Nordic Centre for Research on Marine Ecosystems and Resources Under Climate Change — 2012
NorMER (Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change; www.normer.org) is a Nordic Centre of Excellence that brings together the expertise of leading research groups from all Nordic countries, and several North American institutions, to implement a collective and multidisciplinary research strategy to explore the biological, economic, and management consequences of global climate change on fisheries resources. It will achieve this through a unique program of primary research, implemented by PhDs and Postdocs in a system of collaborative projects, with a focus on the Atlantic cod (Gadus morhua). Though our Nordic focus is on cod, this research is intended to be a platform to extend this knowledge to other marine systems.

The aims and corresponding actions of NorMER are:

1. Perform effect studies to: (1) evaluate climate effects on Nordic marine ecosystems, (2) Build new tools for predicting biological consequences of climate change, and (3) quantify impacts on profit, employment, and harvesting.

   **Actions:** PhDs are co-supervised internationally. Postdocs collaborate internationally. Leading senior scientists and climate researchers provide expert input.

2. Create an effective training environment for young researchers.

   **Actions:** Annual meetings, graduate courses, and special workshops focus on transferable and interdisciplinary skills. Regular interaction between students and international experts in climate- and marine ecosystem-related fields further strengthen the training program in NorMER.

3. Develop a team of outstanding global quality.

   **Actions:** Research institutions from every Nordic country are partners. International researchers and industry representatives are invited to annual meetings. A 7-member Centre Advisory Panel (CAP), consisting of an interdisciplinary mix of globally leading researchers participate at all annual meetings. Annually, one internationally distinguished researcher is selected as the honored Johan Hjort Chair to participate at the annual meeting to share expertise with NorMER partners and students.

4. Link to industry and policy managers.

   **Actions:** Industry and Policy representatives from each of the Nordic countries are encouraged to attend annual meetings for discussing societal/economic effects of climate change, and to learn more about NorMER work. PhD students will be encouraged to visit marine industries or participate in commercial fishing. A strong bio-economic focus within NorMER will facilitate transference of results to fisheries managers.

5. Update marine ecosystem management policies to sustain healthy fisheries.

   **Actions:** NorMER is a research based program to evaluate the effects of climate variability on marine ecosystems and how fisheries management can be adapted to maintain sustainable harvest levels. We hope to produce strong results, built on solid fundamental science, that will be applied to real systems in the Nordic region.

NorMER is primarily supported with funding from Nordforsk, on behalf of the Top-level Research Initiative (TRI), and from each of the main partners. The Centre is administered by the CEES in the Department of Biology at the University of Oslo, but this is a pan-Nordic collaborative project, which includes research teams led by Nils Chr. Stenseth at the University of Oslo, Carl Folke of the Stockholm Resilience Centre in Sweden, Erik Bonsdorff at Åbo Adakemi University in Finland, Markus Lindroos at the University of Helsinki in Finland, Markus Meier at the Swedish Meteorological and Hydrological Institute in Sweden, Guðrún Marteinsdóttir at Marine Academic Research in Iceland, Eyðfinn Magnussen at the University of Bergen in Norway, and Thomas Kiørboe at the Technical University of Denmark.
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SECTION ONE: Comments

008 — From the Chair of NorMER
011 — From the Centre Advisory Panel (CAP) Chair

The eggs of salmon (Salmo salar) from an experiment conducted by the Norwegian National Veterinary Institute (NNI).

Photography: Ruben A. Pettersen
Comments from the Chair of NorMER

PROF. NILS CHR. STENSETH
Centre for Ecological and Evolutionary Synthesis (CEES)

We have been through our first full year as a ‘Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change’ (NorMER), a Nordic Centre of Excellence focusing on training Young Researchers (PhDs and Postdocs) within the topic of how climate change is affecting marine systems – from ecology and evolution, to economics and management. Although our perspective is general, we are focusing on cod (Gadus morhua) as our model organism because we believe this will make it easier to integrate the different disciplines involved within NorMER. All NorMER members will have one common marine system over which they can combine and apply their diverse expertise.

Having observed the developments during the first year, I feel confident that we are on the right track towards our ambitions of being a truly Nordic Centre of Excellence. First of all, we have secured good funding. Second, we have established an excellent team of Young Researchers (YR) and PhDs and Postdocs. Third, there is an excellent interdisciplinary interaction among the YR. Fourth, the 50 core nodes work well together to develop a well-integrated virtual centre. Fifth, we are being provided with good feedback from our Centre Advisory Panel (CAP). NorMER is indeed developing into a successfully and strongly integrated pan-Nordic centre. Already after only one year, we see clearly how NorMER creates a platform for growing a new generation of interdisciplinary Young Researchers with experience in combining physical, biological, social and economic aspects of marine ecosystem science and management. These interdisciplinary Young Researchers are being trained by specialists of various disciplines in a collaborative environment. This is being achieved, in part, through visits lasting for several months at partner institutions. Besides providing PhD students and Postdocs with valuable interdisciplinary training, this shared exchange with scientists from the collaborating institutions in the Nordic countries will contribute to bringing our various scientific groups closer together. In addition, the Young Researchers are organizing activities among themselves – activities which will further develop their interdisciplinary training and their scientific collaboration skills.

All of this will lead to, I am confident, a stronger Nordic position on leading scientific endeavors both in Europe and globally. NorMER is designed so that each of the PhD and Postdoc projects has a strong ‘curiosity-driven’ scientific element: our overall ambition is to provide solid and high-quality science. In addition to the ‘curiosity-driven’ elements, the entire NorMER program has been designed so that our center will address many important ‘problem-solving’ and ‘challenge-driven’ issues raised by scientists, politicians and managers in response to ongoing changes in climate. This means that the new insight obtained within NorMER will ideally be applied in order to improve our management of marine ecosystems under climate change. Such emerging effects of NorMER focusing on the ‘problem-solving’ and ‘challenge-driven’ issues will for sure come by itself. The NorMER leadership – and each of the supervisors – will have to pay particular attention to this aspect of NorMER. The joint YR activities will certainly help in this respect. I suggest that we should aim at producing some good review/perspective papers addressing the overall focus of NorMER: what will the effect of climate change be on the marine system – and how should we humans best adapt to it so as to reduce the damaging effect of climate change. Communicating our perspectives and results to a broad spectrum of people, not the least to politicians, is an important part of NorMER. In order to facilitate such a dialogue with politicians and managers about the science we are doing within NorMER, we organized – just as we did the year before – an open session at the University of Helsinki in connection with our second NorMER annual meeting. At that opening session, both the Finnish Minister of Environment, Ville Niinistö, and the Vice Rector of the University of Helsinki, Jukka Kola, participated – as did the former Norwegian Minister of Research and Higher Education, Tora Aasland. This opening session was a great success – as was the annual meeting that immediately followed. Beside communicating the ambitions and objectives of NorMER at such formal sessions like the opening session of the annual meeting, we aim at developing a rather proactive communication strategy. The ‘Young Researchers’ blog (www.normer.no/blog) is part of such a strategy. In addition we will be in the coming year aim at being far more visible in national and international general media.

In short, NorMER is growing as a Nordic Centre of Excellence fostering high international visibility of science carried out within the Nordic countries. The YR and the collaboration with the core nations will be ideally applied in order to improve our management of marine ecosystems under climate change. Such emerging effects of NorMER focusing on the ‘problem-solving’ and ‘challenge-driven’ issues will for sure come by itself. The NorMER leadership – and each of the supervisors – will have to pay particular attention to this aspect of NorMER. The joint YR activities will certainly help in this respect. I suggest that we should aim at producing some good review/ perspectives papers addressing the overall focus of NorMER: what will the effect of climate change be on the marine system – and how should we humans best adapt to it so as to reduce the damaging effect of climate change. Communicating our perspectives and results to a broad spectrum of people, not the least to politicians, is an important part of NorMER. In order to facilitate such a dialogue with politicians and managers about the science we are doing within NorMER, we organized – just as we did the year before – an open session at the University of Helsinki in connection with our second NorMER annual meeting. At that opening session, both the Finnish Minister of Environment, Ville Niinistö, and the Vice Rector of the University of Helsinki, Jukka Kola, participated – as did the former Norwegian Minister of Research and Higher Education, Tora Aasland. This opening session was a great success – as was the annual meeting that immediately followed. Beside communicating the ambitions and objectives of NorMER at such formal sessions like the opening session of the annual meeting, we aim at developing a rather proactive communication strategy. The ‘Young Researchers’ blog (www.normer.no/blog) is part of such a strategy. In addition we will be in the coming year aim at being far more visible in national and international general media.

