The Department of Biology was established in 1985 through the merging of several smaller biological departments located in Kristine Bonnevie’s House at the Blindern Campus. In 2004, the Department was reorganized into two divisions: the new Department of Biology and the Department of Molecular Biosciences (which earlier had merged with the Department of Biochemistry). In 2007, the Department was awarded a Centre of Excellence (CoE): the Centre for Ecological and Evolutionary Synthesis (CEES).

The Department is organized into three research programs: the Molecular Evolution Research Group (MERG), Marine Biology and Integrative Biology, along with the CoE-CEES. CoE-CEES, MERG and the Toxicology group are strategic research areas within the Faculty of Mathematics and Natural Sciences.

By 31st December, the Department of Biology consisted of 28 permanent academic staff, 9 ‘II-positions’ (professors and associate professors in 20% positions), 8 permanent- and 7 temporary administrative positions and 23.1 permanent- and 4 temporary technical positions. The temporary administrative and technical positions are all related to CEES. 59 postdocs/researchers and 39 research fellows were employed by December 2010. Our staff represented 28 nationalities in 2010. In the fall semester, there were approximately 160 bachelor students, 96 master students and 58 PhD students actively enrolled at the Department. 29 Master degrees and 16 PhD degrees were awarded by the Department.

In 2010, our researchers published 195 articles in peer reviewed journals, 1 book and 12 book chapters, and contributed more than 170 conference papers, media contributions and other professional presentations.

The total budget for the Department of Biology in 2010 was approx. 185 million NOK, of which 74 million NOK was from external funding sources. Financing of the Department’s external projects is distributed from the Norwegian Research Council (58 million NOK), and other national and international funding (EU, public and private sectors, international funding: 15.5 million NOK).
At the end of the year, the employment list of the Department numbers 188 persons, including temporary employed post doctorates and PhD fellows. The Department is also at any time the home for ca 90 MSc and 160 BSc students.

In 2010 we mourned the death of our dear colleague, professor Frode Olsgard, who sadly died on April 19th. In the name of Frode, the Faculty of Mathematics and Natural Sciences has established an award to acknowledge a person or group of persons who have done exceptional meritorious work within HSE at the Faculty.

2010 was a busy year at the Department. 29 MSc and 15 PhD students and 1 Dr. Philos graduated from our Department. We conducted excellent research and produced 195 peer-reviewed papers and 13 books and book chapters within a broad spectrum of biological sub-disciplines. We now start to see the results of the increased number of hard-working young scientists (post docs, PhDs) in our Department, who heavily contribute to the 10% yearly increase in number of publications we have seen at the Department since 2008.

The Department awards for 2010: the Biological Student Committee’s ‘Golden Pointer’ for outstanding teaching was awarded to post doc Tor Carlsen. Professor Stein Kaartvedt and post doc Thor Klevjer were awarded the prize ‘Best publication in 2010’, and the ‘CEES Darwin prize’ was awarded to associate professor Kamran Shalchian-Tabrizi.

2010-11 are the years where our research will be evaluated by an international panel of biologists under the auspices of the Norwegian Research Council. This also happened 10 years ago. At that time, most groups and sub-disciplines of biology in our two biology departments (BIO and IMBV) got a good rating. We are crossing our fingers and hoping that our groups of researchers will receive a fair assessment and also this time be rated as ‘very good’ or ‘excellent’. The biology evaluation was prepared during the autumn of 2010 and came together with the mid-term evaluation of our CoE (CEES); the conclusions will be available in the autumn of 2011.

Today, our politicians and governmental departments and agencies challenge the scientific community to discover and make stronger efforts to solve major global and societal problems. The ‘New Biology’ has emerged as a most rewarding approach to solve such global and societal problems in the field of life science, and represents an additional, complementary approach to traditional biological research. Turning our attention of research to be an integrative part of a broader life science research unit will be an important issue necessary to create cutting-edge research in life sciences in the future. Do we want to attend?

Research-based teaching at all levels is the fundamental principle behind our BSc, MSc and PhD science educational programs. In order to succeed and give a better training program, both on national and international level, scientists from the department must
better than today join forces with those from other departments, institutions and industry to address major interdisciplinary life science challenges in health and environments of the modern society.

Last summer our research production and training, together with educational activities, was once again evaluated by CHE, with exalting results. UiO and the Department of Biology is a preferential place to study biology, rated among the ‘Top 20’ biology educational institutions in Europe.

2010 was also the year for renovation of our research labs and a more firm co-localization of our research programs on the 4th floor in the Kristine Bonnevie’s building. The renovation tasks have been overdue for many years; modern experimental work with new equipment and infrastructure that also meet current HSE standards is an economic challenge for the Department.

Overall, it is a challenge for the Department to balance the resources allocated to support our major issues, e.g. adequate support to the top tire research activities of the CoE (CEES), that is also superior in the ability to address external funding agencies, and to the other prioritized research programs of the Department. Secondly, maintaining a scientific base of research in various sub-disciplines of biology that can quickly rise to meet future needs, and thirdly, to educate high-quality biologists to participate in the broad range of modern society demands, including schools, industry and government management.

On the following pages you can read about our research, educational and outreach activities as we enter 2011. I am grateful to all who have contributed to this report, and especially to our Department manager Maren, who have had a lot of work in editing and putting it all together. Enjoy yourselves . . .

May 22nd 2011

Trond Schumacher
Head of Department

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3 Research .............................................................. page 9
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1 Organization and Management

Department Chair and Deputy Chair

Board

Head of Studies

CoE Centre Chair

Head of Administration

Technical and Administrative Staff

Research and Education

CoE-Centre for ecological and evolutionary synthesis (CEES)

Integrative Biology (IB)

Marine Biology (MB)

Microbial Evolution Research Group (MERG)

Finse Alpine Research Centre

Drobak Marine Research Centre

Research Vessels

Phytotron

Central Engineering Workshop
Board and committees

Board

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<tr>
<th>Name</th>
<th>Role</th>
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<tbody>
<tr>
<td>Trond Schumacher</td>
<td>Department chair</td>
</tr>
<tr>
<td>Anne K. Brysting</td>
<td>Deputy chair</td>
</tr>
<tr>
<td>Tore Slagsvold</td>
<td>Scientific staff representative</td>
</tr>
<tr>
<td>Eirik Framstad</td>
<td>External scientific representative</td>
</tr>
<tr>
<td>Hans Borg</td>
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<tr>
<td>Nanna W. Steen</td>
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<td>Hanne Ballestad</td>
<td>Temporary scientific staff rep.</td>
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<td>Synnøve Botnen</td>
<td>Student representative</td>
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<tr>
<td>Ingebjørg H. Agøy</td>
<td>Student rep.</td>
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<tr>
<td>Stein Fredriksen</td>
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<tr>
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<tr>
<td>Berit Kaasa</td>
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<tr>
<td>Kari Beate Rygg</td>
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</tr>
<tr>
<td>Kristian B. Kristiansen</td>
<td>Deputy student representative</td>
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Committees and workgroups

Research committee (ceased May 14th 2010)
Chair: Ketil Hylland
Trond Schumacher, Kjetill S. Jakobsen, Eli K. Rueness, Kamran Shalchian-Tabrizi, Bente Edvardsen

Employment committee, PhD students and post docs
Chair: Hans Erik Karlsen
Helene M. Lampe, Lee Hsiang Liow

PhD program committee
Chair: Anne K. Brysting
Tom Andersen, Karl Uglan, Guri Sogn Andersen

Master and bachelor program committee
Leder: Glenn-Peter Sætre
Helene Lampe, Ketil Hylland, Stein Fredriksen, Christian Brochmann (NHM), Lars Nersveen, Are Sigurdsen

LAMU
Chair: Stein Fredriksen
Trond Schumacher, Stein Fredriksen, Cecilie Mathiesen, Maren Onsrud, Adine Thoresen, Hanne Hovden, Viggo Stangeby-Nilsen

HSE project group
Chair: Bodil K. Pedersen
Stein Fredriksen, Monica H. Solbakken, Cecilie Mathiesen, Kristian Prydz (IMBV), Paul Grini (IMBV), Bård Mathiesen (IMBV), Maria K. Svendsen

New web workgroup
Sumera Majid, Torbjørn Severinsen (IMBV), Jon Bråte, Marit Bjorbækmo
## Finances

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### Balance 31.12.2010

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### Figure 1a
Salary, running expenses, equipment costs and overhead as parts of basis expenses

### Figure 1b
Salary, running expenses, equipment costs and overhead as parts of external project expenses
Figure 2 Department Research Programs and CoE Centre (per 15.12)

Figure 3 Department positions (per 15.12) - (m) men, (w) women
Organization and research
2010 was the third full year for CEES, a productive year that saw the centre further develop as a consolidated Centre of Excellence with a good body of publications, new scientific advances and exciting topical events. We have generated much media interest in our work, both national and international.

CEES is chaired by Professor Nils Chr. Stenseth. As of 31 December CEES consists of 156 members including students, researchers, technical and administrative personnel. The centre has a core group of 21 employees of which 12 are full-time, one is a part-time employee of the Department of Biology, two are employed by the Department of Mathematics, one by the Department of Economy and one by the Institute of Marine Research. One employee is a visiting scientist at the University of Alberta, Canada, and two Kristine Bonnevie Professors (from Florida State University, USA, and the Norwegian University of Life Sciences) has been working with us. The CEES staff represented 27 nationalities in 2010.

The work of CEES is structured into Colloquia and Themes, the former being focused projects each lasting for three years and the latter consisting of ongoing, long-term work that is accommodated within the centre. This year Colloquium 1 (‘Selection and evolvability: concepts measurements and statistics’) completed the major part of its work and Colloquium 2 (‘Bridging the gap between genomics and evolutionary biology’) started up with a kick-off meeting 11-12 November. Colloquium 2 is expected to be important in regard to the overall goal of bringing ecology and evolution closer together – as well as bridging the gap between genomics and evolutionary biology.

The completion of the full genome sequence of the Atlantic cod, using our two 454-sequencing machines, received widespread global attention. With the full genome sequence we have a basis for addressing many interesting biological questions at a detailed genetic level, such as what makes some individuals mature at an earlier age and smaller size – questions relating directly to our more theoretical work on harvest-induced evolution. We expect to make full use of this data and anticipate that the centre will greatly benefit from it in the coming years; the completion of the Atlantic cod genome and the opportunities that arise from it provide a system in which to interlink all three CEES Themes, forming a model for Colloquium 2: ‘Bridging the gap between genomics and evolutionary biology’. This will further implement our goal of an integrated centre.
As a team we target numerous obstacles for an ecological and evolutionary synthesis using old and new data from the field and the lab. Our research is organized around three mutually dependent Themes: 1) The role of population structuring in adaptive evolution. This year we have focused on effects of habitat fragmentation, on early stages of genetic diversification and on the ecology of microbial communities. 2) The potential for adaptation. In 2010 we particularly focused on human induced evolution, e.g. effects of size selective hunting and fishing. 3) The evolution of reproductive isolation. We have chosen to focus mainly on genetic aspects of reproductive isolation in 2010. Within each research Theme, there is a demand for integration of ecological realism into evolutionary theory, and for evolutionary thinking into ecological modeling. In order to face problems of integrative work, such as conceptual and semantic confusion, and to promote communication across the various research fields (that each have their own limiting assumptions), we will assign targeted projects in the form of four multidisciplinary Colloquia, each of three-year duration. Here we will bring together staff and visiting scientists with experience from a wide range of biological and methodological systems. Each Colloquium will make an excellent setting for inviting highly qualified scientists to collaborate and thus contribute to the overall objectives of the centre. The topics of the Colloquia are: 1) Selection and evolvability: Concepts, measurements and statistics. 2) Bridging the gap between genomics and evolutionary biology. 3) Ecological and evolutionary dynamics of microbial ecosystems. 4) Integration of ecology and evolution: A synthesis.

Colloquium 1: Selection and Evolvability: Concepts, measurements, statistical modeling

This Colloquium focuses on conceptual, statistical and theoretical issues concerned with quantification in biology, with special emphasis on evolutionary biology. It has involved the collaboration of David Houle (Florida State University), Günter Wagner (Yale University), and Hirohisa Kishino (Tokyo University). While many biological disciplines have achieved a high level of statistical sophistication, biology generally lags behind other scientific fields such as physics and economics in its attention to problems of measurement, i.e. to the relationship between data and reality. Formal measurement theory is a mathematical discipline that studies this relationship, but it has rarely been applied to biology. A sub-goal of the Colloquium is to introduce formal measurement theory to ecology and evolutionary biology. More generally, we aim to analyze the quantification of central concepts in evolutionary biology, ecology, and genetics. Concepts such as constraint, evolvability, fitness, rate of evolution, dispersal, and competition are crucial to theory in these fields, and these have all been heavily investigated from theoretical and statistical points of view. What is lacking, however, is attention to the process of quantification of these concepts. How can they be measured in ways that are concordant with their role in theoretical models? For each concept, we examine the theoretical context and models that provide it with meaning, and then investigate the ways in which the concept is quantified, and look at the statistical methods and problems involved in its study.

