

BOOK OF ABSTRACTS

The 47th European Marine Biology Symposium **Arendal, Norway** **3 –7 September 2012**



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The European Network of Marine Research Institutes and Stations

The 47th European Marine Biology Symposium

Arendal, Norway, 3-7 September 2012

**Hosted by:
THE INSTITUTE OF MARINE RESEARCH**

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FOREWORD

Dear participants,

Welcome to Norway and Arendal for this 47th European Marine Biology Symposium, which take place 29 years after last took place in Norway. The history of the European Marine Biology Symposia dates back to 1960 when a series of German marine biological symposia was initiated by Otto Kinne, Director of the Biologische Anstalt Helgoland. These Symposia attracted marine scientists from outside Germany and it was realized that European participation should be encouraged. In answers to a questionnaire sent out in 1965, 98% were in favor of European Marine Biology Symposium being held at regular intervals; 65% were against affiliation to any existing international bodies. As a result the first European Marine Biology Symposium was held on Helgoland in early autumn 1966. Such was the success of this meeting that Symposia have been held annually since 1966. To date they have been organized in about 20 different European countries, some having been visited more than once, attracting marine scientists not just from Europe but from all over the world. Details concerning topics for discussion at the Symposia and all aspects of organization are left to the inviting institution. One, or sometimes two or three topics are chosen which normally reflect the interest of the inviting body. This restricts somewhat the number of participants but allows for an efficient exchange of ideas and discussions.

At the first meeting in Helgoland an ad hoc Committee was organized consisting of a representative from each European country attending that meeting. Such a Committee meets during each year's Symposium. The purpose of the Committee meeting is to ensure the informal nature of these Symposia and their continuity, and also to give advice to inviting institutions when necessary. There is a President, who holds office for 3 years and is supported by a Secretary. The late Harold Barnes of the Dunstaffnage Marine Laboratory, Scotland, was elected the first President. He was followed by presidents coming from France, Germany, Italy, Norway, the Netherlands, Austria and Wales.

In 1967 the 2th EMBS was arranged in Bergen, Norway with University of Bergen as host. Also the 18th EMBS was arranged in Norway (Oslo) with University of Oslo and Norwegian Institute of Water Research as hosts. Now, 29 years later the EMBS-arrangement is back in Norway (Arendal) with Institute of Marine Research as host.

I hope you will enjoy Arendal and the Symposium and wish you all the best.

Erlend Moksness
(Convener)

WELCOME

Dear participants,

On behalf of the Institute of Marine Research, it is a pleasure for me to welcome you to this 47th European Marine Biology Symposium. Our Institute has for more than 100 years performed studies and monitoring of living resources and environmental conditions, both in the oceans and along the coast. The data collected and knowledge gained has formed the basis for our advices to the authorities, with more and more focus on “an ecosystem or holistic approach” to secure the scientific basis for the ministries development of sustainable management plans. The Institute of Marine Research is owned by the Ministry of Fisheries and Coastal Affairs in Norway, and our vision is “knowledge and advice for rich and clean marine and coastal regions”. We have ambitions to be among the international leaders in marine research and management advice. Our Research Station Flødevigen, located here in Arendal, was established 129 years ago. At present the “The coastal zone ecosystem programme” and the “The North Sea ecosystem programme” at the Institute of Marine Research, is organized from Flødevigen. Fields of responsibilities of the programmes include, mapping of marine nature, habitats and biodiversity, monitoring of environment and living resources, studies of introduced species, studies in ecology and development of environmentally and resources-friendly capture methods, and not at least develop scientific based advices to the ministries.

The marine areas under Norwegian jurisdiction, the Norwegian EEZ and coastal areas, are highly productive and present a high biodiversity and the harvesting of all living marine resources from these areas are essential for residents and wealth creation in Norway. Many of the fisheries in Norway are dependent on clean and rich ecosystems, and the Norwegian aquaculture industry benefits from clean and sheltered sites for their installations. On this background, I am sure most of you will understand that the expertise needed by our institute to respond to questions by the Norwegian authorities is wide. This wide variety of expertise forms the basis for the present knowledge based management of marine living resources in Norwegian waters. Looking at the program for this symposium and issues addressed, I find it most relevant for our institute. I also understand that many students attend this Symposium to present their work and build network. To address the many and complex issues and challenges in the marine ecosystems in the future, your expertise will be needed. I will also like to underline that the challenges, both related to the knowledge gaps as well as to the transition of knowledge into advice and management plans, are so huge that cooperation between institutes and universities are crucial if we are to succeed to secure sustainable oceans for the future. Therefore, I see this Symposium as an important event in our work, and I hope you will experience the same and that the Symposium will be of significant value in your future work.

I hope you will enjoy the town of Arendal and the nearby area. I wish you all the best.

Tore Nepstad
Managing director

WELCOME FROM EMBS PRESIDENT

Dear Participant

I am really pleased that you have decided to attend the 47th European Marine Biology Symposium hosted by Institute of Marine Research, Flødevigen Marine Research Station in Arendal, Norway, this year.

The first European Marine Biology Symposium was held in 1966 and was felt to be a success, so a second meeting was organised and the rest, as they say, is history. The EMBS has never been associated with a learned society or commercial entity, it is organised by a local committee and the programme is guided by a steering committee, chaired by a President. So this meeting is your meeting and the future of the EMBS is in your hands. I would like to ask you to engage with process. Please take a little time to help sustain the EMBS. (see <http://www.marsnetwork.org/history.php> for more on the history). At the registration point there is a list of current national delegates – please find out who represents your country. If they are not attending, why not volunteer to replace them? Please talk to your delegate and let them have your views on anything and everything EMBS. The Committee will meet during the symposium.

The EMBS President traditionally serves a three-year term and this is my final year. The President is invited to serve by the International Steering Committee, the Committee would like to hear from you – please let me or your delegate have your nominations.

Future EMBS meetings:

- 2013 EMBS48 will be Galway, Ireland hosted by the Martin Ryan Institute, National University of Ireland.
- 2014 EMBS49 will be held in St Petersburg, Russia
- 2015 EMBS50 – Celebrating half century of disseminating European Marine Biology and a return to Helgoland where it all began.

Finally, I would like to take this opportunity to thank all the attendees, members of the International Steering Committee and the local organising committees for their support, good will and above all friendship during my term as EMBS President.

Best wishes for a successful meeting

Chris Frid
EMBS President 2009-2012

SOCIAL PROGRAMME

MONDAY 3 SEPTEMBER

1930–2130 Reception at the Institute of Marine Research, Flødevigen Marine Research Station

Buss leaves from Hove Campus at 1900 and from City Center of Arendal at 1915. Returns 2230, at City Center of Arendal 2245 and at Hove Campus 2300.



TUESDAY 4 SEPTEMBER

1900–2100 Welcome reception, Host: Arendal municipality and Mayor Einar Halvorsen

Buss leaves from Hove Campus at 1845. Returns 2230 from City Center of Arendal. At Hove Campus

THURSDAY 5 SEPTEMBER

1430–1800 Yellow submarine

1900–2300 Banquet Hove Campus.

Buss leaves from City Center of Arendal at 1415. Returns from Hove Campus 2300 to City Center of Arendal. There are rooms available at Hove Campus for redressing.

KEY NOTE SPEAKERS

Jeffrey A. Hutchings



Jeffrey A. Hutchings works at Dalhousie University, Canada. His research centres on questions pertaining to the life history evolution, behavioural ecology, population dynamics, and conservation biology of marine and anadromous fishes, particularly Atlantic cod (*Gadus morhua*), Atlantic salmon (*Salmo salar*), and brook trout (*Salvelinus fontinalis*). From an applied perspective, this work has bearing on questions pertaining to: the collapse, recovery and sustainable harvesting of marine fishes; interactions between wild and farmed Atlantic salmon; population consequences of fisheries-induced evolution; and the biodiversity of Arctic and sub-Arctic fishes. In addition to his responsibilities as professor at Department of Biology to undergraduate and graduate teaching, supervision of postgraduate students and postdoctoral fellows, and the undertaking of basic and applied research, Jeff is also president in Canadian Society for Ecology and Evolution (www.ecoevo.ca) and Charter Member, Research Advisory Panel, Science Media Centre of Canada.

Geir Lasse Taranger



Geir Lasse Taranger works at the Institute of Marine Research, Norway. He has 20 years experience on reproductive fish physiology, fish welfare and environmental control of reproduction, smoltification and somatic growth in farmed fish. His main interest is in regulation of puberty and spawning in salmon and cod and particularly in photoperiod control. Through the years, Geir Lasse has had a number of central positions at the institute in connection with aquaculture and is now research manager for the research group “Reproduction and growth in fishes”. The group focus on effects of light, temperature, availability of nutrients and environmental toxins/produced water, the effects of underlying mechanisms on interactions between growth and reproduction, and how the allocation of energy to various organs changes in the course of the life-cycle and with condition and

the nutritional situation. National coordinator for the EU funded project FAIR-CT96-1410. Coordinator for the EU funded projects QLRT-2001-01801 PUBERTIMING and FP6 WEALTH.

Simon Jennings



Simon Jennings works at the University of East Anglia/CEFAS, Great Britain. He is a Chief Scientific Adviser at the Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK and Chair of Environmental Sciences at the University of East Anglia. Research conducted by Simon and his colleagues focuses on understanding the impacts of humans and the environment on the ecology of the oceans and has helped to underpin the development of ecosystem-based management. His interests include population, community and ecosystem ecology; biodiversity; food webs; life histories; stable isotope ecology; fisheries ecology; environmental management systems and policy. Through Cefas, he advises national and international bodies on biodiversity, environmental management and fisheries issues.

Thorsten Reusch



Thorsten Reusch works at Helmholtz-Centre of Ocean Research (GEOMAR), Germany. He is professor of marine ecology and chair of research unit Evolutionary Ecology of Marine Fishes at IFM-GEOMAR, Kiel. The focus of his research is the ecology of evolution. Any ecological interaction is also a selection pressure. Consequently, if there is heritable variation, evolutionary change will take place. There is now ample evidence that the separation between ecological and evolutionary scale is misleading, in particular among the fishes. Both time scales are commensurate and should be answered within a common framework. Given the predicted environmental changes in the next decades, one focus area will be the evolutionary response of populations to global change, including biological invasions and selective harvesting. Towards this end, both heritable variation within populations, and the distribution of genetic variation across latitudinal gradients needs to be quantified. Such an approach will benefit from an expansion of the evolutionary ecology toolbox. Once selectively relevant polymorphism is identified, predictions on the evolutionary potential of populations become possible.

Katja Philippart



Katja Philippart works at the Royal Netherlands Institute for Sea Research, Netherland.

She is a marine ecologist at Department of Marine Ecology of NIOZ. She earned her PhD in 1994 on the effects of eutrophication on seagrass at the Wageningen University, The Netherlands. The main aim of her research is to study the trophic interactions between the main primary producers (phytoplankton and microphytobenthos) and primary consumers (bivalves) of shallow temperate coastal waters such as the Wadden Sea. This research is performed by means of various techniques such as automated monitoring networks, field surveys, remote sensing (airborne and satellite) techniques and laboratory experiments under controlled environmental conditions. She has just finished coordinating a European project on the impacts of climate change on marine ecosystems (www.clamer.eu), and is presently coordinating the national project IN PLACE (2009-2013) which includes the setup, maintenance, and exploitation of a coastal monitoring network to study primary production, and the national project WaLTER (www.walterproject.nl) which aims to develop an integrated monitoring system for the Wadden Sea.

Espen Moland Olsen



Espen Moland Olsen works at the Institute of Marine Research, Norway. His main research interest is life history responses to natural selection and human-induced selection in aquatic environments. Are contemporary phenotypic changes in harvested populations purely ecological, or do they also involve evolution? For instance, fishing selectively on large and old individuals may lead to demographic erosion leaving mostly small and young fish in the population, which may influence recruitment patterns and harvestable yield. Over generations, selective fishing may also lead to evolutionary changes in fitness-oriented traits like growth and maturation patterns. He is currently investigating how marine reserves may buffer against ecological and evolutionary effects of harvesting in the coastal zone. His background is mainly from the University of Oslo, Norway, where he did a PhD and Post doc.

Einar E. Nielsen



Einar E. Nielsen works at DTU Aqua, Denmark. He is professor in Fisheries Genetics at DTU-Aqua in Denmark. For more than 15 years he has worked on identification of genetic population structure in freshwater, anadromous and marine fish and the environmental and ecological drivers responsible for population divergence. More recently his research focus has been on understanding the genomic basis of local adaptation in marine fish in space and time, including DNA analysis of historical archived scale and otolith collections. He has participated in and coordinated many national and international (EU) projects on population structure, micro-evolution at historical time scales, impact of farmed fish on wild fish populations and traceability of fish and fish products. He provides advice to the EU and ICES on management of freshwater, anadromous and marine fish, with particular emphasis on genetic resources and biodiversity.

Lisa Levin



Lisa Levin works at Scripps Institution of Oceanography, USA. Lisa Levin is Director of Center for Marine Biodiversity and Conservation (CMBC) and Distinguished Professor at the Scripps Institution of Oceanography in La Jolla, California. She is a marine ecologist who studies benthic ecosystems in the deep sea and shallow water. Together with her students she Levin has worked with a broad range of taxa, from microbes and microalgae to invertebrates and fishes. Her recent research has emphasized 3 major themes: (1) the structure, function and vulnerability of continental margin ecosystems, particularly those subject to oxygen and sulfide stress; (2) wetland biotic interactions as they mediate marsh function, invasion and restoration; and (3) larval ecology of coastal marine populations with emphasis on connectivity and response to ocean acidification and deoxygenation. She has participated in over 30 oceanographic expeditions around the world and served as Chief Scientist on 12 of these. Dr. Levin has served as editor in several scientific journals, and has edited 5 special volumes on aspects of deep-sea biodiversity. She has for decades had a central position in societies of science and as a governmental and international adviser.

Nils Christian Stenseth



Nils Christian Stenseth works at the University of Oslo/CEES, Norway. He is a Research Professor, Core Member, and the Chair of CEES (Centre for Ecological and Evolutionary Synthesis, Univ. of Oslo). In addition, he is a Chief Scientist at the Institute of Marine Research, Norway. His research interests span a broad spectrum of ecological and evolutionary topics, most of which are rooted in population biology. Variations in population densities in time and space - and the underlying demographic processes - have been a main interest. An important example is the interdependent relation between density-dependent and density-independent processes, where the ecological effect of climate is an important example of the latter. He is an ISI highly cited researcher, and he is an elected member of many societies of sciences, and currently the President of the Norwegian Academy of Science and the Letters, DNVA. He also do quite a bit of editorial work, including as Editor-in-Chief of Climate Research.

SCIENTIFIC PROGRAMME

MONDAY 3 SEPTEMBER, 0900–1750

0800–1200 Registration

1200–1230 Opening ceremony

- Managing director Tore Nepstad, Institute of Marine Research
- Mayor Einar Halvorsen, Arendal Municipality

1230–1315 **(27) Introductory lecture by Jeffrey A. Hutchings (Canada)** : Ecological effects of human activities in the sea – challenges and possibilities

1315–1330 Coffee break

THEME 1A: ECOLOGICAL EFFECTS OF AQUACULTURE

CHAIR: HERMAN HUMMEL (NETHERLANDS)

1330–1410 **(29) Key note speaker: Geir Lasse Taranger (Norway)**: Ecological effects of aquaculture

1410 – 1430 **(30) Chris Frid and Odette Paramor (United Kingdom)**: Feeding the World - The potential role of fisheries and aquaculture

1430 – 1450 **(31) Øystein Skaala, Kevin A. Glover, Bjørn T. Barlaup, Terje Svåsand, Francois Besnier, Michael M. Hansen and Reidar Borgstrøm (Norway)**: Performance of farm, hybrid and wild Atlantic salmon (*Salmo salar*) families in a natural river environment: genetic and management implications.

1450 – 1510 **(32) Karl Norling, Trine Dale and Andrew Sweetman (Norway)**: Pelagic and benthic ecosystem responses under aquaculture induced stress in Norwegian fjords

1510 – 1530 **(33) Siri Aaserud Olsen, Arne Ervik and Otto Grahl-Nielsen (Norway)**: Tracing fish farm waste in the northern shrimp (*Pandalus borealis*) using lipid biomarkers.

1530 – 1550 Coffee break

THEME 1B: ECOLOGICAL EFFECTS OF FISHERIES

CHAIR: ANNE KJOS VEIM (NORWAY)

- 1550 – 1630 (34) **Keynote speaker: Simon Jennings (United Kingdom):** Towards integration of fisheries and environmental management
- 1630 – 1650 (35) **A. Kuparinen (Finland)** and **J. A. Hutchings (Canada):** Consequences of fisheries-induced evolution for recovery potential and extinction risk
- 1650 – 1710 (36) **Keno Ferter, Alf Ring Kleiven, Even Moland, Jon Helge Vølstad and Esben Moland Olsen (Norway):** Estimating the Impact of Catch-and-Release Practice by Marine Angling Tourists in Norway – Insights for Future Management
- 1710 – 1730 (37) **Even Moland, Esben Moland Olsen and Jørgen Ree Wiig (Norway):** Real time monitoring of individual fate in a trap fishery: what's up with the one that got away?
- 1730 – 1750 (38) **Vollset K.W., Bjørn Barlaup and Skoglund, H.(Norway):** Spatial and temporal patterns in abundance of sea trout, bAtlantic salmon and escaped farmed salmon in the Hardangerfjord
- 1930 - 2130 Reception at Institute of Marine Research, Flødevigen Marine Research Station

TUESDAY 4 SEPTEMBER, 0900–1800

THEME 2: THE MARINE ENVIRONMENT AND RESPONSES TO CLIMATE CHANGES

CHAIR: STEIN FREDRIKSEN (NORWAY)

- 0900 – 0940 (40) **Keynote speaker: Thorsten B.H. Reusch (Germany):** Evolutionary adaptation to global change? - examples from the base of the marine food web
- 0940 – 1000 (41) **Dan Smale, Thomas Wernberg, Fernando Tuya, Mads Thomsen, Tim Langlois and Gary Kendrick (Australia):** Impact of a 'marine heat wave' on seaweed, coral and fish assemblages in a global biodiversity hotspot
- 1000 – 1020 (42) **Jeanine L. Olsen, James A. Coyer, Wytze T. Stam, Frithjof E. Moy, Hartvig Christie and Nina Mari Jørgensen (The Netherlands):** High diversity in the high north: Norwegian seagrass meadows are alive and very well but still vulnerable
- 1020 – 1040 (43) **Tiia Möller, Georg Martin, Jonne Kotta and Kristjan Herkül (Estonia):** Eelgrass *Zostera marina* in NE Baltic Sea – a survivor?
- 1040 – 1100 (44) **Jonas Thormar, Baden S, Boström C, Canal P, Clausen K, Hasler-Sheetal H, Krause-Jensen D, Nordlund LM, Olesen B, Povidosa K, Rasmussen JR, Svenson C-J and Holmer M (Norway):** Does eelgrass (*Zostera marina* L.) food web structure differ in open and closed coastal systems?
- 1015–1045 Coffee break

CHAIR: GUNILLA ROSENQUIST (NORWAY)

- 1100 - 1120 **(45) Stein Fredriksen, Hartvig Christie, Helen Løvdal Nilsen and Linda Sivertsen (Norway):** Spatial distribution of epiphytes and mobile fauna on *Zostera marina* (L.) and *Fucus serratus* (L.) from the Skagerrak area.
- 1120 – 1140 **(46) Susanne Landis, Josefin Sundin, Martin Kalbe, Gunilla Rosenqvist, Thorsten Reusch and Olivia Roth (Germany):** Get me out of here! Responses to climate warming in a host-parasite interaction
- 1140 - 1200 **(47) Thomas Wernberg (Australia):** Latitude and aptitude: the influence of climatic stress on the distribution, performance and function of seaweeds
- 1200 - 1220 **(48) Ellen Schagerström, Sine Buck, Morten Foldager, Sofia Wikström, and Lena Kautsky (Sweden):** How may climate changes affect reproduction, growth and survival in Baltic *Fucus radicans*?
- 1220 – 1340 Lunch

CHAIR: EIVIND OUG (NORWAY)

- 1340 – 1420 **(49) Keynote speaker: Katja Phillipart(The Netherland):** Changing climate and changing seas: what does it mean for Europe?
- 1420 – 1440 **(50) Johan S. Eklöf, Christian Alsterberg, Jonathan N. Havenhand, Kristina Sundbäck, Hannah L. Wood and Lars Gamfeldt (Sweden):** Experimental climate change weakens the insurance effect of biodiversity
- 1440 – 1500 **(51) Stig Skreslet and Ketil Olsen (Norway):** Decadal changes in wintering north Norwegian macro-zooplankton in relation to climate
- 1500 – 1520 **(52) Santiago Alvarez-Fernandez, Han Lindeboom and Erik Meesters (The Netherlands):** Temporal changes in plankton of the North Sea: community shifts and environmental drivers
- 1520 – 1540 **(53) Camilla With Fagerli, Kjell Magnus Norderhaug, Hartvig C Christie, Morten Foldager Pedersen and Stein Fredriksen (Norway):** Importance of climate and predation for shifts between sea urchin dominated barren grounds and kelp forest
- 1540 – 1600 **(54) Maximov A.A., Eremina T.R., Lange E.K.nand Maximova O.B. (Russia):** Biological invader counteracts the adverse effects of climate variations in the eastern Gulf of Finland, Baltic Sea
- 1600 – 1620 Coffee break

CHAIR: STIG SKRESLET (NORWAY)

- 1620 – 1640 (55) **Tomas Lundälv, Damien Guihen and Martin White (Sweden)**: Population collapse in the deep-water poriferan *Geodia barretti* in the NE Skagerrak, in response to temperature extremes
- 1640 - 1700 (56) **Bryony A Caswell and Chris L J Frid (United Kingdom)**: Benthic ecological functioning: exploring an eight million year record of aperiodic anoxia
- 1700 - 1720 (57) **Anders Jelmert (Norway)**: Climate change and natural boundaries. How climate change affects the distribution of marine species dispersed by human and natural mechanisms.
- 1720 – 1740 (58) **Marianne Holmer (Denmark)**: Seagrass stable sulfur isotopic signals respond to sediment sulfur biogeochemistry
- 1740 – 1800 (59) **Jonas Ribergaard Rasmussen, Morten Foldager Pedersen, Birgit Olesen, Søren Laurentius Nielsen and Troels Møller Pedersen (Denmark)**: Temporal and spatial dynamics of ephemeral macroalgal communities in eelgrass, *Zostera marina*, beds
- 1900–2200 **Welcome reception. Host: The municipality of Arendal and Mayor Einar Halvorsen**

WEDNESDAY 5 SEPTEMBER, 0900–1740

THEME 3: MANAGEMENT OF COASTAL RESOURCES – MARINE PROTECTED AREAS

CHAIR: HALVOR KNUTSEN (NORWAY)

- 0900 – 0940 (61) **Keynote speaker: Espen Moland Olsen (Norway)**: Marine protected areas and recruitment in coastal populations: an ecological and evolutionary perspective
- 0940 – 1000 (62) **Carl André, Marina Panova, Gregory Charrier and Kerstin Johannesson (Sweden)**: Ecotype evolution in *Littorina saxatilis*
- 1000 – 1020 (63) **Alf Ring Kleiven, Sigurd Heiberg Espeland, Thomas Kiland-Langeland, Asbjørn Aanonsen and Torjan Bodvin (Norway)**: Implementation of marine reserves in coastal Norway: A co-management approach and preparing for the unknown
- 1020 – 1040 (64) **Anna Törnroos, Camilla Gustafsson, Christoffer Boström and Erik Bonsdorff (Finland)**: Beyond distribution maps and species lists; functional implications of habitats?
- 1040–1100 Coffee break

CHAIR: EVA DEGRE (NORWAY)

- 1100 – 1140 (65) **Keynote speaker: Einar Eeg Nilsen (Denmark)**: “Genes that matter”:

Application of spatiotemporal population genomics for identifying ecological structures and local adaptation in the sea.

