and travel funds for young scientists. It also hosts workshops in collaboration with international conferences such as Aquaculture Europe 2011.

Contacts:
Prof. Elin Kjorsvik @bio.ntnu.no www.larvanet.org

LeppeProd - Production of Ballan wrasse
The salmon industry currently uses large amounts of wrasse to delouse salmon in cages. Use of wrasse is an environmentally gentle method for removing salmon lice, but extensive capture of wild wrasse to the farming industry is not sustainable. The aim of the project is to develop knowledge to contribute to a stable and predictable commercial production of Ballan wrasse.

The project is a collaboration between NTNU, SINTEF, Nofima, Institute of Marine Research, and Nifes, and the researchers at the four institutions have extensive experience developing production of new marine species. The

iCoast
The iCoast project, focusing on integrated coastal area management, approached its finalization at the end of 2011. The project team is working out a joint framework for an environmentally, socially and economically sustainable development aiming to reduce the number of conflicts in the coastal zone and its adjacent waters. Among the studies carried out during the three year project period, the response of nutrient discharge from salmon farms on the marine food web was investigated. This is a hot topic of high relevance to environmental groups, policy decision-makers, the aquaculture industry and the public in general.

Contact:
Prof. Yngvar Olsen @bio.ntnu.no www.ikyst.no
Membrane filtration in aquaculture recirculation systems

This project is financed by Regional Research Funds Mid-Norway, with the aim of testing membrane filtration as a water treatment component in marine aquaculture recirculation systems. In 2011, three experiments with increasing organic load to the membranes were successfully carried out with different species of zooplankton, and experiments with fish are planned for 2012.

Contact: Dr. Per-Arvid Wold @ntnu.no

PROMICROBE

In this EC-funded project, seven international research partners study “Microbes as positive actors for a more sustainable aquaculture”. Through systematic experimental studies including gnotobiotic systems, novel information on microbial interactions in aquaculture ecosystems and new concepts for microbial management will be developed. These results will be translated into new or adapted protocols to rear aquaculture organisms in a biological stable and economical efficient way.

Contact: Prof. Olav Vadstein @biotech.ntnu.no
www.promicrobe.ugent.be

PRO-EEL - Reproduction of European Eel: Towards a Self-sustained Aquaculture

The PRO-EEL project aims at breeding European eel (Anguilla anguilla) in captivity. Reproduction of eel in culture has become a focus research area due a severe decline of natural stocks and an increasing interest to breed eels for a self-sustained aquaculture. PRO-EEL is an international research project supported financially by the European Commission, with 15 international partners. The objective of the project is to expand the current knowledge on the eel reproduction and develop standardized protocols for production of high quality gametes legs and sperm), viable embryos and feeding larvae of European eel. Methodology and technology will be established using small scale tests and validated in full scale experimental facilities.

Contact: Prof. Elin Kjorsvik @bio.ntnu.no
www.pro-eel.eu

Technology akvARENA

The joint vision of the akvARENA regional cluster of aquaculture technology companies, research centres and organisations in Mid-Norway is “World-leading technology for sustainable fish farming”. In May 2011, more than 40 representatives from aquaculture companies, both producers and suppliers, and research institutes joined the akvARENA excursion to the Faroe Islands. Visits to salmon smolt and ongrowing farms provided a thorough insight in on-land recirculation and exposed cage systems respectively. The excursion also founded a basis for collaboration possibilities between Faroe aquaculture stakeholders and NTNU. Another activity initiated by akvARENA was the SEA2011 conference on “Food supply from environmentally friendly aquaculture – a dream or reality?”. This meeting addressed the potential dilemmas regarding increased aquaculture production.

Contact: Alexandra.Neyts@ntnu.no
www.akvarena.no

WAFOW

Through a comparative study of coastal ecosystems in Norway and Chile, the WAFOW project aims to develop a tool for managing waste emissions from fish farms in coastal waters. In order to investigate whether nutrient discharge lead to changes in the structure of marine food webs, an international and interdisciplinary team of researchers from Norway, Chile, Kurdistan, the Netherlands, Turkey, Colombia and France, have completed two mesocosm experiments in Chilean Patagonia and one in Norway. In addition, field studies were performed to explore photodegradation of organic matter and UV effects on plankton in surface waters.