The Young Researchers are playing key roles within NorMER: they are the new generation who will play leading roles in marine research and management programs in the future. Recruiting PhDs and Postdocs is therefore of utmost importance to the success of NorMER. I am pleased to observe that we, in the second round of recruiting new members, got many more than that were originally planned: we have altogether appointed 14 PhDs and 8 Postdocs, with 2 PhDs and 1 Postdoc still pending. Altogether we are now 22 Young Researchers. Here are some of the highlights from the students work:

NorMER PhD Ana Sofia Ferreira has been assessing how ocean circulation influences the match-mismatch of phytoplankton bloom timing and spatial orientation relative to the timing of fish spawning (see page 26). NorMER PhD Rebecca Holt has been modelling the effects of changes in temperature on the physiological performance and life history strategies in teleost fish such as cod (see page 29). NorMER PhD William Butler has been mapping the spawning and nursery grounds of Atlantic cod along the Icelandic coast (see page 27). NorMER Postdoc Lauren Rogers has been using state space models to assess the dynamics of spatially structured populations of cod in the Skagerrak region (see page 28). NorMER PhD Emmi Nieminen has applied Game Theory approaches to Baltic Sea Fisheries to develop more optimal bioeconomic multispecies fisheries management (see page 30). Finally, you can read about a Young Researcher initiative, involving all of the PhDs and Postdocs in NorMER, to objectivley assess the current state of climate change research in the Nordic region, to identify both trends and gaps in knowledge (see page 32). These are only an overview of a few of the many great projects we are doing within NorMER, projects which are ‘curiosity-driven’ in their nature, but which will contribute to the ‘problem-solving’ mission of NorMER.

I am convinced that these Young Researchers will be able to produce good papers to be published in the very best journals within the respective fields as well as in the more general journals, taking advantage of the guidance – and encouragement – they will get from the senior members of the NorMER team.
The international links to research groups outside the Nordic countries have been an important part of NorMER. I am therefore pleased to acknowledge additional funding we received from Nordforsk to appoint two additional Postdocs, which provide strong links to respected international groups (Bodega Marine Lab at UC Davis, Northwest Fisheries Science Center, and University of Washington in Seattle). We also received funding from the Research Council of Norway for an additional Postdoc and PhD linked with the University of British Columbia Fisheries Centre. These links further broaden the already extensive network brought to NorMER by the senior members. Such an extensive network will surely benefit the YR during their training periods within NorMER, and continue to benefit them throughout their careers.

The added value of being part of a network like NorMER derives from this extensive Nordic – and increasingly global – network. Furthermore, the fact that each of the Young Researchers is participating in joint work within NorMER means that they will be involved in more – and better – papers than they otherwise would. The YR-organized workshops within NorMER have contributed greatly to strengthening this Nordic network, as well as giving the Young Researchers practical experience in collaborative, interdisciplinary research (see page 38). The first two, in the form of two historically valuable scientific texts, were handed out by Bob Dickson at the NorMER 2011 Annual Meeting to Jim Hurrell and myself to honor our inspiring contributions to science – two awards we both humbly received with great appreciation. The third and fourth awards were handed out at the recent NorMER 2012 Annual Meeting to Tora Aasland, and Gregory Beauagrand and Martin Edwards. These same awards will be re-awarded to new inspiring awardees every few years into the future.

We certainly aim at continuing our work – within the NorMER platform – beyond 2015. We have already started to think about our strategy for the continuation of NorMER. I’m convinced that the current good work carried out by the YR – both alone and together with the senior members of NorMER – will help in this respect. I personally see that there is a need for such a research and training platform beyond 2016. One way to secure a continued existence is to link up with the larger European and international networks. However, without a longer term commitment from the involved partner institutions, such a continued existence will be difficult.

Many colleagues have contributed to the groups outside development of NorMER. First of all, I am sincerely thankful to the Young Researchers for their enthusiasm and dedication to make NorMER a true centre of excellence – excellence in ecological science, in evolutionary science, in economic science and in interdisciplinary science. Secondly, I am thankful to our Johan Hjort Chairs (Bob Dickson and Rashid Sumaila) for their inspiration and guidance. Thirdly, I am very thankful to the group leaders of the 10 collaborating institutions in the Nordic countries; in particular I would like to thank my co-chair, Carl Folke, for helping us develop NorMER as a proper interdisciplinary Nordic Centre of Excellence and the Center Advisory Panel (CAP), chaired by Philippe Cury and consisting of top-level scientists within the broad spectrum of fields covered by NorMER. Finally, it is a great pleasure to thank Jason O. Whittington for his very talented and great assistance in developing NorMER, together with Gry Gundersen, he helps Carl and myself with all aspects of chairing NorMER – assistance spanning all sort of issues from the very small details to the larger strategic scientific and management decisions. Indeed, it would be hard to think of how to further develop the scientific platform of NorMER without the able help of Jason; it would be equally difficult to think of how to administrate NorMER with its complicated consortium agreement without the able help of Gry: thanks Jason and Gry.

The future of our marine ecosystems can be met through cooperation between scientists, as collaboration is key to sharing the scientific experience (science is fun, particularly when made with good friends!). Be curious, be creative, but also do not forget to put your research project into a broader NorMER context (i.e. the such as within both global change and the future ecosystem dynamics). Rashid Sumaila tells his students that he wants to help them develop a ‘trained mind’ and I would like to add also a ‘committed mind’! Congratulations for your work and see you all in one year.

Philippe Cury
Chair of CAP

Comments from the Centre Advisory Panel (CAP) Chair

Before closing, and on behalf of the CAP, I would like to congratulate each of you for the quality of your research and for your involvement in NorMER. The CAP was extremely pleased to appreciate the great progress you made during the last year and today. Your presentations illustrated the immense scientific progress that was made. This is a critical time for NorMER, as you will start to deliver during this year the scientific results that constitute the core of NorMER. This is also an important time, as we need to construct a global strategy for NorMER and its future. In 2015, you should have an excellent thesis of which you can be proud, but you should also be proud for having the privilege of participating in this incredible multidisciplinary adventure initiated by NorMER.

The future of our marine ecosystems deserve our attention collectively as their importance and scientific value are immense. The major objectives NorMER hopes to achieve can be met through cooperation between scientists, as collaboration is key to sharing the scientific experience (science is fun, particularly when made with good friends!).
SECTION TWO: New faces

014 — PhDs and Postdocs
016 — Linked programmes on Adaptation to Climate Change
018 — New partnerships

Historical Atlantic cod specimen. DNA retrieved from historic samples may reveal patterns of recent adaptive evolution driven by climatic change or human impacts.

Photography: Bastiaan Star
**PHDs and Postdocs**

**KRISTINA KVILLE**
- **Project title:** Climatic influences on zooplankton dynamics in Lofoten and the Barents Sea
- **Co-supervisor:** B. Leif Chr. Stige, Centre for Ecological and Evolutionary Resilience Centre, Sweden.
- **Leif Chr. Stige, Centre for Ecological and Evolutionary Resilience Centre, Sweden.**

**JOHANNA YLETYINEN**
- **Project title:** The effect of network properties on the dynamics of social-ecological systems and their response to multiple drivers
- **Co-supervisor:** Jorgen Kristensen, Department of Biology, University of Oslo, Norway.

**NADIAFOUZAI**
- **Project title:** Larval cod in environmental gradients: How do recruitment success relate to oceanographic conditions
- **Supervisor:** Henrik Gislason, DTU-Aqua, Denmark.
- **Co-supervisors:** Henrik Gislason, DTU-Aqua, Denmark.

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- **Project title:** Grey-box methods for data-based estimation of fish stocks
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STRENGTHENING THE ADAPTIVE CAPACITY OF INSTITUTIONS IN FISHERIES

FUNDED BY THE RESEARCH COUNCIL NORWAY UNDER THE CALL ‘ORKLIMA’

 Globally, marine ecosystems are under pressure from high exploitation and climatic changes. Some regions in the world are especially vulnerable, because ecosystem resilience is low, or their institutions are ill-equipped to adapt to a changing climate, for example because communities rely largely on fishing as a source of income. Thus, there is a pressing need to analyze how climate change alters marine ecosystem functioning, the fishing sector, and communities in areas that are particularly at risk. The main focus of the proposed project is the complex system of the Barents Sea / Lofoten fishery, taking into account the multiple feedbacks between climate, marine ecosystems, and institutions to understand and disentangle the various aspects of societal adaptation to climate change. The aim is to strengthen the adaptive capacity of institutions that govern marine ecosystems. In particular, we propose to analyze:

- How adaptive action by fishermen is influenced by informal institutions, such as social norms, peer behavior, cultural identity, and social status.
- How quickly formal institutions respond to environmental change, and how this affects social communities and interacts with adaptive action taken by individual users.
- How biological complexity may hinder efforts to adapt, taking into account the risk and uncertainty of a stock collapse or the possibility that users can switch to other species.
- How the adaptive capacity of institutions can be strengthened to respond adequately and efficiently to climate change, providing valuable management lessons for the Arctic regions.

The proposed project is complementary to NormER, which investigates the effects on climate change on marine ecosystems in the Nordic regions with a focus on Atlantic cod. While ecosystem complexity is important, this research proposal fills an important gap by addressing institutional and social complexity. The proposed project takes a global perspective with the aim to learn from fisheries around the world, which will be combined with valuable expertise from NormER to meet Nordic challenges.

Our main international partner, the Fisheries Centre of the University of British Columbia, has expertise on global and regional analysis on climate change effects on marine biodiversity and fisheries and hosts a database comprising distribution maps, and ecosystem and catch data for more than 1,000 species. Thus, this project combines global insights from fisheries around the world with valuable Nordic expertise to meet challenges posed by a changing climate.

We will achieve our research goals by using a unique mix of theoretical modeling and empirical analysis, and benefiting from extensive experience with developing interdisciplinary bioeconomic models among all partners. The proposed project will disentangle the various aspects of adaptation to climate change by analyzing the multiple feedbacks between climate, formal and informal institutions, and ecological complexity, to strengthen the adaptive capacity of institutions that govern marine ecosystems. It will thus clarify the role of risk and uncertainty of climate change, both for managers and stakeholders, and will reveal how management could affect coastal communities, including important equity considerations.