- 1140 – 1200 (66) **Jonne Kotta, Kutser, T., Vahtmäe, E., Pärnoja, M. and Teeveer, K. (Estonia):** Using high spatial resolution remote sensing to map the distribution of benthic macrophyte species in a coastal brackish water environment
- 1200 – 1220 (67) **Consoli Pierpaolo, Mazza Gianfranco, Battaglia Pietro, Romeo Teresa, Incontro Vincenzo and Andaloro Franco (Italy):** The effects of protection measures on fish in the Plemmirio's Marine Reserve (Central Mediterranean Sea, Italy): an example of well-enforced reserve
- 1220 - 1240 (68) **Ross A. Coleman, Davies, C., von Carlshausen, E., Harris, R. and Hoskin, M.G. (Australia):** Lulled into a false sense of power: Pilot sampling must be as representative as possible
- 1240 – 1400 Lunch
- 1400 - 1420 (69) **Paul Kotterba, Cornelius Hammer and Patrick Polte (Germany):** Trophic interactions between Atlantic herring (*Clupea harengus*, L.) and three-spined stickleback (*Gasterosteus aculeatus*, L.) in a shallow coastal lagoon of the Western Baltic Sea.
- 1420 – 1440 (70) **Even Moland, Esben Moland Olsen, Halvor Knutsen, Alf Ring Kleiven and Jan Atle Knutsen (Norway):** Lobster reserves in coastal Skagerrak: a field laboratory for science and management
- 1440 - 1500 (71) **Louise Karlsson, Malin Olofsson and Per-Olav Moksnes (Sweden):** Assessing Methods for Restoration of Eelgrass (*Zostera marina*) on the Swedish NW Coast
- 1500 - 1520 Coffee break

THEME 4: GENERAL MARINE BIOLOGY

CHAIR: BOB KENNEDY (IRELAND)

- 1520 - 1540 (73) **Louise B. Firth, Meredith Schofield, Freya White, Martin W. Skov, Antony M. Knights and Stephen J. Hawkins (Ireland):** Habitat heterogeneity determines patterns of diversity in rocky intertidal communities
- 1540 – 1600 (74) **Pia Norling and Nils Kautsky (Norway):** Alien Pacific oyster (*Crassostrea gigas*, Thunberg) has positive effects on biodiversity in blue mussel beds on the Swedish west coast
- 1600 – 1620 (75) **Christiaan A. Hummel, Pim H. van Avesaath and Herman Hummel (The Netherlands):** Changes in the fish populations of the Eastern Scheldt due to changes of the tidal regime
- 1620 – 1640 (76) **Anna-Christina Bockelmann, Franziska Werner, Maike Rothweiler, Verena Tams, Florian Weinberger and Thorsten BH Reusch (Germany):** Experimental test of *Zostera marina* - *Labyrinthula zosterae* infection dynamics

- 1640 – 1700 **(77) Dániel Nyitrai, Filipe Martinho, Marina Dolbeth and Miguel A. Pardal (Portugal)**: Estuarine resident fishes as indicators of environmental changes: the case of *Pomatoschistus microps* and *Pomatoschistus minutus* in a southern-Europe temperate estuary
- 1700 – 1720 **(78) Anja Oelschlägel, Per Dolmer, Louise K. Poulsen, Jens Kjerulf Petersen and Bent Vismann (Denmark)**: Growth, filtration and respiration in Blue mussels from different salinity regimes
- 1720 – 1740 **(79) Stefanos Kalogirou (Greece)**: The invasive and pest pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) in an area of the eastern Mediterranean
- 1740 – 1930 Poster Session

WEDNESDAY 5 SEPTEMBER, 1740–1900 – POSTER SESSION

THEME 1: ECOLOGICAL EFFECTS OF AQUACULTURE AND FISHERIES

- (99) Peter Wilson and Kay Vopel (New Zealand)**: Predicting the distribution of acid volatile sulfides from sediment profile images
- (100) Vivian Husa, Henning Steen and Kjersti Sjøtun (Norway)** - Historical changes in macroalgal communities in Hardangerfjorden (Norway)
- (101) Øystein Skaala, Steinar Kålås and Reidar Borgstrøm (Norway)** - Seatrout (*Salmo trutta*) populations in the Hardangerfjord strongly reduced by salmon lice, *Lepeophtheirus salmonis*.
- (102) Kevin A. Glover, María Quintela, Vidar Wennevik, François Besnier, Anne G. E. Sørvik and Øystein Skaala (Norway)** - Three decades of farmed escapees in the wild: a spatio-temporal analysis of Atlantic salmon population genetic structure throughout Norway
- (103) P. Tomassetti, E. Persia, I. Mercatali, P. Gennaro, D. Vani and S. Porrello (Italy)** - GOING DEEP INTO THE FISH FARM SEDIMENT
- (104) Otte Bjelland, Keno Ferter, Rupert Wienerroither and Amund Måge (Norway)** - Changes in fish communities of the Hardangerfjord, Western Norway, in a 50 year perspective – the result of human activities?
- (105) Patrick Collins, Adrian Patterson, James Forde and Robert Kennedy (Ireland)**: Long term change in benthic biodiversity and habitat quality of Carlingford Lough, Ireland in relation to mussel fishing

THEME 2: THE MARINE ENVIRONMENT AND RESPONSES TO CLIMATE CHANGES

- (107) Sergienko Liudmila (Russia)** - Ecological-dynamic series of salt marsh vegetation on the Pomorsky and Karelian coasts of the White Sea

- (108) **Bodvin, Torjan¹, Moy, Fritjof¹, Albretsen, Jon¹, Mortensen, Stein¹, Ingrid Bysveen², Jelmert, Anders¹ and Espeland, Sigurd H. (Norway)** - How important is water temperature for an invasion of *Crassostrea gigas* on the coast of Norway?
- (109) **Smolina I., Kollias S., Jueterbock A. and Hoarau G. (Norway)** - Climate change in the Arctic: *Fucus distichus* facing sea temperature increase
- (110) **Norderhaug KM, Aure J, Bjerkeng B, Dahl E, Falkenhaus T, Gitmark J, Green N, Gundersen H, Johnsen TM, Ledang AB, Lømsland ER, Magnusson J, Moy F, Omli L, Oug E, Pedersen A, Rygg B, Sørensen K, Trannum H, Tveiten L, Walday M (Norway)** - The coastal monitoring programme - how is eutrophication and climatic change affecting the coastal ecosystem?
- (111) **Tone Falkenhaus, Espen Bagøien and Cecilie Broms (Norway)** - Dynamics of co-occurring *Calanus finmarchicus* and *C. helgolandicus* in Skagerrak
- (112) **Carla R. Lourenço, Katy R. Nicastro, Ester Serrão and Gerardo I. Zardi. (Portugal)** - First record of the intertidal mussel *Perna perna* along the European coast: long overlooked or a recent range expansion?
- (113) **Josefin Sundin, Gunilla Rosenqvist, Tonje Aronsen and Anders Berglund (Sweden)** - Impact of eutrophication and altered oceanic pH on mate choice and reproductive success in the pipefish model system
- (114) **Tiina Salo, Thorsten Reusch and Christoffer Boström (Finland)** - Production and plasticity of isolated eelgrass clones under irradiance stress
- (115) **Anouk Goedknecht and David Thielges (The Netherlands)** - Biodiversity reduces disease risk in a warmer sea.
- (116) **Philipp R Schubert, Jan Dierking, Anna-Christina Bockelmann and Thorsten BH Reusch (Germany)** - In search of the "population" - unorthodox sampling designs to uncover large-scale eelgrass population structure and eutrophication effects
- (117) **Dorothea Kohlmeier, Conrad A. Pilditch, Janet F. Bornman and Kai Bischof (Germany/ New Zealand/ Australia)** - Intertidal *Zostera* species display effective xanthophyll cycling under high-light exposure: insights from field studies in New Zealand and Germany
- (118) **Andrew D. Naumov (Russia)** - The influence of abnormal ice-melting upon the structure of intertidal community in the White Sea bight
- (119) **Trannum, H.C., Gundersen, H., Norderhaug, K.M. (Norway)** - Soft bottom communities and responses to climatic change and eutrophication in Skagerrak during a period of twenty years
- (120) **Hege Gundersen, Dag Hjermann, Kjell Magnus Norderhaug (Norway)** - The Norwegian Coastal Monitoring Programme (1990-p.t.): Effects of eutrophication and climatic change on rocky bottom macro algae and sessile fauna

- (121) **Louise B. Firth, Stephen J. Hawkins (Ireland)** - Artificial coastal defences: enhancing biodiversity using sensitive design
- (122) **Nadezhda Berezina (Russia)** - Changes in life cycle and ecological significance of coastal community members as a response to climatic variability in eastern Baltic Sea
- (123) **Alexander Jüterbock, Jim A. Coyer, Lennert Tyberghein, Jeanine L. Olsen, Galice Hoarau (Norway)** - Climate change impact on seaweed meadow distribution in the North Atlantic rocky intertidal
- (124) **Wrangle, A-L., André, C., Havenhand, J. (Sweden)** - The role of salinity tolerance and adaptation in barnacle populations along the Baltic Sea salinity gradient
- (125) **Buhl-Mortensen L., Oug E. and Aure J (Norway)** - Hypoxia effects on the composition of hyperbenthos and infauna in Norwegian Skagerrak fjordic basins
- (126) **Camilla Gustafsson and Christoffer Boström (Finland)** - Plant facilitation in mixed seagrass meadows: exploring complex interactive effects of plants and shading stress on eelgrass (*Zostera marina* L.) performance
- (127) **Sergienko Liudmila (Russia)** - Ecological-dynamic series of salt marsh vegetation on the Pomorsky and Karelian coasts of the White Sea

THEME 3: MANAGEMENT OF COASTAL RESOURCES – MARINE PROTECTED AREAS

- (129) **Giulio Relini, Luca Lanteri, Alessandro Franco, Cristina Cimmino (Italy)** - Fishes of Artificial Reefs in the Gulf of Genoa
- (130) **Silje Svendsen, Galice Hoarau and Jarle Tryti Nordeide (Norway)** - Population Genetics in Spawning and Juvenile Cod (*Gadus morhua*)
- (131) **Sara Bonanomi, Nina Overgaard Therkildsen and Einar Eg Nielsen (Denmark)** - Retrospective genomic analysis from archived samples of Atlantic cod stocks in West Greenland Waters: implication for management
- (132) **R. Ferreri, M. Bonsignore, M. Calabrò, G. Basilone, A. Bonanno, S. Genovese, M. Barra, S. Aronica and S. Mazzola (Italy)** - *Engraulis encrasicolus*: recruitment pattern along a temperature gradient in the Strait of Sicily
- (133) **A. Bonanno, R. Ferreri, G. Basilone, S. Genovese, S. Aronica, G. Giacalone, I. Fontana, M. D'Elia, M. Barra and S. Mazzola (Italy)** - European anchovy acoustic and egg production estimates comparison during a ten year time series in the Strait of Sicily

THEME 4: GENERAL MARINE BIOLOGY

- (135) **Rita Guillot, Paula Costa, Joana Campos and Audrey Geffen (Norway)** - Latitudinal comparison of the growth of the common goby, *Pomatoschistus microps* (Krøyer, 1838): does countergradient variation occur?

- (136) **N.N. Marfenin and F.Bolshakov (Russia)** - Fluctuations in settlement and survival of a barnacle *Semibalanus balanoides* at the White Sea intertidal studding by a method photo-registration
- (137) **M.V.Mordashova and N.N. Marfenin (Russia)** - Sample size for quantitative analysis of highly heterogenous *Semibalanus balanoides* barnacles population on sandy with gravel intertidal
- (138) **Husa V, Agnalt A-L, Bysveen I, Holmern T, Heggøy E, Sjøtun K, Svensen R and Rokkan Iversen K. (Norway)** - Rapid coastal survey for marine introduced species in Norway
- (139) **Hornaff, Cindy and Eiane, Ketil (Norway)** - Spatial heterogeneity in Atlantic cod larvae off Vesterålen, Northern Norway
- (140) **Timothy Whitton, Chris Richardson, Jan Hiddink, Stuart Jenkins and Bryan Jones (United Kingdom)** - Colonisation patterns of cockle *Cerastoderma edule* Linnaeus (1758) post-larvae
- (141) **Elena Gudimova, Hans-Christian Eilertsen, Jeanette Andersen and Espen Hansen (Norway)** - Diatoms nutritional quality, toxicity and bioactivity tested by a simple sea urchin assay
- (142) **Abramova A.A. and Markhaseva E.L. (Norway)** - Clarifying the taxonomic status of Pseudocalanus (Crustacea: Copepoda) in the White Sea
- (143) **Skazina M., Khaitov V. and Sofronova E. (Russia)** - To see the offspring and die: the case study of *Astarte borealis* population dynamics
- (144) **Robert Kennedy, James Forde, Patrick C. Collins and Adrian Patterson (Ireland)** - Do benthic ecological quality ratios reflect the distribution of endocrine disrupting chemicals?
- (145) **Robert Kennedy and Louise Scally (Ireland)** - Ecological assessment of the effects on the seafloor of the proposed Atlantic Marine Energy Test Site (AMETS), Co. Mayo, Ireland
- (146) **Aimee Walls, Robert Kennedy, Richard Fitzgerald and Maeve Edwards (Ireland)** - Effect of longline aquaculture of the kelp, *Laminaria digitata*, on holdfast macrofaunal diversity
- (147) **Elena R. Tarakhovskaya, Yuri I. Maslov and Alexander I. Railkin (Russia)** - The pattern of vanadium-dependent haloperoxidase activity in the intertidal and subtidal furoid species
- (148) **Karl Norling, Hege Gundersen, Trine Bekkby, Eivind Oug, Brage Rygg and Mats Walday (Norway)** - How does soft sediment macroinfauna vary with environmental conditions – modelling reference conditions along the Norwegian coast
- (149) **Andrea Bozman, Ketil Eiane and Truls Moum (Norway)** - Population dynamics of *Periphylla periphylla* in a North Norwegian fjord
- (150) **B. Alejandra Juárez-de la Rosa, Juan José Alvarado-Gil and Pedro-Luis Ardisson (Mexico)** - Biomechanical approach to a structural design of biological beam: The black coral skeleton

- (151) **Rinelli P., Bottari T., Conti F., Perdichizzi A. and Profeta A. (Italy)** - Trends in population dynamics and fishery of the deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the Southern Tyrrhenian Sea (South-Western Mediterranean)
- (152) **Busalacchi B., Giordano D., Bottari T., Profeta A. and Rinelli P. (Italy)** - Distribution and population structure of *Pagellus erythrinus* (Linnaeus, 1758) in the Southern Tyrrhenian Sea (Central Mediterranean)
- (153) **Bottari T., Liguori M., Giordano D., Romeo T. and Rinelli P. (Italy)** - Prevalence of *Ceratothoa parallela* (Flabellifera: Cymothoidae) (Otto 1828) in the bogue (*Boops boops*) (L. 1758), South Tyrrhenian Sea (Central Mediterranean)
- (154) **E. M. D. PORPORATO, F. DE DOMENICO, M. C. MANGANO, S. GIACOBBE and N. SPANÒ (Italy)** - First observation on *Pteroeides spinosum* (Anthozoa: Octocorallia) fields in a Sicilian coastal zone (Central Mediterranean Sea)
- (155) **F. DE DOMENICO, G. SCARFÌ, G. IARIA and N. SPANÒ (Italy)** - Distribution of *Paramuricea clavata* (Anthozoa: Octocorallia) on artificial bottom in the Strait of Messina (Central Mediterranean Sea): preliminary data
- (156) **Esther Rickert and Florian Weinberger (Germany)** - Immunostimulation affects cultivated kelp
- (157) **Jo Foden, Swier Oosterhuis, Suzanne Painting, Elisa Capuzzo, Richard Gowen and David Mills (UK)** - Meso-zooplankton production and biomass variability in the North, Irish and Celtic Seas
- (158) **Andreev V.M., Mugue N.S., Fokin M.V. and Strelkov P.P. (Russia)** - Genetic consequences of landlocking for mussels *Mytilus edulis* L. and cod *Gadus morhua kildinensis* Derjugin from marine lake Mogilnoe (Kildin Island, the Barents Sea)
- (159) **Vadim Khaitov, Marina Katolikova, Maria Skazina, Michail Gantsevitch and Petr Strelkov (Russia)** - The simple conchological feature allows discriminating of *Mytilus edulis* L. and *M. trossulus* Gould in the White Sea hybrid zone
- (160) **Coleman R.A. and Williams, E.R.M. (Australia)** - No place like home: The consequences of previous occupancy for distribution of limpets on rocky shores
- (161) **S.Genovese, A. Bonanno, G.Basilone, A. Corriero, G. Buscaino, M. De Florio, I. Fontana, R. Ferreri, M. Bonsignore and S. Mazzola (Italy)** - Information on Atlantic bluefin tuna (*Thunnus thynnus* L.) from the last “Mattanza” episodes of the Favignana tuna trap (North-west Sicily)
- (162) **Ermelinda Prato, Isabella Parlapiano, Francesca Biandolino (Italy)** - Individual and combined toxic effects of mercury, copper and cadmium on *Tigriopus fulvus* (Copepoda, Harpacticoida)
- (163) **Christiaan A. Hummel, Pim H. van Avesaath and Herman Hummel (The Netherlands)** - Changes in the fish populations of the Eastern Scheldt due to changes of the tidal regime

- (164) **Clarissa Fraser, Ross Coleman and Frank Seebacher (Australia)** - Limpet orientation in response to changes in barnacle cover
- (165) **A. Legaki, A. Dosi, & A. Nicolaidou (Greece)** - Population structure and production of the bivalve *Abra tenuis* (Montagu, 1803) in Vouliagmeni Lake, Greece
- (166) **Pim H. van Avesaath and Herman Hummel (The Netherlands)**: The invasion of an artificial lagoon (Lake Veere, The Netherlands) by *Mnemiopsis leidyi*: a guest that permanently settles in the deeper parts of the system?
- (167) **James Forde, Adrian Patterson, Patrick C. Collins and Robert Kennedy (Ireland)**: Comparison of sediment grain size analysis techniques to explain variation in macrobenthic coastal communities: A short time series example
- (168) **Lene Christensen, Wenche Eikrem, Anna Vader and Tove M. Gabrielsen (Norway)**: Seasonal variation in the picoeukaryote *Micromonas pusilla* in an arctic fjord, Svalbard, as revealed by quantitative PCR
- (169) **Bannister R.J., Tjensvoll I., Kutti T., Søvik G. and Fosså J.H. (Norway)**: Physiological responses of deep-water sponges to anthropogenic stress
- (170) **Martin Gullström, Hans W Linderholm and Mats Björk (Sweden)**: Capacity of tropical seagrass meadows as blue carbon sinks
- (171) **Wenche Eikrem, Anette Engesmo, Sergio Seoane, Thomas Rundberget, Vladyslava Hostyeva and Bente Edvardsen (Norway)**: A new potentially harmful dinoflagellate from Norway
- (172) **Lars Johan Hansson (Sweden)**: The invasive comb jellyfish *Mnemiopsis leidyi* in a changing climate: more plankton prey are eaten in warmer waters

THURSDAY 6 SEPTEMBER, 0900–1240

THEME 4: GENERAL MARINE BIOLOGY

CHAIR: ANNE GRO SALVANES (NORWAY)

- 0900 – 0940 **(80) Keynote speaker: Lisa Levin (USA)**: Deoxygenation and Acidification of Continental Margins: Oxygen Minimum Zones on the move.
- 0940 – 1000 **(81) Bannister R.J., Valdemarsen T.B., Hansen P.K. and Ervik A. (Norway)**: Impact of deep-water fish farms on the biogeochemistry in underlying sediments
- 1000 – 1020 **(82) Adrian Patterson, O'Reilly, R. and Kennedy, R. (Ireland)**: The quantification and in-situ observations of biogenic structures in intertidal sediments by time-lapse sediment profile imagery(tSPI).
- 1020 – 1040 **(83) Lodewijk van Walraven, Victor T. Langenberg, Henk W. van der Veer (The**

Netherlands): Changes in benthic-pelagic coupling by changing predation on meroplanktonic larvae in the Wadden Sea

1040 – 1100 Coffee break

CHAIR: FRITHJOF MOY (NORWAY)

1100 - 1120 **(84) Kay Vopel and Aysha Hohaia (New Zealand):** Thin terrestrial sediment deposits on intertidal sandflats: effects on bivalve burial behavior and pore water chemistry

1120 – 1140 **(85) Morten F. Pedersen; Nejrup, Lars B.; Pedersen, Troels M. and Fredriksen, Stein. (Denmark):** Biomass and productivity of epiphytic algae on kelp *Laminaria hyperborea*

1140 - 1200 **(86) Eivind Oug and Sabine K.J. Cochrane (Norway):** Changes in benthic fauna after the invasion of the alien red king crab (*Paralithodes camtschaticus*) in a north Norwegian fjord

1200 - 1220 **(87) Timothy Whitton, Chris Richardson, Jan Hiddink, Stuart Jenkins and Bryan Jones (United Kingdom):** The effect of prey aggregation on predation rates: Juvenile shore crabs (*Carcinus maenas*) foraging on post-larval cockles (*Cerastoderma edule*)

1220 - 1240 **(88) Aino Hosia, Tone Falkenhaus, Lars Johan Naustvoll (Norway):** Jellyfish trends at Flødevigen Research Station, Norwegian Skagerrak coast, from 1993 to 2011.