We discuss problems regarding scaling, transformations, and comparisons across traits and species in meta-analyses and comparative studies. We put particular focus on situations where there is a conflict between the theoretical process models that motivated the research, and the statistical methods that are used to analyze the data. While statistical quantification of data is common, the exact link of the statistics to theoretical parameters is often tenuous, and theoretical meaningfulness may be further obscured by transformations of the data, significance testing, etc.

The scientific output of the Colloquium has been rich, but also diffuse in that it is spread across a large number of papers and projects from the colloquium members, their students and collaborators.
**Colloquium 2: Bridging the gap between genomics and evolutionary biology**

The goal of Colloquium 2 is to facilitate interactions between the knowledge-base of molecular sciences and classical evolutionary theory. Due to the progress of high-throughput sequencing technologies over the past 4-5 years, and the establishment of the Norwegian Sequencing Centre (NCS) we have modified the original scope of Colloquium 2 towards bridging the gap between classical evolutionary thinking and genomics. The Colloquium has been operative since August 2010, but was formally launched in November 2010 with an international meeting at the Academy of Science and Letters in Oslo. Experts in various fields such as ecology, evolution, genomics, theoretical biology and statistics attended.

The Colloquium will take advantage of the broad competence profile at CEES in genomics, molecular biology, ecology and evolution. Key issues and phenomena in ecology and evolution will be addressed by linking molecular and genomics information to conceptual and methodological structures that have not yet been significantly influenced by such information – classical evolutionary biology being a prominent example. This will involve more extensive use of genetic markers and genomics information in current life history projects, as well as identifying new projects where this would represent added value. More importantly, the Colloquium will focus on finding causative genetic variation underlying focal adaptive events – and thus make use of the genome data for Atlantic cod that was generated at CEES (as well as other fish and vertebrate genomes).

Additionally, we have initiated a new project under the ‘umbrella’ of Colloquium 2, with the main goal of providing the foundation for a long-term theoretical-experimental research program addressing the phenomenon of epigenetic inheritance (transgenerational phenotypic plasticity) in a truly integrative way, bridging the mechanistic, ecological and evolutionary explanatory domains associated with the phenomenon.

**Ecosystem-based approach to fisheries management**

Marine ecosystem and the services which they supply are under threat from a wide range of human activities. In order to achieve sustainability, an ecosystem based approach to fisheries management (EBFM) that integrates multiple drivers in a common framework is therefore needed. The overarching aim of the article *Preventing the collapse of the Baltic cod stock through an ecosystem-based management approach* published in PNAS 2009, was to develop a decision-support tool fit for achieving EBFM in the Baltic Sea, an ecosystem heavily impacted by overfishing and climate change. To that end, a theoretical approach for modeling multi-species population dynamics was combined with advanced statistical methods in order to develop a stochastic food-web model integrating species interactions, between cod and the forage fish species herring and sprat, with external forcing through commercial fishing, zooplankton and climate effects. Furthermore, by linking models across sectors, i.e., with climate and bio-economical models, we were able to account for management consequences over a wide range of policy objectives and define overall ecologically and economically optimal management solutions. To that end, our coupled modeling tool demonstrates how by adopting an ecosystem approach we may quantitatively forecast the response of Baltic fish stocks to climate change and take appropriate management actions to mitigate negative effects on future fisheries production. Together with co-authors Christian Möllmann, Anders Nielsen and Nils Chr. Stenseth at CEES, the above mentioned article received the 2010 year’s Ecological Society of America (ESA) Sustainability Science Award. By presenting the ecological need and economic advantage of our ecosystem-based approach it is our hope and ambition to establish the institutional and political will necessary for successful implementation of EBFM in the Baltic Sea and beyond, a vital first step towards achieving long-term sustainability in marine fisheries worldwide.

**Impacts of climate variation on behavior, ecology and evolution**

Effects of climate variability and change on different aspects of biology is a focus of many of the scientists at CEES. This is reflected by authors at CEES having contributed to no fewer than 22 ISI-listed papers with ‘climate’ in the abstract or keywords in 2010. These papers cover a wide range of systems and species, from (human plague) bacteria to cod and perch, spring-fruiting fungi and evolutionary history of the *Arabidopsis lyrata* complex to interacting effect of wolves and climate on caribou recruitment. Two more detailed examples are given here:
Quantification of climate impact on ecology are complicated by interactions within and between species causing indirect, often delayed, effects. This was demonstrated by a study on the first life stages of key fish species in the Norwegian Sea–Barents Sea ecosystem and their predators, competitors and zooplankton prey. By analyzing growth and survival from one life stage to the next (eggs–larvae–juveniles–recruits), evidence for both bottom-up, direct and top-down effects of climate were found. Whilst all species experienced improved growth and feeding conditions in a warm year, cohorts born in the following year will experience increased predation and competition because of increased densities of sub adult cod and herring, leading to delayed climate effects. These findings exemplify that climate impacts are to some degree propagated to later life stages when density dependence is strong.

Human cases of plague (Yersinia pestis) infection originate, ultimately, in the bacterium’s wildlife host populations. The epidemiological dynamics of the wildlife reservoir therefore determine the abundance, distribution and evolution of the pathogen, which in turn shape the frequency, distribution and virulence of human cases. Earlier studies have shown clear evidence of ‘climatic forcing’ on contemporary plague abundance in rodents and humans. A CEES-led study concludes that Central Asian climate fluctuations appear to have had significant influences on regional human plague frequency in the first part of the 20th century, and probably over the past 1500 years. Furthermore, as plague activity in Central Asia seems to have followed climate fluctuations in past centuries, the authors expect global warming to have an impact upon future plague epidemiology, probably sustaining or increasing plague activity in the region.

While the broad scope shown above is one of CEES’s strengths it is also a challenge. Cooperation within established disciplinary groups functions well, but there is a need to foster closer collaboration across these groups. Towards this means an Action Group was formed in December 2010. This is an arena for learning about colleague’s climate-related work through short presentations and discussions, sharing data and exchanging knowledge on methods, software, literature, journals, and web sites. The Action Group ultimately exists to provide the environment for establishing cross-disciplinary/ cross-habitat teams working on common papers.
Economics and biology of harvesting in the Barents Sea

The fishery in the Barents Sea and around Lofoten is of great cultural importance to Norway. The North-East Arctic (NEA) cod stock, which is currently the largest cod stock in the world, has been harvested for thousands of years. Until this day, it has been a source of wealth and will continue to be so if it is harvested in a sustainable manner. Our research suggests ways in which the economic value of this natural resource could be significantly increased, and how improved management could lead to a much more abundant fish stock of better quality. The cod stock of the Barents Sea is shared by Russia and Norway. The performance of the fishery has improved in recent years with the introduction of a harvest control rule by the Joint Russian-Norwegian Fisheries Commission, and the problem of illegal, unreported and unregulated (IUU) fishing appears to have been curbed. Current quotas are large and the spawning stock biomass is at a record high. Does this mean that management has achieved its aims and that our concern has become obsolete? Not quite: although conditions look good on the surface, there have been dramatic changes within the fish stock. It now consists of fewer and younger age classes; while fish older than eight years made up more than half of the stock’s biomass after the Second World War, this share has now dropped to less than 10%. Additionally, the age at maturation has fallen and there are growing concerns that this has been caused by fisheries induced evolution. Currently, fish are targeted from an age of three to four years. At this age, the value of the cod would continue to increase by approximately 20% per year; it is therefore a bad investment to harvest the fish at this age. It is this aspect that our studies concentrate on. By combining biology with economics, we have developed a detailed model of the NEA cod fishery. We optimized fishing effort and gear selectivity to find the harvesting pattern which would maximize the profits for the fishery. A fundamental insight from fisheries economics is that optimal management implies a large standing stock, so that many fish can be harvested per unit of effort. This can be achieved by effectively sparing the young fish from being harvested. Our model calculations show that the average annual profits could be more than doubled from 0.93 billion NOK to 2.06 billion NOK. Even at current effort levels, targeting only fish that are older than 8 years leads to average profits of 1.96 billion NOK. The importance of optimal gear selectivity has been largely overlooked in the literature to date.

The second part of our research analyses the forces that could lead to targeting fish that are too young. We model the joint exploitation of Barents Sea cod as a non-cooperative game. Incidentally, the resulting Nash-equilibrium is close to the current harvesting pattern. The fundamental problem is well summarized by the ‘tragedy of the commons’, that is, no nation can be certain that fish left in the ocean as an investment for the future are not taken by the other nation, and therefore each nation has an incentive to overfish. Our research shows that this particularly materializes as ‘growth overfishing’, i.e. catching fish before they have grown to a decent size. It is therefore necessary that gear selectivity is recognized as an important tool for fisheries management. In light of the recent advances in the Barents Sea, there is hope that this issue will be highlighted.

Climate influences on the behavior of deer

Despite great interest in climate impact on populations and ecosystems, there are few studies of behavioral responses to climate in mammals. Populations of all species of deer are influenced by annual climate variation, but it can be difficult to determine the underlying mechanisms. Using individuals fitted with GPS transmitters that send hourly position data throughout the year, researchers at CEES have conducted a series of analyses on behavioral responses to climate change in red deer, moose and Svalbard reindeer. Red deer increased the size of their home range with increasing temperature in the winter, whilst increasing snow depth decreased movements. During summer, home range size decreased with increasing temperature. This correlation was strongest when measured over longer periods, suggesting that increased temperature results in higher quality and/or more abundant forage, reducing the area that the red deer use to meet their energy needs. Moose, however, were more influenced by ambient temperature, suggesting that the direct effects of warm weather are more important to moose than red deer. During years with icing events, the pastures of Svalbard reindeer can be virtually ‘locked’ by the ice (i.e. ice layers limit access to forage). Crashes in reindeer populations have been documented during such events, with up to 60% of the reindeer dying during the win-
Analyses of space use affirm that the reindeer react immediately to icing events by seeking out other areas without ice outside of their normal home ranges. This means that some individuals are able to buffer the effects of local icing by relocating to favorable, ice-free areas, and survive. If the trend of climate warming continues, the extent of ice sheets may increase. These behavioral studies suggest that reindeer may experience an upper limit at which individuals are no longer able to find ice-free areas within their search radius. If this happens, Svalbard reindeer face an uncertain future. Behavioral studies can therefore provide critical information when attempting to predict future effects of global climate change.

Egg-rejection behavior in hosts of avian brood parasites

Around 1% of the world’s known bird species are obligate brood parasites, and rely on other bird species to raise their offspring. Hosts often pay a high price when successfully parasitized, since the offspring of many parasite species will kill all host offspring within a nest. The result is a co-evolutionary arms race, in which the host evolves new defenses against parasitism, and the parasite evolves new tricks by which these defenses can be bypassed. A central and particularly well-studied defense against parasitism is the ability of many hosts to reject odd-looking eggs, which in turn has selected for egg mimicry by the parasites. Egg ejection has been thought of as a difficult trait to evolve in hosts, since it seems to require both the ability to recognize eggs and the behavior needed to remove them. In this study we constructed an optimality model of egg rejection that allowed for a wide range of host behavioral tactics to be used, including the acceptance of all eggs, single-egg ejection, multiple egg ejection, and nest desertion followed by re-nesting. Experimental studies have revealed that some hosts are more likely to reject parasite eggs after observing adult parasites near the nest, and such effects were also incorporated in the model. The model predicts that egg ejection can be beneficial even when hosts cannot discern between own and parasite eggs, which suggests that egg ejection could evolve as a defense strategy prior to the evolution of egg recognition. The model also demonstrates that within-population variation in egg rejection behavior may represent flexible and optimal rejection behavior, and not necessarily maladaptive behavior or constraints as commonly assumed. For instance, multiple-egg ejection is often explained as the result of accidental damage to other eggs when hosts attempt to eject a single egg. However, multiple egg ejection may in some cases simply be the most effective way to reduce the risk of a parasite being in the nest.

Functional analysis of the gastrointestinal (GI) microbiota

Gut microbiota have been shown to be of great importance to the development and health of animals, humans included. During the last decade tremendous progress has been made in the characterization of the components of the GI microbiota, and the significance of these components in health and disease. Nevertheless, our understanding of the GI microbiota as an ecological system remains limited at best. Consisting of several hundred species and thousands of strains, a functional analysis of this system is a daunting but worthwhile task; a more complete understanding of the ecology of the GI microbiota would be invaluable in the design and administration of...
therapeutic strategies, as well as in the prevention of common maladies such as obesity, diabetes and various allergies.