LINKED PROGRAMMES ON ADAPTATION TO CLIMATE CHANGE

BOTTOM-UP CONTROLS IN FISHERIES MANAGEMENT AND ADAPTATION TO CLIMATE CHANGE

Nordic countries are particularly dependent on their marine resources which hold exceptional national, cultural, and economic significance. However, the Nordic region is also particularly vulnerable to climate change and high fish stock exploitation. Thus, understanding methods of adaptation within fisheries management systems that preemptively address both biological and human responses to these pressures are urgently needed. Of the fisheries management systems, those that employ individual transferable quotas (ITQs) may be especially valuable: the total allowable catch (TAC) of a stock for the year is divided into individual quota shares, which are traded as property by individuals. However, preventing the race for fish that may have led to past fisheries collapses, the tradable aspect of ITQs has often been avoided due to criticism for detrimental socioeconomic effects. This problem illustrates how the success of any fisheries management system relies heavily on both biological and social aspects. In this context, biological aspects and policy and regulations can be thought of as top-down controls in the setting and enforcement of TACs, whereas social aspects are bottom-up controls that can undermine biological goals if adherence to fisheries regulations is ignored. This latter aspect underscores how the human dimension of resource management can have unintended consequences if incentives are improperly designed.

In multi-species fisheries, species are rarely caught by a fishermen in proportion to the his own array of quotas. Thus, it may be profitable to discard one species if its quota fills up more quickly than a more valuable species, thereby avoiding the necessity to stop fishing. Alternatively, regulations that would prevent such losses, and would also allow fishermen to account for overages in the quota system, have been avoided due to criticism for disincentives to discard and for ignoring social norms. This latter problem and the desire to avoid such unintended consequences have caused differential socio-ecological effects, despite the benefits that such systems can have if appropriately designed and managed.

This project aims to: 1) analyze past trends in how environmental trends, relative abundance, and relative profitability have caused differential socio-ecological effects by fisheries of individual quota trade, species conversions, and yearly transfers to affect fishing pressure, and 2) use this information to parameterize a simulation model in which the fishing regulations will be improved to affect long-term sustainability and profitability.

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Collaborators: Dr. Claire Armstrong, Stockholm Resilience Centre. Pamela Woods is a postdoctoral researcher at the University of Iceland where she is working on bottom-up control strategies for fisheries management. This project continues a partnership between the University of Iceland and the University of Washington’s Northwest Fisheries Science Centre, USA, that was established during her PhD work. She completed her PhD studies in December 2011 on the field and the financing of a species that exhibits high intraspecific diversity. Claire has worked since that time at the University of Iceland and a laska. She is currently completing her postdoctoral work at the University of Washington. Contact: Pamela Woods, North Pacific Science Center, NOAA Fisheries, Seattle, WA 98116, USA. Phone: +1 206 526 5889. E-mail: pamela.woods@noaa.gov.

Target species have been recorded in Icelandic trade, transfer, and catch records. This bottom-up component of the Icelandic management system, which is not normally considered within more traditional top-down forms of adaptive management, may be beneficial to the ecosystem by allowing response to occur on a much faster time scale and with less top-down investment. However, it may also be detrimental by consistently allowing a legal route for fishing over individual species TACs. This project aims to: 1) analyze past trends in how environmental trends, relative abundance, and relative profitability have caused differential socio-ecological effects by fisheries of individual quota trade, species conversions, and yearly transfers to affect fishing pressure, and 2) use this information to parameterize a simulation model in which the fishing regulations will be improved to affect long-term sustainability and profitability.

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New partnerships

UBC FISHERIES CENTRE

O ur planet’s fisheries have fished their way to the limits of their potential. As benefits from fisheries decrease, pressure grows to develop other sources of revenue, not necessarily compatible with ecosystem health. Policy and planning for ecosystem-based management must then be informed by knowledge of the interplay of human, biotic and environmental factors that affect ecosystem structure and function. Key requirements are sufficient time, an ability to capture biodiversity and ecosystem services. The Sea Around Us Project was established by Rashid Sumaila to document large-scale impacts on marine ecosystems and find solutions to the challenges they pose. Its work is catalogued and accessible on the web, offering ecosystem data, distribution maps and catch data for more than 1,000 species, historical trends and peer-reviewed publications. We are currently working with William Cheung to add to and make use of this excellent database of knowledge.

Daniel Pauly

Dr. Daniel Pauly is a French citizen who completed his high school and university studies in Germany; his doctorate (1979) is in Fisheries Biology, from the University of Kiel. After many years at the International Center for Living Aquatic Resources Management (ICLARM), in Manila, Philippines, Daniel Pauly became in 1994 Professor at the Fisheries Centre of the University of British Columbia, Vancouver, Canada, and from 2003 to 2009 its Director. Since 1999, he is also Principal Investigator of the Sea Around Us Programme, and the Centre for the Blue Planet, a new non-profit organization in the USA. Daniel Pauly has published more than 600 papers on a wide range of topics, including several books. His impact on ocean sustainability is well known to the world community, and his achievements have been recognized by many awards, among them the International Cosmos Prize, Japan (2005), the Volvo Environmental Prize, Sweden (2006), the excellence in Ecology Prize, Germany (2007), the Ramon Margalef Prize from the Government of Catalonia (Spain, 2006), the Grand Prix 2011 of the French Ecological Society (2012), and the Nienbergen Award for Science in the Public Interest for the Scripps Institution for Oceanography, California (2012).

William Cheung

William is an Associate Professor at the UBC Prior to joining UBC in 2007, he was an Associate Professor in the School of Earth and Ocean Sciences at the University of Victoria. William obtained a BSc (Biological) in 1996, and subsequently a M.Phil. in 1999 and a PhD in 2001 from the University of Hong Kong. After working in WWF Hong Kong for two years, he completed his PhD in Resource Management and Environmental Studies in the UBC Fisheries Centre in 2007. He then worked as a postdoctoral fellow in the Sea-Around Us Project for two years. From 2009 to 2011, he was Lecturer in Marine Ecosystem Services in the School of Environmental Sciences, University of East Anglia in the UK. His main research is assessing the impact of global and climate change on marine ecosystems and their goods and services, and studying ways to incorporate the stakeholders in management. He works on various interdisciplinary research projects and is an expert in using social-ecological models to inform marine management. He works on issues such as long-term catch rates, trends in biodiversity and their relationship to the fishery.

Rashid Sumaila

As the 2012 NorMER Johan Hjort Chair, his bio can be seen on page 37 of this report. 

NORTHWEST FISHERIES SCIENCE CENTER (NWFS)

T he Northwest Fisheries Science Center studies living marine resources (e.g., salmon, groundfish, and killer whales) and their habitats in the Northwest Pacific Ocean primarily off the coasts of Washington and Oregon and in freshwater rivers and streams in Washington, Oregon, Idaho, and Montana. The Center seeks to better understand living marine resources and their ecosystems to assist resource managers in making sound decisions that will build sustainable fisheries, recover endangered and threatened species, and sustain healthy ecosystems, and reduce human health risks. The Center’s 500 scientists and staff conduct research in 5 primary areas:

- Status of Stocks. Center scientists and research associates conduct stock assessments for West Coast groundfish and salmon stocks in the Pacific Northwest by taking a variety of measurements (e.g., data from fishing vessel catch or landings, scientific surveys, observers stationed on fishing vessels, and life history studies), analyzing the data, and using mathematical models to draw conclusions from the results.

- Human-Caused Stress/Risk. Center scientists are conducting research to better understand how salmon, marine fish, and marine mammals react to the stresses of human impacts on the environment and to quantify, assess, and minimize these risks.

- Ecosystem Observations and Climate Variability. Center scientists are conducting research on physical and biological processes that influence aquatic, marine and terrestrial ecosystems at the global and regional scales.

- Recovery & Rebuilding Species. The Center studies genetic variation and coordinates stock assessments for West Coast groundfish and salmon stocks in the Pacific Northwest by taking a variety of measurements (e.g., data from fishing vessel catch or landings, scientific surveys, observers stationed on fishing vessels, and life history studies), analyzing the data, and using mathematical models to draw conclusions from the results.

- Developing New Partnerships. New partnerships are constantly being sought to bring new ideas and expertise to the Center. The Center leads the Marine Climate Observation Network (MCORN), the Pacific Salmon Framework, the Marine Invasive Species Network (MISNet), and the Regional Aquatic Monitoring Strategy (RAMS). The Region has worked closely with partners and the Center has recently completed a USGS Interagency Agreement to expand the fish species identification capability at the NMFS laboratory in Seattle to include all species of fish and invertebrates. The Center is currently working on a project to increase the accuracy of early life stage identification in the fish species and to identify more species in the center.
The Atlantic cod (Gadus morhua) is one of the most important fishery species in the Nordic region. They average 26 cm by the end of their first year. Most reach sexual maturity at 1.7–2.3 years and are harvested at ages 2–5.