1240 – 1400 Lunch

1430 – 1800 Yellow Submarine, bus from Arendal Kulturhus to Hove Campus 12:15

2000 Banquet at Hove Campus

FRIDAY 7 SEPTEMBER, 0900–1500

THEME 4: GENERAL MARINE BIOLOGY

CHAIR: YNGVAR A. OLSEN (NORWAY)

0900 – 0920 **(89) Trine Bekkby, Eli Rinde, Hege Gundersen, Kjell Magnus Norderhaug, Hartvig Christie and Janne K. Gitmark (Norway):** The effect of wave and current exposure on kelp (*Laminaria hyperborea*) structure and associated algae and fauna communities

0920 – 0940 **(90) Tiphaine Chauvelon, Alexis Chappuis, Paco Bustamante, Sébastien Lefebvre, Françoise Mornet, Paula Méndez Fernandez, Jérôme Spitz, Florence Caurant, Christine Dupuy (France):** Combining biological and environmental variability with carbon and nitrogen stable isotope analysis for the study of marine species' trophic ecology: the case of European sardine *Sardina pilchardus* and anchovy *Engraulis encrasicolus* in the Bay of Biscay.

- 0940 – 1000 **(91) Tone Falkenhaus, Padmini Dalpadado, Else Torstensen, Cecilie Kvamme and Jon Albretsen (Norway):** Feeding ecology of Sprat (*Sprattus sprattus*) in Hardangerfjord, Norway
- 1000 – 1020 **(92) Britta Munkes, Paul Lavery and Mat Vanderklift (Germany):** The role of hydrodynamics and herbivory in ameliorating the effects of nutrient enrichment in marine ecosystems.
- 1020 – 1040 **(93) Jennifer Welsh and David Thieltges (The Netherlands):** Biodiversity and disease risk: How marine communities reduce parasite infection levels
- 1040 – 1100 Coffee break

CHAIR: CHRIS FRID (UK)

- 1100 - 1120 **(94) Sigurd Heiberg Espeland and Jon Albretsen (Norway):** Connectivity: Different spawning strategies may shape population structure
- 1120 – 1140 **(95) Tina Kutti and Raymond Bannister (Norway):** Deep-water sponge grounds on the northern Norwegian continental shelf: community composition and the functional role of *Geodia barretti*
- 1140 - 1200 **(96) Monika I. Orchowska, Piotr Kukliński and Katarzyna Grzelak (Poland):** The Baltic Sea salinity gradient as a driving factor for diversity of encrusting organisms
- 1200 – 1330 Lunch
- 1330 – 1415 **(97) Finale lecture by Nils Christian Stenseth (Norway):** Challenges for the Marine Environment for the next decade
- 1415 – 1500 Awards:
- Best oral presentations – Wiley-Blackwell
 - Best poster presentations - Herman Hummel, MARS-network
 - Best student presentations - Matthew Frost, MBA of the United Kingdom
- Closing remarks

Abstracts

Oral Sessions

Introductory lecture

47th European Marine Biology Symposium
Arendal, Norway
3 – 7 September 2012

Ecological Effects of Human Activities in the Sea - Challenges and Possibilities

Jeffrey Hutchings
Professor at Department of Biology, Dalhousie University, Canada/
Centre for Ecological and Evolutionary Synthesis, University of Oslo, Norway

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Abstract

The oceans constitute a vital biological and physical milieu that supports human health, societal well-being, and creation of wealth. Among many other ecosystem services, the oceans provide more than half the oxygen humans breathe, serve as a potentially rich source for modern pharmaceuticals, and offer a physical integrity that reduces erosion and buffers the land from oceanic storms. Sustainably exploited fish populations and environmentally responsible aquaculture operations should provide secure global access to the protein and oils contained in seafood.

Canada, Norway, and the EU have the benefit of, and responsibility for, 83% of the world's coastlines. However, these jurisdictions (and others) face significant challenges in conserving and sustaining marine biodiversity in light of climate change, fisheries, and aquaculture. Although climate change represents the greatest challenge, primarily because its effects are neither readily predictable nor readily reversible, the exploitation and farming of marine life also present significant ecological challenges to marine biodiversity and ocean ecosystems.

Biological depredation of, and ecosystem change within, much of the waters bordered by Canada, Norway, and the EU ultimately reflects ineffectual leadership, societal ambivalence, and disingenuous commitment to meaningful ocean stewardship and management actions. Arguably the most appropriate means of dealing with these three key stressors is to rebuild, and effectively protect, depleted populations and species to restore natural diversity. Such a strategy should restore the natural resilience of ocean ecosystems to adapt in response to the challenges posed by climate change and other human activities.

Oral Sessions

Theme 1: Ecological effects of aquaculture and fisheries

Theme 1: Ecological effects of aquaculture and fisheries

Invited speaker

47th European Marine Biology Symposium
Arendal, Norway
3 – 7 September 2012

Risk assessment of environmental impact of Norwegian Fish farming

Geir-Lasse Taranger, Terje Svåsand, Abdullah S. Madhun and Karin Kroon Boxaspen

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Abstract

Norwegian fish farming has expanded rapidly during the last 30 years with Atlantic salmon and rainbow trout as main species, and more recently also with some production of Atlantic cod and Atlantic halibut. The grow-out period is mainly in open sea cages in close contact with the coastal ecosystem, and due to the scale of production in terms of fish biomass and the amount of feed supplied farming has visible ecosystem impacts. However, the scale and the importance of these impacts are under scientific and public discussion, and the general sustainability of this farming activity is debated. In a recent risk assessment of Norwegian aquaculture transfer of salmon lice to wild salmonids and introgression of farmed salmon into wild populations were scored as the major risk factors, based on data from ongoing monitoring programs. Other factors such as eutrofication due to the relative release of nitrogen and phosphorous and organic load were scored to represent low risk at a regional level, although local effects occur, and knowledge on the impact on vulnerable habitats and species close to the farms are still limited. There is also a need for better basic knowledge and monitoring programs for other risk factors such as transfer of other diseases (than salmon lice), therapeutics used to combat diseases such as those used against salmon lice, and wider ecological impact e.g. by feed spill on local fish populations. Current state-of-the art will be discussed along with suggestions for future development and assessments.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Feeding the World - The potential role of fisheries and aquaculture

Chris Frid and Odette Paramor

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Abstract

This paper considers three challenges that must be faced in the next 4 decades. 1. Fisheries provide around about 15% of the animal protein consumed each year by the 7 billion people currently living on planet Earth. However, over 1 billion of those people are malnourished and by 2050 there will be over 9 billion citizens to be fed. 2. The global fish catch has been static since the 1990s and mot stocks are fully exploited or over exploited. 3. Aquaculture reamins a capital intensive industry supplying 'luxury' items while most of the malnourished and most of the population growth will be in low capital economies. So what role will fisheries and aquaculture have in meeting the food needs of the global population peak in the mid 21st century?

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Performance of farm, hybrid and wild Atlantic salmon (*Salmo salar*) families in a natural river environment: genetic and management implications.

Øystein Skaala, Kevin A. Glover, Bjørn T. Barlaup, Terje Svåsand, Francois Besnier, Michael M. Hansen and Reidar Borgstrøm

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Abstract

Survival, growth and diet was compared for farm, hybrid and wild Atlantic salmon families from the eyed egg to the smolt stage in river Guddalselva. All individuals that survived until the smolt stage were captured in a Wolf trap, and identified to one of the 69 experimental families, using microsatellite markers. Survival of farm salmon progeny was significantly lower than for hybrids and wild progeny. However, survival varied considerably, from 0.17 % to 6.4 %, among farm families, suggesting that some families may constitute a fast track for gene flow from farm to wild gene pools. Egg size had an important influence on survival, and since farmed salmon had larger eggs, their inferior fitness was masked in the first generation. The overall relative survival of farm families compared to their hybrid half sib families fell from 0.86 in the second cohort to 0.62 in the last cohort with increasing fish density. The overlap in diet among types suggests competition, and thus farm and hybrid progeny will reduce the river's capacity for production of wild salmon

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Pelagic and benthic ecosystem responses under aquaculture induced stress in Norwegian fjords

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Abstract

Aquaculture industry has increased the last decades and in 2010 about 1 million ton of salmon and trout were produced Norway. The increased production is due to increased number of Norwegian concessions as well as higher fish biomass produced per locality. A large part (>50 %) of the feed supplied is discharged as organic material and nutrients, which represent a major loss of resources and a significant contribution of the anthropogenic discharges in coastal waters. An alternative to the best available technique mediating these discharges using closed systems are Integrated Multi-Trophic Aquaculture (IMTA), which refers to multi species aquaculture that allows wastes to be recycled by other species. To investigate how far from the farm wastes will be spread and incorporated; bioassays (Blue mussels shallow at 5 m and deep at 200 m and Sugar kelp at 5m depth) were put out on moorings in reference fjords without aquaculture and at five sites at 0-1800 m distance from two farms. The outer Hardangerfjord farm was characterized by a stronger bottom current compared to the inner Hardangerfjord farm. The field experiment was performed during September to November in 2010 at all reference and farm sites. Results show different Blue mussel and Sugar kelp growth among regions with significantly higher growth in the outer fjord compared to the reference and inner fjord sites. Growth of Sugar kelp (5 m depth) and deep Blue mussels (200 m depth) close to the inner Hardangerfjord farm were significantly higher, whereas growth of shallow Blue mussels (5 m depth) increased with distance away from the farm.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Tracing fish farm waste in the northern shrimp (*Pandalus borealis*) using lipid biomarkers

Siri Aaserud Olsen, Arne Ervik and Otto Grahl-Nielsen

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Abstract

A large amount of organic effluents are released annually from coastal fish farming locations primarily in the form of faeces that settle to the seabed, constituting a substantial food source for benthic communities. The inclusion of marine and vegetable oils as sources of lipids in salmon feed has resulted in a fatty acid (FA) composition that differs markedly from marine-derived material, providing an efficient tracer for the distribution of fish farm waste in both sediments and fish. To obtain a better understanding of the flux of organic fish farm waste through the benthic food web, we sampled northern shrimp *Pandalus borealis* from fish farming and reference locations in 4 regions along the Norwegian coast. Analyses of the FA compositions of muscular tissue demonstrated that shrimp collected 0–800 m from fish farms had a higher content of vegetable-derived FAs 18:2n6 (linoleic acid) and 18:3n3 (linolenic acid) and marine FAs 20:1n9 and 22:1n11, compared to shrimp from reference locations. This difference in specific FA contents allowed to separate shrimp collected from farming and reference locations. Our results demonstrate that shrimp within the distribution range of fish farms can incorporate organic fish farm waste as a part of their diet, either directly through the consumption of waste feed and faeces or indirectly by feeding on influenced infauna.

Theme 1: Ecological effects of aquaculture and fisheries

Invited speaker

47th European Marine Biology Symposium
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Towards integration of fisheries and environmental management

Simeon Jennings

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Chair of Environmental Sciences at the University of East Anglia.

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Abstract

Fisheries have wide-ranging impacts on the marine environment. Thus the ways that fisheries are conducted and managed will influence progress towards meeting environmental targets and management measures taken to meet environmental targets will affect fisheries. The political drivers for the integration of fisheries and environmental management in Europe have never been so strong. Scientists and advisers who called for better integration now have the opportunity to help deliver it. Perhaps the biggest challenges they face are to provide the necessary evidence on a short timescale with few additional resources and to make better use of existing research. Here, I comment on progress and propose some options for providing a reliable, internally consistent and trusted evidence base that supports integration.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Consequences of fisheries-induced evolution for recovery potential and extinction risk

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Abstract

Fisheries-induced evolution has become a major branch of the research on anthropogenic and contemporary evolution. Within the conservation context, fisheries-induced evolution has been hypothesized to negatively affect the persistence and recovery potential of depleted populations, but this has not been explicitly investigated. Here, we investigate how fisheries-induced evolution of Atlantic cod (*Gadus morhua* L.) life histories affect per capita population growth rate, a parameter negatively correlated with extinction risk. We simulate the evolutionary and ecological dynamics of a cod population for a 100-year period of size-selective harvesting, followed thereafter by 300 years of recovery. To evaluate the relative importance of harvest-induced evolution, we either allowed life histories to evolve during and after the fishing period, or we assumed that fisheries-induced evolution was absent. Population growth rates did not differ appreciably between the evolutionary and non-evolutionary simulation scenarios, despite the emergence of rather pronounced differences in life histories. The underlying reason was that in the absence of fishing the cumulative lifetime reproductive outputs were very similar among differing life-histories. The results suggest that fisheries-induced evolution might not always have as clear-cut an effect on population growth rate as previously anticipated.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Estimating the Impact of Catch-and-Release Practice by Marine Angling Tourists in Norway – Insights for Future Management

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Abstract

During the last two decades a large marine angling tourism industry has developed in Norway, and impacts on fish stocks cannot be excluded. Although the landings of marine angling tourists seem to be insignificant compared to the landings of commercial and Norwegian recreational fishermen, marine angling tourists release large proportions of their catch. For many target species, the release amounts actually exceed landings, which may have direct consequences for the ecosystem. The practice of Catch-and-Release (C&R) may not only lead to post-release mortalities, but also cause behavioral changes to the fish due to stress and infections. To study the lethal and sub-lethal effects of C&R under laboratory and natural conditions, we used a combination of classical and modern methods. Moreover, techniques to increase the survival of fish were investigated. The insights from this study give important knowledge about the impact of C&R on the ecosystem which is necessary for the development of release guidelines, and for the implementation of further management regulations.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Real time monitoring of individual fate in a trap fishery: what's up with the one that got away?

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Abstract

Fisheries typically remove large and old individuals, leading to 'longevity overfishing'. It is becoming widely recognised that common harvest rules such as minimum legal size (MLS) select for early maturation and slow growth, because fishing mortality increases with size. Harvest selection may also act on behavioural traits, although this field of research has so far received less attention. We used acoustic tags and a network of receivers to monitor the home range behaviour and fate of individual male European lobster (*Homarus gammarus*, N = 50) above MLS (25 cm total length), in their natural habitat on the Norwegian Skagerrak coast before (September) and during the two month fishing season (October and November). In addition, we recorded the Global Positioning System (GPS) positions of traps throughout the study area during the fishing season. The combination of data thus obtained allowed us to estimate the harvest pressure experienced by individual lobsters. Fates of tagged lobsters were decided based on tag returns from fishers and cessation of acoustic signals within the network of receivers. Fishing mortality in the tagged population was high (> 80 %), and survival favoured home range behaviours that avoided the most popular fishing grounds suggesting that longevity will depend on settlement and occupancy in habitat considered unfavourable for lobsters by the human predator. The link between behaviour and survival raises interesting issues at the interface between harvesting and life history dynamics.

Theme 1: Ecological effects of aquaculture and fisheries

Presentation: Oral

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Spatial and temporal patterns in abundance of sea trout, Atlantic salmon and escaped farmed salmon in the Hardangerfjord

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Abstract

The rivers that drain into the Hardangerfjord were historically known to have numerous stocks of both sea trout and Atlantic salmon as a basis for maintaining a substantial local fishery. After a marked decline in catches during the last two decades a large part of the rivers has been closed for fishing. It has been suggested that this decline is due to an increased mortality during migration in the fjord. The goal of this paper is to use data from snorkelling observations and catch statistics from 2004-2011 to describe the current stock situations and analyse the spatial and temporal patterns of sea-trout, salmon and escaped farmed salmon between the rivers of the Hardangerfjord.

Abstracts

Oral Sessions

Theme 2:

The marine environment and responses to climate changes

Theme 2: The marine environment and responses to climate changes

Invited speaker

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Evolutionary adaptation to global change? - examples from the base of the marine food web

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Abstract

Will populations and species adapt to global change? - is a key question in marine ecology and evolutionary biology. I present examples from the base of the marine food web where our group studies adaptive genetic variation and its genetic basis in diverse photoautotrophs. In marine flowering plants (seagrasses), we used a space-for time substitution design to address how gene expression patterns are correlated with thermal tolerance across southern and northern *Zostera marina* (eelgrass) populations, exposed to a summer heat wave in a common stress garden. Interestingly, the transcriptomic response only diverged after the stress during recovery, with southern genotypes rapidly returning to control gene expression, while northern ones revealed many genes indicative for protein degradation. Accordingly, we propose transcriptomic resilience, the return to normal (control) gene expression, as one measure of genotypes/populations to cope with global change associated stress. Phytoplankton species are amenable to more direct tests of evolutionary adaptation owing to short (~1 day) generation times. In an experimental evolution approach using the coccolithophore *Emiliania huxleyi*, we are studying adaptation to ocean acidification in both, mono-clonal and multi-clonal replicated selection lines after 1000 generations of propagation. As important correlated traits, calcification was partly restored as a result of adaptation, indicating the potential biogeochemical implications of our findings for the ocean's potential to sequester excess anthropogenic carbon. Gene expression studies address the question whether or not the same genetic solutions are underlying identical phenotypes. Taken together, I will argue that evolutionary responses need to be taken into account when projecting biological effects of global change.

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Presentation: Oral

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Impact of a 'marine heat wave' on seaweed, coral and fish assemblages in a global biodiversity hotspot

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Abstract

Extreme climatic events are predicted to increase in frequency and magnitude but their ecological effects are poorly understood, particularly in marine ecosystems. Heat waves are discrete, extreme warming events that are likely to increase in severity as a result of anthropogenic climate change. In marine ecosystems, physical drivers of heat waves are complex and vary between regions but ecological responses often include physiological stress, mass mortalities, species range shifts and changes in the structure of communities and entire ecosystems. In early 2011, the vast coastline of Western Australia experienced a significant warming event, where SSTs were the highest on record and warming anomalies of 2-4°C persisted for many weeks along >2000 km of coastline. The warming event was driven by unusually strong La Niña conditions, which were superimposed onto a decadal-scale warming trend. Here, we describe the effects of the heat wave on the benthic ecosystem of temperate Western Australia, which represents a global hotspot of diversity and endemism. Extensive biodiversity surveys were conducted by scuba divers and an Autonomous Underwater Vehicle (AUV) and compared with long-running baseline data to elucidate the effects of the warming event. Key ecological responses included: (i) localized extinction and regional range contraction of a prominent habitat-forming seaweed; (ii) anomalously high rates of bleaching at a high-latitude coral reef system; and (iii) significant shifts in the structure of seaweed and reef fish assemblages. These observations, and their implications, are discussed within the general context of extreme warming events in marine systems.