In order to achieve a functional description of the GI microbiota as an ecosystem we need to identify the mechanisms through which its members interact with each other and with their host, and how these interactions impact the dynamics of the system as a whole. The application of ecological modeling may allow us to develop a more detailed understanding of the parameters that determine the dynamical properties of the GI microbiota. Knowing how the growth of one group of community members relates to that of other groups, as well as to more external factors, would enhance our ability to explain several phenomena of general interest. Events of considerable medical importance, such as shifts in ecosystem composition that lead from healthy to dysbiotic states, invasion of pathogens into the established community, and the community level impact of therapeutic intervention, are best understood from an ecosystem point of view. A functional ecological model of the GI microflora would potentially allow us to predict under what circumstances the system is susceptible to the occurrence of such events, and to devise new means of countering unfavorable dynamics by restoring system stability.

CEES has a strong and longstanding tradition in the statistical modeling of ecosystem dynamics. Traditionally this kind of modeling is done by analyzing time series data of population abundances and other relevant variables relating to environmental conditions, in order to identify and quantify the factors that are the dominant drivers of dynamics. We have applied this approach to microbes, both in laboratory- and in vivo settings (Trosvik et al., 2008, 2010, 2010). More recently, we have characterized the population structure of *Escherichia coli* in a cohort of Norwegian mothers and their infants (de Muinck et al., 2011). We are currently studying the interaction parameters that determine colonization patterns by using population structure information, full genome sequencing and in vitro experimental systems. In addition, we are comparing innocuous *E. coli* with strains isolated from sick infants to understand the evolution of pathogenicity.

In general, there are several features of experimental microbial systems that make them especially suitable for addressing basic issues of general biological interest. Short generation times allow for the collection of population data on evolutionary time scales. Large populations grown in small spaces in the lab facilitate experimental replication and manipulation of environmental conditions. Experimental cell samples may be frozen in suspended animation, creating a revivable fossil record. Genomic tools, as well as the means for genetic manipulation, are highly developed and affordable. As such, this kind of system allows us observe, in real time, the interplay between ecological and evolutionary processes.
The Integrative Biology program represents a broad range of research areas, such as ecophysiology, taxonomy, human toxicology and ecotoxicology, life history traits, linking life history and effects of environmental variations, population biology, environmental modeling and ecological stoichiometry. Toxicology is identified as a strategic research area (‘emerging research area’) by the Faculty.

The program, established in its present form in 2007, comprises seven professors, two associate professors, two postdoctoral fellows, three technicians, 10 PhDs and 5 external PhDs (registered at UiO, but do most of their research at other institutions). Toxicology is one of three master’s study programs in biology, and we supervise around a third of all master students at the Department. The staff is involved in courses both at bachelor and master levels.

The master students’ work is generally linked to larger ongoing projects or PhD-projects. There has been an increasing need for toxicologists in Norwegian society, and following graduation (MSc), most candidates have been quickly employed in management, research institutes, consultancy or industry.
Within toxicological research, we have over the last years focused on interactions between environmental stressors, effects of offshore activities and oil as well as development of biomarker methods to understand effects of contaminants in marine ecosystems within the NRC funded project INTERACT. In addition, there is a current activity on developing cell based methods and methods by which to study mechanisms of oxidative stress and DNA damage. In addition to analytical methods, particularly biomarkers, the group has established different experimental systems according to the scientific issue being tackled and is at the forefront in developing and using long-term fish exposure systems, caging systems, sediment mesocosms and pelagic mesocosms.

We have also investigated fundamental processes through using one or more external modulating agents. A recent project has e.g. followed the maturation process of Atlantic cod and how this was affected by low concentrations of substances released by offshore oil and gas platforms. The project has resulted in new knowledge about the temporal development of symptoms relating to the exposure (important to be able to interpret observations in nature), but also about natural processes in cod. In other projects we investigate the development of oxidative stress in cell systems under various conditions, including chemical stressors. A spin-off is increased understanding of fundamental processes relating to cellular defense mechanisms under different physiological states.

Ecological stoichiometry builds on the concept that all living organisms are constructed over the same general template. Recognizing that vital rates and stoichiometry are linked through the causal chain of growth rate, protein synthesis, ribosome density, and cellular P content has recently lead to a partial merge between the metabolic theory of ecology and ecological stoichiometry. The main contribution to ecological stoichiometry is the focus on interactions between temperature and food stoichiometry comparing several phylogenetically distant organism groups. In the stoichiometric approach to ecology there is often a focus on how imbalances between carbon fixation and mineral nutrient acquisition in autotrophs can lead to reduced growth efficiency in herbivores. In a recent project, we explore how the same stoichiometric principles can be applied for optimizing the lipid yield in experimental biofuel reactors.

Research on linking life history to effects of environmental variation combines studies of tolerance to climate stress (ecophysiology), phenotypic plasticity in life history traits (acclimation, thermal reaction norms), phenology and spatial heterogeneity with population dynamics and species interactions. Studies are done in experimental model systems as well as in the field, with terrestrial arthropods and in freshwater systems. Climate change impact on the Arctic and sub-Arctic soil systems have been studied in a long-term project since 2001. The focus is on physiological ecology and soil biology, with experimental investigations on soil fauna, plant and microorganism interactions, decomposition processes and food web complexity. A recent project concerning blowflies on stockfish has allowed a detailed study on life cycle and phenological strategies of the fly species involved, and improved knowledge of blowfly life history has been used to develop strategies for reducing the damage on stockfish.

Habitat variation and community dynamics
Lakes are ideal systems for testing predictions and responses related to biodiversity since they are units with well-defined boundaries, as inverted islands isolated by land. A strong east-west gradient in both phytoplankton and zooplankton species richness makes a longitudinal transect across Norway and Sweden and is a natural laboratory for investigating effects of biodiversity on natural lake ecosystem functioning. The relationships between species pool saturation, ecosystem functioning, and vulnerability to bioinvasions will be approached by field sampling of natural biodiversity gradients, classical and molecular measures of phyto- and zooplankton biodiversity, and up-scaling by predictive modeling tools. Statistical modeling will also be used to disentangle effects of multiple stressors like eutrophication, climate change, and invading species on the ecosystem services of lakes.

Integrative projects. One such project involves collembolans and quantification of DNA-damage in collemolan hemocytes by the Comet method

An overarching ambition of the program is to include the above research areas in an integrated approach to answer fundamental questions in ecology and toxicology, such as clarifying underlying mechanisms for the vulnerability of
species towards environmental changes and how individual fitness have consequences for population development. Research within the program addresses variations in the physical and the chemical environment, and how they may affect fundamental processes of life. Such studies have particularly included interactions between factors such as climate, habitat, nutrient stoichiometry and the influence of stressors such as oil and xenobiotics. There is an ongoing project that addresses interactions between the factors of nutrients, oil and xenobiotics in marine systems.

In order to understand the effects on population and community level, the program also incorporates habitat heterogeneity, habitat fragmentation and demographic processes into the experimental and analytical approach. The possibility to investigate links between individual performance, population growth and the dynamics of species assemblages is one of the aims of this integrative approach, being a fundamental background for understanding the effects of environmental change on natural systems, and thus contributing to the ability to predict future effects. Life history traits, such as growth rate, age and size at maturity are central response variables in our focus on phenotypic responses, but also important determinants of population responses. Species-specific differences in these responses may have great effects on species interactions, and thus on community structure and ecosystem functioning. An important challenge is to improve our understanding of direct compared to indirect effects of environmental variables and why related species may react very differently on environmental changes, and to what extent this might affect their co-existence. This clearly also has implications for invasive species.

Our focus on ecosystem functioning and ecosystem services is primarily linked to questions concerning productivity in freshwater systems and in higher plants, and the interaction between soil fauna and decomposition processes in the soil. These questions will be more closely linked to our studies on species assemblages and biodiversity. The ongoing integrative approach in the studies on effects of environmental changes and in developing systems to investigate links between molecular and subcellular processes and individual fitness and further to population dynamics of a species, is at the front of current research in this area. Such approaches, based on simple principles such as laws of mechanics, mass and energy conservation, as well as natural selection, have inspired important research trends in biology in the last decades, such as the metabolic theory of ecology and ecological stoichiometry.

Originating within relatively narrow circle of limnologists, ecological stoichiometry is now recognized as an important integrative principle across a range of biological disciplines, from cell physiology to global biogeochemical cycles, and even with applications to cancer research and astrobiology.

The experimental nature of the research activity in the program requires terrestrial and aquatic model systems that are well understood and amenable to manipulation. This work includes both experimental design and mathematic/statistical modeling, with model systems ranging from cell cultures to population assemblages. The scientific staff of the program has extensive experience with experimental work on appropriate systems, e.g. collembolans, rotifers, cladocerans, selected plant species, marine fish species and sediment-dwelling organisms. There is work in progress to establish compact and flexible exposure systems, which may be designed for experimental studies at high degree of complexity, including multi species interaction and interaction between environmental variables. The chosen model organisms are currently used in experiments in simplified cultures and in micro- and mesocosms, as well as in field studies and field experiments. The expertise in molecular and cellular methods currently available in the toxicology group will be applied in approaches to understand mechanisms underlying individual responses to climate modulation, environmental stress and nutrition.

As will be apparent, a large part of the research activity within the program concerns the effects of environmental changes on natural biodiversity and human livelihood, issues clearly relevant to society. In particular, hazardous substances, eutrophication and climate change are on the political agenda and receive attention by the media.
Scientific collaboration, representation and outreach

The toxicology group has close collaboration with human toxicological research groups and ecotoxicological research groups. In Norway main collaborators have been the National Institute for Public Health (genotoxicity), Norwegian College for Veterinary Sciences (microarray, autoradiography, reproductive toxicology), the Norwegian Institute for Water Research (toxicity testing, food-web modeling, sediment processes, analytical chemistry, passive samplers) and the University of Bergen (pelagic ecology). In addition to a well-established ICES network, including marine research institutes from most European countries with an Atlantic coastline, the group collaborates on a regular basis with colleagues at universities in Bilbao, Göteborg, Plymouth, Porto, Vigo, Stockholm and Zagreb. The group is currently co-coordinating an international project (ICON) based on the ICES network. Recent RCN projects have involved colleagues from Croatia, Spain and UK, and the group currently co-ordinates two WPs in an EU project with colleagues from Spain, Portugal and France. The national and international collaboration has ensured high-quality projects and has been used a mechanism for exchange of methods and training of MSc- and PhD-candidates.

Members of the group have chaired and contributed to a range of national and international organizations and have contributed substantially towards supranational processes, particularly in occupational toxicology, risk assessment and marine environmental issues. This includes work in OECD, ICES, OSPAR, JRC and EU working groups and committees. In 2010 a member of the program chaired a government-appointed commission that recently submitted its report on how to reduce exposure to hazardous substances in Norway (http://www.regjeringen.no/nb/dep/md/dok/nou-er/2010/nou-2010-9.html?id=622877).

The ecological stoichiometry group has from the start had close collaboration with key researchers in this field from USA, Europe, and Japan, a collaboration which has also resulted in exchanges of PhD students.

National collaboration on terrestrial arthropods involves Norwegian School of Veterinary Science and Institute of Health and Society, Faulty of Medicine, University of Oslo (PhD-project on the transport of tick borne pathogens with migrating birds), and the Norwegian Institute of Public Health (PhD-project on blowflies on stockfish). Through a Norway-South Africa collaborative framework there has been close integration of projects between Norway, South Africa, Sweden and France with a focus on climate adaptation, life history, population biology and biodiversity of springtails. The main partners are Centre for Invasion Biology, Stellenbosch University, Department of Ecology, Swedish University of Agricultural Sciences and Museum National d’Histoire Naturelle, Paris. There is also collaboration with the University of Copenhagen and the Danish National Environmental Research Institute within the fields of soil food web dynamics, climate change effects on the soil system, and on the study on combined effects of toxic and climatic stress in arthropods.
Marine Biology Program (MB)

www.mn.uio.no/bio/forskning/grupper/marinbiologi

The MB research activities focus on marine pelagic ecology, benthos ecology and algal biodiversity and systematics. MB presently consist of 4 professors, 2 associate professors, 3 adjunct professors/associate professors, 2 post docs, 5 internal and 3 external PhD students, 2 technicians and 20 master students. Although marine research is carried out to some extent within all four programs at the Department, the Marine Biology program is responsible for the marine curriculum.

The program has contributed to understanding the taxonomy and systematics of marine species, their interactions, how they respond to their environment, the general patterns of marine diversity and how the structure of marine assemblages relates to the functioning of such systems. This research spans not only the long coastline of Norway, it extends to polar and tropical seas. The research is conducted in the field and in the lab, using observational and experimental approaches. The expertise ranges from molecular techniques, advanced microscopy and video tracking to acoustics and community studies, and statistical analyses and modeling. The basic research carried out in the program has implications for ecosystem understanding and thereby ultimately management of marine resources.