Photography: Øyvind Haugen

SECTION THREE:
Scientific activity

022 — Organization of the research
024 — Scientific highlights
032 — Young researcher workshops
Organization of the research

SCIENTIFIC FRAMEWORK

NORMER will evaluate the risks and opportunities of the effects of climate change on fisheries in the Nordic region, with a particular focus on the Atlantic cod (Gadus morhua), a species of ecological and economic importance throughout our region. The individual projects are designed to fit within (for PhDs) or between (for Postdocs) four Thematic clusters within our scientific framework.

1. Develop a comprehensive model of physical processes and their interactions with marine food webs.
2. Define the importance of lower trophic levels and their influence on harvested species.
3. Detail the drivers, patterns, and trends of harvested populations.
4. Create guidelines for optimal management of marine resources to maximize profit and yield, now and in the future.

This will be done for all northern seas.

NORMER’S GRAND CHALLENGES: COD AS A MODEL OF CLIMATE CHANGE IMPACTS

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This will be done for all northern seas.
**SCENARIOS OF CLIMATE CHANGE FOR THE BALTIC SEA**

By Helén C. Andersson, Swedish Meteorological and Hydrological Institute, Sweden.

Climate model results for the Baltic Sea, based on IPCC A1x scenarios, indicate that a significant warming of the region can be reality before the end of the 21st century. The warming is projected to be most pronounced during the winter season and in the north-eastern part of the region, where the change in mean winter air temperatures at 2 m above the sea surface in some scenarios is more than 4°C.

The global warming will hence have large impact on the marine environment of the Baltic Sea, with resulting increase of water temperature and reduced sea-ice cover. The warming will also affect the hydrological cycle and model results show a likely increase in river runoff in the northern areas which will reduce the over-all salinity of the Baltic Sea.

The Baltic Sea is a sensitive sea. It is one of the World’s largest estuaries and its semi-enclosed location, with the only exchange with the open sea through the narrow and shallow straits between Sweden and Denmark, means restricted deep-water renewal and long residence times. In combination with high nutrient loads to the basin, this results in severe eutrophication and large hypoxic areas.

The low-salinity setting, with surface salinity ranging from about 9 psu in the south west to about 2 psu in the north, gives that relatively few species are adapted to this rather special environment. Changing conditions due to climate change might have significant impact on all levels of the ecosystem and can affect distribution, population sizes, growth and reproduction. This may particularly influence reproduction of cod, since this has been linked to temperature, salinity and oxygen conditions at the spawning grounds.

As a response to global climate change, the ocean temperature of the Baltic Sea is expected to increase in all areas and throughout the whole water column. The climate-induced warming is modeled to be significant by midcentury. By the end of the century the volume averaged mean temperature is projected to have increased with about 2.5°C (Fig. 2, upper panel). The volume averaged mean salinity responds to the increased precipitation and river runoff by a decrease of about 2 psu (Fig. 2, lower panel) – a decrease that means that the salinity conditions presently found in the Bothnian Sea can in the future be the state of the Baltic proper.

The models suggest that due to increased water temperatures, oxygen saturation concentrations will decrease and turnover rates of biochemical processes will increase. Due to increased river flows eventually larger amounts of nutrients may also be flushed out from land. The low bottom oxygen levels in large parts of the Baltic are of present concern and intensive abatements for the whole Baltic Sea region are introduced through the HELCOM Baltic Sea Action Plan (BSAP). However, the scenarios indicate that these efforts are less effective for the marine environment in future compared to present climate. Future bottom oxygen levels under the BSAP scenario will not increase significantly and will even be reduced assuming present loads (Fig. 3).

**Fig. 1:** Warming induced changes in water temperature and salinity and hypoxia area (with bottom oxygen concentrations below 2 ml/l) in the Baltic Sea (solid lines). The ranges of plus/minus one standard deviation around the ensemble means are depicted by dotted and dashed lines, respectively. Straight lines indicate the 99% confidence interval for significant changes from present climate variability during 1978-2007. (From Meier et al 2011)

**Fig. 2:** Volume integrated water temperature and salinity and hypoxic area (with bottom oxygen concentrations below 2 ml/l) in the Baltic Sea (solid lines). The ranges of plus/minus one standard deviation around the ensemble means are depicted by dotted and dashed lines, respectively. Straight lines indicate the 99% confidence interval for significant changes from present climate variability during 1978-2007. (From Meier et al 2011)

**Fig. 3:** Warming induced changes in water temperature and salinity and hypoxia area (with bottom oxygen concentrations below 2 ml/l) in the Baltic Sea (solid lines). The ranges of plus/minus one standard deviation around the ensemble means are depicted by dotted and dashed lines, respectively. Straight lines indicate the 99% confidence interval for significant changes from present climate variability during 1978-2007. (From Meier et al 2011)
HOW IS A WARMER NORTH ATLANTIC AFFECTING PRIMARY PRODUCTIVITY?

By Ana Sofia Ferreira, NormER PhD student, DTU Aqua, Denmark

When the available concentration of nutrients and light match phytoplankton demands, the basis of aquatic life, blooms occur. Increased mixing of water masses has been linked to an increase in nutrient supply, but may also act as a light-limiting factor. Phytoplankton will then have a cascading effect on zooplankton production and, subsequently, on fish survival. Thus, ocean circulation is a key factor influencing access to light and nutrients for phytoplankton.

In the North-Atlantic, the subpolar gyre can be used as a proxy for the marine climate in the North-East Atlantic (NEA) (Fig. 1). A weak SPG allows salty, warm, and stratified eastern waters to dominate in the European continental slope (Fig. 1b). Previous studies have reported the influence of SPG in phytoplankton abundance and changes in the zooplankton community structure in the NEA using data from the continuous plankton recorder (CPR).

Satellites are a powerful source of data, they provide highly resolved temporal and spatial products. These products are extremely valuable when one aims at assessing spatial patterns. From the GlobColour Project, one can obtain long time series of consistently calibrated global ocean color information as a proxy for chlorophyll concentration.

With the first signs of spring, phytoplankton blooms flourish in the NEA, as can be observed in the phenomenon of chlorophyll concentration (Fig. 2). The higher the latitude, the later the bloom occurs. But how does this relate to climate? In years with a strong SPG (negative index), average chlorophyll concentrations are lower. This is expected, for a strong SPG means fresh, cold waters over the region. However, bloom initiation appears to behave differently. A strong SPG, thus a strong atmospheric forcing, seems to affect the timing of phytoplankton blooms within and outside of the SPG region, such as blue whiting, North Atlantic cod, haddock, Atlantic salmon, northern shrimp, Norwegian spring spawning herring, and possibly Bluefin tuna.

The earlier the bloom initiates, and the longer it lasts, the higher the probability the timing of bloomed blooms will match the timing of fish spawning. If a warmer NEA would mean a somewhat late bloom, my question is how big would you put on commercial fish species be?

MAPPING THE SPawning GRouNS OF ATLANtic COD (GADUS MOrHUA) IN ICelANDIC WaTERS

By William Butler, University of Iceland

Historically, the main spawning grounds around Iceland were considered to be along the south-eastern coast of Iceland, from where eggs and larvae are transported to nursery grounds in the north via the coastal and inshore currents. Recent studies based on back-calculated hatch dates of 0-group cod have indicated that other areas located within fjords of the West, North and East coasts appear to contribute significantly, at least in some years, to the survival pelagic juvenile population.

To achieve this, the distribution of cod during the spawning season and occurrences of spawning cod confirmed by Marine Research Institute (MRI) samples. Data were considered from 1991 to present as logbook records have been mandatory for all vessels with gross tonnage exceeding 9.9 tonnes for the last 30 years.

Satellites are a powerful source of data, they provide highly resolved temporal and spatial products. These products are extremely valuable when one aims at assessing spatial patterns. From the GlobColour Project, one can obtain long time series of consistently calibrated global ocean color information as a proxy for chlorophyll concentration (Fig. 1). The higher the latitude, the later the bloom occurs. But how does this relate to climate? In years with a strong SPG (negative index), average chlorophyll concentrations are lower. This is expected, for a strong SPG means fresh, cold waters over the region. However, bloom initiation appears to behave differently. A strong SPG, thus a strong atmospheric forcing, seems to affect the timing of phytoplankton blooms within and outside of the SPG region, such as blue whiting, North Atlantic cod, haddock, Atlantic salmon, northern shrimp, Norwegian spring spawning herring, and possibly Bluefin tuna.

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Using state-space models to assess how climate affects the dynamics of spatially-structured cod stocks

By Lauren Rogers, NorMEr postdoc, University of Oslo

Assessing the sensitivity of fish stocks to current and future climate change remains an important but challenging goal. Fish population dynamics are notoriously noisy, and distinguishing the effects of climate from intrinsic population processes can be difficult. Atlantic cod (Gadus morhua) are known to exhibit strong cohort interactions due to competition and cannibalism, and combined with stochastic recruitment processes this can lead to both high- and low-frequency variation in abundance. Furthermore, evidence suggests that many marine fish stocks consist of multiple subpopulations characterized by differences in genetics and/or life history, yet most studies fail to incorporate this within a stock community, potentially affecting the ability to detect important ecological processes.

In this project, we developed a dynamic state-space model that accounts for spatial structure in order to study how changes in climate have affected recruitment and survival in Skagerrak coastal cod. The historical (1919–present) Flødevigen beach seine survey along the coast of Norway presents a unique opportunity for studying the effects of changes in climate on Atlantic cod population dynamics. Every year, juvenile age 0 and 1 could have been sampled at this location and age 0 cod are found in several fjords along the coast (Fig. 1). These cod are non-migratory, and genetic population structure is known to exist within Atlantic cod populations.