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Presentation: Oral

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High diversity in the high north: Norwegian seagrass meadows are alive and very well but still vulnerable

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Abstract

Our present understanding of how Nordic seagrass habitats are linked by means of currents, gene flow or animal movements is still very limited, and studies identifying relevant scales and thresholds in habitat connectivity are urgently needed in order to assist conservation and management efforts. Here we report on a pilot survey financed through the Framcentre flagship "Effects of climate change on sea and coastal ecology in the north" of genetic variation and population structure within and between three fjords in Troms County, Norway (70 ° latitude) including two RAMSAR sites at Kobbervågen and Sørkjosen. *Zostera marina* shoots (>600) were genotyped with eight 8 microsatellite loci. Contrary to the expectation of low genetic diversity in high latitudes, high allelic richness was found at several locations; large clonal genets were rare. These results indicate that sexual recruitment from seeds is ongoing and supportive of large effective population sizes, which generate adaptive potential. Population differentiation among fjords was strong (suggesting isolation from one another) but often absent within fjords (suggesting adequate connectivity within the metapopulation). At the Sørkjosen RAMSAR site significant differentiation was detected between intertidal and subtidal meadows. However, these differences do not correlate with the ecotype *Z. marina*, var, *angustifolia*. Conservation guided by an evolutionary perspective seeks conditions that will allow populations to continually adapt to inevitably changing conditions. The pristine meadows of the high north clearly harbor the standing genetic variation needed to cope with climate change; let's hope that proximal anthropogenic stress can be minimized.

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Eelgrass *Zostera marina* in NE Baltic Sea – a survivor?

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Abstract

The loss of seagrasses due to worsening environmental conditions has been alarming worldwide. Unfortunately we lack long-lasting eelgrass survey in the NE Baltic Sea that would answer the question whether and how much the distribution of eelgrass has changed here. But, as a first step we give an overview of the present situation of eelgrass growing at its lowest salinity tolerance. We summarize the mapping results of several different seabed mapping projects carried out in Estonia in 1995-2011. Different methods have been applied – grab/frame sampling and diver/video estimations. Over the years eelgrass has been recorded in 346 locations with maximum biomass 280 g m⁻² dw. Using modelling techniques the estimated area of eelgrass beds is about 150 km². Environmental conditions where eelgrass grows vary greatly – from exposed to sheltered coasts, from sandy to limestone-pebble bottoms. Eelgrass forms mostly monospecies meadows, but in more sheltered bays it grows together with *Potamogeton* spp, *Zannichellia palustris* and *Myriophyllum spicatum*. In exposed coasts the mixed communities of *Z. marina* and *Fucus vesiculosus* are also common. As eelgrass tolerates a wide range of environmental conditions it seems at least for the moment that in the NE Baltic Sea *Z.marina* can survive the effects of climate change.

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Does eelgrass (*Zostera marina* L.) food web structure differ in open and closed coastal systems?

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Abstract

Seagrass beds host a diverse marine fauna and are regarded as important habitats in coastal marine systems and their management. Both proximity to populated areas as well as water exchange and exposure influence seagrass health and thus its food web structure. Our objectives were to investigate differences between the eelgrass (*Zostera marina*) ecosystems in physically open and closed coastal areas 6 km apart in N. Funen, Denmark. Our hypothesis were (i) closed systems have lower species diversity than open systems due to limitation of connectivity/recruitment, (ii) closed systems are more influenced by human impact, and (iii) differences in food web structure between open and closed systems can be explained by vegetation and sediment characteristics. Kertinge Nor is a shallow fjord with restricted water exchange with the sea, while Dalby Bay is fully connected to the sea. The former has historically received a high nutrient load until 1990 and is still affected by internal nutrient loading. We sampled and analysed sediment and vegetation characteristics, epifauna, infauna and fish and utilized stable isotope analysis to identify links. In the closed system, eelgrass canopy height and above/below ground biomass ratio were twice as high, indicating light limitation and higher nutrient load. Total diversity was lower within the closed system, while nutrient concentrations and biomass of intermediate predators were highest in the closed system and points to both a top-down and bottom-up effect resulting in significantly higher biomass of filamentous algae. Conceptual models of the eelgrass food web structure in the two systems are presented.

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Spatial distribution of epiphytes and mobile fauna on *Zostera marina* (L.) and *Fucus serratus* (L.) from the Skagerrak area

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Abstract

Seagrass meadows are scattered along the entire Norwegian coast. In this study we have compared the epiphytes and mobile fauna from *Zostera marina* and *Fucus serratus* from 8 different sites in the Skagerrak area in southern Norway. Both macrophytes have a flattened thallus and are present the whole year and can be found at the same depth (2 – 3 m). However, while *F. serratus* is growing in a more or less continuous belt along the coast, *Z. marina* shows a more scattered distribution. A total of 69 taxa of benthic algae and 25 taxa of sessile animals were found on the two macrophytes. Of these 36 was found exclusively on *Z. marina* and 22 on *F. serratus*. The tunicate *Botryllus schlosseri* and several species of red algae was found only on *Z. marina*, while the hydroid *Dynamena pumila*, the polychaet *Spirorbis spirorbis* and the barnacle *Balanus improvisus* was only registered on *F. serratus*. The number of taxa showed a positive correlation (corr. coeff. 0.8) with the degree of exposure. 181 taxa of mobile fauna were identified, with amphipods and gastropods as the two dominating groups in both habitats. The closely related gastropod species *Rissoa parva* and *R. membranacea* and the amphipods *Jassa falcata* and *Erichthonius difformis* preferred different habitats; the first mentioned almost exclusively found on *F. serratus*. Although the seagrass beds were scattered and varied a lot in canopy high, plant density and biomass, the species composition showed a higher similarity than for the fauna associated to *F. serratus*.

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Get me out of here! Responses to climate warming in a host-parasite interaction

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Abstract

Extreme climate events such as heat waves and storms are expected to rise in frequency and thus to affect host-parasite interactions. In addition, higher mean temperatures can increase parasite development rates, transmission and number of generations per year. Hosts can on one hand benefit from higher temperatures due to an enhanced physiological energy rate but on the other hand, higher temperatures were demonstrated to decrease the efficiency of the immune defence. We experimentally assessed the effects of a warmer environment on host – parasite interactions of the broad-nosed pipefish *Syngnathus typhle* with two different parasites: the trematode *Cryptocotyle lingua* and bacteria of the genus *Vibrio*. First, we examined whether a heat wave disrupts patterns of locally adapted host-parasite combinations (sympatric vs. allopatric) by measuring the parasite's transmission success as well as the host's adaptive and innate immune defence. While parasite performance was better on the local hosts, parasites were unaffected by changing temperatures. However, hosts suffered from a decreased immunocompetence due to the heat wave. In a natural environment that is thermally stratified, behavioural plasticity may allow hosts to overcome these negative effects of global change (e.g. increased parasite virulence, decreased immune defence) by moving to a habitat with a different temperature. To test this idea, we performed a temperature choice behaviour experiment. We found that infected fish showed a preference for colder water. This was in particular evident in pregnant males, as moving to warmer water shortens their brooding period. Behavioural plasticity allowed pipefish to escape high bacterial prevalence that is expected under rising ocean temperatures.

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Latitude and aptitude: the influence of climatic stress on the distribution, performance and function of seaweeds

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Abstract

Combined studies of biogeography, ecology and physiology can provide unique information on how species and ecosystems might respond to climate change. An analysis of ~100,000 herbarium records document the profound influence of ocean climate on the distribution of seaweeds in Australia. The herbarium records also indicate that changes in distribution patterns have occurred over the past ~50 years, with several temperate species retreating poleward as the waters have warmed. Experimental studies along a latitudinal temperature gradient in southwestern Australia show how changes in temperature sensitivity of metabolic processes allow temperate seaweeds such as kelps, to maintain ecological function across ocean temperatures, but also that such physiological adjustments have implications for their ecological competency. Moreover, there are strong negative relationships between ocean temperature and the genetic diversity of these kelp populations, the physiological versatility of their individuals and the ecological resilience of the kelp habitat. This is compelling empirical evidence, that ecosystem function and vulnerability is linked to genetic variation and climatic stress.

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How may climate changes affect reproduction, growth and survival in Baltic *Fucus radicans*?

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Abstract

Fucus radicans is an important structuring brown algae in the species poor and marginal Baltic Sea where it occurs in sympatry with its mother species *Fucus vesiculosus*. Like many other algae living in brackish environments, it complements its sexual reproduction with asexual cloning. An increase in freshwater runoff to the Baltic Sea might change the present distribution of *F. radicans* further south and into the Baltic Proper. Experiments were performed to test climate factors (i.e. increased temperature and different salinities), and their effects on growth rate and fertilization success in *F. radicans*. Results shows that *F. radicans* has an increased growth at high temperature and low salinities compared to *F. vesiculosus*, suggesting growth to be a factor with which *F. radicans* can compete for space in a low salinity environment. Even though *F. radicans* is believed to be endemic to the Baltic Sea, it shows the marine trait of increasing fertilization success with increasing salinity. Grazing pressure, in synergy with abiotic factors, might explain its southern distribution today.

Theme 2: The marine environment and responses to climate changes

Invited speaker

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Changing climate and changing seas: what does it mean for Europe?

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Abstract

Beyond reasonable doubt, climate change has already impacted all oceans and seas of Europe and beyond. Within the past 25 years, seawater temperatures from the surface to the deep sea have increased, with enclosed seas such as the Baltic, the Mediterranean and the Black Sea warming more rapidly than the open ocean. In the Arctic, warmer waters have resulted in a decrease in the area and thickness of sea-ice. Warming waters, together with mass additions from melting ice-sheets and increased landward winds at several locations, have also contributed to sea-level rise. The combination of sea-level rise and increased winds, have contributed to the erosion of 15% of the European coasts. Many marine species, including zooplankton, benthos and fish, have migrated northwards, resulting in local increases in biodiversity and changes in the marine food web. Some marine organisms have even been able to cross from the Pacific to the Atlantic via seasonal ice-free passages through the Arctic. Although large climate changes occurred during the geological past, the present rates of change are unprecedented. The warming has been speeding up, especially during the past 25 years during which it has been about ten times faster than the average rate of increase during the previous century. Synthesizing the findings of European research on the impacts of climate change on marine environments reveals that the marine environment is also changing rapidly. Many of the observed changes which are thought to be predominantly a consequence of climate change can be grouped as follows: (i) changes in the physical properties and motions of the sea; (ii) melting of the Arctic sea-ice; (iii) northward movements of marine organisms; (iv) shifts in timing of life-cycle events; (v) cumulative effects of multiple stressors; and (vi) the socio-economic consequences of all these changes.

This presentation summarises the current state of knowledge with regard to general and region-specific impacts of climate change on European marine and coastal environments. Results from long-term studies are used to examine past changes, put recent rapid changes into context, and to forecast likely future ecosystem responses to climate change. Increasing efforts using a multidisciplinary approach considering the most appropriate range in spatiotemporal scales to further understand and predict the inevitable impacts of climate change on marine environments are strongly recommended.

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Experimental climate change weakens the insurance effect of biodiversity

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Abstract

Ecosystems are simultaneously affected by climate change and biodiversity loss, but we know little about how these factors interact to affect ecosystem functioning. Here, we suggest that in food webs where herbivore efficiency trades-off with resistance to predation, climate change (warming and CO₂-enrichment) should strengthen trophic cascades, by increasing growth of plants more than consumption by predation-resistant herbivores. As a consequence, climate change should weaken the insurance effect of herbivore diversity to dampen trophic cascades. We tested this hypothesis using experimental ocean warming and acidification in seagrass ecosystems. First, meta-analyses of published predation experiments confirmed a trade-off among algal-feeding herbivores, where the most efficient (amphipods) were also the most vulnerable to predation. Second, the mesocosm experiment showed that three common herbivores (the efficient but predation-vulnerable amphipod *Gammarus locusta* L. and the two predation-resistant gastropods *Littorina littorea* L. and *Rissoa* sp.) together controlled macroalgae and facilitated seagrass dominance, despite experimental ocean warming and CO₂-enrichment. When excluding the predation-vulnerable *G. locusta*, the two predation-resistant gastropods upheld grazing control and maintained seagrass-dominance in ambient conditions. Under warming, however, increased algal growth outstripped their grazing capacity and the system shifted to a macroalgal-dominated state. Consequently, climate change may reduce net efficiency of predation-resistant herbivores, and thereby weaken the insurance effect of biodiversity.

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Decadal changes in wintering north Norwegian macro-zooplankton in relation to climate

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Abstract

There is little empirical evidence that geophysical relationships link atmospheric processes to production and abundance of marine zooplankton. This study reports how inter-annual variation in seasonal abundance of selected zooplankton species vary with temperature and salinity in two fjord basins investigated in February and October from 1983 to 2005. Five replicates were intended on each date, sampled by random vertical net tows from bottom to surface. Temperature and salinity profiled by Nansen casts or ctd was averaged over depth intervals. In both fjords the upper mixed layer and the basin water was colder before 1991-95 than after, both in February and October. The salinity of the upper mixed layer decreased from the first to the last period of years in Saltfjord, but only during October and not in February or either month in Mistfjord. In both months, the bottom water salinity of the Mistfjord basin increased from the first to the last period, which was not notable in the Saltfjord basin. In several cases the average abundance of herbivorous and carnivorous plankton changed from the period before 1991. Several abundances changed with temperature and salinity, which could erroneously be interpreted as general effects of climate on annual marine biological productivity. Taking into account a number of abiotic and biotic factors, only numerically dominant zooplankton species with short generation times and low trophic position, may be expected to signal the extent of climate forcing on annual marine food-web productivity.

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Temporal changes in plankton of the North Sea: community shifts and environmental drivers

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Abstract

This paper analyses long-term and seasonal changes in the North Sea plankton community during the period 1970 to 2007. Based on Continuous Plankton Recorder (CPR) data covering 38 yr, major changes in both phytoplankton and zooplankton abundance and community structure were identified. Regime changes were detected around 1978, 1989 and 1998. The first 2 changes have been discussed in the literature and are defined as a cold episodic event (1978) and a regime shift towards a warm dynamic regime (1989). The effect of these 2 regime changes on plankton indicators was assessed and checked against previous studies. The 1998 change represents a shift in the abundance and seasonal patterns of dinoflagellates and the dominant zooplankton group, the neritic copepods. Furthermore, environmental factors such as air temperature, wind speed and the North Atlantic water inflow were identified as potential drivers of change in seasonal patterns, and the most-likely environmental causes for detected changes were assessed. We suggest that a change in the balance of dissolved nutrients driven by these environmental factors was the cause of the latest change in plankton community structure, which in turn could have affected the North Sea fish community.

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Importance of climate and predation for shifts between sea urchin dominated barren grounds and kelp forest

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Abstract

Kelp forests are recovering in the southern parts of a 2 000 km² area on the Norwegian coast formerly grazed by sea urchins (*Strongylocentrotus droebachiensis*). Density reduction in sea urchin populations may be related to climatic change and field experiments in kelp regrowth areas show low sea urchin settlement coinciding with an increasing trend in temperature. Increasing temperatures may facilitate northern range extensions for potential sea urchin predators. Micropredation on post-settlement juvenile sea urchins has been given little attention in the NE Atlantic but may play an important role regulating sea urchin densities. Due to their small size and susceptibility to predation, juvenile sea urchins have a crevice-dwelling behaviour making it difficult to study predator-prey interaction in natural environments. Through a combination of field- and laboratory experiments potential predators on juvenile and small adult sea urchins were assessed. Relative predation rates were determined on newly recruited sea urchins. Juvenile *Cancer pagurus* was the most efficient predator. Small sea urchins were tethered for 24 hours in their natural habitat to study predator-prey interaction and predation related mortality. Experiments were carried out in both kelp forest and on sea urchin dominated barren grounds. The predation rates were high in all experiments with no significant differences between kelp forests and barren grounds. Effects of increasing temperature and predation on sea urchins will be discussed as possible explanations why kelp recover in south and sea urchins still dominate in northern parts.

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Biological invader counteracts the adverse effects of climate variations in the eastern Gulf of Finland, Baltic Sea

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Abstract

Climate variations have strong impact on the Baltic biological systems. In the eastern Gulf of Finland variations of climate were the main reason of the most significant ecosystem changes during last decades. Immediate causes of these changes were long-term variations in hydrographical conditions, governed by large-scale atmospheric phenomena, particularly the North Atlantic Oscillation. The most important effect of climate oscillations in the eastern Gulf of Finland was periodical deterioration of deep-water oxygen conditions. The hypoxic events led to the mass mortality of benthic organisms and fish resources decrease. Hypoxia resulted in phosphate release from bottom sediments stimulating cyanobacteria blooms and eutrophication. In 2008–2009 radical changes took place in the bottom communities because of large-scale biological invasion hypoxic-tolerant arctic polychaetes *Marenzelleria arctica*. After invasion the negative effects of hypoxia ceased despite of the extremely severe oxygen depletion recorded in 2010. The biomass of macrozoobenthos increased drastically because of mass development of *M. arctica*. These polychaetes dig the bottom deeper than native inhabitants of the Baltic Sea, essentially affecting the exchange processes at the water – bottom interface. The bioturbation and bioirrigation activity of polychaetes resulted in enhancement of nitrogen/phosphorus ratio in water column. As consequence of this, biomass of nitrogen-fixing colonial cyanobacteria declined drastically caused decrease of total phytoplankton biomass and chlorophyll “a” content. Thus biological invasion compensates for negative effects of climate-induced hypoxia. The resultant communities are more viable and stable in changing environment conditions.

Theme 2: The marine environment and responses to climate changes

Presentation: Oral

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Population collapse in the deep-water poriferan *Geodia barretti* in the NE Skagerrak, in response to temperature extremes

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Abstract

Geodia barretti has been a dominating poriferan species at depths below 60 m in fjord environments of the NE Skagerrak. Starting winter and spring of 2006/7, multiple observations were made during ROV-missions of large numbers of dead or dying colonies of *Geodia*. High mortality in *Geodia* was again observed in winters of 2008/9 and 2009/10 respectively. Decline in *Geodia*-populations was quantified at a fixed bottom transect at a cold-water coral reef (Tisler) in the Hvaler area. A bottom transect was established in this area at depths around 120m in 2005, and has been monitored regularly by video and still photography until present. Temperature, salinity and current was recorded continuously at the same depth over the period 2006/11. The transect contained dense populations of *Geodia* in 2005. About 40 % of the population died in the winter of 2006/7. An additional 25 % of the population died in the winter of 2008/9 and 35 % in the winter of 2009/10, resulting in a total mortality rate of approximately 95 % over the observed period. High mortality rates in *Geodia* were preceded by periods of high temperatures (approximately 2 - 3°C above normal, as indicated by available historical records) recorded in the late autumn of respective years. ROV-observations indicated that mortality rates in *Geodia* were highest at depths above 90m and low at depths below 140m. Our observations could be one of the first indications of major ecological effects in deep-water habitats in the Skagerrak as a result of global warming.

Theme 2: The marine environment and responses to climate changes

Presentation: Oral

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Benthic ecological functioning: exploring an eight million year record of aperiodic anoxia

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Abstract

Deoxygenation has profound effects on marine biota and delivery of ecological functions, such as nutrient regeneration, in benthic systems. The global occurrence of hypoxia within marine ecosystems is increasing due to anthropogenic activities such as eutrophication and climatic change. However, hypoxia is not a new phenomena, it has occurred many times in the palaeoenvironmental record and little is known about the response of marine ecosystems to deoxygenation over long timescales and the consequences for ecological functioning. Biological Traits Analysis (BTA) assesses ecosystem functioning using the biological traits expressed by species as an index of function. This approach can explore how benthic communities function, determine and monitor anthropogenic impacts and assess conservation status. BTA has never been applied to palaeocommunity data. Whilst trophic composition has been explored for some intervals of the geologic past community function is not a product of trophic state alone. Although the fossil record is biased, significant information regarding life habit is preserved on organism remains and can be inferred from analogues. This study presents results from BTA of alternations between 26 time averaged fossil assemblages from the Wessex Basin, UK, over a period of 8 million years with fluctuating anoxia during the Kimmeridgian (~148-155 Ma). These assemblages contained gastropods, brachiopods, scaphopods, bryozoans, serpulids, hydroids and crustaceans, but were dominated by bivalves. We report on changes in ecological functioning between anoxic, hypoxic and normoxic periods and consider how increasing anthropogenic hypoxia may alter long-term and large-scale delivery of marine ecological functions and economically valuable ecosystem services.

Theme 2: The marine environment and responses to climate changes

Presentation: Oral

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Climate change and natural boundaries. How climate change affects the distribution of marine species dispersed by human and natural mechanisms

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Abstract

Based on examples from the North Sea and the Norwegian coast, the impact of climate change on the distribution of indigenous and non-indigenous species along the Norwegian coast will be discussed. Temperature is a very important factor impacting on the spatial distribution of the species on earth (and in the marine environment). Especially seasonal extremes, but also average temperature is of importance in regulating a species distribution (Hutchins, 1947). When temperature conditions over decades (=climate) changes at any given habitat, the local biota's autecological and synecological relations will be impacted on a multitude of levels. Seasonal temperature extremes may represent stress to one or several life-stages, and may eventually lead to local displacement of species. The species from neighboring climatic zones may eventually move into the habitat and compete for resources and space. Simultaneously, the preconditions for human-mediated transportation of (alien) species may change in several ways. A change of marine temperature conditions may change both the areas (with matching environmental conditions) from which alien species may be transported, the recipient ecosystem's resilience as well as the transportation routes (e.g. the polar sea routes) from where alien species may be transported.