**Pelagic ecology and behavior**

The research focuses on different aspects of plankton interactions, dynamics and diversity in the pelagic habitats. Studies address responses of individual plankters, and how plankton community composition and abundances vary in time and space as a function of environmental forcing. The research group takes advantage of easily accessible, sheltered and deep fjord locations, each selected to address a particular topic, using modern hydroacoustic methods in novel ways. To exemplify, swimming behavior of krill has been addressed in fjord branches with very weak currents; the effects of hypoxia on the pelagic fauna is studied in fjords with low oxygen levels; behavior of mesopelagic fish and jellyfish is studied in fjords providing superior conditions for these organisms. Currently, the biology of mesopelagic fish in the oligotrophic and warm Red Sea is compared with mesopelagic fish in the murkier and seasonally productive Norwegian waters. Research also includes krill, salps and mesopelagic fish in Antarctica, acoustic studies of fish in the hypoxic part of the Benguela current off SW Africa, and studies of plankton distribution in relation to bowhead whales in Greenland.

A research focus is also on small scale behavioral interactions in crustacean and jelly plankton. These activities involve a mix of experimental and field work, and sometimes mechanistic modeling. To study the dynamics at species level of virus, pico- and nanoplankton, and the role of virus for phytoplankton bloom dynamics, molecular methods are combined with advanced microscopy and flow cytometry.

At the Biological Station in Drøbak a project is studying reactions of fish and pelagic crustaceans to sound. Setups where behavioral responses can be observed (video) in response to acoustic stimuli have been developed. The aim is to understand how predation has influenced the evolution of peripheral senses in fish and zooplankton. The group also investigate the impacts of seismic noise on fish and marine mammals, aiming to understand how predation has influenced the evolution of peripheral hearing mechanisms in fish (mainly), and how behaviors of different groups of fish are affected by high intensity sound pulses such as from seismic exploration activities, monopiling etc.

**Benthic ecology and interactions**

Benthic ecology and interactions focus on experimental ecological studies of macroalgal systems to elucidate why large areas of kelp forests have disappeared and become barren along the coast. Food web studies have clarified the importance of kelp as a food source and a habitat creator. Additionally, the role of sea grass systems for holding high biodiversity has been explored, and one of the research fellows will work on biodiversity in relation to disturbance within sea grass systems.
The studies in both kelp and sea grass systems are carried out in close collaboration with the staff at NIVA.

**Biodiversity and biosystematics**
The group has worked with patterns in biodiversity and developed a model for estimation of species abundance distributions (SADs). The model has shown to be useful for a range of different ecosystems and has recently been applied to fungal, plant, macroalgal and plankton communities to study community structures and estimate species richness.

The research has also focused on population dynamics, biology of seals (diet, parasites and lipid compositions), fish biology, biodiversity and detection of disturbance on communities due to human activity.

Marine protist biodiversity is explored within the EU project BioMarks by combining high-throughput 454-sequencing, advanced microscopy and a range of other methods. This work is conducted in collaboration with partners abroad and at MERG and IB. We have also explored biodiversity of protists/algae in Southern Ocean and Arctic (within BIPROPOL and AKES).
We also cooperate with leading marine biological research institutes in Europe and elsewhere through our EU and national projects.

The program supports yearly participation at conferences for scientists, technicians and MSc students. Together with IB we arrange weekly seminars with staff or guests as speakers.

Faculty staff regularly participates in outreach activities in TV, radio and newspapers, and publish in popular scientific journals and books. A web page shows in real time the life in a fjord recorded by echo sounders (http://www.oceanobservatory.com/news/masfjorden). The Biological Station in Drøbak arranges field courses in marine biology (16 weeks per year) for secondary schools, colleges and universities in Norway and abroad.

One of the staff members chairs the national expert group that evaluates environmental impacts of offshore and gas activities, and has led the development of national guidelines for sediment risk assessment. Our research has contributed to a more sustainable management and trawling of kelp. We have contributed to knowledge on toxic algae and causes for harmful blooms, and have produced national lists of invasive and threatened macroalgae.

**Algal/protist systematics and evolution**

Algal taxonomy, phylogeny and evolution are research areas with collaboration between the research programs MB, MERG and CEES. The MB group has described several new microalgal species and combined morphological and molecular data to systematically place new species and to revise the taxonomy within several algal groups. Harmful algae that bloom in Norwegian coastal waters and elsewhere have been studied for decades. These studies include morphological and genetic characterization and phylogeny, genetic diversity and distribution, molecular probe development for detection and monitoring, culture experiments to clarify growth preferences and toxicity, and genomic analyses of genes expressed and phenotype. The research is now performed through the EU-project MIDTAL and several RCN and UiO projects.

**Applied and basic research**

While most of our research qualifies as basic research, we also engage in applied research focusing on effects of pollution, fisheries and other anthropogenic disturbances on marine benthic faunal communities, and on changes in kelp forests and in eel grass systems, harmful algae and development of monitoring tools. We are involved in studies on prospecting for bioactive compounds in aquatic organisms. Other projects target detection and ecosystem implications of invasive species (jellies, macroalgae, toxic algae).

**Scientific collaboration, representation and outreach**

MB cooperates with MERG and CEES on protist and cyanobacterial evolution and genomics, and with IB on algal physiology, plankton ecology and modeling. IB also has activity in marine toxicology, which is part of MarLis. There is well developed collaboration with NIVA in research and education, and several researchers at NIVA hold adjunct positions at UiO. We collaborate with NIVAs research group on marine benthic systems, IMR on pelagic ecology, with VI on harmful algae, University of Bergen on pelagic and benthic ecology and biodiversity, NTNU, UNIS, NPI on polar biology, GI on benthic soft bottom systems, Fi on marine biochemistry and IMBV on fish physiology and advanced microscopy.
Microbial Evolution Research Group (MERG)

The research program MERG integrates ecological and evolutionary approaches to solve basic questions in microbial biology. We aim at answering ecological and evolutionary questions related to microorganisms, i.e. bacteria, fungi and protists (unicellular eukaryotes), and also address theoretical and methodological approaches to solve challenging questions within health, environment, climate, energy, and food production. MERG has a scientific staff of 5 professors, 2 associate professors, 2 adjunct associate professors, 7 post docs, 4 technicians and 1 infrastructure project leader. In addition, we have 13 PhD fellows (internal and external) in the research group.

The faculty staff has experiences from field-biology, stoichiometry, bioinformatics, genetics, taxonomy, systematics, mycology, protistology, general microbiology, limnology, ecology, evolutionary biology and statistics. Our research and teaching are interdisciplinary and aim at creating synergies across a wide range of sub-disciplines.

**Microbial functioning**

We use various –omics approaches (e.g. metagenomics, transcriptomics, metabolomics) to investigate the function of microorganisms in their natural habitats, and how the genomes have been shaped by ecology of the microorganisms over time. For instance we use metagenomic approaches for comparing microbial diversity at the sea floor and in oil reservoirs in order to understand which organisms (and their relative proportions) and which genes (i.e.; biochemistry) are present in different deep sea sediment ecosystems and oil reservoirs. We study genomes and transcriptomes of cyanobacteria and eukaryote algae with particular focus on toxin producing genes and gene clusters in relation to molecular function, the ecology of the organisms, and horizontal gene transfer processes. These studies also aim at understanding evolution of genes and genomic rearrangements. Toxic compounds and potential toxic algae are characterized and connected to projects for development of detection assays for harmful organisms and their compounds.

**Microbial diversity**

Several projects in the past have focused on revealing unknown microbial diversity (both prokaryotes and eukaryotes) by applying PCR on environmental sampled DNA, including an EU-funded project on characterizing diversity of unicellular eukaryotes and fungi. Beside marine habitats we have investigated freshwater lakes, terrestrial systems and air born spores. We have recently moved our attention to eukaryote microorganisms that act as symbionts and parasites in plants, marine animals and planktonic heterotrophic protists. These studies have revealed a tremendously large diversity that has been unknown. We have published new concepts and implemented next generation sequencing technologies. Another development is the use of whole genome amplification of single cells that are uncultivated. By picking cells from marine environments and optimizing this molecular approach we have been able to reveal both the host and symbiont diversity in selected groups of eukaryotes.

**Phylogeny and evolutionary genomics**

We study evolutionary relationships and classification, from species to domains of life, by using molecular and morphological data. Over the last few years we have applied phylogenetic, genomic and transcriptomic approaches to resolve major questions about the Tree of Life and character evolution and transitions and innovations in the history of life. We have investigated the relationships of supergroups and the origin of enigmatic radiolarians © Kjell Bjørklund
eukaryote lineages (Ministeria, Breviata, Telonemia and Collodictyon), resulting in articles that suggest substantial revisions of the eukaryote Tree of Life. We also address evolutionary questions that played key roles in the transition from unicellular to multicellular animal and plant life. We study speciation processes among eukaryote and prokaryote microorganisms and the evolution of chloroplasts, mainly secondary and tertiary plastids among dinoflagellates, by including species and specimens from different habitats and environments. We have revealed that differences among habitats, such as for instance fresh water and the oceans, constitute a substantial barrier against dispersal and hence are a major constraint in speciation processes among organisms living in such habitats. We have inferred the phylogeny of prokaryotes and identified ecotypes among cyanobacteria and habitat-specific distribution of SAR11 bacteria.

**Microbial populations and communities**

Microbial communities, their structure and dynamics, are analyzed using high throughput sequencing techniques in combination with traditional synecological approaches. Examples of such analyses include exploration of fungal communities in the plant rhizosphere, within living plants (endophytes) and within dead wood. We analyze the population and biogeographic structure of microorganisms and try to find out at which spatial scales microorganisms are structured and dispersed. We study interactions between microorganisms, such as symbiosis and parasitism, and how abiotic (e.g. climatic changes) and biotic factors (e.g. parasitism) affect and regulate the spatial-temporal characteristics of microbial populations. One of the projects aim at understanding the interaction between strains of fungi and cyanobacteria, e.g. interactions between cyanobacterial ecotypes and chytrid fungi.

**Bioinformatics, molecular methods and databases**

From its early emergence, MERG has focused on bioinformatics, and in integrating novel computational and molecular methods into our research. We have developed bioinformatic applications useful for ecological and evolutionary studies and built databases applicable for fungal species identification. These pipelines and applications, including applications for identification of genes, taxa, functional annotation, gene and genome comparisons, multiple sequence alignments and multigene phylogenies, make surveys of environmental DNA and phylogenomics more feasible to researchers in the field. The projects have resulted in papers and publically available services. Recently, we have developed better tools for diversity surveys of environmental DNA samples and for genomic studies of single cell.

**Scientific collaboration, representation and outreach**

MERG is a part of a larger microbial network at the MN-faculty that includes LaMDa (Dept. of Pharmacy) and GlycoNor (Dept. of Molecular Life Sciences). Currently we collaborate on research projects in the field of metagenomics, genomics, microbial interactions between plants, bacteria and fungi, and organelle biology. We are also involved in the national Plant network and contribute to proposals to the Research Council of Norway for a national, large infrastructure allocated to plant biology research. Our labs for culturing, experiments and storage of microorganisms are made available for the Plant network. We also work together with the Dept. of Informatics on establishing an extended bioinformatics core facility at UiO.

Our staff is collaborating with scientists at leading universities in Europe and USA and Canada and we are presently participating in a large EU network (Biomarks) with common interest of investigating the eukaryote microbiology in marine environments. MERG is heading the Nordforsk research network ‘Fungi in boreal forests’, focusing on implementation of high-throughput sequencing technologies and identification arrays for fungal ecology research. About 15 North European research groups are participants in the network, including ca. 100 researchers and students.

We have for years collaborated and published with colleagues across Europe, North America and Japan, which have had a tremendous positive impact on our research activities and scientific publications. Most of our research is directly or indirectly of great relevance to the society, including projects such as bloom-forming toxic cyanobacteria and dinoflagellates, mycorrhizal symbiosis, climate change, habitat fragmentation related to conservation biology, monitoring of invasive crayfish plague, deep sea metagenomes of oil reservoirs and abundance of parasites and harmful organisms.
Teaching

The Department of Biology awards the Bachelor’s, Master’s and PhD degrees in biology, and teaches courses at all levels. External students also take our courses as part of their study programs. This mainly applies to students at IMBV and students following the Educational Studies program in Natural Sciences.

In 2010 we taught 41 courses; 10 Bachelor, 29 Master- and 2 PhD-courses. Figure 5 shows the total number of credits produced from 2007 to 2010.