Contact: Assoc. Prof. Murat V Ardelen@nt.ntnu.no
Dr. Lasse Olsen@bio.ntnu.no
An increasing demand for high quality fresh seafood products, and the high competitiveness on industry level creates new requirements for higher efficiency and optimised design of equipment and systems. NTNU research teams have contributed significantly to innovations on automation, chilling, freezing and drying of marine raw materials through enhanced process engineering and tailoring solutions. In addition, a more efficient management of the supply chain is planned through a holistic approach, involving production processes and traceability systems. Techniques within blue biotechnology make it possible to extract novel products of high value from marine biomass and macromolecules, and to isolate genetic resources and biopolymers from the oceans. Research groups at NTNU focus on a better exploitation of by-products and unexploited marine organisms, and on bio-prospecting, which involves the search for new exploitable (micro-)organisms.
Marine bioprospecting

Bioprospecting is the search for new biologically active molecules, genes and enzymes for the development of novel medicines and industrial processes. In 2011, the following activities in this field were funded by the Norwegian Research Council:

- The development of a targeted screening technology for identification of bioactive agents with a potential for use in anti-cancer treatment from marine bacteria
- The discovery and characterization of new bioactive compounds through genome-based bioprospecting of marine bacteria
- The establishment of a SINTEF/NTNU collection of marine bacteria as a national biobank resource

Contact:
Prof. Sergey.Zotchev @ biotech.ntnu.no

SEAFoodplus

The mission of the SEAFoodplus research platform is to initiate, stimulate and encourage international integrated multidisciplinary seafood research covering the whole production chain from aquaculture and fisheries to consumers’ health and well-being. Further to influence the European research agenda with focus on seafood research related to human health, quality. Storage time and temperature were found to be more important for the quality properties than the handling stress. Sensory analysis has been used for quality analysis in addition to biochemical and instrumental parameters. Proteome analysis has been used to determine the proteins which are important for the texture properties of cod.

Contact:
Prof. Turid.Rustad @ biotech.ntnu.no
www.seafoodplus.org

SOLBIOPTA

The Biotechnological Production of Materials for Optimized Solar Cell Efficiency project studies the production and use of novel bio-nanomaterials from the microalgal group diatoms in solar cell applications. We study basic aspects of frustule anatomy and optical characteristics, and possible applications such as alteration of chemical composition of frustules and use of frustules as templates. The project is funded by the Research Council of Norway.

Contact:
Assoc. Prof. Gabriella.Tranell@ntnu.no; Prof. Olav.Vadstein@biotech.ntnu.no

Stresscod

The main objectives of the Stresscod project have been to determine effects of handling stress combined with storage conditions on quality of farmed cod (Gadus morhua), and to determine which biochemical changes that are important for the resulting sensory quality. During the project it was confirmed that cod can be stressed with a clear physiological response without a reduction in

Contact:
Prof. Trygve.M.Eikevik@ntnu.no

Super freezing of fish

Applying ultra low temperatures will become more interesting for the industry when the production capacity increases and need for storing fish over longer periods is requested. Ultra low temperatures below –30 °C (ULT) provide benefits for the quality and an extended shelf-life which gives the opportunity of having “like a fresh” fish and seafood at any moment irrespective of the season. In 2011, a method using compressive yield stress and Young modulus changes vs. temperature of the sample to determine the glass transition temperature of fish muscle was investigated. The results were positive and repeatable for whole muscle fish samples, but negative for minced fish samples.

Investigations in the ice nucleation zone (-1.5 – -3.0 °C) also gave encouraging information about usage of ultrasonic assistance, which possibly can cut down freezing time for 20 % approximately.