Theme 2: The marine environment and responses to climate changes

Presentation: Oral

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Seagrass stable sulfur isotopic signals respond to sediment sulfur biogeochemistry

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Abstract

Stable sulfur isotope signals in seagrasses show that all species examined so far incorporate substantial amounts of ^{34}S -depleted sulfides in the tissues (up to 87% of total sulfur). In roots and rhizomes, the signal is stronger, where $\delta^{34}\text{S}$ as low as -15‰ were found in *Zostera marina* roots. Correlations between $\delta^{34}\text{S}$ in leaves, rhizomes and roots confirm that sulfides are entering through the roots and invading the rest of the plant. The total sulfur content of the plants increases as the proportion of sulfides in the plant increase, and accumulation of elemental sulfur inside the plant with $\delta^{34}\text{S}$ similar to the sediment sulfides show elemental sulfur as an important reoxidation product of sulfides. The accumulation can, however, not account for the increase in total sulfur indicating that other sulfur compounds are formed in the plants. Decreasing $\delta^{34}\text{S}$ in several seagrasses coincide with negative plant performance, indicating that sulfide invasion contributes to reduced seagrass performance. $\delta^{34}\text{S}$ signals can be used as an indicator of seagrass health, although further studies are needed to establish isotopic composition of sulfur as a strong indicator.

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Presentation: Oral

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Temporal and spatial dynamics of ephemeral macroalgal communities in eelgrass, *Zostera marina*, beds

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Abstract

In a field study we investigated the temporal dynamics of drift-algal assemblages on both small (1 m²) and larger (2500 m²) spatial scales in two shallow (1-3 m) and relatively sheltered locations in Aarhus Bay and Isefjorden, Denmark. Drift-algal cover was estimated every second day in 40 permanent plots (1 m²) randomly positioned in a 2500 m² study area during three 8-12 days periods of the growth season.

Results show that the algal assemblages were highly dynamic on the small spatial scale as cover within individual plots changed regularly between subsequent observations. The change in algal cover was inversely correlated with the cover of eelgrass, *Zostera marina*, suggesting that algae were retained by the eelgrass leaves.

At the larger spatial scale algal cover was less variable and significant changes occurred just a few times during the study periods. Variability was caused either by algal growth, as indicated by a steady increase in cover, or by physical forces moving large aggregations of algae into or out of the study area leading to significant changes in cover within few days.

Thus, in shallow coastal ecosystems aggregations of ephemeral macroalgae can be highly dynamic, algae are often moved around within a site and large changes in total site cover can occur within days. This may have implications for the interpretation of experimental set-ups investigating effects of algal mats on seagrasses, where the fixed nature of mats may intensify effects on biogeochemical conditions and make prediction of seagrass loss caused by macroalgal blooms difficult.

Abstracts

Oral Sessions

Theme 3:

Management of coastal resources – Marine Protected Areas

Theme 3: Management of coastal resources – Marine Protected Areas

Invited speaker

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Marine protected areas and recruitment in coastal populations: an ecological and evolutionary perspective

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Abstract

There is accumulating evidence for spatial structure and local recruitment in marine species with dispersive life stages, such as the coastal Atlantic cod (*Gadus morhua*). Also, adaptive evolution may occur on contemporary time scales in response to both natural and human-induced selection pressures in the marine environment. Long-term sustainable management of coastal resources is therefore a challenging task, where recruitment may depend on fine-scale ecological and evolutionary processes. Marine protected areas are increasingly being implemented as a management tool in the coastal zone, with anticipated positive ecological effects such as spillover and recruitment benefits to neighboring areas. Here, I will discuss potential challenges and benefits of coastal marine protected areas for recruitment from a combined ecological and evolutionary perspective. I will use the population complex of coastal Atlantic cod in Skagerrak, southern Norway, as an example to illustrate some of these issues.

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Ecotype evolution in *Littorina saxatilis*

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Abstract

To understand how new species are formed we need more knowledge about the evolution of genetically-based reproductive barriers between populations. The periwinkle *Littorina saxatilis* form distinct ecotypes in different habitats on European shores. Snails living in wave-exposed areas are smaller and have a thinner shell, whereas snails in sheltered areas with high densities of predatory crabs typically are larger and more thick-shelled. Breeding experiments show that these ecotype differences are to some extent inherited, but the genes involved are not described. Here we report on two different approaches to investigate the mechanisms behind ecotype formation. First, we used molecular markers and demographic modelling to discriminate between different historical scenarios behind ecotype evolution. Second, we used analyses of gene expression to search for the genes involved. Field-collected snails representing the exposed (E) ecotype and the sheltered “Crab” (S) ecotype from different localities were acclimatized to similar conditions in the lab, and then exposed to either crab smell or used as control. RNA was extracted, converted to cDNA and hybridized against a Nimblegen 12-plex microarray with 26 000 putative genes in *L. saxatilis*. The genes used can be found in the database LSD at <http://mbio-serv2.mbioekol.lu.se/Littorina/>. Preliminary analyses show that a number of genes were differentially expressed in the two ecotypes, but also that many genes are differentially expressed in snails from different localities.

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Implementation of marine reserves in coastal Norway: A co-management approach and preparing for the unknown

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Abstract

Marine zoning, including marine reserves, have attracted much attention as a promising tool for management of biodiversity and ecosystems. However, zoning of coastal marine areas may cause conflict of interests. For example the process towards implementation has been identified as a crucial factor for the future success of a reserve. A co-management approach to establish marine reserves in the municipality of Tvedestrand, Norway, has been tested since 2008. Collaboration between the elected representatives in the municipality and the governmental management and research institutions was established. Public meetings, collaboration with the local newspaper, user surveys to map fishing activities and public hearings were conducted in order to facilitate for involvement and influence by local stakeholders. Meanwhile, biological data has been collected to evaluate suggested reserves and secure before-data. Local stakeholders have taken part in the data collection through catch diaries and reporting recapture of tagged lobsters and cod. The marine reserves are expected to be implemented in 2012. This paper presents the steps taken throughout the public consultation process and discusses the challenges to collect biological data when the sites and potential biological effects are partially unknown.

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Beyond distribution maps and species lists; functional implications of habitats?

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Abstract

Coastal ecosystems suffer from a broad range of human-related activities of which loss and degradation of habitat and biodiversity are some of the most obvious, particularly affecting the functioning of these systems. Commonly monitoring and management is based on static geographical distribution models or species lists. However, there have been few attempts to classify the importance and distribution of habitats based on their functional properties. To address the functional relevance of coastal habitats and their species, we quantitatively combined biological traits of both habitat-forming macrophytes and macrofauna, in five habitats; algal belts, seagrass meadows, drifting algal mats, bare sand and bare mud. We scored species to a set of biological traits associated with species morphology, reproduction, living and dispersal habits and weighted the traits with habitat specific species abundances in order to get the relative importance of traits in the different habitats. By using this method we illustrate functional generalities and specific characteristics of the habitats. Our results show that trait analysis can be applied on the habitat level using the floral and faunal components with useful implications for coastal resource conservation. We also present a conceptual model of the functional role and diversity of the set of coastal habitats, representing open or semi-enclosed bays in the Northern Baltic Sea. This type of functional knowledge is necessary in order to assess impacts and manage resources in rapidly changing coastal ecosystems.

Theme 3: Management of coastal resources – Marine Protected Areas

Invited speaker

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“Genes that matter”: Application of spatiotemporal population genomics for identifying ecological structures and local adaptation in the sea.

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Abstract

For a long time marine species were viewed as being relatively genetically homogenous across their spatial distributions. Thus, differences in ecology and life-history were thought to emerge almost exclusively from environmental differences. More than a decade of genetic studies using high resolution markers such as microsatellites have challenged this conventional wisdom by demonstrating extensive population structuring even at small geographical scales for many marine organisms. However, still the evolutionary and ecological significance of these minute genetic differences have been intensely debated. With the ongoing genomic revolution new tools have become available which allow assessment of variation in “genes that matter”, i.e. the parts of an organism’s genome which is involved in adaptation to the surrounding environment. Here we present and review the evidence of local adaptation in marine organisms using population genomics approached applied at both spatial and temporal scales. We provide a series of recent examples of how population genomic information can and be used in practical management of coastal resources. We discuss how information on genomic based adaptation in space and time needs consideration for the design of Marine Protected Areas and highlight the need for further integration of genetic and ecological research in order to obtain sustainable future management and conservation of marine resources.

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Using high spatial resolution remote sensing to map the distribution of benthic macrophyte species in a coastal brackish water environment

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Abstract

Marine spatial planning decisions are often based on insufficient data on benthic species and habitats as costs of in situ measurements (diving, video, grab sampling) are too high to cover larger areas and there is often a shortage of trained personnel. On the other hand, model simulations show that broad taxonomic groups of benthic algae (e.g. red, green and brown algae) can be mapped using remote sensing methods in optically complex coastal waters. In the present study we mapped the distribution of benthic macroalgae and invertebrates using traditional diving, a remote underwater video device and airborne (CASI) remote sensing in a coastal brackish water habitat of the Baltic Sea. In order to relate remote sensing and traditionally mapped data we used boosted regression trees modelling – a method that is flexible enough to express typical features of biological data, such as nonlinearities and interactions. The models showed that air-borne hyperspectral imagery captured the variability of the majority of keystone macroalgal and some benthic invertebrate species. The addition of publicly available bathymetry and wind data (e.g. indices of coastal slope and exposure to waves) into statistical models improved the explanatory power of models. This indicates that the usage of hyperspectral imagery has a very high value in predicting marine benthic patterns, especially when combined with other predictive environmental variables and modelling technique. Thus, such modelling tool combining strong sides of different methods (e.g. remote sensing and spatial modelling) enables integrated and more efficient management of the studied coastal sea.

Theme 3: Management of coastal resources – Marine Protected Areas

Presentation: Oral

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The effects of protection measures on fish in the Plemmirio's Marine Reserve (Central Mediterranean Sea, Italy): an example of well-enforced reserve

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Abstract

The Plemmirio MPA located on east coast of Sicily was established in 2004. Then, this 2-year study was aimed to investigate the early effects of protection measures on fish assemblages by UVC techniques. Plemmirio reserve was characterized by an high level of enforcement and fish response to protection was very high with a total fish density on average 2.5 times greater inside the reserve. Results showed significant inside/outside differences in the multivariate abundance of fish assemblages, across both sampling years and were also confirmed by significant univariate differences between locations across years for total abundance, species richness and diversity of the fish assemblage: values of these metrics resulted higher inside the reserve than outside. Small fish size and species of low-medium fishing value did not displayed significant inside/outside differences in abundances whereas medium, large size fish and high value species showed abundances significantly higher inside the marine reserve. Protection effects were particularly evident for fish predators of sea urchins and large specimens of high fishing value, most of which were exclusively found inside the reserve. Moreover, the increase in the number and size of predators inside the reserve might have altered the trophic cascades by increasing the pressure on prey since cryptic fish species were rarely recorded inside the reserve and in any case with lower densities than outside. The reserve effect on fish populations was provided after only five years since its establishment; that is an extraordinary result likely due to the high level of enforcement.

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Presentation: Oral

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Lulled into a false sense of power: Pilot sampling must be as representative as possible

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Abstract

The proper evaluation of the effectiveness of marine protected areas involves testing the hypothesis of an effect using appropriate experimental design tools. The gold standard here is to use data from previous research or pilot studies to estimate the replication needed to refute the null hypothesis of no difference whilst holding type II error rates to a minimal level. The establishment of an MPA at Lundy in the UK led to such a test. Here we report how the outcomes of a pilot experiment meant we ended up retaining the null hypothesis of no effect of the MPA on scallop (*Pecten maximus*) populations and discuss whether this is an unfortunate type II error.

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Trophic interactions between Atlantic herring (*Clupea harengus*, L.) and three-spined stickleback (*Gasterosteus aculeatus*, L.) in a shallow coastal lagoon of the Western Baltic Sea

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Abstract

The importance of transitional waters like coastal lagoons and estuaries for reproduction processes is not limited to the resident fish community, but also for typical off shore species entering the shallow systems periodically for spawning. However, trophic interactions between migrating species and the local predators are rarely quantified or even documented. Hypothesising that these interactions might be crucial in a bidirectional manner, we analysed the predation of three-spined sticklebacks on the spawn of Atlantic herring in order to examine 1) the importance of available herring spawn for the resident stickleback population as a food source and 2) the potential impact of spawn predation on the recruitment of Baltic herring. The study area Greifswalder Bodden is a shallow brackish lagoon at the Baltic Sea coast of Germany. It is regarded to be one of the most important spawning areas of Baltic herring. The resident fish community is dominated by the three-spined stickleback throughout the whole year. Between March and May, the spring spawning herring enters into the area in massive waves for spawning. Stomach samples of sticklebacks caught at spawning grounds of herring showed a high proportion of herring eggs compared to the residual content. Combining these findings with data on the overlap of sticklebacks and herring eggs a significant reduction of herring spawn in the field has been proved. Additionally, exclusion experiments with herring spawn in the field and laboratory feeding experiments were performed in order to quantify the stickleback's capability to control Baltic herring recruitment.

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Lobster reserves in coastal Skagerrak: a field laboratory for science and management

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Abstract

Scientific documentation of Marine Protected Areas (MPAs) as a means to conserve species and ecological processes has reached a level where this management tool is considered a critical component in ecosystem based management and successful rebuilding efforts. However, because there are opportunity costs to conservation, there is a continuing need for science based assessment of MPAs whenever this measure is introduced to new areas, species or systems. Experimental lobster reserves were implemented along the Norwegian Skagerrak coastline in 2006 as a collaborative effort between the Norwegian Institute of Marine Research and the Directorate of Fisheries, with support from commercial fishers. The primary aim was to provide a science based evaluation of small-scale effects of protection on local lobster populations, with potential to improve management of this iconic species. In addition to long term monitoring inside MPAs and control areas, launched in 2004 (two years prior to protection), complementary studies were conducted within the framework of three research projects. These incorporated socio-economics, lobster ecology and -demography, and lobster population genetics in MPAs context. Results from this multidisciplinary approach suggested rapid rebound of lobster within MPAs, strong stakeholder support for the MPAs, high site-fidelity and increased survival of protected lobsters, and weakly structured lobster populations along the Skagerrak coast. Here, we highlight some of the most important findings and discuss their implications for lobster management in particular, and more broadly, for introduction of MPAs as a management tool in northern temperate coastal waters.

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Assessing Methods for Restoration of Eelgrass (*Zostera marina*) on the Swedish NW Coast

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Abstract

More than 50% of eelgrass habitats have been lost from the Swedish NW coast in the last 30 years. Restoration of eelgrass is being considered as a mean to help the recovery, but methods for Scandinavian eelgrass are presently lacking. In the present study we assessed two techniques for eelgrass restoration (planting shoots with and without intact sediment) in the Gullmarsfjord area in 2011 to determine suitable methods for large-scale restoration in Sweden. Shoots were cross-transplanted between 4 habitats; sheltered-shallow/deep, exposed-shallow/deep, to assess importance of choosing donor meadows with similar physical conditions as the site of restoration. Adverse effects on donor meadows and labor time were assessed for each method. Overall, harvesting and planting single eelgrass shoots without sediment was 5 times faster, yielded >5 times higher growth rate, and resulted in smaller negative impacts on donor meadows compared to planting with intact sediment. Four months after planting, shoot density had increased on average 277% and 53% for shoots planted without and with sediment, respectively. Growth was similar in exposed and sheltered areas, but significantly higher at 1-1.5 compared to 2.5-3.5 m depth. The origin of transplants had surprisingly small effects on growth. Thus, physical properties of the planting habitat, rather than shoot origin appears to be important for restoration success in these areas. Results indicate that the single shoot method constitutes a relatively efficient restoration method for eelgrass on the Swedish NW coast, with minimal negative effects on donor meadows. Studies will continue in 2012 to assess winter survival.

Abstracts

Oral Sessions

Theme 4: General Marine Biology

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Presentation: Oral

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Habitat heterogeneity determines patterns of diversity in rocky intertidal communities

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Abstract

Environmental heterogeneity provides a diversity of resources underpinning coexistence of competitors and is therefore an important mechanism in the maintenance of biological diversity. Rocky shores support a variety of habitats of different types and degrees of heterogeneity. In addition to the diversity of habitats available, the type and quality of the habitat is an important determinant of local biodiversity. Tide pools are a ubiquitous feature of rocky shores across the world and it is commonly asserted that they are more biologically diverse than emergent rock habitats, but few studies support this paradigm. Furthermore, little is known about the processes determining the structure and functioning of biotic communities in tide pools, particularly in relation to abiotic factors of depth and slope of substratum.

The epibiotic communities of mid-shore tide pools and adjacent emergent rock were sampled at 2 locations in each of Ireland, Wales, England and Norway in 2011. Furthermore, the influence of depth and slope of substratum on epibiotic communities was also investigated in tide pools at both the low- and mid-shore levels at two replicate locations in Wales.

Biodiversity was found to be much greater in tide pools than on emergent rock at all locations. The investigation of how depth and slope influenced community structure revealed results that were generally site-specific. However, in contrast to expectations, shallow habitats tended to support higher diversity than deep habitats. The implications of these findings are discussed.

Theme 4: General Marine Biology

Presentation: Oral

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Alien Pacific oyster (*Crassostrea gigas*, Thunberg) has positive effects on biodiversity in blue mussel beds on the Swedish west coast

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Abstract

Non-native species are often regarded as a threat to native biodiversity and ecosystem functioning, however invaders may also have positive effects on native species, and ecosystems. We have studied the effects of the establishment of the alien Pacific oyster (*Crassostrea gigas*) on species richness, abundance and biomass of associated fauna and flora species by conducting a four month manipulative field experiment in subtidal sediment habitat. Patches (15x15cm) of six different Pacific oyster and blue mussel (*Mytilus edulis*) treatments (Pacific oyster, oyster shell, Fucus/oyster shell, blue mussel, mussel shell and sediment control) were constructed and placed on a bare sediment bottom at approx. 50 cm depth. At the end of the experiment, point sensing observations were conducted and thereafter were sediment samples and whole patch samples collected. The aim of the study was to compare the effects of the alien Pacific oyster on associated species to that of the native blue mussel, as both are ecosystem engineering species that occupy the same habitat. We found significantly higher species richness, abundance and biomass of associated species in the oyster and mussel treatments compared to the sediment control. The species richness was highest in the Fucus/ oyster shell treatment. The study demonstrated that at this low oyster density, Pacific oysters appear to have positive effects on associated fish, invertebrates and macroalga. This is probably due to increased heterogeneity, substrate availability and shelter. We conclude that the effects of non-native species on native species vary with the ecology of the invader, phase of invasion, nature of the invaded ecosystem and shifting ambient conditions.

Theme 4: General Marine Biology

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Changes in the fish populations of the Eastern Scheldt due to changes of the tidal regime

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Abstract

This study will focus on changes in long term and seasonal trends of fish populations in the Eastern Schelde during and after the completion of the stormsurge barrier. Hereby the sytem turned into a more stable marine basin. After the stormsurge in The Netherlands in 1953, a plan was devised to protect the Dutch coast against future storm surges. Most estuaries in the Southwestern part of the Netherlands were closed. The Eastern Schelde was partially closed. The construction of a barrier started in 1976 and completed in 1986. During and after completion of the storm surge barrier major changes in environmental conditions occurred due to alteration of the tidal regime such as reduction of tide, lower current velocities, and stable salinities. Seasonal fish monitoring in the Eastern Schelde was conducted from 1983 to 1990 and resumed from 1999 to 2001. Twelve stations were sampled along a 40 km transect from west (mouth of the former estuary, where the barrier was build) to east. Clear seasonal differences in densities, biomass and diversity of fish species were observed. Higher values were observed during the summer period, lower in winter or spring. Flatfish were found more near the mouth of the estuary, gobies more inland. During later years, after completion of the stormsurge barrier, in general densities changed. For flatfish densities decreased, for gobies increased. For flatfish densities of juveniles decreased more than adults. In our presentation we will discuss the observed seasonal and long-term changes in composition of the fish population in relation to environmental changes and function of the basin as nursery area.

Theme 4: General Marine Biology

Presentation: Oral

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Experimental test of *Zostera marina* - *Labyrinthula zosterae* infection dynamics

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Abstract

The largest worldwide losses of eelgrass (*Zostera marina*) in the past have been caused by infection with the protist *Labyrinthula zosterae* (Eelgrass Wasting Disease). Today, *L. zosterae* prevails in Baltic and Wadden Sea eelgrass beds causing the typical lesions and is detectable by specific ITS-primers. Nevertheless no large scale die-off events clearly associated with *L. zosterae* infection can be observed in the study region. In a series of infection experiment in a mesocosm facility, we tried to disentangle the impact of *L. zosterae* and *Z. marina* origin, of earlier exposure to infection, and of heat stress on infection and development of disease symptoms. In all experiments, *Z. zosterae* plants raised from seeds quickly developed lesions on the infected leaves, but infection was only minor in leaves formed post infection, showing that the plant can effectively control infection under good environmental conditions. Moreover, plants with infection experience were infected at a lower rate than naive plants. Results from a third experiment that will test impact of a heat wave on host-pathogen interaction, will be presented.