Bachelor’s degree program

The Bachelor’s degree program provides a broad understanding of biology and imparts basic knowledge of natural sciences, such as mathematics, statistics and chemistry. The cornerstones of the program are the study of biodiversity, the structure and function of organisms, interactions between organisms and their environment (ecology) and evolution processes. Laboratory and field work are also emphasized in the Bachelor’s degree program. In 2010 we taught 10 Bachelor courses, where 6 were compulsory courses for the Bachelor’s degree. 82 students enrolled in the program in 2010.
Master’s degree programs

The Department offers three Master’s degree programs which are Ecology and Evolution, Marine Biology and Limnology, and Toxicology. Additionally, we offer Master specialization in biology for students at the Educational Studies program. The Master’s degree program consists of courses corresponding to 60 credits and a science-based thesis corresponding to 60 credits (for the students enrolled in the Educational Studies program, the thesis corresponds to 30 credits). The thesis shall provide skills within field and laboratory work, report based writing, statistical analysis and research presentation.

The number of students on the Master’s degree programs are shown in figure 6, and the 2010 Master candidates and their thesis titles are listed below. The number of Master students per 31.12 was 96.

![Graph showing admission to Master programs 2007-2010](image)

*Figure 6 Admission to Master programs 2007-2010. (The programs Evolution and biodiversity and Ecology were phased out in 2009.)*

PhD study

The doctoral program builds upon a Master’s degree in biology. The study is intended for those who want to qualify for academic positions or other occupations demanding high professional qualifications. The PhD study lasts for 3 years.

16 candidates defended their doctoral degrees in 2010; 15 PhDs and 1 Dr. Philos. Per 31.12.2010 the Department had 58 PhD students.

Student advisors

The Department has 3 student advisors who administrate the programs, deal with admissions, organize the courses and exams and provide student counseling among other tasks.
Courses given at the Department per 31.12.2010

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<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Credits</th>
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<td>BIO1010</td>
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<td>Evolution and systematics of organismal groups: plant kingdom</td>
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<td>Evolution and systematics of organismal groups: fungal kingdom</td>
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Master candidates 2010

Engebretsen Pettersen
‘Migration patterns and taxonomy of Dryas octopetala L. in the North Atlantic region’

Nina Hårdnes
‘Effects of perfluorooctanesulfonate (PFOS) and perfluororonanoic acid (PFNA) on protein expression and steroidogenesis in the human adrenocortical carcinoma cell line H295R’

Ida Schaanning Forsberg
‘Hvordan Littorina littorea – Vanlig strandsnegl påvirker gjenvekst i fjæresonen etter en isskurings situasjon’

Charlotte E0riksen
‘Betydningen av oppvekstforhold og kondisjon for sang hos ettårige kjøttmeis (Parus major): en feltstudie’

Irene Beate Sørvik
‘Effects of two DDT metabolites and one synthetic DDE-analogue on testicular steroidogenesis in LH-stimulated neonatal primary porcine Leydig cells in vitro during neonatal development’

Dan Kristofer Ree
‘Development of a protocol for environmental PCR of 18S rDNA V4 region and diversity survey of freshwater protists using 454 Titanium pyrosequencing’

Maria Mæhle Kaurin
‘Vertical and horizontal distribution of mesopelagic fish in the oceanic areas of the sub-Antarctic and Southern Ocean’

Tonie Leonora Torgrimsby
‘En undersøkelse av planktoniske protister og mageinnhold til Antarktisk krill, Euphausia superba, i den atlantiske sektor i Sørishavet, ved bruk av ribosomalt DNA som markør og lysmikroskopí’

Eivind Dypvik
‘Invers døgnvandring og fødebiologi hos nordlig lysprikkfisk (Benthosema glaciale) i Masfjorden’

Jeanette Heimvåg
‘Betydningen av oppvekstforhold og kondisjon på sang hos ettårige blåmeis (Cyanistes caeruleus’

Per Erik Johansen
‘Cryptomonader som indikatororganismer for vannkvalitet. Vekstforsøk med Plagioselmis lacustris (syn. Rhodomonas lacustris) i vann fra en forsuringsgradient’

Marte Bruu Tanum
‘Effects of two DDT metabolites and one synthetic DDE-analogue on testicular steroidogenesis in primary porcine Leydig cells in vitro’

Åshild Setvik
‘Effects of Water Based Drilling Muds on Recolonization of Sandy Soft Bottom Communities’

Renate Myking Fossdal
‘Multilocus DNA sequencing of a widely distributed wood-inhabiting fungus reveals two main lineages with overlapping ranges in Europe: do hybrids occur’

Anette Øwre Bollvåg
‘Mitochondrial Ewe-application of ancient DNA typing to the study of domestic sheep (Ovis aries) in mediaeval Norway’

Iselin Rynning
‘Kjønnsforskjeller i risiko for lungekreft: Karakterisering av østrogenreceptorer og kjernereceptor ko-aktivatorer i human lunge’
Bjørn Borge Skei
‘DNA damage in red blood cells of dab (Limanda limanda) and haddock (Melanogrammus aeglefinus) as a marker for chemical exposure in the North-East Atlantic’

Anette Engesmo
‘seudo-nitzschia og Fragilariopsis (Bacillariophyceae) i Antarktis og Arktis: Utbredelsesmønster, morfologi og genetisk variasjon’

Ida Rustad
‘Bølgeeksponering som økologisk faktor for gjenvekst etter en simulert isskuringssituasjon ved Steilene i indre Oslofjord’

André Bommo
‘The effect of aposematism and food calls on the feeding behaviour of domestic chicks’

Evguenia Nassonova
‘Mechanisms Involved in the Cell Death in PC-12 Cells and Chicken Cerebellar Neurons under Serum-deprivation, Bisphanol-A Exposure and MEHP Toxicity’

Silje Lied
‘Oxidative DNA damage following in vivo exposure to Benzo(a) pyrene in the testis, lung and liver of wild type and Ogg1-deficient mice’

Elin Camilla Rosenberg Imrik
‘Effekter av miljøgifter på torsk fra Indre Oslofjord’

Kjersti Sternang Kvie
‘Epirrita autumnata (Lepidoptera Geometridae): one diverse species or a complex of several cryptic species’

Frithjof Bård Andersen
‘Zooplanktonsamfunn i lavlandslokaliteter i et karakteristisk østnorsk mosaikklandskap: Gradi-entanalyser av zoooplankton og utvalgte abiotiske og biotiske miljøfaktorer’

Anders Bjørnsgaard Aas
‘Diversity and species composition of fungal endophytes in avenella flexuosa under different sheep grazing regimes’

Anders Kristian Krabberød
‘Evolutionary studies of uncultivated Radiolaria and their symbionts using Single Cell Whole Genome Amplification’

Tore Magnussen
‘Aerial dispersal of invertebrates on Svalbard and the influence of weather’

Hanne Friis Berntsen
‘Neurotoxic effects on cerebellar granule cells and induction of ROS formation in human neutrophil granulocytes after exposure to polychlorinated biphenyls and penitrem A’
Disputations 2010

Even Tjørve (Dr. philos)
‘Species-area curves and the modelling of species diversity’

Marianne Aastebøl Minge (Ph.D)
‘Acquisition and loss of organelles: A driving force in eukaryotic evolution’

Dinara Sadykova (Ph.D)
‘Integrating diverse data by a likelihood function based on models of population dynamics and of observational processes: application relevant for managing aquatic resources’

Sigurd Heiberg Espeland (Ph.D)
‘Connectivity mechanisms in a population complex of coastal cod’

Even Moland (Ph.D)
‘Ecology of European lobster in a marine reserves context: implications for conservation biology’

Philippe Sabarros (Ph.D)
‘Patterns and mechanisms of seabird-environment interaction in southern Africa: population and individual studies’

Kyrre Kausrud (Ph.D)
‘Population dynamics and adaptive strategies of the spruce bark beetle Ips typographus; generalities and particulars of a forest pest’

Tamara Ben Ari (Ph.D)
‘Inferring plague dynamics from epidemiological data’

Søren Larsen (Ph.D)
‘Carbon, catchment and climate connection – a limnological perspective’

Thomas Owens Svennungsen (Ph.D)
‘The evolution and maintenance of phenotypic variation in adaptive traits’

Anne Maria Eikeset (Ph.D)
‘The ecological and evolutionary effects of harvesting Northeast Arctic cod – Insights from economics and implications for management’

Camilla Svendsen (Ph.D)
‘Studies on the intake of 5-hydroxymethylfurfural from heat-treated food and intestinal tumourigenesis in Min mice’

Ingeborg Bjorvand Engh (Ph.D)
‘The evolution of the dry rot fungus Serpula lacrymans and its allies’

Marcin Włodzimierz Wojewodzic (Ph.D)
‘Somatic growth in invertebrates: physiological effects of temperature and food stoichiometry’

Floris Michiel van Beest (Ph.D)
‘Factors affecting the spatiotemporal distribution of moose, with a special emphasis on supplementary feeding’

Anders Aak (Ph.D)
‘Mass trapping of the blowfly Calliphora vicina (Diptera: Calliphoridae) in Norwegian stockfish production areas – lure development, damage reduction, and pest species phenology’
Phytotron

www.mn.uio.no/bio/forskning/om/infrastruktur/ftyotronen

The Phytotron is an advanced plant growth facility enabling plant growth experiments in varying growth environments and climate zones (from arctic to tropical climate zones). The Phytotron has 9000 m² climate controlled growth areas, laboratories, course rooms, cold rooms and freezer rooms, seminar room and offices.

In 2010 the Phytotron was primarily used for UiO projects, i.e. research projects at the Department of Biology, Department of Molecular Biosciences (IMBV), School of Pharmacy and Natural History Museum/Botanical Garden. The UiO Park uses the Phytotron for overwintering of sensitive plants and raising some of the summer plants.

In 2010 the Phytotron also had commissions from research institutions and companies.

Personnel
Manager: Associate Professor Aud Berglen Eriksen

Technicians: Ingrid Johansen, (70% position), Marit Langrekken, Øyvind Rise and Per Rudidalen

Finances
Operating costs are financed through user payments (rental fees). The internal users, the Department of Biology, Department of Molecular Biosciences and the Botanical Garden pay a low cost, while external users (other UiO departments, universities, companies and research institutions) pay running costs.

Courses and education
The Phytotron has two course laboratories adjacent to climate control growth chambers and other lab facilities. 200 bachelor students have followed the courses BIO2150 and MBV1020 in the Phytotron in 2010.

The renovation in 2010 has focused on waste water from plant quarantine chambers. The waste water is treated to prevent living materials to be flushed into the sewage. Our ‘plant sauna’, eliminating various harmful organisms from plants, earth and equipment has been upgraded with a new steam generator. The Phytotron uses as little chemicals as possible, and will mainly use mechanistic methods to fight detrimental organisms.

BIO 2150 students working on the course task ‘effect of N on growth in different wheat species’ © A.B. Eriksen
In addition to courses given at the Phytotron, plant materials are grown for other courses. The Phytotron’s collection of plants are used both for teaching and in research projects. The Phytotron is also used for outreach purposes, like school visits.

Number of Master and PhD candidates; papers, talks and posters
The number of candidates, talks and posters related to Phytotron projects in 2010 were: 2 PhDs, 3 MSc, 10 papers, 16 talks and posters.

Operation
The Phytotron facilities have been fully booked in 2010. Most users are from the Department of Biology, IMBV and NHM/Botanical garden. The users normally have long term projects, which give a good overview of the use of the Phytotron for the next years. Large parts of the climate controlled growth areas will be occupied by such long term projects in the years to come.

Research projects
Many research projects at the Department combine field studies and Phytotron experiments to investigate the effects of factors such as climate and nutrition. The Phytotron’s flexibility and the scientific span is clearly illustrated in the list of research projects:

- The Seeds of Adaptation in the face of climate change. Assessing gene flow in maize at a local and global scale.
- Diploid and tetraploid Parnassia palustris: One or more taxa? Do polyploids have an adaptive advantage?
- PEA - Puccinellia in the European Arctic - Who is who, who's where and why?
- Leaf development in Sansevieria
- Biodiversity of Eastern Africa (lilies, orchids, sedges).
- Independent immigration history of western populations of Dryas octopetala and Arabidopsis lyrata ssp. petraea?
- From food to waste to food.
- In vivo dynamics of plant response to tropospheric ozone.
- Effect of different waxes on Norway spruce and grafted grape vine plants.
Natural History Museum, Botanical Garden and researchers at the department have for many years collaborated in research projects where plant growth experiments are carried out in the Phytotron. This cooperation has now been taken over by the National Centre for Biosystematics. The projects are prevalingly related to polar research. Migration of different plant species and long distance dispersal in Polar Regions have been addressed. When the Journal of Biogeography published a paper on the genus Saxifraga in Polar Regions, the picture above - from the Phytotron - adorned the front page.