While we cannot directly identify the mechanism linking warmer temperatures to reduced survival in Skagerrak coastal cod, both direct effects on physiology as well as indirect effects via the planktonic prey community are likely. These results are supported by other studies that have found negative effects of warming on cod at the warmer edges of their species distribution, and suggest that coastal cod in the Skagerrak will face an increasingly challenging environment as climate continues to warm.

Climate responses in fish: temperature dependence of physiological performance and consequences for ecological functions

By Rebecca Holt, Department of Biology, University of Bergen

Marine ecosystems are under pressure from anthropogenic drivers such as climate change, pollution, and exploitation. Among these, climate change has an unprecedented influence on the marine environment, as it affects individual organisms during their life history strategies of fish in diverse evolutionary settings. The focus on mechanistic approaches to fish physiology and ecological responses to climate change may influence the life history strategies of fish in diverse ways. As temperatures increase, greater energetic costs are incurred resulting from the increase in the rate of biochemical reactions, reducing the amount of metabolic scope or energy available for allocation to growth and reproduction. Emergent patterns in foraging behaviour are observed, whereby increased temperature results in an increased rate of foraging. Fish forage harder, behaviourally compensating for changes in temperature-dependent physiological processes. Natural mortality increases due to the evolutionary life history response towards a smaller, increased predation risk and elevated reproduction investment. The model demonstrates that under increasing temperature scenarios fish will mature earlier and at smaller sizes. This result extends the standard expectation for life history responses as observed from high levels of mortality such as that caused by fishing.

5 Hijmans, R.J., Elith, J., Graham, C.H., Hijmans, R.J., Graham, C.H., Phillips, S.J., and sidewalk (Fig. 2). As temperatures increase, greater energetic costs are incurred resulting from the increase in the rate of biochemical reactions, reducing the amount of metabolic scope or energy available for allocation to growth and reproduction. Emergent patterns in foraging behaviour are observed, whereby increased temperature results in an increased rate of foraging. Fish forage harder, behaviourally compensating for changes in temperature-dependent physiological processes.
INTRODUCTION

Baltic cod (Gadus morhua colani), Baltic herring (Clupea harengus membras), and sprat (Sprattus sprattus) are the most commercially exploited fish species in the Baltic Sea. Since 1980, cod catches have rapidly decreased, and simultaneously sprat catches – a prey species of cod – have increased remarkably.1 The reason for lower cod catches was – in addition to high fishing pressure – the low salinity and oxygen levels for cod recruitment. Continuing climate change may have decreasing effects on the salinity level in the Baltic Sea2 due to changes in the atmospheric circulation and therefore decrease the salinity of water pulses from the North Sea.3

The species interactions have effects on the development of the fish stocks in the Baltic Sea and an important influence on both biological and economic performance. Here we will first present our previous multi-species fisheries management study with the underlying bioeconomic model and the results. Then, the upcoming research project with a theoretical application will be introduced.

OPTIMAL MULTISPECIES BIOECONOMIC MANAGEMENT

We have earlier developed a deterministic, discrete, multispecies bioeconomic model for cod, herring, and sprat concerning the Baltic Sea fishery.4 Our simulation period is 50 years with a one-year time step. To find the economically optimal fishing mortality paths for the species, we construct a numerical model combining biological and economic factors, and maximize the net present value (NPV) over the simulation period subject to the biological constraints. The optimization is conducted from the viewpoint of a fisheries management planner, and the aim is to maximize the social welfare of the entire fishing industry. The basic principle of the model consists of population dynamics and the biological interactions of the species. The recruitment function for herring and sprat is modeled using Ricker’s density dependent formulation. Cod recruitment follows a function according to Heikinheimo5 with a salinity factor included. The main interaction between the species is the cod predation on herring and sprat6 (Fig. 1). We model the interaction by using a predation mortality functions based on functional response rates. In addition, herring benefits from lower sprat stock and cod cannibalism is also included. The cost function for cod follows a non-linear format as in Amassian et al.7 According to the function, an increase in cod biomass decreases harvesting costs because the fish are then easier to locate. For herring and sprat, the costs are linear function of fishing effort according to Gordon8. We assume that price is constant for each species. We simulate the model under different scenarios. The first scenario is the current situation with current fishing mortalities under low salinity conditions. Scenario 2 is also conducted under these conditions, but in this case we optimize the fishing mortalities. Scenarios 3 and 4 consider situations under higher salinity conditions with current and optimal fishing mortalities. All the main results are presented in Table 1.

The fisheries of cod, herring, and sprat in the Baltic Sea is a prey species system, where the costs can be almost three times higher in the long run if fishing mortalities were optimized. A lower fishing mortality for cod allows time for individuals to grow and achieve a higher economic value and reproduction potential. This would increase the net present value due to higher catches and lower harvesting costs. In Scenario 3 under improved salinity conditions, which leads to better conditions for cod recruitment, the net present value would be almost seven times higher than in Scenario 1 even with current fishing mortalities. Higher salinity level would increase the cod stock remarkably and furthermore affect herring and especially sprat stocks negatively, and their harvests almost disappear. When the fishing mortalities are optimized in Scenario 4, the net present value would be even higher. Still, even under higher salinity conditions the optimal fishing mortality of cod would be lower than currently.

In Scenario 3, the net present value becomes almost three times higher compared to Scenario 1, but the sprat stock is much less in Scenario 4 compared to Scenario 3. According to this, fishing regulations are relatively more important under low salinity conditions and are likely to prevail in the future due to changing climate.

GAME THEORY - UPCOMING RESEARCH

In our bioeconomic analysis we assumed there is a single decision maker, a sole owner, who can choose the optimal fishing mortalities for the species. The model assumes the狭义的beings. What about if we have several decision makers as it is often in the real world? There are nine countries harvesting in the Baltic Sea (Fig. 2), and it is definitely not a sole owner situation. Our tool for analyzing this kind of strategic interaction of more than one rational decision maker is game theory. The decision makers, or players, affect the availability of fish stock by their own actions and thus the economic profits of other players as well. Game theory helps explaining the different actions players take in fishery. So far there exist only few economic multispecies studies that have been conducted from a game theoretical point of view. In our model the players, i.e. countries, are asymmetric as they have different harvesting costs and discount rates. These differences affect their optimal harvesting strategies. In this research, we will first optimize the fishery from a viewpoint of all three countries. The countries will maximize their joint profits by choosing their optimal fishing mortalities each year. Why is it then difficult to attain this cooperative solution? The problem lies in the incentive to free ride. One country may leave the agreed cooperation and free ride if it benefits more by doing so. Thus, the free-rider is harvesting more than has been agreed according to quotas. Our second task is to assess the profits countries receive when instead of cooperating they decide to non-cooperate. Now each country maximizes its own profits instead of joint profits. Countries have to take into account the choices of others, since those affect the availability of fish that can be harvested. Usually non-co- operation yields lower profits and higher fishing mortalities in total than a cooperative solution. Finally, our focus is on partly cooperative games where two of the countries start harvesting together and form a coalition whereas the third country acts as a singleton. The coalition is cooperating and maximizing its joint profits, but they are playing a game against the singleton that maximizes its personal profits. The main focus in the study will be comparing the different types of games, the profits gained from those, and the stability of the cooperation. We will also examine the effects of different discount rates between the countries. Finally all the games will be compared with the present real world situation in order to discover what kind of game structure is closest to the current one.
Young researcher workshops

Training a new generation of researchers to tackle issues related to climate change and marine ecosystems is one of the primary goals of NorMER. This new generation should be skilled at collaborating and communicating across disciplines ranging from physical to biological to social sciences. As a geographically distributed center, developing such skills can be a challenge. Following the NorMER Annual Meeting in October 2011, the young researchers (YR) developed, on their own initiative, two activities to become a more cohesive group of collaborating researchers: the first was to start a NorMER Blog (which can be seen at http://www.normer.uio.no/blog), and the second was to organize workshops to bring the young researchers together on a regular basis to work towards a common goal. Two YR-organized workshops have followed, giving all YRs the opportunity to learn and apply real skills in collaborative, interdisciplinary research.

1 12–13 MAY 2012 MARINE BIOLOGICAL STATION DRØBAK, NORWAY

We first came together for two days in Drøbak, Norway. The idea was to consider proposals for a group project we could all participate in, and to subsequently embark on such a project. It quickly became clear that the Copenhagen node (led by Ana Sofia Ferreira, Martin Waever Pedersen, and Alexandros Kakaliotis) would lead the charge, having developed a clear idea for a project that would (i) require the expertise of all YRs, (ii) increase our knowledge of climate effects on Nordic marine ecosystems, and (iii) likely result in one or more YR-authored publications of interest to other researchers and the general public (see box).

Following their lead, we embarked on our first task: defining commonly-used terms in marine research. This was educational for all, as we realized that we may use the same words to refer to different things, and vice versa. Despite having talked of taking a relaxed hike in the woods, we ended up working around a white board until late at night, eagerly debating definitions and developing a common language. We started again early the next morning, setting goals and a timeline for work before we would meet again. We left with a new appreciation for the challenges of interdisciplinary group work, but also with great enthusiasm for being part of such an engaged community of young researchers.