Theme 4: General Marine Biology

Presentation: Oral

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Estuarine resident fishes as indicators of environmental changes: the case of *Pomatoschistus microps* and *Pomatoschistus minutus* in a southern-Europe temperate estuary

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Abstract

A long-term survey was conducted between June 2003 and June 2011 to assess the effects of extreme climatic events in the abundance and growth of two estuarine resident fish species in the Mondego estuary (Portugal). The observed species were the common goby (*Pomatoschistus microps*) and the sand goby (*Pomatoschistus minutus*) that are among the most abundant estuarine resident species in the Mondego estuary. During the study period, considerable changes occurred in precipitation regimes, causing a consecutive series of drought and heavy rainy periods. During the dry years, both species occurred with lower abundance, while in rainy periods *P. minutus* increased in abundance. Cohort analysis was performed in order to estimate the recruitment and growth rate of the species and to evaluate the effects of the different environmental conditions in the juvenile and adult individuals. For both species, temperature and freshwater runoff were the most determinant factors in the distribution. Individuals of *P. minutus* grew faster than *P. microps*, with the highest rates observed during the extreme drought period. The production of the two species was also highly affected by temperature, as *P. microps* production was higher at lower temperatures. Besides temperature, freshwater flow had also considerable influence in the production of the two species. Our results show that estuarine resident species are important indicators of environmental changes, related to global climate change.

Theme 4: General Marine Biology

Presentation: Oral

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Growth, filtration and respiration in Blue mussels from different salinity regimes

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Abstract

Due to decade-long nutrient loading to Danish coastal systems and the implementation of the Water Framework Directive (WFD), new efforts and actions have to be taken, to reduce the impact of eutrophication and to improve good ecological status. As one counteracting measure and mitigation tool, nutrient extraction by blue mussel farming on long lines is suggested and tested in different projects all over the Baltic rim. Placing production units in estuaries provides the opportunity to extract nutrient nearest to their source, at highest concentrations. The conditions in Danish fjords bring along a number of challenges for Blue mussels (*Mytilus edulis*). Low salinity may have several effects, as reduced growth, filtration and thereby reduced nutrient extraction efficiency. The presentation will refer to latest results from lab and field experiments conducted within the framework of the MuMiHus-project (Production of mussels - Mitigation and Feed for Husbandry). An experiment was conducted to measure individual mussel growth - in relation to salinity and food conditions. Native blue mussels were exposed in situ, at 6 different locations with salinities from 7 up to 30 PSU. Growth rates and respiration rates were measured to test the effect of salinity and the cost of osmoregulation, in relation to oxygen consumption. The results are discussed in terms of developing nutrient extraction platforms as mussel farms in low saline estuaries.

Theme 4: General Marine Biology

Presentation: Oral

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The invasive and pest pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) in an area of the eastern Mediterranean

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Abstract

In this study, the ecological and societal impact of the non-indigenous invasive and pest pufferfish *Lagocephalus sceleratus* in coastal habitats of an area of the eastern Mediterranean Sea was investigated. Seasonal quantitative samplings in two common coastal habitats were used to investigate habitat use of different life-stages. Sandy areas were found to be highly important for the early life stages of *L. sceleratus*. In contrast, *Posidonia oceanica* habitats were mainly preferred by larger (> 29 cm) reproductive adults, not exceeding the size of 64 cm. *Lagocephalus sceleratus* was found to be an invertebrate and fish feeder while size classification revealed a tendency for an ontogenetic diet shift with increased size. Diet shift was most probably attributed to shift in habitat use with increased size. During early life stages, *L. sceleratus* inhabits sandy bottoms where it feeds on various invertebrates and mollusca, among which species of the genus *Nassarius* and the family *Dentaliidae* were present. The predominant molluscan species found in the diet of larger (> 20 cm) *L. sceleratus* individuals were the economically important *Sepia officinalis* and *Octopus vulgaris*. The impact of *L. sceleratus* on local stocks of these species is discussed. Societal impacts were alarming due to increased public attention concerning its lethal effects and the presence of tetrodotoxin. The condition of *L. sceleratus* did not show any significant seasonal variations. Together with its high abundances found in the coastal fish communities of the studied area, combined ecological and social effects clearly classify *L. sceleratus* a pest.

Invited speaker

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Deoxygenation and Acidification of Continental Margins: Oxygen Minimum Zones on the move.

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Abstract

The ocean's deep continental margins exhibit incredibly high biodiversity, and some of the strongest environmental gradients and most extreme conditions on earth. Temperature, oxygen and even pH can decline rapidly over short depth increments and distances and can naturally reach extremely low values. Animal morphologies, behaviors, distributions and diversity patterns reflect these gradients.

In recent decades, increased CO₂ in the atmosphere has initiated a series of cascading effects in the ocean that include warmer waters, enhanced stratification and reduced ventilation of those waters, elevated CO₂ concentrations (which translates to lowered pH) and reduced carbonate saturation states which can inhibit biological calcification. Collectively these climate-change effects are referred to as global warming, deoxygenation and ocean acidification. Their effects are transforming the margin seascape at a rapid rate, and challenge the ability of the deep ocean to perform the ecological functions and provide the habitat, trophic support and climate regulation services required for a healthy planet.

As a result of global change, naturally occurring low oxygen, low pH zones called oxygen minimum zones are expanding, particularly in the tropical ocean and in upwelling areas of the world ocean. Species diversity is reduced in oxygen minimum zones and soft-bodied taxa are favored. A new synthesis suggests that low oxygen, especially in warmer waters, rather than low pH, is responsible for most of the diversity reduction in the benthos of these zones. Sessile species and attached life stages such as benthic egg capsules may experience hypercapnic hypoxia and must adapt or perish. As oxygen minimum zones move into shallower waters the vertical distributions of mobile fish and plankton species are shifted upward. At the same time a warmer more acidic surface waters are creating less suitable habitat above. Thus the appropriate habitat is compressed changing their interactions with other species and making them easier targets for fishermen.

At the same time there is increasing direct human contact with deep-sea settings, in the form of fishing, energy extraction, dumping, and soon, mining. The overprint of stress from climate change (lower oxygen, lower pH, elevated T) is likely to increase ecosystem vulnerability, threaten biodiversity and limit resilience (ie potential to recover from human disturbance). These challenges demand a global commitment to improved stewardship of deep-ocean ecosystems and resources. Use of marine spatial planning and ecosystem-based management, greater public awareness of the issues, global capacity building and multidisciplinary approaches are needed to maintain the integrity of deep-ocean ecosystems.

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Presentation: Oral

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Impact of deep-water fish farms on the biogeochemistry in underlying sediments

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Abstract

During the past decades fish farms have been moved to deeper and more exposed sites in order to improve farming conditions. This is probably also accompanied by positive environmental side-effects such as increased dispersion of particulate waste and mitigated benthic impacts. However, until now only few studies have investigated the benthic impact of intensive fish farms located at deep water. In this study we investigated the impact of two deep water fish farms (>200 m water depth) on the biogeochemical cycling in the underlying sediments. We found that two farms with similar production (and hence similar production of waste products) had very different environmental impacts that depended primarily on the hydrodynamic conditions at the farming location. The fish farm located at the most sheltered location had a dramatic effect of the biogeochemistry in the underlying sediments, as evidenced by stimulated O₂ consumption, accumulation of toxic hydrogen sulfide and eventually severely hampered C- and N-mineralization. The fish farm located at the exposed location, however, only had a relatively modest impact on sediment biogeochemical cycling, which was within acceptable limits. This study shows that deep water fish farms may have the same dramatic impact on the biogeochemistry in underlying sediments as observed for shallow water fish farms, especially if the fish farm is located at a sheltered location.

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The quantification and in-situ observations of biogenic structures in intertidal sediments by time-lapse sediment profile imagery(tSPI)

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Abstract

Direct observation of infaunal activity is of great utility in investigating the relationship between biodiversity and ecosystem function. Animal sediment relations at two stations in an intertidal mudflat were observed using time-lapse photography incorporating a novel sediment profile imaging camera. The dominant fauna observed were Nereid and Arenicoloid polychaetes, Corophium volutator shrimps and nematode worms. Burrow formation, abandonment and destruction rates were quantified. Both circadian (tidal) and predator-prey interactions were observed between the visible macrofauna. The dominant bioturbation type at the sediment water interface changed rapidly, indicating that ecosystem function is highly dependent on biodiversity on small timescales. There was a lack of circadian influence on biogenic activity which may be due to water retention by muddy fine sediments in mudflats. The observations of the interactions between large polychaetes and smaller more abundant nematodes suggests that the relationship between these two groups of organisms is complex and depends on what type of polychaete is present. The use of time-lapse sediment profile imagery allows researchers to investigate these interactions in a rapid, non-destructive manner facilitating a greater understanding of biodiversity ecosystem function relationship in intertidal mudflats.

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Changes in benthic-pelagic coupling by changing predation on meroplanktonic larvae in the Wadden Sea

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Abstract

Little is known about the influence of predation in the pelagic life stage on population dynamics of benthic organisms such as bivalves and fish. We examined changes in Wadden Sea meroplankton predator phenology, seasonal patterns and species composition and relate these to seasonal patterns in spawning and larval presence of bivalve and flatfish species. Over the past decades the phenology and species composition of the zooplanktivorous predator guild changed; scyphozoa such as the moon jellyfish *Aurelia aurita* are now occurring much earlier in the season, but absolute abundances have decreased. The same changes are also observed to a lesser extent in the native ctenophore *Pleurobrachia pileus*. In recent years the invasive ctenophore *Mnemiopsis leidyi* has been the most abundant zooplanktivorous predator. Its seasonal pattern however is different from that of *A. aurita* and *P. pileus*. The latter are most abundant in late spring and early summer while *M. leidyi* is most abundant in late summer and autumn, although on one occasion a spring bloom has been observed. As a result, the period of highest predation pressure in the pelagic Wadden Sea has shifted from the first half to the second half of the year, when different prey species are affected. Prey preference of the different zooplanktivores will also lead to changes in predation pressure.

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Thin terrestrial sediment deposits on intertidal sandflats: effects on bivalve burial behavior and pore water chemistry

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Abstract

Sea level rise and coastal urbanization increase the supply of terrestrial sediment to coastal and estuarine waters. This increase affects the function of soft sediment ecosystems; the underlying mechanisms, however, are not well known. We conducted a laboratory flume experiment to investigate how millimeter scale deposits of terrestrial clay affect the burial behavior of benthic juvenile recruits. This experiment built on evidence for a link between the biogeochemistry of the deposit-underlying sediment and the behavior of recruits on the surface of the deposit. First, we describe how pore water profiles of pH, redox potential, and oxygen concentration change after deposition of terrestrial clay onto natural intact intertidal sediment and intertidal sediment depleted of organic matter. Second, we compare the burial behavior of post-settlement juvenile *Macomona liliana* placed onto the surfaces of these sediments and the surfaces of terrestrial clay deposits over these sediments. We predicted that juveniles would not bury into clay-covered intertidal sediment. They would, however, bury into clay-covered intertidal sediment if this sediment was depleted of organic matter.

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Biomass and productivity of epiphytic algae on kelp *Laminaria hyperborea*

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Abstract

Laminaria hyperborea is the most common and abundant kelp species in the sub-littoral zone along the west coast of Norway. These populations are characterized by a high density of individuals and high productivity. A large number of epiphytic alga species uses the stipe of *L. hyperborea* as a substrate. The amount of epiphytes can be substantial and are typically made up by fast-growing species. The potential epiphytic production may therefore be substantial and contribute significantly to total primary production in these ecosystems. Epiphytes were abundant on the stipe of older plants (>4 years). The epiphytic assemblages were mainly made up by 8-10 species, but neither the biomass per stipe, or species composition changed significantly with season. The kelp canopy intercepted most of the incident light. Only 2-5% of the surface light penetrated through the canopy and less than 1% reached the bottom. Epiphytic algae below the canopy did therefore suffer from immense shading. Photosynthesis of the epiphytes increased with increasing light levels and the P-I relations could be described by mathematical models. The P-I relations did not vary significantly across sites and seasons. The areal production of the epiphytes was correlated to total insolation and varied therefore across season. The annual production was very low, ranging from 15 to 115 g DW m⁻² y⁻¹. The low productivity is likely caused by the poor light conditions below the canopy and we conclude that the production of these epiphytes does not contribute significantly to the total primary production in *L. hyperborea* forests.

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Changes in benthic fauna after the invasion of the alien red king crab (*Paralithodes camtschaticus*) in a north Norwegian fjord

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Abstract

The red king crab (*Paralithodes camtschaticus*) was introduced from the northern Pacific to the Russian Murman coast during the 1960s and 1970s. The crab invaded NE Norwegian coastal waters in the early 1990s and became particularly abundant in the Varanger fjord area close to the Russian border. The crab is an active predator on benthic fauna especially feeding in soft-bottom environments. Recent studies have shown that soft-bottom epifauna and infauna have become markedly reduced in crab-invaded areas. We here present results for quantitative soft bottom macrofauna in the Varanger area sampled in 1994 just before the crab became abundant and revisited in 2008. The sampling included a station transect (10-90 m depth) in the inner part of the fjord which was originally established in need of reference data for environmental impact assessments. The results indicate that echinoderms, non-moving burrowing and tube-dwelling polychaetes, and larger bivalves had been reduced, whereas some small-sized polychaetes and small bivalves had increased. The species changes have been compared with data from a simultaneously established (1994) and revisited (2008) station transect (10-90 m) in another north Norwegian fjord which has not yet been invaded by the crab. Further, recent studies have indicated that crab predation affects ecosystem functioning as organisms performing important functions such as bio-irrigation and sediment reworking are removed. The present results have been assessed with regard to ecosystem functioning and compared to effects reported from deeper parts of the Varanger fjord area.

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The effect of prey aggregation on predation rates: Juvenile shore crabs (*Carcinus maenas*) foraging on post-larval cockles (*Cerastoderma edule*)

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Abstract

Many soft sediment invertebrates show highly patchy distributions within populations across small (centimetres – 10s metres) and large (10s – 100s kilometres) scales, despite relative large scale homogeneity in the physical environment. The common European cockle *Cerastoderma edule* one such species. Predation during the post-larval period of *C. edule* is important in determining recruitment success and potentially the spatial distribution. We investigated if aggregation (being 'patchy') of *C. edule* post-larvae increases survival against predation from juvenile shore crabs *Carcinus maenas* compared to a uniformly dispersed distribution. We hypothesised this will be caused by interference competition between *C. maenas*. Aquarium based experiments were conducted testing two factors of prey arrangement (aggregated and dispersed) and predator number (one and 5 crabs), and their interaction in controlling prey mortality and predator behaviour. Prey mortality was higher by 30 – 40 % for both predator treatments when foraging on aggregated prey, there was no interaction between factors. Lone crabs spent 30 % longer searching when prey was dispersed, indicating that prey encounter rates limit foraging efficiency. When multiple crabs foraged together a similar amount of time was spent searching and in interference competition (average of 8.5 % of the total time) for both prey arrangements, other behaviours did not explain the difference in prey mortality. We demonstrate that juvenile *C. maenas* are able to maintain a higher foraging efficiency on aggregated prey despite interference competition, contrary to our original hypothesis. Therefore the migratory behaviour of *C. edule* post-larvae that create or maintain such distributions could be significant for post-settlement survival.

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Jellyfish trends at Flødevigen Research Station, Norwegian Skagerrak coast, from 1993 to 2011

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Abstract

Potential global increase in jellyfish abundances has received considerable attention in recent years. Still, long time series documenting actual changes in jellyfish numbers remain scarce. We have analyzed a semi-quantitative jellyfish time series from 1993 to 2011 from Flødevigen Research Station on the Norwegian Skagerrak coast. The time series consists of daily to thrice weekly surface observations of the most common scyphozoan jellyfish of the region, *Aurelia aurita* and *Cyanea spp.*. These data have been examined in conjunction with time series on temperature, salinity, zooplankton abundance and chlorophyll a. The most striking result is a clear decline in *A. aurita* abundance during the study period. The *A. aurelia* abundance also exhibited 5-year cyclicity. No trend could be seen in *Cyanea spp.* abundance, which also fluctuated more randomly. Our results illustrate the importance of considering differences between regions and species when discussing trends in jellyfish abundances.

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The effect of wave and current exposure on kelp (*Laminaria hyperborea*) structure and associated algae and fauna communities

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Abstract

The *Laminaria hyperborea* kelp forests cover large areas along the Norwegian coast, are highly productive and have a high diversity. How wave and tidal current exposure interact and affect both kelp and associated algae and fauna communities have so far not been studied. Our data were collected at Møre on the West coast of Norway, an area with large, dense and healthy kelp forests and a wide range of exposure levels. Kelp plant size and weight increased with wave and current exposure, mainly due to increasing stipe size (length and thickness) and holdfast size. Results also indicate that exposure are beneficial up to a certain intensity, after which the plant growth levels off. The total biomass of epiphytic algae on the stipe increased with wave exposure. The proportion of functional groups for epiphytic algae (classified as smooth, leaflike, rough and bushy) also varied with wave exposure (but not with tidal current). The fauna community associated with the epiphytes seemed to be more influenced by the size of the habitat (i.e. the epiphytic algae), and only indirectly affected by exposure through the effect on the epiphytic algae. These results imply that variation in wave and current exposure levels is of principal importance to the kelp and its associated community of algae and fauna and thereby to the structure and function of kelp forests. These results provide new and more detailed knowledge of high importance to management and planning, conservation of marine biodiversity and harvesting strategies for kelp.

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Combining biological and environmental variability with carbon and nitrogen stable isotope analysis for the study of marine species' trophic ecology: the case of European sardine *Sardina pilchardus* and anchovy *Engraulis encrasicolus* in the Bay of Biscay

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Abstract

The study of species' trophic ecology is a critical aspect for the comprehension of their role in marine food webs or of the recruitment drivers. Stable isotopes analysis (SIA) of carbon and nitrogen in consumers' tissues may constitute reliable indicators of their trophic position and/or their feeding zone. However in open marine ecosystems such as the Bay of Biscay (North-East Atlantic), a high biological diversity as well as oceanic and terrigenous influences may lead to an important heterogeneity in isotopic values, constraining the use of these markers. In light of this heterogeneity, this study aims to highlight the trophic links between mesozooplankton and adults of two pelagic fish of ecological and economical significance in the area through SIA, the European sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*). $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of identified mesozooplanktonic organisms and individuals of sardines and anchovies were analysed. Isotopic values of more than 90 species including fish, cephalopods and other invertebrate species are also reported for comparison. The results demonstrated significant spatial variations of isotopic signatures within all taxa and trophic levels considered. They also revealed the necessity to take into account this heterogeneity for a reliable use of isotopic markers in further study of trophic relationships. To investigate foraging areas and potential diets overlapping of sardine and anchovy, mixing models were finally applied. Anchovy showed a greater trophic plasticity by foraging likely offshore and on a wider range of mesozooplanktonic prey, while sardine seems limited to neritic waters and associated mesozooplankton species for feeding.

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Feeding ecology of Sprat (*Sprattus sprattus*) in Hardangerfjord, Norway

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Abstract

Sprat (*Sprattus sprattus*) is a small-bodied pelagic schooling zooplanktivorous fish, which plays a major role in the fjord ecosystems of western Norway, both as an important food resource for higher, piscivorous trophic levels and as a significant predator on the zooplankton community. This study presents seasonal and spatial variations in feeding activity, diet composition and length weight relationships in sprat in the Hardangerfjord. Four cruises were performed in spring and autumn in 2009 and 2010. Sprat fed on a high variety of prey, dominated by invertebrate eggs, copepods and phytoplankton. The most frequently occurring prey was the planktonic harpacticoid copepod *Microsetella norvegica* which may have an important role in the pelagic food web in the fjord, especially late in the season. The mean fish size decreased towards the fjord head, reflecting the variation in zooplankton composition within the fjord. The mean fish size was smaller in 2010 than in 2009, demonstrating large inter-annual variations in prey availability and growth conditions. Despite a strong decrease in zooplankton biomass towards the fjord mouth, high abundances of sprat were recorded in the inner fjord branches, indicating that the distribution of sprat is affected by other factors than food availability alone, as for instance the physical environment and circulation patterns. The observed variations in distribution, diet and condition of sprat are discussed in relation to within-fjord variations in zooplankton composition, hydrography and predation risk.

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The role of hydrodynamics and herbivory in ameliorating the effects of nutrient enrichment in marine ecosystems

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Abstract

Eutrophication is one of the most serious impacts on coastal ecosystems worldwide. It causes a startlingly high loss of seagrass habitats. Among factors influencing ecosystem susceptibility to nutrient enrichment, is the diversity and abundance of herbivores. Recent results draw a contradictory picture about the role of these grazer communities in different seagrass ecosystems. Based on field experiments and laboratory wave tank studies, our research examined the role of hydrodynamics (bottom-up) and grazers (top-down) in controlling responses to eutrophication in seagrass ecosystems. Results showed that epiphytic biomass increase strongly with nutrient enrichment, but grazer partially controlled growth of epiphytic algae on seagrass leaves and ameliorated negative effects of eutrophication. Hydrodynamic conditions and seasonal effects modified the outcomes between the increase in epiphytic biomass and the control through mesograzer. During autumn we did not observe any strong effects, neither of the nutrient enrichment nor of the top-down control. In contrast during summer, nutrient enrichment led to a strong increase in epiphytic biomass in treatments without grazers. Also hydrodynamic effects took place during summer, where exposed sites showed a much lower epiphytic biomass than sheltered sites. Our wave tank experiments showed two different pathways how hydrodynamic forces will modify the outcome between grazer-plant interactions. The results are a novelty in science and will give an important understanding how hydrodynamic forces will modify seagrass ecosystem structure and function.