Cooperation with commercial partners
The Phytotron has for a long time worked with the Norwegian company ‘Norsk Wax A/S’ and Swedish forest industry to find a mechanical way to protect spruce plug plants against snout beetles. The first two growing seasons after planting are particularly critical. The solution is waxing of the lower part of the trunk. Considerable efforts have been put into finding a wax coat which is not damaging to the plants, has elasticity to withstand two years growth and can withstand large dial and yearly temperature fluctuations. Another demand has been to ensure that the wax degrades easily when it falls off the trunk.

Related projects:
SURV-ICE – Did vascular plants and bryophytes survive the last ice age in Scandinavia?

EC Integrated Project, ECOCHANGE: Challenges in assessing and forecasting biodiversity and ecosystem changes in Europe

Cryptic speciation in arctic plants
Central Engineering Workshop

www.mn.uio.no/bio/tjenester/sentralverkstedet

The Central Engineering Workshop mainly serves the two biological departments (Department of Biology and Department of Molecular Biosciences), though it also undertakes construction work for external organisations such as Veritas, NIVA and NINA.

Our workshop stands out due to the close proximity to the research groups and the broad-ranged skills of the team. The workshop carries out construction and repair work in mechanics and electronics, glass blowing and welding, and also assists in developing new equipment. The workshop is usually contacted when the user is faced with difficulties in buying necessary equipment. If you have a bright idea and need help to build equipment to prove your theory, do get in touch with us!

In 2010, the workshop had full order lists and many interesting and challenging assignments. A total of 170 projects of varying complexity were undertaken for the biological departments. Many of our tasks were related to marine research, e.g. design of a new 0.15 m² grab for taking sediment and chemical samples simultaneously. CEEs has also had many orders related to bird research field work.

As in previous years, the workshop has had a close collaboration with the workshop at the Faculty of Medicine, where we conduct CNC processing. These two workshops have complementary equipments and machinery.

The personnel
Hans Borg, senior engineer
Johan Erland, principal engineer
Mads Granberg, principal engineer
Stein Høydahl, senior engineer
Bjørn Langrekken, principal engineer

Costs
Researchers from the two biological departments pay NOK 200 per job and 35% of material costs.

Cars
The workshop administrates 5 cars; 4 Toyota Hiace and 1 Ford Transit Connect. The cars can be lent to employees at the Department of Biology and IMBV. To rent the cars, go to http://www.mn.uio.no/bio/tjenester/sentralverkstedet/bilbestilling/

Johan Erland mills pressure chamber parts for a fish research project © Hans Borg
The Faculty of Mathematics and Natural Sciences at the University of Oslo has two research vessels in the Oslofjord: F/F Trygve Braarud (70 ft) and F/F Bjørn Føyn (40 ft). The Department of Geosciences, represented by Elísbeth Ave and Eyvind Aas, Department of Biology represented by Stein Kaartvedt, Bente Edvardsen and Ketil Hylland (in connection with projects in the inner and outer Oslofjord and on the West Coast), and the research institutions NIVA, NGI and NGU.

F/F Trygve Braarud was in 2010 used for monthly sampling in the outer Oslofjord, which represents a key contribution to an EU-project at the Department of Biology. It was also used for sampling sediments and organisms for experimental studies related to a NCR funded projects where both the Department of Geosciences and Department of Biology have been participants.

F/F Bjørn Føyn has in 2010 been used for school courses and to some extent for field work in Drøbak.

Activities
The vessels have in 2010 been extensively used in connection with students’ fieldwork, courses and research projects. The main users in 2010 were

F/F Trygve Braarud ©Sindre Holm
The design and equipment of the vessels have been made mainly for the purpose of research, but also work quite well for teaching purposes. The equipment on board can be changed rapidly to the needs of the users. Some of the tasks include trawling, the use of submersible acoustic sensors, large and heavy grabs and corers and the launch of large buoys for surveillance. The equipment and instruments are tested and developed in cooperation with private firms, exposing the crew and researchers to fresh knowledge and skills.

**Board and Staff**

The Faculty of Mathematics and Natural Sciences have appointed a board which is responsible for the use and maintenance of the vessels. The board consists of four members, with the head being directly appointed by the Faculty. A temporary board has been in effect in 2010. The members are Bente Edvardsen (head), Elisabeth Alve, Ketil Hyl-land and captain Sindre Holm.

3 of the staff at the Department of Biology are authorized to manage the vessels. These are: Sindre Holm who is the Main Ship’s Captain, Jan Sundøy who is Ship’s Captain and engineer Tom Erik Baa-de. These people together with a regular crew of temps contribute to maintaining high activities.

**Use and Management**

The use and management of the vessels has been extremely satisfactory in 2010 and has been kept up to the mark. There have been no sudden cancellations apart from those created by icy conditions in the Oslofjord in February and March. Apart from these extraordinary circumstances, the planned schedule has been implemented. The vessels are being kept in good order in regards to both yearly and long term maintenance. The routine maintenance is the responsibility of the crew. F/F Trygve Braarud went through a five-year control with license renewal in 2010. The vessel was determined to be in good working order and no new orders of improvement were given.

There is a great demand for service and maintenance on tools and equipment. This has become a considerable expenditure. There is an immediate need to replace the CTD onboard TB and during 2010 the purchase of a new CTD has been on the agenda.

The Central Workshop at the Department of Biology contributes heavily with mechanical repairs and maintenance of the vessels and their equipment. They conduct mechanical first aid which prevents postponed or cancelled voyages.

**Goals**

The Board and the crew work towards maintaining the vessels in good shape and creating a safe work environment for the various users. Health and Safety regulations are actively followed and implemented. During the yearly stay at the ship’s yard, the necessary Health and Safety regulations were implemented. There have been no accidents or damages to people or equipment in 2010. The running and maintenance of the vessels in an ethical, secure and well organized manner is of great concern to all involved.
Drøbak Research Station

The marine research station in Drøbak was established as a field station in 1894 and includes the research station (Biologen) and a course centre (Tollboden). Both the research station and the course centre are historic buildings within the heritage conservation zone in the centre of Drøbak.

Personnel and Board
Director: Associate professor Hans Erik Karlsen
Technicians: Grete Sørnes (50% position) and Son dre Ski (3 months employment).

The board (01.01.2009 to 31.09.2013) consists of:
Chair Stein Fredriksen, deputy chair Kamran Shal chian-Tabrizi. Board members: Hans Erik Karlsen, Josefin Titelman and Harald Rognehaug. Deputy members: Karl I. Ugland and Tom Andersen.

Courses and seminar activity
A total of 1177 overnight stays were registered at Tollboden in connection with courses, seminars and meetings, and 2513 persons visited the research station in 2010. 6 guest researchers stayed at the station in 2010. Additionally 3 master students stayed at the station for shorter periods. 5 UiO field courses, 2 UMB field courses and 4 international university field courses were held in 2010.
8 UiO seminars/meetings, 6 meetings for external research institutions and 3 seminars/meetings for international institutions were also held at the station.
The scientific outreach consisted of several news reports on NRK1, TV2 and regional TV about massive jellyfish blooms (Cyanea capillata) in the Oslofjord in the summer. The Research Station was also in the regional media related to sea nettles, ctenophores, Pacific oysters and field course activities. The station contributed with marine animals at 'Forskningstorget' in Oslo, and participated with talks at four international meetings/conferences. Biologen was also film stage in connection with the TV series 'Ibsens kvinner'.

Research projects at the station in 2010 were:

- 'Fiskehørsel, fiskeatferd og seismikk' (H.E. Karlsen, Jared Eckroth og Rune Roland Hansen),
- 'Forekomster av brennmaneter og Mnemiopsis Leidyi i Oslofjorden i 2010' (H.E. Karlsen & Sondre Ski), Ålegress og ålegressenger (Stein Fredriksen, Hartvig Christie et al.), Protists (Kamran Schalzi-an-Tabrizi), Forekomster av stillehavsøster i Oslofjorden (Pia Nordling, NIVA et al.).

**School visits**

The Research Station has for more than 40 years offered different field courses in marine biology. This is a popular activity, and demands are high. In 2010 we had a total of 25 days of field courses for 11 schools, i.e. 265 pupils and 33 teachers.

**Facilities**

The research station is equipped with seawater inlet, aquaria and culture facilities enabling studies of marine flora and fauna under controlled conditions. The station has a microscopy lab with sophisticated fluorescence microscopes and image analyzing software, a chemical analysis lab, cold storage facilities, seawater filtration system, air compressor for scuba cylinders, small boats, field equipment and a marine sample collection. The station is additionally furnished with all relevant teaching aids for course and seminar activity.

**Winter 2010**

The fall and early winter in 2010 was cold with persistent northerly winds. Already in December sea ice was forming in large parts of the Drøbak strait, which is exceptional. The ice caused problems related to sea water intake and outlet, use of small boats and field activities, and gave warning of the coldest winter in the area since 1943.
Finse Alpine Research Centre

The Research Centre at Finse is formally owned by the University of Oslo (UiO), but the funding to build the station was originally issued on condition that the University of Bergen (UiB) will have equal rights to the centre. The practical operation and administration of the centre is conducted by Department of Biology at UiO, and UiB contributes around half of the operating grant. The Technical Department at UiO is responsible for the buildings at the centre. The centre has two divisions: a Research Unit with laboratories and 14 beds, and a Course and Conference Unit with 44 beds. Research and teaching connected with the MN Faculties of both UiO and UiB have priority use of the station, but the station is also used largely by other research and educational institutions from Norway and abroad. The station has a board consisting of two scientific representatives and one technical representative from both UiO and UiB. The board is appointed by the Department of Biology, UiO and the MN Faculty at UiB. News and information about the activities of the centre are updated regularly on the station’s website: http://www.finse.uio.no/

Operation and administration

The daily operation and administration of the centre is carried out by the Director, Torbjørn Ergon and the Manager, Erika Leslie, both from the Dept. of Biology at UiO. In 2010, the board consisted of:

Chair: Geir Hestmark (UiO)
Scientific representatives: Torstein Solhøy (UiB), Atle Nesje (UiB), Dag Klaveness (UiO)

Technical representatives: Solfrid Hjelmtveit (UiB), Hans Borg (UiO)
Deputies: Klaus Høiland, Göran Högstedt, Ole Humlum, Knut Helge Jensen, Johan Erland

Technical operation and maintenance

For the second consecutive year, the centre employed summer assistants to carry out research assistance, maintenance for the Technical Department (TA) and centre operation assistance (e.g. transportation, cleaning, etc.). Three assistants worked a total of 871 hours at the station during June–September, of which 26% were research assistance, 30% centre operation assistance and 44% work for TA. The ‘summer assistant’ scheme is popular with researchers at the station and will continue in future years. In 2010, both of the centre’s buildings were painted and various other maintenance works were carried out.

The station has broadband internet via radio-transmission provided by DirectConnect. In order to continue the delivery of broadband networks at Finse, an application for support to the sum of 74 000 NOK was made to the Ulvik municipality for the upgrading of equipment. After the mayor raised the issue at the Finse Forum (see ‘Outreach’ below), USIT (UiO) contributed 1/3 of the upgrade costs whilst the hotel Finse 1222, DNT Finsehytta and the municipality contributed the rest. The upgrade means that the centre now has a substantially faster network (8000 kbps for both downloading and uploading).

The catering agreement with Tajo a/s at the Course and Conference Unit works well for all parties and will continue indefinitely in the future.

Research activity

The Research Unit was well-used in the summer months, but there was a slight decrease in the number of days booked in connection with research activities. 453 working days (361 overnight visits) were recorded for research-related activities.

The station was used mostly by researchers from UiO (10 persons), UiB (7 persons) and UMB (5 persons). Other research institutions using the station were: Telemark University College, Norwegian Institute for Nature Research, Norwegian Radiation Protection Authority, Swedish Agricultural University (Swedish Species Information Centre), University of Cambridge, University of Lancaster, Senckenberg Research Institute (Germany) and the Natural Science Museum of Trento (Italy).
Furthermore, the Norwegian Radiation Protection Authority and the Norwegian Meteorological Institute (DMNI) have installed permanent measuring equipment at the station. A brief description of each research project at the centre and a list of publications are published on the centre’s website: http://www.finse.uio.no/research/

The centre is part of the EU-funded project INTERACT which consists of a circum-Arctic network of 32 terrestrial field stations. The project was scheduled to start in autumn 2010 but postponed to January 2011. We will receive funding to invite foreign researchers to the station, and researchers from Norway will receive support to work at field stations outside of Norway. For more information on the project, refer to the project website: http://www.eu-interact.org/.

Courses and seminar activity
A total of 2029 overnight stays were registered in connection with courses, seminars and meetings in the Course and Conference Unit of the centre (an increase of 18% from 2009).

2010’s research seminar was, as usual, conducted at the station for two days in late April. This was the third research seminar in the series, with 29 people from 10 different institutions participating. This annual event has shown a yearly increase in size. The programme for the seminar is available on the station’s website.