2 6–7 OCT 2012 LAMMI BIOLOGICAL STATION LAMMI, FINLAND

Five months later, we met at Lamm. We had grown to 18 young researchers, comprised of 6 postdocs and 12 PhD students, representing 8 NorMER nodes and 11 nationalities. For two days, we pored over results from our pilot study, assessed our original goals, set out additional ones, and left with a concrete plan for turning ideas and analyses into manuscripts. The interactions fostered during the workshops, as well as the continuing discussions over email and Skype, have been essential for creating a cohesive community of young researchers from different countries and disciplines. It’s clear that the network that we are forming now will benefit us and our science throughout out careers.

The database will serve as a valuable asset for future studies to everybody involved in NorMER. However, the potentially most valuable outcome of the project is the lessons learned from the exercise of constructing the database, compiling the literature, and above all coordinating and collaborating among the many international nodes and diverse backgrounds of people involved in NorMER. Currently, all NorMER young researchers are involved with creating the database. There are currently plans of publishing a scientific paper describing the trends in the literature in relation to climate change studies in the North Atlantic using the information gathered in the database. However, the database will contain such a vast amount of information that several other papers have been discussed, such as a network analysis of collaborations between research groups in the Nordic region. Such publications, coauthored by all young researchers, would not only be of value at the individual level, but also identify NorMER as a coherent center.

TRENDS IN NORTHERN MARINE CLIMATE CHANGE RESEARCH

By Martin Waever Pedersen

This project is a collaboration between all young researchers (PhD students and postdocs) affiliated with NorMER and aims to address the following questions: What is the current state of climate change research within the Nordic marine region? Specifically, what has been studied so far, what are the trends in research activity, and where are the gaps? The approach is to create a database categorizing the literature relevant to NorMER (limited by certain criteria). The contents of the database can then be visualized and synthesized, and used to answer specific questions. For instance, which species are the most studied in the climate change research within the North Atlantic? Most people may have an opinion about this, but with the database the question can be answered using facts rather than speculation. The database will also contain information about the spatial and temporal structure of the relevant literature such that trends in climate change research can be quantified. This includes also trends in more complex aspects such as interdisciplinary approaches to research, spatial variability in research foci, or the temporal development of cod temperature studies. The database will serve as a valuable asset for future studies to everybody involved in NorMER. However, the potentially most valuable outcome of the project is the lessons learned from the exercise of constructing the database, compiling the literature, and above all coordinating and collaborating among the many international nodes and diverse backgrounds of people involved in NorMER. Currently, all NorMER young researchers are involved with creating the database. There are currently plans of publishing a scientific paper describing the trends in the literature in relation to climate change studies in the North Atlantic using the information gathered in the database. However, the database will contain such a vast amount of information that several other papers have been discussed, such as a network analysis of collaborations between research groups in the Nordic region. Such publications, coauthored by all young researchers, would not only be of value at the individual level, but also identify NorMER as a coherent center.
SECTION FOUR:
Awards and honors

038 — Johan Hjort Chairs
040 — The University of Oslo ‘Inspiration’ Awards
**Johan Hjort Chairs**

**Robert (Bob) Boys Dickson**

**Normer’s 2011 Johan Hjort Chair**

Bob Dickson was educated at the University of Edinburgh in 1961–64, and gained a Ph.D. in Environmental Sciences at the University of East Anglia in 1965–67. Since joining the Lowestoft Laboratory (now CEFAS) in 1964, he has maintained four main research interests: first, the early days of the self-recording current meter, he has contributed to the available stock of direct current measurements by which the sense and variability of the deep ocean circulation has become better understood. Second, he has studied the processes that drive variations in the physical environment of the North Atlantic, including the varied ocean response to an extreme multi-decadal shift in the North Atlantic Oscillation between the 1960s and 1990s. Third he has investigated ways in which change in the ocean circulation and climate at interannual to decadal time scales have affected various components of the Atlantic ecosystem from plankton to commercial fish stocks. Fourth and most recently, he has contributed to major international research efforts aimed at understanding the role of the high latitude ocean in Global Change. This has involved (principally) the task of chaining and coordinating the international Arctic Sub-Arctic Ocean Flux Study (ASOF) from its inception in 2000 to becoming one of the largest ocean observing systems in the Hemisphere, and his continuing efforts on behalf of the Arctic Ocean Sciences Board to piece-together an integrated Arctic Ocean Observing System (AOOS) for the International Polar Year and its “legacy phase” in pursuing these interests in the role of the Northern Seas in climate, Bob Dickson has acted as Deputy Chairman of the Arctic Ocean Sciences Board, as a member of the WORC-CLIVAR Atlantic Panel, as a Member of the SSC for the University of Washington Study of Environmental Arctic Change (SEARCH), as a Member of the Steering Committee for the “RAPID Climate Change” thematic programme of UK-ICE, and as a member of the Royal Society’s UK National Committee for the International Polar Year 2007/8. Most recently, in March 2011, his report defining an Ocean-Observing System for Northern Seas during the Legacy Phase of the International Polar Year, written at the request of the Arctic Science Summit Week in Seoul, South Korea. Since 2011, Bob has been a member of the Advisory Board for SOS (Svalbard Integrated Arctic Earth Observation System), part of the international effort to define its optimal scientific profile, and from 2011–12, he was one of the 9 member international Committee under Thomas Rosswall charged with the “Evaluation of Norwegian Climate Research” for the Research Council of Norway (submitted June 2012). In recognition of his long-sustained efforts to measure the cold, dense Denmark Strait Overflow (his own research contribution to ASOF), he was elected a Fellow of the Royal Society of Edinburgh (1995), was awarded the Plymouth Marine Sciences Silver Medal (1995) and was appointed first Fellow of the Sir Alister Hardy Foundation for Ocean Sciences (1997) in recognition of his role in recussing the long-term Continuous Plankton Recorder Survey, now the World’s leading index of change in the planktonic ecosystem; and was awarded the Kelvin medal of the Royal Philosophical Society of Glasgow (2004). On his retirement in 2006, Bob Dickson was appointed the first CEFAS Emeritus Research Fellow and his contribution to science was recognized in his appointment as CBE in the Queen’s New Year Honours List of January 2007. Bob was invited to take part in the British Library ‘Life Stories’ series (now on the point of completion). In October 2011, in recognition of his sustained and fundamental contributions he made to field of marine science throughout his retirement in October 2011, he was appointed to the 1st Johan Hjort Chair in Marine Biology and Management by the Nordic Centre of Excellence ‘Normer’ led by the University of Oslo. As part of that contribution, he initiated the ‘Inspiration Awards of the University of Oslo’ endorsed enthusiastically by the University, with the first two awards made during the first annual Normer Meeting in Oslo in Oct 2011 and the second pair awarded in Helsinki Oct 2012 during the 2nd annual Normer meeting. A third and final pair will be awarded at the 2013 annual meeting in Reykjavik.

**Rashid Sumaila**

**Normer’s 2012 Johan Hjort Chair**

Usuf Rashid Sumaila is Professor and Director of the Fisheries Economics Research Unit at UBC Fisheries Centre. He specializes in bioeconomics, marine ecosystem valuation and the analysis of global issues such as fisheries subsidies, IUU (Illegal, unreported and unregulated) fishing and the economics of high and deep sea fisheries. He is deeply interested in how economics, through integration with ecology and other disciplines, can be used to help ensure that environmental resources are sustainably managed for the benefit of all generations. Sumaila has experience working in fisheries and natural resource projects in Norway, Canada and the North Atlantic region, Namibia and the Southern African region, Ghana and the West African region and Hong Kong and the South China Sea. He has published articles in several journals including appearances in Science, Nature and the Journal of Environmental Economics and Management. Sumaila’s work has generated a great deal of interest, and his work has been cited by media such as the Economist, the Boston Globe, the International Herald Tribune, Marine Sunday Telegram, the Financial Times, the Globe and Mail, VOA, CBC News and the Vancouver Sun. The recognition of Sumaila’s contribution to the global debate on achieving sustainable ocean fisheries has won him awards, including the Leopold Leadership Fellowship, the Pew Fellowship for Marine Conservation, Craigdaroch Award for Societal Contribution, the Zayed International Prize for the Environment and the Peter Wall Institute Senior Early Career Scholar Award. The evidence of his policy influence can be judged by the many high-level invited talks he has given over the years including at the UN Rio + 20 Ocean Dialogue, the White House, the U.S. Congress, the Canadian Parliament, the House of Lords, UK and the WITO. Indeed, Sumaila got an audience with Prince Charles at the St James Palace in London in 2010, where they discussed how to achieve sustainable ocean fisheries worldwide. In October 2011, in recognition of Sumaila’s contributions to the field of ocean and marine economics, management and policy, he was appointed to the 2nd Johan Hjort Chair in Marine Economics and Management by the Nordic Centre of Excellence ‘Normer’ led by the University of Oslo. As part of that contribution, Sumaila gave a keynote speech in Helsinki Oct. 2012 during the 2nd annual Normer meeting.