Contact:
Prof. Trygve.M.Eikevik@ntnu.no
AVAILABLE RESEARCH INFRASTRUCTURE

Research vessel Gunnerus

In 2011, 70 different missions were carried out, of short or long duration. Gunnerus had a full occupancy, with 80% of the 2011 cruise time being pre-ordered already in November 2010. For the first time, the total of expeditions exceeded 1300 person days. In 2011, all the vessel certificates were renewed and a 5-year control was performed. A hydraulic walkway was mounted, providing a more secure and improved access to the ship for the expedition participants. The Polarcirkel service boat was used at a number of occasions, both for teaching and research purposes. Through focus on safety matters, the work boat was supplied with a series of new equipment: an additional chart plotter, a VHF radio, a Wired Mobile waterproof UHF radio and an AIS (Automatic Identification System). The Remote Operation Vehicle (ROV) mission activities showed a strong increase in 2011. A ROV LARS (Launch and recovery system) was established to ensure a secure launch and landing of the vehicles. This was especially directed at the marine archaeological expedition near “Ormen Lange”.

Contact:
Svenn.Linde@ntnu.no
www.ntnu.edu/marine/gunnerus

NTNU Centre for Fisheries and Aquaculture (Sealab)

The multidisciplinary NTNU Centre for Fisheries and Aquaculture consists of an experimental aquatic facility and a meeting place for marine scientists and students from four different faculties at NTNU. It is also a main node for marine cooperation between NTNU and SINTEF. In 2011, 25 experiments were performed with fish (cod, salmon, ballan wrasse, goldsinny), zoo- and phytoplankton, focusing on biological and technological aspects of aquaculture, ecotoxicology, environmental change, and ecophysiology. The “CodTech” laboratory, probably one of the most technically advanced larval rearing facilities worldwide, got further upgraded in 2011. Next to 41 scientists and PhD students, the Centre is a base for about 40 MSc students, and hosts teaching and laboratory classes for marine courses from Bachelor to PhD level.

Contact:
Prof. Elin.Kjørsvik@bio.ntnu.no, Manager Arne.Kjosnes@ntnu.no
www.ntnu.edu/marine/sealab

Trondhjem Biological Station (TBS)

The station is located at seaside premises close to Trondheim. It is the centre for marine biological research at NTNU, offering good office and laboratory facilities, and direct access to the Trondheimsfjord ecosystem. TBS offers 600 m² of wet lab space with a constant supply of sea water from 100 m depth and 800 m² of well equipped standard laboratories. It houses four temperature-controlled rooms, several seawater tanks, a large outdoor basin and a number of service boats. The pier right in front of the station makes it convenient to perform tests and measurements from land, and to handle sampled material between the vessel and the laboratories. All ROVs and AUVs are stored at and operated from TBS.

Contact: Prof. Jarle.Mork@bio.ntnu.no
www.ntnu.edu/biology/about_tbs
Applied Underwater Robotics Laboratory (AUR-Lab)
Environmental mapping and monitoring of the ocean surface, water column and seafloor are of utmost importance for a sound management of the marine resources. Because the creation of functional engineering solutions demands a strong technical and scientific expertise, the AUR Lab was established at NTNU. The lab, established in 2011, brings together experts from cybernetics, control engineering, marine biology, marine chemistry, marine archaeology, electrical engineering and telecommunications, and underwater technology to produce new scientific results that would otherwise be difficult to achieve. This cooperation between marine technology and science in research-based education through use of the AUR-Lab is a tool for further development of underwater robotics and sensors. Their applications are many, such as exploitation of offshore oil, gas and minerals, mapping of marine resources, monitoring of environmental variables and resources, and the creation of tools for decision making and sound management of marine resources.

Contact: Prof. Geir.Johnsen
www.ntnu.no/aur-lab

Sletvik field station
The station is located at the shore of the Bay of Hopavaagen, which functions as a natural experimental basin. It is ideal for eco-hydrodynamic and transport studies relevant for marine chemists, biologists, physicists and geologists. The Bay is also well suited for mesocosm experiments and for testing of instruments and monitoring devices. The station is used both for field research experiments within marine ecology and monitoring, for meetings and seminars, and for field courses in botany, ecology and zoology. It can accommodate a total of 50 people. It holds bedrooms, a kitchen and dining room, lounge, lecturing rooms and laboratories.