The University of Birmingham held, for the second consecutive year, a five-day field course in mid-July. Otherwise, the following regular UiB and UiO courses ran as usual: BIO344 Winter Ecology (UiB), BIO1200 Diversity (UiO), GEO1010 Physical Geography (UiO), GEO1006 Quaternary Geology (UiB), and BIO343 Alpine Ecology (UiB).

The Science School Laboratory at UiB hosted a five-day course in biology for teachers in mid-August.

In mid-September, a five-day workshop was conducted at the research station, funded by NordForsk and directed by Torbjørn Ergon: ‘Species Occupancy Modelling’ plus a two-day preparatory course: ‘Statistical Estimation Methods’. There were 27 participants, mainly PhD students and postdocs from the Nordic countries (with two from NINA, one from Greenland Institute of Natural Resources, and one from the University of Aberdeen).

Annexes
The Garpen annex, which belongs to the research station, is rented out on a daily basis to staff and students at UiO and UiB. There has been considerable interest in this offer and the facility has been rented 69 days during the year, mainly on weekends. In busy periods, Garpen is used for extra accommodation for researchers and summer employees at the station. The station also has a lease agreement with landowners in Ulvik regarding the use of the Torbjørnstølen for similar purposes. For the second consecutive summer, Bjarte Aarseth from the NHM donated two weeks of his holiday to renovating Garpen, inside and outside. A new combustion toilet was operational at the facility from winter 2010.

Outreach
There is great interest from the public in the activities at Finse Alpine Research Centre. The centre participates in the Finse Forum, where representatives from business and leisure as well as from the municipality and county’s Department of Environmental Affairs meet once or twice a year.

A journalist and a photographer from Uniforum, an internal UiO newspaper, was present during some of 2010’s Winter Ecology course. The article is available at the following address:

Experimental facilities

The DNA Lab has an infrastructure consisting of an isolation lab, separate PCR facilities, post PCR and DNA sequencing laboratories (see ABI lab below). In addition there is a dedicated lab for class 2 security research. The lab is fully equipped for DNA and RNA extraction from various types of bacteria, protists, algae, fungi, animal and plant tissues (including blood, faeces and ancient DNA). It contains all of the basic instrumentation of a modern molecular biology laboratory including equipment for gene cloning, genomic libraries, real-time PCR, DNA/RNA quantification (Nanodrop spectrophotometer for μl volumes) and chip-based analysis of DNA, RNA and protein (Agilent Bioanalyzer).

The ABI lab (www.mn.uio.no/bio/forskning/om/infrastruktur/abi-lab/) is shared between the Departments of Biology and Molecular Biosciences, and provides DNA sequencing and fragment analysis. The lab functions as a service centre for various research groups nationally and internationally. The lab is equipped with two ABI 3730 capillary electrophoresis sequencers, each currently equipped with 48 capillaries. A total of ~42,000 samples was sequenced with an average of 3509 samples every month.

The Ultra-high Throughput Sequencing Platform/Norwegian High-Throughput Sequencing Centre. In 2007, the Department of Biology/CEES was awarded funding to establish the ‘Ultra-high throughput sequencing platform’ by the Research Council of Norway (RCN). The platform was further strengthened through a new Infrastructure Program grant from RCN and consolidation with the Illumina sequencing platform at Institute of Medical Genetics (IMG), Oslo University Hospital, to establish a national sequencing centre ‘Norwegian High-Throughput Sequencing Centre – NSC’ (www.sequencing.uio.no). The NSC is currently the only Norwegian platform offering the research community HTS services for resequencing, transcriptomics, metagenomics and de novo sequencing and provides customized analyses of data.

The UTSP 454 sequencing service lab has been functional since January 2008. In 2009, 131 samples for different research environments were sequenced (65 % more relative to 2008) in 95 runs. During 2010, the 454 node of the NSC experienced an almost explosive increase in interest and quantity of samples, and a total of 284 different samples from 47 groups of researchers were sequenced.

In 2010, necessary upgrades to the laboratory activities, which include improvements of the protocols, as well as procurement of equipments, were initiated. New protocols resulted in faster processing of samples, and a reduced DNA amount requirement for some applications. Additionally, we have obtained a Hamilton liquid handling robot – on which a robotic Enrichment Module (REM) is integrated. This robot is fully tested and in operation today and shortens the time and manual work load during a critical sequencing step. Furthermore an Agilent Bravo robot for DNA library creation and setup of qPCR is purchased.
The Laboratory School has in 2010 had the following employees:

Cato Tandberg, 100% position, January to August
Maria Sviland, 100 % position since August
Lars Qviller, 12.5 % temporary position

The Laboratory School resource group, which functions as a consulting body, comprises of Halvor Aarnes, Stein Fredriksen, Olav Sand and Reidun Sirevåg.

New premises
The Laboratory School premises have been renovated, and a new, up-to-date laboratory opened in 2010. The adjacent meeting room and office will be renovated in 2011.

Supplementary training for teachers
Quantitative measurements of photosynthesis
This course gives an introduction to photosynthesis with emphasis on photosynthesis light reaction. In addition, the course covers chloroplast development and explores the utilisation of chloroplast genes in the realms of gene technology and barcoding of species. The laboratory work includes quantitative measurements of photosynthesis, during which teachers vary the different parameters, e.g. amount of photosynthetic tissue and ambient light. The results are processed and interpreted using basic skills in mathematics and ICT.

Computerized biology instruction
The course addresses the use of computers in the teaching of biology, and is intended for secondary school Biology 2 teachers. It covers two computerized teachings plans. The first deals with bioinformatics and how molecular biology and gene techniques impart new knowledge about the evolution of species and development of phylogenetic trees. The National Center for Biotechnology Information (NCBI) webpage is used to find gene sequences for a selection of primates and a phylogenetic tree is calculated based on these sequences. The second plan deals with the Hardy-Weinberg equilibrium, where we use genetic data from the Chinchilla species. The teachers test different hypotheses with Hardy-Weinberg as null hypothesis.

School visits
Due to renovations of the premises, only three school classes visited the Laboratory School in 2010. These three classes were given a guided tour of the Phytotron as well as some laboratory based teaching.

New lab courses that will be used both for supplementary training of teachers and school visits are in preparation. These courses will be directly linked to scientific research at the Department, and will be a part of scientific outreach to the school society.
New education plans
New compendia and web based teaching are developed for all courses. All courses consist of theory and a practical part. Whenever possible, mathematics, oral and written skills and use of digital tools are included in the Laboratory School education plans.

Phylogenetic trees of primates
The pupils learn how unknown organisms can be identified to species by means of their DNA. The plans contain student exercises which demonstrate isolation and DNA, PCR and electrophoresis. In addition, the pupils learn about sequencing and how DNA can be used to make a phylogenetic tree for primates. The course plan is prepared in collaboration with Centre for Ecological and Evolutionary Synthesis (CEES) at the department.

Chinchilla population genetics
In this course the pupils will investigate the evolutionary relationship between three populations of chinchilla. The pupils analyse genetic data by testing hypotheses. They learn about Hardy-Weinberg equilibrium and its use as a null hypothesis. Plans for the course are prepared in collaboration with CEES.

Project job position
The project job position involves research dissemination linked to the new secondary school subject Technology and Research Education. One of the goals of the subject is to give the pupils a greater understanding of what research entails so that research activity remains a legitimate part of society in the long run. The project job position is a 50% position lasting one year. The work is subsidized by the Laboratory School and is financially support by ‘Naturfagsenteret’. We hope that this work will make the biological research at the University of Oslo visible, and have a positive impact on the recruitment of new students.

MERG and the Laboratory School collaboration
MERG and the Laboratory School collaborated in an application for funding of a PhD position at MERG, where part of the project will be scientific outreach to the school system through work at the Laboratory School.

The project will focus on understanding how RNA interference (RNAi) has contributed in evolution. RNAi is a cellular process that regulates gene expression through targeted degradation of messenger-RNA, and may be shown to have played an important part in the transition from single-celled eukaryote organisms to multicellular animals. This transition represents a huge leap in the evolution of the eukaryote genome and organization of cells, which is of tremendous importance to biology and medicine. The PhD-student will have 20% of their mandatory work at the Laboratory School. This application has been granted.

In addition
In december 2010, the Laboratory School hosted four student from Cambridge who participated in an international competition in the field of gene technology (iGEM). The students visited UiO in relation with a talk by Drew Endy about Synthetic biology.
The Biology Library is the department library for the Department of Biology and the Department of Molecular Biosciences. The library is supporting both research and teaching at the departments. The library’s goal is primarily to provide students, scholars and employees the best possible access to information and scientific material in biology and biochemistry, in printed and electronic form. The library maintains dialogue with the departments to assure the most relevant and current priorities of the library’s academic resources.

The library’s regularly updated website provides easy access to a variety of relevant resources. The library offers courses in literature search and source criticism for students with optimal academic information literacy as a goal. These courses are for the most part integrated with the departments’ own courses, but the library also holds courses for students and staff by request.

Library staff 2010
Berit Johansen (main librarian) serves as general manager. Kirsten Borse Haraldsen is university librarian and Edel Bøhn is office consultant. Heidi Sjursen Konestabo was employed as a new university librarian from September 2010. As for now, she is working in a 50% position. Kyrre Traavik Låberg has held a temporary position as a university librarian throughout the year. Kyrre Grotan worked as an assistant consultant until April 1st. Martin Knudsen Tvete is employed as a student aide in the afternoon.

Collection Development and Finance
Book loans still constitute a large portion of library activity, and also loans to and from other libraries, while loans from the large collection of printed journals are small. When it comes to current journal subscriptions, we have only kept a few of the printed ones, such as Nature, Science and some Norwegian ones.

The New Science Library is currently under construction and migration to Vilhelm Bjerknes’ Hus is scheduled to take place in January 2012. In light of this centralization, we have initiated a comprehensive effort to dispose of duplicate items, and also dispose of our stow away journals for which we have a secure online access.

Teaching
The Library is working to integrate library knowledge into the departments’ programs so that all students are guaranteed to learn about library services, and that they get a good opportunity to solve their tasks in the study process. The library courses include knowledge about literature databases, source criticism, the ethics of scientific communication, publishing and the reference tool EndNote. The goal is to raise students’ awareness on academic information literacy. EndNote-courses for students / staff at the departments and the faculty have been held by Kirsten Borse Haraldsen, Heidi Sjursen Konestabo and Kyrre Traavik Låberg.

Bio5000 - The Library, in collaboration with the Study section developed BIO5000 to include 5 study credits. The course includes several of the Department of Biology’s lecturers and has been expanded to include the idea history of biology, bioethical issues in society in collaboration with
The Norwegian Biotechnology Advisory Board and the Career Center. The new BIO5000-course includes exam and a written submission by the students of project proposals for their master thesis. The students will also hold a lecture on their thesis for next semester’s BIO5000 students. BIO5000 is set up as a intensive week course at the beginning of both spring and fall semesters. (Http://www.uio.no/studier/emner/matnat/biologi/BIO5000/index-eng.xml).

BIO1000 - Citing, academic integrity and cheating during examination (2 hour lecture).

The library collaborates with Biologisk fagutvalg / Fadderuka to let new biology students explore the library and get training in the Bibsys catalogue.

Although much of our collection is now online, the students still use the library a lot. There is a particular need for textbooks and undergraduate literature for the students. The library’s reading rooms and PCs are used a lot, and we would have liked to have even better conditions for the students here.

In the spring of 2012, we expect to move out of the Biology Library and into the New Science Library. The new library in Vilhelm Bjerknes’ Hus will be a future-oriented library and learning center. There, students and staff will have over 500 workstations and 13 colloquium rooms at their disposal.

One of our main priorities is to maintain the good relations with the biology departments. We are now in a process where we evaluate and plan the commitment to the departments after the move.
The Biological Students’ Committee

www.biologiskfagutvalg.com

The Biological Students’ Committee (Biologisk Fagutvalg) is a student body for undergraduates/graduates affiliated with the Department of Biology. BFU is engaged in efforts to create and maintain a good academic and social environment among biology students. The representatives of BFU work for and on behalf of biology students in matters related to teaching and the learning environment at the Department. The group arranges two weekly events: ‘The Biographer’, the presentation of films/documentaries with biological relevance, and ‘Breakfast with Kristine’, a popular series of science lectures supplemented with breakfast every Tuesday morning. In addition, there is the bimonthly ‘Fertile Friday’, a forum for biology-themed lectures or performances/lectures from outside the Department, with subsequent cross-disciplinary discussions. The goal of ‘Fertile Friday’ is to engage students in topics outside the curriculum and to encourage dialogue with other faculties at Blindern. There are also daytrips to relevant employers for biologists, the first such trip being to SABIMA in autumn 2010.