For more information, see Professor Sumaila’s homepage: [http://www.fisheries.ubc.ca/faculty-staff/rashid-sumaila](http://www.fisheries.ubc.ca/faculty-staff/rashid-sumaila)
**The University of Oslo ‘Inspiration’ Awards**

**A BRIEF EXPLANATION AND NOTES FOR RECIPIENTS**

In 2011, a new Nordic Centre of Excellence NorMER (Nordic Centre for Research on Marine Ecosystems and Resources under Climate Change) was established to combine the expertise of internationally recognized research teams from all the Nordic countries in order to explore the biological, economic, and societal consequences of global climate change on fisheries resources in the Nordic region. The programme is administered within the Department of Biology at the University of Oslo.

As part of the new programme, a ‘Johan Hjort Professorship’ was also instigated, with the aim of inspiring the multidisciplinary research teams of NorMER in some clear and focused way, and the ‘Inspiration Awards’ described here are one direct result. The idea for these awards stems from a rather plain volume sent to me out of the blue in the late 1980s by Henry Stommel, carrying his brief inscription on the flyleaf (award #6). As Jim Luyten and Nelson Hogg of Woods Hole wrote in 1992 (special Stommel issue of Oceanus magazine), ‘for most of the past 50 years, Henry Stommel carried his brief inscription on the flyleaf [of a book] in his own, with congenial colleagues, unfettered by supervision, with a scientific problem in one’s mind when he goes to bed and awakes next morning, to be able to give undivided attention to unraveling some puzzle of nature it is a privilege beyond compare. If you have received one of these awards, it is because, in someone’s considered opinion, a significant step in that “unravelling” process has been down to you!’

Bob Dickson, Cefas, NorMER, Johan Hjort Professor, 2011–12

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1 **Award for Marine Biology**

A first sight this may seem a strange choice for an Award Volume. Rather scruffily and lacking a dust jacket, it may seem an unlikely candidate for a green leather slip case and gold tooling. But quite the reverse is the case. In one of these winter evenings over a bottle of wine at the home of the great Lowestoft marine ecologist David Henry Cushing, when Cush was intent on showing me his treasures, this plain slim volume was one he returned to time and again and was plainly something special to him. The inscriptions make it so. This monograph on *The Biology of a Marine Copepod*, printed in 1955, summed up much of the life’s work of two marine biologists from the Millport Marine Station on the isle of Cumbrae, Sheina M. Marshall and A.P. Orr, and was inscribed by them both to R.S. Wimpenny of the Lowestoft Laboratory – another lover of Calanus. David Cushing later obtained the volume from Wimpenny’s estate and his ownership signature completes a flyleaf that may be slightly foxed, but which is ‘sharpened’ with portent by its direct association with these pioneers of plankton research. Though it’s not the purpose of this brochure to list the award-winners, – that can come later – it was good to notice that this point was certainly not lost on Nils Christian Stenseth, the founder of NorMER, when he became its first recipient in 2011.

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2 **Award for Meteorology**

This delicate but early and influential account of the temperature changes in the North Atlantic Ocean and atmosphere was presented to me in his usual quiet way, ‘Here. I’d like you to have this. You like these things’, by Odd Henrik Saalen, who had been Professor of Physical Oceanography at both the University of Oslo (from 1960) and University of Bergen (from 1978) and whose great specialisation was the hydrography of the Norwegian Sea. While Harold Sverdrup wrote his famous work *On conditions for the vertical blooming of phytoplankton* in 1933, it was based on the comprehensive data set collected at Ocean Weather Station ‘N’ by Odd Saalen. Though this presentation copy was written by Bjorn Helland-Hansen and Fridtjof Nansen, its existing feature is the inscription to ‘Captain Gunnar Isachsen from the authors, (signed) Fridtjof Nansen’. Isachsen had been topographer on Otto Sverdrup’s Fram Expedition to the Arctic Archipelago from 1898 to 1902, mapping large areas of Northern Canada in the course of long sledging journeys. He was promoted ‘Rittmeister’ (~Captain) in 1899 and led topographic and bathymetric expeditions to Svalbard from 1906 to 1910, funded both by Prince Albert of Monaco and by his own government. Isachsen is credited with the founding of systematic research work on Svalbard. Fittingly, the first presentation of this volume as an Inspiration Award was made in October 2011, during the celebrations in Oslo to mark the 150th Anniversary of Nansen’s birth.

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4 Award for Ecosystem Science

This award is a 1930 first edition of Sir Maurice Yonge’s A Year on the Great Barrier Reefs, inscribed by him on behalf of the Great Barrier Reef Expedition to Prof. J.H. Dawsholt RSL, and including The Expedition Christmas Card of 1928-29 sent from Low Isles North Reef. The flyleaf also carries the ownership signature of David Cushing, who presented the volume to me towards the end of his life. With the consent and enthusiastic support of the Team that operates the Continuous Plankton Recorder (CPR) support of the Team that operates the CPR, this award is appropriately ‘special’ too. Simply inscribed ‘To W. Dickson (my father) from CTR Wilson’, it is the Nobel Lecture that CTR delivered in Stockholm in 1927 describing his discovery of the cloud chamber, a device described by Ernest Rutherford as ‘the most original and wonderful instrument in scientific history’, and used in many of the discoveries that led to the development of particle physics. Wilson was also deeply interested in atmospheric electricity and his ideas about thunderstorms are at the heart of modern theories. My father and CTR developed their close friendship after finding themselves sitting together at a lecture in Edinburgh by the great Danish physicist Niels Bohr, and as Head of the Science Department at George Watson’s College in Edinburgh, my father would annually insist that the Science 6th should send Birthday and Christmas greetings to the great man at his retirement home in Carlops until his death in 1959. Some of his replies are tipped in. Simple stuff maybe, but direct ‘touches’ none of what I find ‘inspirational’ about this volume.

*Source: Royal Society of Edinburgh.*

5 Award for Numerical Climate Studies

While this volume may appear at first sight to be the least prepossessing of the set, it is in fact one of the treasures of the Inspiration Awards scheme, presented to me for this purpose by Peter Rhines of the University of Washington and containing the imprint of three major figures of our science, L.F. Richardson, Henry Stommel and Peter Rhines himself. Lewis Fry Richardson (1881–1953) was an English mathematician, physicist, meteorologist, psychologist and pacifist whose interest in meteorology led him to propose a scheme for weather forecasting by solution of differential equations which he published in 1922 as *Weather Prediction by Numerical Process*. This became in Peter’s words ‘the spark for all numerical climate studies’. The Award volume is an unbound copy of this book, together with a range of manuscript notes on a range of topics, that he presented to Henry Stommel with the simple inscription ‘Henry Stommel, complements of L.F.R.’ in 1948. Thirty years later, Hank passed on the volume to Peter with the words, ‘L.F. gave me this unbound copy of this book. Attached are some experimental notes in his own hand. I think you may like to have them for sentiment’s sake.’ Henry, April 1978. And Peter Rhines’ ownership signature completes the set.

6 Award for Physical Oceanography

This simple volume on the origins and data set at Station ‘S’ off Bermuda by Henry Stommel has already been described in the introduction to these notes, as having an inspirational impact on myself. The story of the Great Salinity Anomaly that Henry refers to was one that I published with others in 1988 telling the tale of a huge freshwater pulse that passed out of the Subarctic Seas through Denmark Strait in the late 1960s to circle the Northern Gyre over a 14-year period before returning to the northern Nordic Seas once again around 1982. It was a special event for all sorts of reasons. its spreading gave a first direct estimate of the mean circulation speed of the Atlantic subpolar gyre (~3 cm/s) and helped us to test and improve a range of ocean circulation and hydrobiological models, the export of this 2000 km³ of extra fresh water from the Greenland-Iceland Seas to the North Atlantic carried the potential for significant effects on global climate via its control of the changing effectiveness of deep water formation: and it ‘generated more variability in fishery during the last quarter of a century than any other hydrographic event in recent years’ (Jakobsson, 1992, 15 major stocks were identified). However I like to think that Henry’s kind note reflected none of these things. In those days, when one long hydrographic time-series after another was being shout down across the North Atlantic, the tracing of even such a large and (one might think unmeasurable feature as the GSI through the gappy and fragmentary historical hydrographic record) and the hard part. So I like to think that the data series that Henry helped build at Station ‘S’ off Bermuda was sent to reflect this. Inspirational or not, it is not an especially gripping read. So although Stommel’s writings in this manuscript are very hard to find – he burnt a lot of his papers and others are sequestered in the libraries of Woods Hole and MIT – I have tucked whatever m’s pages we have inside the cover for added interest; no doubt these can be supplemented with time as other papers come to light.
## NORDFORSK-APPROVED BUDGET 2011—2015

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### PROJECT 1 — OSLO

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<td>Project 2: Normer Adaptation Workshop costs</td>
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<td>Administration (max 10% of mobility costs)</td>
<td>NOK 14,100</td>
<td>NOK 20,600</td>
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<td><strong>Total</strong></td>
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People at NorMER

**NORMER STAFF CONT.**

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<tr>
<th>NAME</th>
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<tr>
<td>Philip Buckley</td>
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<td>University of California</td>
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<td>Tomasz Hamaki</td>
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**NORMER CAPS**

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<tr>
<td>Philip Cury</td>
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<tr>
<td>Simon Lane</td>
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**NORMER PHDS AND POSTDOCS**

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**NORMER GUESTS**

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**NORMER STAFF**

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THURSDAY, 4 OCTOBER 2012

— Morning Programme (0930–1050). Venue: Pentti Juurijoki, Small Hall, Fabianinkatu 33, University of Helsinki Main Building.