Contact: Alexandra.Neyts
www.aceaquaculture.com

Acoustic Underwater Laboratory (AUL)
The laboratory is equipped with an Experimental Underwater Network System. It consists of transmitters, amplifiers, hydrophone arrays, and a data acquisition system. The system and the research vessel R/V Gunnerus, provides unique possibilities of obtaining data in real sea environment and experience to support the research and educational programs. Such facilities are rarely found in academic institutions and make NTNU/Acoustics an attractive partner in national and international research project. Underwater experimental campaigns were conducted in the context of underwater acoustic communications in the Trondheim Fjord at ranges up to 10 km and the signal processing tools for underwater acoustic communications were improved.

Contact: Prof. Hefeng.Dong
www.ntnu.no
EVENTS

Dialogues on aquaculture

The marine and globalisation thematic research areas at NTNU jointly took the initiative to organize a workshop dedicated to sustainability issues in aquaculture. The objective of the meeting was to stimulate dialogue and integration between social scientists, biologists and technologists in the further development of the aquaculture sector, in Norway and abroad. Its intercultural dynamics were presented and discussed: communication, responsibility and development. The dilemma between conservation and utilisation, and production ethics were central themes during the workshop, which was attended by Norwegian and Chilean researchers and industry representatives.

Contact:
Prof. Jennifer.Bailey@svt.ntnu.no

AquaNOR 2011

AquaNOR is the world’s largest aquaculture exhibition. From 16 to 19 August 2011 a total of 460 exhibitors, and more than 17,500 visitors from 61 nations attended the event in the centre of Trondheim. NTNU had a joint booth with SINTEF Fisheries and Aquaculture, and MARINTEK. In connection with the exhibition, a number of professional conferences and seminars took place. At the forum on upscaling aquaculture systems, organised by the European Aquaculture Society, more than 150 attendants were present.

www.nor-fishing.no

International collaboration – China

The marine strategic research area joined the Norwegian/Belgian JPI Ocean delegation to Qingdao in October 2011. The delegation discussed future cooperation in the marine sector between Europe, represented by JPI Oceans, and China, represented by the China-Europe CAFNet partners in Qingdao, i.e. Ocean University of China, Yellow Sea Fisheries Research Institute and Institute of Hydrology. The European network partners are Ghent University, Wageningen University and NTNU. The aim of the meeting was to establish links between JPI Oceans and the Chinese network. The delegation also attended a “Blue Economy Summit” with representation of Chinese vice-ministers and high rank regional officials. China will invest major efforts in the development of their blue economy (fisheries, aquaculture, shipping and offshore oil/gas), with Qingdao in the Shandong province as a center for this activity. It will be of major importance for Europe and for Norway to take part in this development. The joint meeting discussed further steps for developing cooperation. The process is driven by the Belgian JPI representatives, who were well represented in the delegation.

Contact:
Prof. Yngvar.Olsen@bio.ntnu.no
International collaboration – Vietnam

The collaboration between NTNU and Vietnamese research teams has been very active for many years, especially in the field of aquaculture and marine biotechnology. In 2011, a delegation from the Nha Trang University (NTU) led by its rector and vice rector visited NTNU. The visit marked the end of a large collaborative project related to aquaculture and marine biotechnology between NTU and Norway. A seminar was organised as a formal meeting followed by scientific presentations and discussions.

Contact: Prof. Kjell.Morten.Vaarum@biotech.ntnu.no

Workshop on Climate Change

On 1 and 2 October 2011 a workshop on the Impact of Climate Change on Biogeochemical Cycles and Ecosystems in Arctic–Antarctic Polar Seas was organized. Its goal was to bring together researchers to discuss integrated polar research, addressing research gaps in the knowledge about the impact of climate change on polar oceans, and to achieve more comparable results from the two polar oceans. The workshop was a collaborative action between Norwegian (NTNU, the Norwegian Polar Institute, the University of Bergen), Indian (the National Institute of Oceanography, the Centre for Cellular and Molecular Biology and the National Centre for Antarctic and Ocean Research), German (Alfred Wegener Institute for Polar and Marine Research) and Chilean (University of Austral de Chile and University of Concepción) researchers. The workshop paved a way for follow-up actions on important topics of mutual interest between the involved countries. The discussion results were published in national (www.forskning.no, “Om isen smelter”) and international (Science Daily; “Polar Oceans in Transition”) press.