On the social agenda, BFU hosts two annual parties: the ‘Nature Carnival’ during the spring semester and the ‘Biology Evening’ during the autumn semester. In addition, the group arranges stays in holiday cabins, football practice/games (against partner institution, the Department for Molecular Biosciences) and photography competitions. At the end of the autumn semester, BFU arranges the annual ‘Golden Pointer’ award; the three nominees for 2010 were Klaus Høiland, Tor Carlsen and Asbjørn Vøllestad. The prize was awarded at the Department’s Christmas Party and went to Tor Carlsen for his ability to engage students, and his excellent, insightful lecture programme. In addition to organizing social events and activities for students, BFU distribute locker space in the Biology building’s basement.

Field excursion with the department head © BFU
Health, Security and Environment

One of the 2010 focus areas was to establish laboratory routines and responsible persons for all labs, and complete a revision of the HSE handbook - both in Norwegian and English.

A seminar for all personnel was arranged in March focusing on work environment and HSE. Internal auditing was carried out in the spring and issues were followed up throughout the year.

A HSE coordinator was employed in the fall 2010 for a two year project period to ensure proper HSE standards in the Kristine Bonnevive’s House. An advisory HSE project group was established in October with equal representation from both the Department of Biology and Department of Molecular Biosciences. The coordinator reports quarterly to the managements.

HSE project 2010-2012
In the fall 2010 inspections and mapping were carried out, and goals, strategy and plan of action for the project period were established. A common HSE plan of action for 2011 is prepared for both departments.
HSE Vision
"A safe work and study environment inspires both staff and students, and they look forward to come to work every day. Through common responsibilities, involvement and contribution a thriving department is created."

HSE goals (HSE-Project 2010-2012)
Make sure that all laws and regulations related to HSE are followed, as well as the University’s own guidelines

The Department’s own HSE guidelines, routines and procedures are known and followed by staff and students

A well functioning system for risk assessment is established and incorporated in all research and educational activities

There is an established acceptance that well functioning HSE work is an important part of the department’s activities. There is also a notable change of attitude among staff and students with regards to HSE routines

The infrastructure is greatly improved and facilitates improved laboratory safety

through proper storage, handling and disposal of chemicals, gases, isotopes and biological material

Clear chains of responsibilities have been established at the Department. Interactions and involvement contribute to a more satisfying work and study environment

The department should have a clear ethical attitude with regards to the environment

HSE-/safety training
HSE general information has been included in the BIO5000 Introductory course for Master students, and more specific training is given in the laboratories.

All laboratory personnel attended a fire safety course and a course focusing on chemical safety, handling and storage. LAMU members, safety deputies and the HSE coordinator have additionally participated in various HSE related courses, seminars and HSE-network meetings given by the faculty, UiO and external course providers.

Work environment
To ensure a healthy psychosocial work environment the department has focused on creating a community culture at the department through various arrangements: seminars, summer party and Christmas party. Additionally, various arrangements are held by the research programs and the centre. A local work environment committee was established late 2010.

Safety deputies 2010
Cecilie Mathiesen (MERG), Head Safety Deputy
Gry Gundersen and Hege Bakke (CEES)
Stein Fredriksen (MB)
Tom Andersen (IB)
Marit Langrekken/Øyvind Rise (Phytotron)
Adine G. Thoresen (Administration)
# Staff per 31.12. 2010

## Chair
Schumacher, Trond

## Chair (CEES)
Stenseth, Nils C.

## Professors
- Andersen, Tom
- Edvardsen, Bente
- Fredriksen, Stein
- Hagelberg, Erika
- Hansen, Thomas F.
- Hessen, Dag O.
- Hestmark, Geir
- Hylland, Ketil D. E.
- Heiland, Klaus
- Jakobsen, Kjetill S.
- Klaveness, Dag
- Lampe, Helene M.
- Leinaas, Hans Petter
- Mysterud, Atle
- Nordal, Inger
- Slagsvold, Tore
- Sætre, Glenn-Peter
- Ugland, Karl
- Vøllestad, Asbjørn
- Aarnes, Halvor

## Associate professors
- Brysting, Anne
- Eriksen, Aud B.
- Ergon, Torbjørn
- Karlsen, Hans Erik
- Kauserud, Håvard
- Salchian-Tabrizi, Kamran
- Titelman, Josephi

## Adjunct professors
- Kaartvedt, Stein
- Øvrebø, Stein

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- Bakke, Torgeir
- Eikrem, Wenche
- Rohrlack, Thomas
- Sverdrup, Line

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- Alemu, Diress Tsegaye
- Ben Ari, Tamara Myriam
- Bischof, Richard
- Carlsen, Tor
- Colman, Jonathan
- Cromsigt, Joris
- Dittami, Simon
- Durant, Joël M.
- Edeline, Eric
- Eftestøl, Sindre
- Eikeset, Anne Maria
- Fischer, Barbara
- Færevig, Per-Johan
- Gaustad, Arild O.
- Grimholt, Unni
- Gunderson, Hege
- Harstad, Håvard
- Hedfors, Ida
- Henderiks, Jorinjeta
- Hildago Roldán, Jose M.
- Hjermann, Dag
- Holen, Øistein H.
- Holth, Tor Fredrik
- Hutchings, Jeffrey
- Jorde, Per Erik
- Kausrud, Kyrre L.
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- Labra Lillo, Antoineta
- Lagesen, Karin
- Langangen, Øystein
- Le Bohec, Céline
- Liow, Lee Hsiang
- Martinsen, Lene
- Nesbø, Camilla Lothe
- Nielsen, Anders
- Nilsson, Anna
- Ohiberger, Jan
- Olsen, Ebba M.
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- Ota, Shuhei
- Pavlicev, Mihaela

## PhD students
- Andersen, Guri S.
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- Bråte, Jon
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- Egge, Elianne Sirnæs
- Ellesat, Kathrin
- Heier, Lise
- Helberg, Morten
- Hermansen, Jørgen Skeie
- Husak, Jan
- Jalal, Marwa
- Junge, Claudia
- Jørgensen, Marte H.
- Knudsen, Endre
- Kumar, Surendra
- Malmstrøm, Martin
- Mazzarella, Anne V. B.
Moe, Therese F.
Orr, Russell
Pettersen, Ruben A.
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Rivrud, Inger M.
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Stomperudhaugen, Eirin S.
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Yazdani, Mazyar
Zhao, Sen

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Borg, Hans
Brubak, Sissel

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Granberg, Mads
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Langrekken, Marit
Leslie, Erik Anita
Mathiesen, Cecilie
Nerli, Emelita R.
Nederbragt, Alexander J.
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Bogojev, Sibinka
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Engh, Aasta K.

Grønli, Katinka
Grøtland, Eva I.
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Lambrou, Jayne P.
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Onsrud, Maren
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Thoresen, Adine G.
Wallem, Tore

Professor/Associate professor emeriti
Andersen, Thorvin
Hasle, Grete Rytter
Mysterud, Ivar
Rueness, Jan
Ryvarden, Leif
Schram, Thomas
Stenersen, Jørgen
Thronsen, Jahn
Wielgolaski, Frans E.
Økland, Jan

Others
Mysterud, Iver
Ottersen, Geir
## RCN projects

<table>
<thead>
<tr>
<th>Name</th>
<th>Project leader</th>
<th>Funding</th>
<th>Period</th>
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<tbody>
<tr>
<td>Adaptive management of living marine resources by integrating different data sources and key ecological processes: A joint effort by IMR and CEES</td>
<td>Stenseth, N.C.</td>
<td>RCN</td>
<td>2010-2015</td>
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<tr>
<td>Biogeochemistry in Northern Watersheds, a Reactor in Global Change</td>
<td>Hessen, D.O.</td>
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<td>Biogeographic and population analyses of Thermotogales bacteria from hydrocarbon-rich environments</td>
<td>Nesbø, C.</td>
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<td>Centre for Ecological and Evolutionary Synthesis</td>
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<td>Comparison of Marine Ecosystems of Norway and the US</td>
<td>Stenseth, N.C.</td>
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<td>2009-2013</td>
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<td>Darwin jubilee 2009</td>
<td>Stenseth, N.C.</td>
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<td>Diversity and dynamics of marine haptophytes</td>
<td>Edvardsen, B.</td>
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<td>Effects of climate change on soil microarthropod diversity and ecological function</td>
<td>Konestabo, H.S.</td>
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<td>Flexibility and constraints in animal movement patterns: ecology, evolution and annual cycles</td>
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<td>Functional genomics of phenotype plasticity of cod: a national consortium - GENOFISK</td>
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<td>Genome sequencing of cod by exclusive uses of ultra high-throughput sequencing technology</td>
<td>Jakobsen, K.S.</td>
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<td>Genome size, cell size and growth; searching for the causal links</td>
<td>Hessen, D.O.</td>
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<td>Host-virus interactions in Atlantic salmon</td>
<td>Grimholt, U.</td>
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<td>iCod: Integrative environmental genomics of cod</td>
<td>Hylland, K.</td>
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<td>Integrated statistical analysis based on likelihood and confidence: applications to the hare-lynx cycles and the status of bowhead whales</td>
<td>Schweder, T.</td>
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<td>Interactions between eutrophication, oil and contaminants in marine ecosystems</td>
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<td>Investigations of population structure in shrimp (Pandalus borealis) in the North Atlantic</td>
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<td>Linking physics and biology - Structuring of cod populations in the North Sea/Skagerrak water-system</td>
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<td>Long-term ecological effects of sheep grazing in alpine ecosystems and its integration with management.</td>
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<td>Marine ecosystem effects of eutrophication: Interactions between small pelagic fish and predators in low oxygen waters</td>
<td>Kaartvedt, S.</td>
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<td>Project Description</td>
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<td>Match-mismatching of trophic levels as a structuring force of ecosystems</td>
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<td>Modelling ecosystems under climate change: Windermere as a model lake system</td>
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<td>National research infrastructure Norwegian Marine Data centre</td>
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<td>National resources for genomics, functional genomics and health research in Atlantic salmon and Atlantic cod</td>
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<td>Natural and farmed habitat as a basis for production of red deer in Norway</td>
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<td>Norwegian High-Throughput Sequencing Centre</td>
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<td>Norwegian Russian Cooperation in estimating the cost structure of the Northeast Arctic cod</td>
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<td>RCN</td>
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<td>‘Nutrient tunneling’ and other alternative pathways of mineral nutrients through the microbial food web to copepods</td>
<td>Hessen, D.O.</td>
<td>RCN</td>
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<td>Oceanography and match-mismatch</td>
<td>Stenseth, N.C.</td>
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<td>Optimizing lipid production by planktonic algae</td>
<td>Andersen, T.</td>
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<td>Phytoplankton size: Climatic adaptation and long-term evolution</td>
<td>Henderiks, J.</td>
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<td>Response of trophic relationships to climate change in Sub-Arctic Seas</td>
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<td>Spatiotemporal variability in mortality and growth of fish larvae in the Lofoten-Barents Sea ecosystem</td>
<td>Hjerman, D.</td>
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<td>Speciation processes in fungi examined through experimental and empirical approaches</td>
<td>Kauserud, H.</td>
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<td>Springtail (Collembola) responses to changing variable environments: a bi-polar approach linking individuals to ecosystems</td>
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<td>Statistical tools for studying genetic architecture</td>
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<td>The possible role of zooplankton in modulating ecosystem effects of acute oil spills in the Norwegian and Barents Seas</td>
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<td>Tracking signatures of adaptive diversification during post-glacial colonization: the build-up of genomic isolation</td>
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<td>Translating the cod genome for aquaculture</td>
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<td>Unravelling population connectivity for sustainable fisheries in the Deep Sea (EuroDEEP)</td>
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<td>Watershed Eutrophication management</td>
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<td>Wildfire effects on biogeochemistry of soil and surface water</td>
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Other public sector/private sector projects

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<td>A design document for Decision Support Tool (DTS) for Impact Analysis</td>
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<td>Arctic and sub-Arctic climate system and ecological response to the early 20th century warming</td>
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<td>Can nuisance growth of the aquatic macrophyte Juncus bulbosus be related to elevated nitrogen deposition as well as hydropower regulations?</td>
<td>Hessen, D.O; Andersen, T.</td>
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<td>Platform for Viral Aquamedicine</td>
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<td>Pre-project for cable-based ocean observatory</td>
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**International projects**

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<td>Thresholds of environmental sustainability</td>
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Publications

Books and book chapters


Publications in peer reviewed journals


Dittami, Simon; Wichard, Thomas; Malzahn, Arne; Pohnert, Georg; Boersma, Maarten; Wiltshire, Karen. *Culture conditions affect fatty acid content along with wound-activated production of polyunsaturated aldehydes in Thalassiosira rotula* (Coscinodiscophyceae). *Nova Hedwigia, Beiheft 2010; Volum 136.* s. 231-248