0930–0940: Prof. Marko Lindroos (NorMER Partner). Welcome. Importance of NorMER.

0940–0950: Prof. Nils Chr. Stenseth (Chair of NorMER). NorMER – status and further development.

0950–1000: Jukka Kila (the Rector of the University of Helsinki). «The Role of the Rector of the University of Helsinki».

1000–1010: Ville Närässö (Finnish Ministry of Education). Topic to be determined.

1010–1020: Dr. Robert Dickson (Centre for Environmental Fisheries and Aquaculture Science, UK). University of Oslo Inspiration Awards.

1020–1030: Tara Aaaland (Farmor Naturo Senter for Fish and Environment, Norway). The importance of political leadership in scientific programmes.

1030–1040: — 10 min break

1040–1100: Prof. Gregory Bauwraadt (Centre National de la Recherche Scientifique, Laboratory (CNRS) de Géosciences, Université Paris 6). The effects of climate change on biological and ecological systems.


FRIDAY, 5 OCTOBER


0900–1000: Presentations by new PhD students and postdocs, Part 1.

1000–1010: Katharina Otteassen (Faroe Islands). Spatial distribution of cod on the Faeroe Platau in relation to climate and other environmental conditions.

1010–1020: Prof. Kathleen Segerson (Copenhagen). The importance of political leadership in scientific programmes.

1020–1030: — 10 min break


1110–1140: Anna Törnroos (Opp). — Species traits and benthic functioning: from toolbox to implementation.

1140–1210: Katharina Otteassen (Faroe Islands). — Strengthening the adaptive capacity of institutions in fisheries.

1210–1220: — Group Lunch.

1300–1345: — Bus to Rantapuisto Hotel.

1330–1500: — Poster session (PhD students and postdocs).

1500–1530: — Board Meeting.


1700: — Coffee.

1730–1750: — Session A: CAP meeting. Session B: Slow Talk continued (PhD students and postdocs).

1750: — Reconvene for meeting closure.

1800: — Dinner.

1830: — Bus from Rantapuisto Hotel for workshop attendees.


1400–1450: Welcome.

1450–1500: — Speed talks by continuing PhD students and postdocs (listed below).

1500–1510: Martin Pedersen & Ana Sofia Ferreira (Copenhagen). The Tøtby Høytøys project.

1510–1515: — Poster session (coffee available during this session).


1510–1645: Johanna Yletyinen (Reykjavik). — Using network analysis to quantify the effect of climate on spatial explicit marine food web interactions in the context of social-ecological system dynamics.

1645–1650: — Breakout meetings and continuation of poster discussions.

1650–1700: — Dinner.

2130–2300: — The role of habitat composition to zooplankton.

2300: — Meeting closure.

T he following is a brief, and somewhat personal, account of the second annual NorMER meeting. The actual meeting was held on two days, on October 4th and 5th in Helsinki, but I think it is fair to say that the meeting was but the culmination of an inspiring week of NorMER activities. Prior to the meeting, there was a three-day course in economics, and after the meeting, there was a two-day workshop where we (the young researchers) continued to work on our collaborative project. The latter is described in more detail on page 32.

The course was taught by three renowned experts, in addition to our own Marko Lindroos. On the first day, ØI Tahvonen introduced to the core concepts of fisheries economics and dynamic optimization. On the second day, Martin Quass highlighted market aspects and Ann-Sophie Crepin discussed threshold effects on the third day. Being an economist myself, I think that the lecturers did a truly great job of breaking the technically demanding material into digestible pieces. The course had a tremendous value in familiarizing all network members with the economic terminology, thus allowing a more effective cross-disciplinary communication.

The structure of the annual meeting was planned long before October by the NorMER postdocs. In addition to the conference-style format, we wanted to try new avenues of communicating research. To this end, we introduced ‘speed talks’ and ‘slow talks’.* Speed talks were 3–5 minute presentation of a poster that the young researcher was exhibiting. After everybody had gotten a chance to advertise his/her poster, we had an extended poster session with many in-depth discussions of the individual posters. The ‘slow talks’ on the next day were more intimate group discussions, where 4–5 young researchers discussed each other's manuscripts. The idea was to provide a sheltered thinking room to foster inter-disciplinary discussions of ongoing work. Judged by the evaluation survey where we conducted, both innovations were a great success. A remaining challenge is how to better integrate and benefit from the presence of the senior researchers and experts. We already have a number of ideas how this could be improved, and I am very much looking forward to the next annual meeting in Reykjavik.
Develop a comprehensive model of physical processes and their interactions with marine food webs.

Define the importance of lower trophic levels and their influence on harvested species.

Detail the drivers, patterns, and trends of harvested populations.

Create guidelines for optimal management of marine resources to maximize profit and yield, for the future.

See below for a list of NorMER publications from within the last year, and their relevance to the centre. NorMER staff who are directly funded are in bold and underlined. NorMER staff receiving indirect support are in bold.

**GRAND CHALLENGE 1**


   Relevance: Climate affects marine ecosystems through a multitude of pathways. This paper reports how climate influences the Barents Sea ecosystem, with a focus on the lower trophic levels.


   Relevance: Our new methodological approach to study climate effects on fish larvae distributions combines numerical and statistical modelling to draw robust inferences from observed distributions and will be of general interest for studies of many marine fish species.


   Relevance: Climate affects marine ecosystems through a multitude of pathways. This paper reports how climate influences the Barents Sea ecosystem. 

**GRAND CHALLENGE 2**


   Relevance: A population of identical individuals can exhibit different vertical migration behaviours even when there is no explicit density dependence. This pattern emerges through game theoretic considerations where behavioural cascades impose apparent density dependent effects.


   Relevance: Uses empirical trait-based analysis as a tool to reveal differences and similarities between assemblage structure and function. It functions as a useful tool for comparing different environments.


   Relevance: The fitness seeking (adaptive) behaviour of grazers in a marine food web can have quite a significant effect on the dynamics of the system, and promote stability in an otherwise unstable configuration.


   Relevance: The fishing on cod affects also the fish web dynamics of other areas via spillover effects.


   Relevance: Historical changes of high-latitude ecosystems. Here such hydrographic and ecological changes are demonstrated for the Barents Sea.


   Relevance: The fishing on cod affects also the food-web dynamics of other areas via spillover effects.


   Relevance: The fishing on cod affects also the food-web dynamics of other areas via spillover effects.


   Relevance: Climate affects marine ecosystems through a multitude of pathways. This paper reports how climate influences the Barents Sea ecosystem. 

**GRAND CHALLENGE 3**


   Relevance: The fishing on cod affects also the fish web dynamics of other areas via spillover effects.


   Relevance: The fishing on cod affects also the fish web dynamics of other areas via spillover effects.


   Relevance: The fishing on cod affects also the food-web dynamics of other areas via spillover effects.
   — Relevance: A statistical method developed to analyse data used in the NorMER project.

   — Relevance: A method based on body morphology was developed to discriminate between the different cod morphs. This method is one of the three methods used to classify cod in one of the NorMER student projects.

   — Relevance: The NEA cod population migrates southwards along the Norwegian coast to spawn every year. Over the last century the spawning grounds further south have been abandoned, resulting in a much lower overall temperature exposure for eggs and larvae. Here we have used general circulation models to quantify this effect, and the results show that the temperature exposure of early life stages are more sensitive to variability in spawning ground usage than to climatic variability.

   — Relevance: This paper deals with populations structure of cod and lays a foundation for one of the NorMER student project.

   — Relevance: Here the spatial overlap between large ecologically and commercially important pelagic fish species in the Norwegian sea is examined and reasons for temporal variability in overlap discussed. The role of processes involving competition and other inter-species interaction is of interest will beyond this one ecosystem.

   — Relevance: Shows the importance of achieving international cooperation in the cod fishery by using a serially correlated recruitment function.

   — Relevance: The individual growth potential of commercial fish is an important margin of rent dissipation that has hitherto not been explicitly analysed from an economic, game theoretic perspective in this paper. Moreover shown that quotas in terms of numbers are far superior to conventional quotas in terms of biomass.

   — Relevance: Hardin’s metaphor of the tragedy of the commons has been controversial. However it was instrumental in inspiring a large literature that studies under which conditions rational actors find it in their own best interest to cooperate.

   — Relevance: Cost-benefit analysis to study the salmon stockings in the Baltic Sea.

   — Relevance: Computes critical number of fishermen (players) in the case of species interaction so that both species are sustained in the long run.

   — Relevance: A partition function game application in a four-player bioeconomic model of Baltic salmon illustrates how international cooperation may sometimes be cooperation only on paper, not shown in real fisheries policy.

   — Relevance: Three-species (cod, herring and sprat) optimisation model with age-structured dynamics illustrates how present management could be improved by taking into account species interactions.

   — Relevance: Coalition model including harvest control rules, shows the importance of including international aspect in the development of harvest control rules.

   — Relevance: The global community faces several very pressing environmental challenges such as climate change, depletion of the high-sea fisheries, and unprecedented rates of biodiversity loss. This chapter provides an overview of the literature on the circumstances under which governmental policy can crowd out protective action taken by private citizens and stakeholder and how policy can be designed to preserve the intrinsic motivation to act voluntarily.
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