Contact: Assoc. Prof. Murat.V.Ardelan@ntnu.no

Transatlantic Science Week

A session dedicated to Technology development for marine monitoring and ocean observation was organized by NTNU at the University of California Berkeley, on 25 September 2011. Researchers from US (UC Berkeley, Woods Hole Oceanographic Institution, California Polytechnic State University, Stanford University) and Norwegian (NTNU, UNIS) universities discussed opportunities for collaboration within applied underwater robotics.

Contact: Prof. Geir.Johnsen@bio.ntnu.no
www.norway.org/scienceweek
International Master of Marine Coastal Development (MACODEV)

MACODEV is a two-year international multidisciplinary Master of Science programme. It is especially designed to give the students a broad understanding of the complex interactions in the marine sector.

The programme offers three specializations which include an individual research project with publication of a Master Degree thesis according to international standards, i.e.

- Aquaculture
- Fisheries and Marine Resources
- Marine Biology and Biochemistry

Contact: studier@bio.ntnu.no
www.ntnu.edu/studies/msmacodev

International Master in Marine Technology

The two year Master of Science degree in Marine Technology gives students a challenging and exciting education for the future. Marine Technology is an ideal specialisation for first-degree engineers with technical interests. This is an education that provides innovative, professional challenges and lead to a variety of career possibilities. The Master programme offers two international specialisation options:

- Marine structures: choose between the profiles Marine Structures, Marine Hydrodynamics, or Marine Cybernetics
- Marine systems: choose between the profiles Marine Operation Technology, Marine Machinery, Marine Systems Design, or Renewable Marine Resources

Contact: studier@ivt.ntnu.no
www.ntnu.edu/studies/msn1

Nordic Master in Aquatic Food Production – Safety and Quality

This master’s programme provides knowledge about the whole value chain for aquatic food from harvesting and production of aquatic resources through processing to the consumer. The main focus throughout will be on safety and quality. The programme gives the foundation needed for a global understanding of the aquatic food production value chain. The Nordic Master is a collaboration between five different universities in the Nordic countries, and results in a double degree. Students will spend one year each in two of the collaborating universities, taking 60 ECTS at each of the institutions.

Contact: studies-master@nt.ntnu.no
www.ntnu.edu/studies/msaqfood

Marine projects in secondary schools

Project-based learning material was developed aimed at secondary school students. The objective is to stimulate young people’s interest in science and technology. The material fits into the subject natural science and environment, and into the newly launched optional subject on technology and research in secondary schools. In the marine area, the student project called “the young naval designer” has been successful for a number of years. It constitutes of a practical part on how to design a model ship, based on the theoretical material published in “Ocean Space Technologies”, with a competition in the ocean basin for all participating teams. In 2011, a new project on the cultivation of rotifers as live feed for use in marine aquaculture was developed, and tested by students at three different secondary schools. It will be offered as a student project on a national basis in 2012.

Contact: Prof. Haavard.Holm@ntnu.no, Dr. Jan.Ove.Evjemo@bio.ntnu.no
The university offers a number of different marine educational programmes both on Bachelor and Master level. The main marine-oriented programmes at NTNU are:

- Bachelor in Marine Biology and Aquaculture (3 years) www.ntnu.no/studier/bbi/studier/biologi/marinakva
- Master in Marine Technology (5 years) www.ntnu.no/studier/mntmart
- Master in Fisheries and Aquaculture Cybernetics (2 years) www.ntnu.no/itk/studiedepbygning/havbrukskybernetikk
- Nordic Master in Maritime Engineering (2 years) www.ntnu.edu/studies/msnmme
- Master in Coastal and Marine Civil Engineering (2 years) www.ntnu.edu/studies/mscoastmar
- Master in Subsea Technology (2 years) www.ntnu.no/studier/miuvt

An overview over the international Master’s programmes at NTNU can be found at www.ntnu.edu/studies/international/master

Contact: studentservice@adm.ntnu.no

Continued education in water recirculation systems

A course on “Water quality and -treatment in recirculating aquaculture systems (RAS)” was performed for the first time during the spring semester 2011. This is a postgraduate course for professionals from the aquaculture industry who want to learn more about water treatment and reuse. Lectures were held during two weekend gatherings at NTNU Sealab. Several relevant topics were presented and discussed, such as RAS design, water chemistry, microbial control, hydraulics and water treatment. The course was attended by 18 persons from different parts in Norway. Credits were given based on a written web-based exam.