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Biodiversity and disease risk: How marine communities reduce parasite infection levels

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Abstract

The links between marine biodiversity and ecosystem functioning have received much interest. Recent research has revealed yet another effect of biodiversity: marine communities and biodiversity can influence pathogen dynamics via effects on transmission pathways. For example, macrobenthic fauna such as suspension feeders and predators can interfere with free-living infective stages of pathogens, preventing them from infecting their target hosts. Such interference can thus reduce disease risk for the host, through this so-called 'dilution effect'. However, whilst it is known that an increase in biodiversity can reduce infection levels, little is known regarding the specific mechanisms causing the reduction. This presentation reports on experimental research to unravel and understand the effects of density, diversity, species traits and diluter size on pathogen reduction using digenean trematode as a model system.

Theme 4: General Marine Biology

Presentation: Oral

47th European Marine Biology Symposium
Arendal, Norway
3 – 7 September 2012

Connectivity: Different spawning strategies may shape population structure

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Abstract

Dispersal of pelagic offspring is one of the most important connectivity mechanisms shaping population structure. Retention of offspring may create a small scaled population structure while long distance dispersal may indicate a larger population complex consisting of local spawning grounds interconnected as a metapopulation. In this paper we investigate the dispersal and retention of cod eggs in spawning grounds along three sections of the norwegian coast: Hordaland, Nordland south and Nordland North-Troms. Differences in dispersal may indicate different life history strategies of partly overlapping populations.

Theme 4: General Marine Biology

Presentation: Oral

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Deep-water sponge grounds on the northern Norwegian continental shelf: community composition and the functional role of *Geodia barretti*

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Abstract

Sponge grounds within the 300 km² Trænadypet MPA were mapped using photographic techniques. Three types of sponge communities were identified. The eastern side of the central circular depression was dominated by fan-shaped *Phakellia* spp. sponges and further characterized by *Mycale* spp. and *Oceanapia* spp. sponges. *Phakellia* density was positively correlated to the number of drop stones found. The western side of the depression was dominated by *Geodia barretti*, *G. macandrewii* and *G. atlantica* with 2.4 kg WW/m². A third type of sponge community was found on sites with high coral cover on both sides of the depression. It was characterized by *Mycale* spp. and *Oceanapia* spp. and had a higher within site variability in species composition than the other sponge grounds, due to greater variability of substrates. Average *Geodiidea* biomass was high (1.6 kg WW/m²). The two last communities resembled 'ostur' sponge grounds (Klitgaard and Tendal 2004) and could be continuous along 2 km transects. Average biomass of *Geodiidea* sponges across the MPA was 1.8 kg WW/m² with total sponge density of 1 ind./m². Water processing and respiration of the dominant *Geodia barretti* were measured, equating to 3000 l/kg DW/day and 1.5 µmol O₂/g DW/h. Up-scaling this to the Trænadypet MPA as a whole (using a conversion factor of 0.75 from oxygen to carbon (Hatcher 1989) suggests that *G. barretti* alone could consume approximately 15 tonnes of carbon and filter approximately 144 million m³ of water daily. This exercise emphasises the functional role of sponges as carbon vectors on the shelf.

Theme 4: General Marine Biology

Presentation: Oral

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The Baltic Sea salinity gradient as a driving factor for diversity of encrusting organisms

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Abstract

The Baltic Sea is one of the largest basins that presents a very high salinity gradient ranging from 0.5 to 30 from Gulf of Bothnia to Danish Sounds respectively. This environmental conditions result in variability in biodiversity and abundance, which strongly depend on biotic and abiotic factors. This study determines predominately the species richness and ecological characteristic of encrusting organisms of the Baltic Sea rocky shores from Skagerrak to Gulf of Bothnia. Rock samples were collected from 13 locations within five salinity classes (0.5-3, 3-5, 5-10, 10-18 and 18-30). A total number of 66 encrusting taxa among 184 of all taxa found in the samples were considered separately in terms of total species richness and abundance at different locations. High alpha diversity of encrusting species was followed by high number of species associated with hard bottom environment. However total abundance among all and only encrusting species did not show significant differences. Encrusting species diversity followed the salinity gradient increasing toward more saline environment. Biogeographic distribution of species reflects salinity conditions. Species turnover was observed in the transition zone at salinity ranges from 10 to 18 ($S=16.73$). This zone was represented by only one location and was characterized by the highest total abundance but low community complexity ($H' \log_e \sim 1$) being a result of medium species richness.

Finale lecture

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Challenges for the Marine Environment for the next decade

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Abstract

In this lecture I will review what has been the ecological effects for climate variation in the past and present, and use this as a basis for speculating what might happen in the future under climate change and increased need for food to feed the ever-growing human population. As part of the presentation I will also review the effect of selective harvesting, and use this in my considerations of what the condition in the marine environment might be in the future. Although most of the presentation will focus on biological issues, I will close with some bio-economic considerations.

Poster Session

Theme 1: Ecological effects of aquaculture and fisheries

Theme 1: Coastal habitats and ecosystem services

Presentation: Poster

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Predicting the distribution of acid volatile sulfides from sediment profile images

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Abstract

The sediment content of acid volatile sulfides (AVS) is an important determinant of coastal soft-sediment ecosystem functioning. The measurement of AVS, however, is laborious and therefore rarely considered in routine coastal monitoring. Here, we describe an approach to rapidly measure the in situ distribution of AVS in subtidal soft sediment. Using amperometric H₂S microelectrodes and a flatbed scanner in the laboratory, we first established a strong correlation ($R^2 = 0.95$) between the AVS content and the color intensity of sediment collected at 12 m water depth off the eastern coast of New Zealand. We then used this correlation to map the distribution of AVS in the upper 20 cm of this sediment from sediment profile images. These images were obtained in situ with a novel, simple, lightweight imaging device consisting of a modified flatbed scanner housed inside a watertight acrylic tube (SPI-Scan™, Benthic Science Ltd.). We made two types of predictions from the acquired images: First, we obtained a vertical AVS concentration profile by averaging the color intensities of horizontally aligned pixels. Second, we created a two-dimensional distribution plot of AVS concentration by mapping individual pixel color intensities. Because our technique enables rapid and cost-effective assessments of temporal and spatial variations in the distribution of AVS we suggest using it in routine monitoring of subtidal soft sediment.

Theme 1: Coastal habitats and ecosystem services

Presentation: Poster

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Historical changes in macroalgal communities in Hardangerfjorden (Norway)

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Abstract

Hardangerfjorden is the second largest fjord in Norway and is situated on the southwest coast. During the last century the fjord has been influenced by a variety of antropogenous activities such as industry, hydro electrical power plants and since 1980 also an increasing fin fish farming. This study was carried out in order to investigate if changes in the macroalgal communities of Hardangerfjorden have taken place since the 1950s. The macroalgal composition at a number of stations investigated in 2008-2009 was compared to recordings from the same stations during the 1950s. While the distribution and abundance of dominant groups (furoids, kelps) showed a high resilience when compared to recordings from the 1950s, some changes in the macroalgal communities in the fjord were evident. The present study showed higher species richness and a higher frequency of species with a warm water affinity. Since the first part of 1990s an increase in SST summer temperatures has taken place in the area, and the observed algal changes suggest a pronounced temperature effect on macroalgal communities. A number of red algal species was observed to protrude further into the fjord in the present study than in the 1950s.

Theme 1: Coastal habitats and ecosystem services

Presentation: Poster

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Sea trout (*Salmo trutta*) populations in the Hardangerfjord strongly reduced by salmon lice, *Lepeophtheirus salmonis*

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Abstract

The Hardangerfjord basin is one of the areas with highest density of salmon farms in Norway. Infection levels of salmon lice in wild anadromous fish, particularly sea trout, has been serious for a number of years. Return rates of sea trout have been exceptionally low for a number of years. In order to investigate potential population effects of salmon lice on sea trout, smolt from river Guddalselva and returning sea trout were counted over a number of years. Return rates were related to observed infection pressure in the fjord, with the highest return rates corresponding to years with the lowest infection pressure. Smolt groups treated with Substance EX in 2004 and 2005 had significantly higher return rates compared to untreated controls.

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Presentation: Poster

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Three decades of farmed escapees in the wild: a spatio-temporal analysis of Atlantic salmon population genetic structure throughout Norway

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Abstract

Each year, hundreds of thousands of domesticated farmed Atlantic salmon escape into the wild. In order to study the potential genetic impact that this has had on wild populations, we conducted a spatio-temporal analysis of 3049 fish that had been sampled in the period 1970-2010, and from 21 populations covering all of Norway. Based upon the analysis of 22 microsatellite markers, individual admixture, pair-wise F_{ST} and increased allelic richness revealed temporal genetic changes in six (29%) of the populations. These changes were highly significant in four of them. For example, 76% and 100% of the fish comprising the contemporary samples for Vosso and Opo were excluded from their respective historical baseline samples at $P = 0.001$. In the remaining 15 populations, some of which had also been exposed to high numbers of escapees, clear genetic changes were not detected. Significant population genetic structuring was observed among the 21 populations in the historical (global $F_{ST} = 0.038$) and contemporary data sets (global $F_{ST} = 0.030$), although significantly reduced with time ($P = 0.008$). This reduction was especially distinct when looking at the six populations displaying temporal changes (global F_{ST} dropped from 0.058 to 0.039, $P = 0.006$). We draw two main conclusions: 1. The majority of the historical population genetic structure throughout Norway still appears to be retained, suggesting low general success of farmed escapees in the wild; 2. Genetic introgression of escapees has been strongly population-dependent, which is potentially linked to the native population's density.

Theme 1: Coastal habitats and ecosystem services

Presentation: Poster

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GOING DEEP INTO THE FISH FARM SEDIMENT

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Abstract

Italy is the fourth largest European seabass and gilthead seabream producer in both Europe and among GFCM-FAO countries (FAO, 2010). Sustainable way to conduct productive activities is the relevant issue of modern aquaculture, also because it depends on good environmental and water quality conditions. To perform monitoring surveys on marine fish farms the best chemical indicators had to be developed in terms of efficiency, cost effectiveness, robustness, feasibility, accuracy and precision. The present study aims to present results of a fish farm sediment chemical study, considering both the first superficial and 12 cm layers to better understand the geochemical changes and to get information about the best chemical indicators in evaluating sediment organic enrichment. Study was carried out, in the framework of the European project ECASA, in the Adriatic Sea (Western Mediterranean) at a fish farm producing European seabass *Dicentrarchus labrax* (L), and gilthead seabream *Sparus aurata* (L). Sediment sampling was carried out in three stations, one beneath cages, one 25 m away and a control station, by both grab and coring methods. For each coring sample, 12 different sediment layers, from 0 to 12 cm, were analysed by means of ten different chemical indicators. Results confirmed changes in the chemical indicators among the different layers and confirmed TOC and Eh as relevant fish farming impact indicators in general, while labile OM gave the best results in the coring methods. Labile OM could be considered in fish farming monitoring as a relevant and cost-effective chemical indicator.

Theme 1: Coastal habitats and ecosystem services

Presentation: Poster

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Changes in fish communities of the Hardangerfjord, Western Norway, in a 50 year perspective – the result of human activities?

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Abstract

Fish communities have changed in many regions of the North Atlantic during the last decades. There are many factors that may have lead to these changes including environmental alterations and human impacts. To investigate long-term changes in demersal fish communities of the Hardangerfjord, Western Norway, an experimental longline survey conducted in the 1950s was repeated from 2009 to 2011 using comparable methods. The list of species was supplemented with underwater video recordings. Additionally, the catches of commercial fishermen and angling tourists were analyzed. To study potential pollution of the fjord system, the mercury concentrations in the filet of two deepwater species (Lotidae) caught during the longline study were measured. The results of this study show a significant decrease in the distribution and occurrence of the skate *Dipturus nidarosiensis*, but a larger distribution and more common occurrence of the smaller shark species *Galeus melastomus*. The distribution and occurrence of other demersal species did not change significantly, although some upward and downward trends were identified. The data indicate that the decline of *D. nidarosiensis* in the fjord may partly be attributed to bycatches in the commercial fishery. Moreover, the inner fjord is significantly impacted by industrial pollution, as high concentrations of mercury were found in the tested filet with decreasing concentrations towards the outer parts of the fjord. To secure the species diversity and viability of the Hardangerfjord further monitoring programs and restrictions on discharge are recommended.

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Long term change in benthic biodiversity and habitat quality of Carlingford Lough, Ireland in relation to mussel fishing

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Abstract

Benthic macrofaunal distributions were surveyed in Carlingford Lough, Ireland in 1992 and 2008. Species abundance and biomass were higher in 1992 than 2008.

Poster Session

Theme 2:

The marine environment and responses to climate changes

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Ecological-dynamic series of salt marsh vegetation on the Pomorsky and Karelian coasts of the White Sea

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Abstract

Investigations of long-term changes of coastal zone ecosystems of Arctic regions is now becoming ever more urgent in connection with quickly developing processes of climate transformation and active development of coasts of the seas and oceans. . The species, which are a part of this complex, differ on the breadth of their ecological amplitude and are united in such ecological groups, as euhalophytes, strictly dated to primary marches on muddy wetlands and bearing the strong soil salinity; mesohalophytes – the species, growing on the secondary marches and miohalophytes - the species of local flora which are bearing the weak soil salinity. At present postglacial period the coastal marshes of the Northwest of Russia correspond to the place of functioning of ancient water-currents, but territorially they are young formations in condition of constant change. The coast of the Onega gulf sharply differs from the other coasts of the White Sea in the expressed proficiency of mellow deposit of ice-sea, sea and alluvial genesis. The basic changes of vegetative cover of salt marsh communities connected with the change of level of the White Sea and with the eustatic raising of coast, are the following: the area of plant communities with domination of boreal - European, and boreal – Eurasian species on the marshes wetland of the Pomorsky and Karelian coasts of White Sea is constantly expanding.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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How important is water temperature for an invasion of *Crassostrea gigas* on the coast of Norway?

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Abstract

The Pacific oyster is an alien species that has been established in Norwegian waters in the last few years, showing a rapid growth in both number and abundance. Until 2007, only 2 registrations of wild specimens were officially known. Later it has been shown that the species was found already in 2002 in Vestfold County. Then, in 2008, the first larger population was discovered near the island of Hui in the Tønsberg fjord and since then more than 100 locations have been registered. But in the winter 2009/2010 and 2010/2011, a long period of ice coverage led to a major mortality on the shallow growing populations. One of the reasons for allowing import of *Crassostrea gigas* to Europe was that one thought that the water temperature was too low for the oyster to reproduce. The history has shown that this was wrong. Most of the temperature observations that has been used as background for this conclusion have been collected at 1 m depth. However most pacific oysters are found on 0-1 m depth where the water temperature potentially can reach much higher levels during summertime. Some of the oysters will also be directly exposed to sunlight on low tide, amplifying the temperature increase inside the oyster even more. In this presentation we discuss which impacts these temperature differences might have on gonad development and reproduction, and what consequences this might have on our judgement of the spreading potential for these species along the Norwegian coast.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Climate change in the Arctic: *Fucus distichus* facing sea temperature increase

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Abstract

The Arctic region is likely to be severely affected by climate change as the warming is expected to be substantially greater than the global average. However, how climate change will affect coastal arctic ecosystems remain unclear. Question is still open whether intertidal organisms are the best able to cope with environmental changes or are already living at their tolerance limit. We focused our study on an important ecosystem engineer of the Arctic rocky shores, the macroalgae *Fucus distichus*. Using an ecological niche modeling approach (MaxEnt) and the IPCC climate change projection for the coming two centuries, we predict a northward shift of suitable habitat for *F. distichus*. As sea surface temperature appeared to be the most important environmental factor for *F. distichus* distribution, we tested heat stress (20°C, 24°C and 28°C) tolerance for three populations living under different temperature regimes (Svalbard, Kirkenes and Bodø). We assessed their physiological performance by measuring photosynthetic activity and modulation of heat shock gene expression (sHsp, Hsp90, Hsp70) by qPCR. The populations responded differently at 15 min and 60 min heat stress and after 24 hours recovery.

Theme 2: The marine environment and responses to climate changes

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The coastal monitoring programme - how is eutrophication and climatic change affecting the coastal ecosystem?

Norderhaug KM, Aure J, Bjerkeng B, Dahl E, Falkenhaus T, Gitmark J, Green N, Gundersen H, Johnsen TM, Ledang AB, Lømsland ER, Magnusson J, Moy F, Omli L, Oug E, Pedersen A, Rygg B, Sørensen K, Trannum H, Tveiten L and Walday M

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Abstract

Through the Coastal Long-term Monitoring Programme of Environmental Quality in the coastal regions of Norway, the environmental status in South Norway coastal waters has been monitored from 1990 and until today. The programme is holistic and includes climate, nutrients, water quality and biodiversity in the plankton, on hard bottom (macroalgae and sessile fauna) and soft bottom (infauna). The aims of the programme are to: •give an overview of the environmental status with regard to nutrients and effects of nutrients •identify important nutrient inputs to Norwegian coastal areas •describe temporal changes in nutrient concentrations •describe effects from nutrients on the status and development in plankton, hard bottom and soft bottom communities •describe the biodiversity and possible changes in biodiversity. •although this was not in focus from the beginning, the holistic approach makes the programme able to detect ecosystem changes resulting from climatic change Time series data from programmes like the Coastal monitoring programme is particularly valuable to scientists and the environmental management for understanding the effects in coastal ecosystems from eutrophication, climatic change and interactions between eutrophication and climatic change.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Dynamics of co-occurring *Calanus finmarchicus* and *C. helgolandicus* in Skagerrak

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Abstract

The con-generic copepods *C. finmarchicus* and *C. helgolandicus* co-occur in the northern North Sea, and are important food for several commercial fish species. Changes in total abundance as well as seasonality of *Calanus spp.* may have important impacts on juvenile fish. The objective of this study was to describe long-term year-to-year fluctuations for the two species, and to reveal possible causes for the observed variations. Zooplankton and associated environmental variables were sampled at a fixed monitoring station in Skagerrak off southern Norway twice a month since 1994. We found a clear seasonal pattern, with *C. finmarchicus* dominating in the spring peak and *C. helgolandicus* in the autumn peak. *C. finmarchicus* was associated with low temperatures and high Chlorophyll a concentrations, while *C. helgolandicus* was related to higher temperatures, and low nutrient concentrations. A considerable between-year variation was observed, both regarding total abundances and relative proportions of the two species. The observed inter-annual and seasonal variations is discussed in relation to advective processes and hydroclimatic changes in the region. Preliminary analyses suggest that increasing temperatures may alter the relative abundances of the two species. However, additional factors such as advection into the North Sea and overwintering conditions in the Skagerrak deep, may explain the observed year-to-year fluctuations in abundance of *C. finmarchicus* in this region.

Theme 2: The marine environment and responses to climate changes

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First record of the intertidal mussel *Perna perna* along the European coast: long overlooked or a recent range expansion?