Contact: Dr. Per-Arvid.Wold@ntnu.no

Departments at NTNU involved in the marine strategic area, and their main fields of competence (in alphabetical order)

- Archaeology and Religious Studies: Marine archaeology, maritime history, cultural heritage
- Architectural Design and Management: Harbour architecture
- Biology: Marine biology, biological oceanography, aquaculture, eco-toxicology, coastal ecology, behaviour
- Biotechnology: Marine biotechnology, marine biopolymers, marine lipids and proteins
- CeSOS: Centre of Excellence for Ships and Ocean Structures
- Chemistry: Trace metal chemistry, metal pollution
- Centre for Rural Research: Regional policies, regional development, coastal communities, resource use/management, coastal industries
- Civil and Transport Engineering: Coastal engineering, infrastructure, geotechnique
- Electronics and Telecommunications: Acoustics, underwater communication
- Energy and Process Engineering: Processing engineering, energy and value chain management
- Engineering Cybernetics: Aquaculture and fisheries cybernetics, instrumentation, telemetry
- Engineering Design and Materials: Design methodologies, sustainability and simulation.
- Geology: Coastal geography, societies
- History and Classical Studies: Fisheries and aquaculture history
- Hydraulic and Environmental Engineering: Water processing technologies
- Industrial Economics and Technology Management: Value chain management, Life Cycle Assessment (LCA), environmental management and innovation
- Interdisciplinary Studies of Culture: Cultural perspectives of coastal communities
- Marine Technology: Marine constructions, marine systems and operations, fisheries and aquaculture technology
- Mathematical Sciences: Bio-modelling, statistics
- Museum of Natural History and Archaeology: Marine archaeology, maritime history, cultural heritage, marine biodiversity
- NTNU Social Research, Studio Apertura: Organisation studies, work processes and management in aquaculture
- Physics: Marine optics
- Production and Quality Engineering: Food technology and manufacturing
- Sociology and Political Science: Fisheries politics, risk evaluations
- Urban Design and Planning: Ecological based planning of coastal land use

PhD education

NTNU provides extensive programmes for a doctoral degree in most marine disciplines. PhD students at NTNU are offered cutting edge research training, collaboration with fellow PhD candidates, and highly specialized instruction. Candidates must be admitted to a specific PhD programme, and undertake both research and coursework in order to earn a degree from NTNU. www.ntnu.edu/studies/phd

“Sett Sjøbein”

The national project “Sett Sjøbein” is dedicated to increase recruitment to the marine sector, to improve the qualifications of its employees, and to enhance the attractiveness of a marine education at all levels. The project is supported by the Ministry of Fisheries and Coastal Affairs (FKD) and by the Fishery and Aquaculture Industry Research Fund. Decisions are taken jointly by representatives from the Norwegian industry organizations, schools, training institutions and universities. The project was extended with one year. NTNU joined the recruitment events in Trondheim and Froya, and represented the higher education sector in Sjøbein steering committee. During the “Researcher’s Night”, which is a Europe-wide event, the Centre of Fisheries and Aquaculture demonstrated some of its research activities to the public.

Contact: Alexandra.Neyts@ntnu.no
www.settsjobein.no
NTNU – The Norwegian University of Science and Technology.
The Norwegian University of Science and Technology (NTNU) in Trondheim represents academic eminence in technology and the natural sciences as well as in other academic disciplines ranging from the social sciences, the arts, medicine, architecture and the fine arts. Cross-disciplinary cooperation results in ideas no one else has thought of, and creative solutions that change our daily lives.

NTNU
NO-7491 Trondheim, Norway
Phone:  + 47 73 59 50 00
Fax:  + 47 73 59 53 10
www.ntnu.no

Visit us at  www.ntnu.edu/marine