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Abstract

Climate variability affects geographical ranges and distributional limits of species. The predicted forthcoming climatic changes are expected to increasingly affect biogeographical patterns, causing poleward shifts in different geographic regions. A trend of rising sea-surface temperature has been observed along the Iberian coast and this has been associated to shifts in intertidal species' ranges. Following a first record of the subtropical intertidal mussel *Perna perna* on this coastline, the temperature trends in the last 10-year were reassessed, providing an accurate estimate of the warming process. Intensive surveys along the south-west Atlantic Iberian rocky shores were carried out reporting abundances and limits of the newly recorded *P. perna*. Within the recently reported range, *P. perna* was found only in exposed locations and was absent from sheltered areas. Individuals were interspersed within the more abundant mussel *Mytilus galloprovincialis* showing no habitat segregation typical of other systems where both species coexist. Genetic analyses confirmed recent expansion of *P. perna* along the Atlantic Iberian south coast. This represents a striking shift of the previous northern distributional boundary along the Moroccan coastline and underlines the importance of intertidal species as ideal models to detect early warning and impacts of climate change.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Impact of eutrophication and altered oceanic pH on mate choice and reproductive success in the pipefish model system

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Abstract

A variety of animal behaviors are affected by human induced environmental change, which in turn may alter species interactions, population dynamics and evolutionary processes. In marine ecosystems, overfishing, eutrophication, ocean acidification and the destruction of physical and biogenic habitats change the environment at an unnatural speed. Due to eutrophication, increased amounts of phytoplankton and filamentous algae alter the environment of marine organisms that have to adapt to changes in habitat, pH, oxygen, and visibility. We use pipefish as our study organism, which is a group of highly specialized marine fish practising male pregnancy. Pipefish have evolved in close relation to seagrass, which they mimic in colour, shape and behaviour. Seagrass meadows are one of the most important habitats for marine organisms; it is also one of the most threatened habitats in terms of anthropogenic disturbance. In a series of experiments we have shown the effects of eutrophication on the genetic mating system, mate choice- and search, as well as reproductive success. Through behavioural and genetic analyses we show that mate choice and reproductive success are environment dependent. Altered pH and algal induced turbidity impairs adaptive mate choice, hinders the development of female sexual ornament, and overall decreases the reproductive success.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Production and plasticity of isolated eelgrass clones under irradiance stress

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Abstract

Due to the absence of sexual reproduction, eelgrass (*Zostera marina*) meadows in the northern Baltic Sea commonly consist of one or a few clones. Some of these clones have been estimated to be over 1000 years old. In the light of recent knowledge demonstrating the importance of genotypic diversity on population persistence and functioning, the long time survival of these edge populations is paradoxical. To assess the stress tolerance and plasticity of different eelgrass clones, we established replicated monocultures of eight clones in a common garden field experiment. The experiment ran for 12 weeks, and plots were shaded for 4 weeks before a recovery period. Subsamples of each plot were sampled at each experimental phase. Shading had a strong negative effect on growth and shoot, rhizome and root biomass, while the effect of genotype varied. Genotype and shading had no interactive effect on plant performance. While the effect size of responses for shading varied somewhat between clones, the direction of responses was more uniform. In addition to the treatment effects over time, growth and changes in shoot and rhizome biomass were also controlled by an interaction between time and shading. Although statistically non-significant, resistance, resilience and recovery varied from negative to positive depending on the clone. The results indicate that a much better understanding of effects of stressors on donor clones is needed if conservation and restoration efforts are to be successful.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Biodiversity reduces disease risk in a warmer sea

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Abstract

The transmission of infectious free-living parasite stages is influenced by biotic and abiotic factors. Biodiversity surrounding parasite-host systems can substantially reduce disease risks in target hosts, a process that is known as the dilution effect. In addition, temperature is positively correlated with infection levels in target hosts for different species. However, the effect of temperature on the dilution effect is yet unknown. In this study, we test the hypothesis that the dilution effect can compensate for increased infection levels of temperature effects. Levels of infectivity of free-living stages of the parasite *Renicola roscovita* in the target host (the blue mussel *Mytilus edulis*) were measured with and without presence of diluters at three different temperatures: 12.5, 18 and 25 °C. The diluters were three invasive species living in the Dutch Waddensea, as they are supposed to benefit most from a warmer world. The oyster (*Crassostrea gigas*) and the barnacle (*Elminius modestus*) showed a significant effect of temperature on the dilution effect, which reflects the thermal response of feeding rates of these species. These experiments showed that the dilution effect can become stronger with increasing temperatures, which has the potential to counterbalance increasing infection levels in future climate change scenarios.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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In search of the “population” - unorthodox sampling designs to uncover large-scale eelgrass population structure and eutrophication effects

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Abstract

Many marine populations are more or less continually distributed along coastlines, yet sampling regimes usually define haphazard locations as the unit of study, often dubbed ‘population’. This applies particularly to population genetic studies. To assess the validity of current population definitions, we used a large scale monitoring data set and designed an unbiased sampling regime by continually sampling along a stretch of 400 km of coastline in the ecosystem foundation species eelgrass (*Zostera marina*) in the south-western Baltic Sea. Leaf shoots were collected every 500 m and analyzed for 9 microsatellite loci. The genetic structure from those 600 samples was compared to traditional population sampling at defined locations. Population divergences and structural breaks along the coastline were compared with coastline topology and currents, while genetic contrasts were formed across depth at a total of 110 perpendicular transects. Local diversity estimates (allelic richness, heterozygosity) in a sliding window approach were correlated with exposure index and depth. Moreover, we assessed the amount of anthropogenic nutrients fixed within the seagrass beds using nitrogen stable isotope ratios of d15N, as a measure of long-term eutrophication effects.

Theme 2: The marine environment and responses to climate changes

Presentation: Poster

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Intertidal *Zostera* species display effective xanthophyll cycling under high-light exposure: insights from field studies in New Zealand and Germany

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Abstract

Intertidally growing seagrasses are experiencing highly variable environmental conditions over daily and tidal cycles. *In situ* irradiances, both photosynthetically active radiation (PAR 400-700nm) and ultraviolet (UV) radiation, can be high when the seagrasses are exposed at low tide, and PAR may be limiting when they are submerged in turbid waters. Thus acclimation mechanisms need to be in place in order to adjust to these variable light conditions and to achieve photosynthetic plasticity. One important mechanism in photoprotection is the xanthophyll cycle (XC), enabling the seagrass to dissipate excess energy. There have been few *in situ* studies on seagrass photosynthesis and XC pigment turnover from intertidal environments. In this study whole-day surveys (from pre-dawn until sunset), were conducted in two intertidal seagrass meadows, one (*Zostera marina*) located in the Wadden Sea off the island of Sylt, Germany, and the other (*Zostera muelleri*) in Tauranga Harbour, New Zealand, under respective summer conditions. At each site, surveys were conducted on two separate days when low or high tide coincided with solar noon. Sampling for photosynthetic (via PAM-Fluorometry) and pigment analysis was performed at three hour intervals and accompanied by constant logging of *in situ* irradiance and temperature. Even under highest irradiance the results show little inhibition of optimum quantum yields of photosynthesis, thus indicating very effective energy dissipation mechanisms. This is well-supported by the pigment data, which show a high turnover of XC pigments. Results obtained provide further insight into seagrass acclimation mechanisms to a highly dynamic light environment.

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The influence of abnormal ice-melting upon the structure of intertidal community in the White Sea bight

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Abstract

Long-term observations of intertidal communities were carried out annually every hydrological season at the White Sea Biological Station in two small bights during last 25 years. Bottom assemblages of lower and upper intertidal were different in species composition and community structure in all cases. In winter, ice lies upon the surface of sediment during spring low tide. It may lead to freezing in of the upper layer of ground into the ice cover. Normally ice melted inside bights, but in 1988, 1994, 1998, 2002, 2005, 2006 and 2008 it was removed due to abnormally windy weather. It led to transportation of a thick layer of sediment with frozen in benthic organisms out of the bight. Such events caused substantial changes in intertidal community structure. Communities at lower and upper horizons of intertidal flat remained more stable than intermediate ones, which led to periodical shifts of the border between lower and upper intertidal assemblages. Restoration of normal community structure lasted about four months in all cases. The exception was 1998 when assemblages returned to the normal state only in 2002.

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Soft bottom communities and responses to climatic change and eutrofication in Skagerrak during a period of twenty years

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Abstract

As part of a coastal monitoring programme, soft bottom communities in Skagerrak have been monitored for a time period of twenty years, together with hydrography, nutrients, plankton and hard bottom communities. This data series provides a highly valuable time series which can be used to identify the most important environmental drivers for the structuring of the benthic communities, in particular eutrofication and climate. At deep stations, the ecological status has improved or been unchanged during the monitoring period, while the shallow stations are characterized by much larger fluctuations. Possible explanations for this divergent pattern are discussed. Two of the coastal monitoring stations are in the vicinity of Arendal, and these are presented more thoroughly with regard to community composition and environmental variables.

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The Norwegian Coastal Monitoring Programme (1990-p.t.): Effects of eutrophication and climatic change on rocky bottom macro algae and sessile fauna

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Abstract

Eutrophication and climatic change are of the most serious and challenging environmental problems in the North Sea and Skagerrak and may cause severe changes in the composition of benthic communities. The Norwegian Coastal Monitoring Programme provides more than 20 years of data on species composition and measures of hydrography and –chemistry, and has in this study been subject to statistical analyzes in order to assess the spatial and temporal changes of rocky bottom macro algae and sessile fauna. This long-term dataset reveals both year-to-year variation and overall trends in species abundance and diversity and also spatial variation between bio-geographical areas (Outer Oslofjord, South coast, Southwest coast and West coast). This complex spatio-temporal pattern is most likely caused by multiple potential factors (stressors) acting in combination. Generalized Additive Modeling

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Artificial coastal defences: enhancing biodiversity using sensitive design

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Abstract

Global climate change is one of the greatest threats facing society, the predicted effects of which include rising global temperatures, rising sea levels and changes in weather patterns. The predicted effects of climate change will be increased flooding and erosion prompting the need for building and upgrading of coastal defences to protect property and infrastructures. These structures provide hard-substrate habitat in areas that typically comprise soft sediments, acting as stepping stones, facilitating the range extension of rocky shore species. Coastal defences can also alter local hydrodynamic processes which can in turn affect benthic infaunal communities. By building coastal defences using ecologically sensitive design principles, it is possible to increase habitat-availability and enhance biodiversity.

We are involved in two consortium projects (THESEUS & URBANE) relating to the ecology and design of coastal defences. Here, we introduce the two projects, giving information on the background and objectives of both. The projects have 3 main objectives: (i) assess the biodiversity of both natural rocky shore and coastal defences; (ii) test the effects of defences on community structure of benthic assemblages and; (iii) examine the effect of different structure designs on colonizing biodiversity. We outline plans for objectives relating to the ecologically sensitive design of coastal defences.

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Changes in life cycle and ecological significance of coastal community members as a response to climatic variability in eastern Baltic Sea

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Abstract

The non-tidal Baltic is a shallow brackish inland sea (mean depth 55 m; 17% of bottom areas <10 m deep) and long (1400 km) is characterized by low species diversity (due to osmotic stress for both marine and freshwater origin species) and is easily colonized by allochthonous species. Global warming has facilitated the rapid dispersal of warm-water crustaceans from Ponto-Caspian basin to the Baltic Sea. This paper focuses on dynamics of coastal ecosystem of the eastern Baltic Sea ((primarily Gulf of Finland, Curonian and Vistula lagoons). Coastal area is an important habitat for representatives of malacostracan crustaceans and a sensitive ecotone subjected primarily to climate changes (water temperature, hydrology and nutrient balance) and other stress (eutrophication, toxic pollution). I analysed history and current distribution of malacostracan crustaceans and study life span of dominating species (*Pontogammarus robustoides*, *Gmelinoides fasciatus*, *Gammarus tigrinus*). Species and community responses to environmental changes differed strongly between years. In cold years the primary productivity and nutrient release from catchment area as a rule decrease and only stenothermic species are extremely stressed and can decrease their significance. In warm years, higher temperatures are likely to lead to higher primary productivity with more intense algal blooms; and invertebrate communities are especially vulnerable to eutrophication (oxygen depletion, hydroxide sulphide production). Climatic changes can be environmental limits leading to shifts in life span and reproductive success of Ponto-Caspian amphipods; to deceleration of species abundance and changes in trophic links and food-web structure of coastal community.

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Climate change impact on seaweed meadow distribution in the North Atlantic rocky intertidal

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Abstract

Seaweed meadows are a crucial component of rocky intertidal ecosystems, providing habitat and food supply for a broad range of species. In the North Atlantic rocky intertidal, seaweed meadows are dominated by the brown macroalgal species *Fucus serratus*, *Fucus vesiculosus* and *Ascophyllum nodosum*. To predict distributional changes of these key species under three IPCC climate change scenarios, over the coming two centuries, we generated Ecological Niche Models with the program Maxent. The models predict shores below 45° latitude to become unsuitable for at least two of the three species, on both, the NW- and the NE-Atlantic coast. If these macroalgal species are unable to adapt rapidly to rising temperatures, the loss of seaweed meadows and their associated fauna could soon trigger a shift in the North Atlantic intertidal ecosystem, and affect human society and economy that is linked to this coast.

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The role of salinity tolerance and adaptation in barnacle populations along the Baltic Sea salinity gradient

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Abstract

Understanding how organisms respond to environmental change and how new evolutionary adaptations arise is key knowledge in planning for future management of the sea. The barnacle *Amphibalanus improvisus* is a common fouling organism worldwide. It was introduced into the Baltic Sea in the mid- 19th century and is the only barnacle species there. The unique low salinity environment of the Baltic Sea has resulted in rapid local adaptations in several species in the area. However, little is known about how barnacle populations are affected by different salinity regimes and if local adaptations may have arisen in areas where salinities remain constantly low. Common-garden experiments were performed to characterise population differentiation indicative of physiological plasticity, and therefore local adaptation. Multiple batches of newly settled barnacles from each of three different geographical areas along the Skagerrak-Baltic salinity gradient were exposed to different salinities during nine weeks and phenotypic traits including survival, growth, shell strength and reproductive maturity were recorded. Future climate scenarios include reduced salinity inside the Baltic Sea due to increased precipitation and the implications of this for barnacle populations will further be discussed.

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Hypoxia effects on the composition of hyperbenthos and infauna in Norwegian Skagerrak fjordic basins

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Abstract

In environmental management there is a need for early warning of environmental degradation. Identification of sensitive indicator-organisms is therefore crucial. We will present the response of “hyperbenthos fauna” and macro-infauna to a gradient in eutrophication-related hypoxia represented by 11 fjord-basins. Fauna and sediment was collected with epibenthic sledge, grab and box corer. Diversity was strongly correlated with near bottom oxygen minimum during the last 5 years. For hyperbenthos, species number was clearly related to oxygen minimum ($R^2 = 0.91$). Species number decreased from 48-56 in the well-oxygenated basins (> 3 ml/l) dominated by Ostracoda, Isopoda and Tanaidacea, to 22-32 in intermediate hypoxia (2-3ml/l) dominated by Amphipoda and Cumacea. In the most hypoxic environment (< 2 ml/l) Cumacea dominated and species number varied from 0-7. For infauna, diversity (H') clearly decreased with oxygen concentration ($R^2 = 0.81$). Species number varied from 62-123 in oxygen concentrations > 2 ml/l and was 27 below 2 ml/l. Assessment of functional attributes showed that above 2 ml/l the attributes: tube construction, shallow sediment dwelling depth, and surface deposit feeding increased with lowered oxygen condition whereas mobility and swimming activity tend to decrease. Loss of species over time was estimated using the relation between oxygen concentration and species richness. Many fjords have lost $> 50\%$ of their species since 1980. This trend may be emphasized in the future due to climatic related changes in hydrographaphic and meteorological conditions e.g. reduced renewal of basin water and higher temperature and lower oxygen concentration of the advected water mass.

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Plant facilitation in mixed seagrass meadows: exploring complex interactive effects of plants and shading stress on eelgrass (*Zostera marina* L.) performance

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Abstract

In some regions, *Zostera marina* occurs in mixed assemblages. However, the effects of plant diversity on *Z. marina* performance during disturbance have rarely been investigated. To study how much plant species richness might act as an insurance against shading stress, we conducted a field study lasting 2.5 months in the Baltic Sea. We shaded *Z. marina* in monocultures and mixed assemblages (*Potamogeton perfoliatus*, *P. pectinatus* and *P. filiformis*) in a factorial design at 2 m depth and measured *Z. marina* performance in terms of shoot density, biomass production, leaf C/N and carbohydrate production. We used structural equation modeling (SEM) to discern the overall causal effects of plant richness and shading on *Z. marina*. The mean biomass change of *Z. marina* growing in polycultures was always more positive compared to monoculture biomass change. SEM revealed that shading had a negative effect on e.g. shoot density and the CN-ratio of plants, which, in turn, influenced biomass and plant tissue carbohydrates. However, plant richness did not have any clear causal effects on the performance of *Z. marina*. Our results indicate that plant community species richness can enhance *Z. marina* production during shading stress, but the overall effects of plant richness are complex and not clear-cut. Thus, effects of diversity on stability vary depending on which response is investigated.

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Ecological-dynamic series of salt marsh vegetation on the Pomorsky and Karelian coasts of the White Sea

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Abstract

Investigations of long-term changes of coastal zone ecosystems of Arctic regions is now becoming ever more urgent in connection with quickly developing processes of climate transformation and active development of coasts of the seas and oceans. . The species, which are a part of this complex, differ on the breadth of their ecological amplitude and are united in such ecological groups, as euhalophytes, strictly dated to primary marches on muddy wetlands and bearing the strong soil salinity; mesohalophytes – the species, growing on the secondary marches and miohalophytes - the species of local flora which are bearing the weak soil salinity. At present postglacial period the coastal marshes of the Northwest of Russia correspond to the place of functioning of ancient water-currents, but territorially they are young formations in condition of constant change. The coast of the Onega gulf sharply differs from the other coasts of the White Sea in the expressed proficiency of mellow deposit of ice-sea, sea and alluvial genesis. The basic changes of vegetative cover of salt marsh communities connected with the change of level of the White Sea and with the eustatic raising of coast, are the following: the area of plant communities with domination of boreal - European, and boreal – Eurasian species on the marshes wetland of the Pomorsky and Karelian coasts of White Sea is constantly expanding.

Poster Session

Theme 3:

Management of coastal resources – Marine Protected Areas

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Presentation: Poster

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Fishes of Artificial Reefs in the Gulf of Genoa

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Abstract

Fishes of ARs in the Gulf of Genoa (Ligurian sea – NW Mediterranean) have been monitored regularly since 1998 by means of scuba diver visual census and some trammel and long line catches. In the four main ARs (depth range 10-35 m) in total 91 fish have been recorded, all bony fish. 65 monitored by visual census, 48 caught by trammel net, 15 with long lines. Differences in the fish populations among the ARs can be mainly attributed to the age of the AR, stage of development of the community in particular benthos settled on artificial substrates, presence in the neighbourhood of *Posidonia* meadows and/or rocky bottoms. Most species belongs to families Sparidae, Labridae and Serranidae, the same families are the most important on natural rocky environment in the NW Mediterranean sea. Thirty-eight species out of 47 recorded at Port Cros MPA were common to both biotopes and *Chromis chromis* was numerically dominant in both communities. There was an obvious seasonal change: two different populations, one Summer-Autumn, the other Winter-Spring occurred. These variations were often linked to the arrival of juveniles, mainly in mid-Summer and in Autumn for the majority of the species, indicating that the ARs acted as a nursery. The biomass, evaluated by monthly censuses, ranged between 9.59 g m⁻² and 117.9 g m⁻², with an average of 31.68 g m⁻². The trammel catches 12 hours during night ranged from 1.01 Kg/100 m net to 4.61 kg with an average of 2.32 Kg.

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Population Genetics in Spawning and Juvenile Cod (*Gadus morhua*)

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Abstract

Cod fishery is of vital importance in Norway. In 2011, 15% of the total landed catches was cod which made out 24% of the commercial value of Norwegian fishery. Fishery management discriminates Norwegian Coastal Cod (NCC) and North East Atlantic Cod (NEAC) as two different stocks. While the fishery on NEAC is sustainable, the fishery on NCC is not. However, since they intermix in Northern Norway, sharing common spawning grounds, stock discrimination and management is challenging in the area. Although some studies indicate NCC to differ from NEAC in phenotypic and genetic markers, it is still not clear whether they make up one single interbreeding population or two genetically separate ones. With the aim to clarify the relationship between NEAC and NCC, we collected larval cod at spawning grounds of Vesterålen, juveniles from Troms and adults from Hordaland, Salten, Lofoten and Troms. DNA was extracted from a total of 480 individuals. By genotyping them for 10 microsatellite markers, we tested for genetic differences at the larval stage and for the occurrence of hybrids from the two stocks. Focusing on the larval and juvenile stages can help to identify if the NCC and NEAC interbreed but then become differentiated by selection or if the two stocks do not interbreed at all.

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Retrospective genomic analysis from archived samples of Atlantic cod stocks in West Greenland Waters: implication for management

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Abstract

Atlantic cod *Gadus morhua* stocks in West Greenland waters have declined drastically during the last 40 years, presumably as a result of excessive fishing pressure and environmental changes. An important question for management is whether areas where populations have been depleted can be repopulated by cod from other areas. Recently, genetic studies have suggested that cod in Western Greenland is structured genetically into two major components, inshore and offshore. Likewise, tagging experiments have shown that some year-classes of Icelandic origin migrate from West -to East Greenland and back to Iceland when they are mature. At present there is no knowledge of whether these populations are locally adapted, however, environmental variation across the area suggest this could be the case. Here, we apply analysis of gene-associated Single Nucleotide Polymorphisms (SNPs) to historical samples of cod (scales and otoliths) from West Greenland waters in order to investigate micro-evolutionary processes. Specifically we aim at: a) Describing spatial and temporal dynamics of population structure and distribution of spawning populations, b) Spatiotemporal distribution and abundance of mixed feeding aggregations and c) The occurrence of local adaptation at the DNA level in space and time. Understanding the temporal changes in population structure and local adaptation in Atlantic cod and the association with environmental drivers of these processes will allow a better prediction of future distribution and abundance of cod in relation to climatic variation and fisheries.

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***Engraulis encrasicolus*: recruitment pattern along a temperature gradient in the Strait of Sicily**

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Abstract

The interannual fluctuation of small pelagic resources is a well known phenomenon in literature, as due mainly to recruitment success or failure. The recruitment success is thus linked to the effect of environmental variability on mortality during the early and juveniles life history stages. During October 2005 a survey was carried out in the Strait of Sicily to study abundance and distribution of juveniles of European anchovy (*Engraulis encrasicolus*). Specimens were collected on board of R/V “Dallaporta” by means of a pelagic trawl. Environmental data were also obtained by means of a CTD probe. The gonadosomatic index evolution (GSI), considered as a proxy of the anchovy egg production, was calculated in order to assess the duration of the spawning season by means of a fortnightly intervals landing sampling during 2005, from commercial catches. The monthly length frequency distributions, from the landing samples, suggest that the recruitment period extends between November and February, as shown by the most abundant size class. The spatial distribution and abundance of juveniles have been discussed along with environmental data. Condition factor (CF), considered as proxy of food availability, does not appears a crucial factor in structuring a favorable growing site. The oceanographic parameters and juvenile spatial distributions, among the examined variables, showed a negative linear relationship between water temperature and juvenile anchovy average length for each trawl suggesting a preference for smaller organisms to inhabit warmer waters.

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European anchovy acoustic and egg production estimates comparison during a ten year time series in the Strait of Sicily

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Abstract

The European anchovy (*Engraulis encrasicolus*), a batch spawner with indeterminate fecundity, is an ecologically important small pelagic species. This is widely distributed throughout the eastern Atlantic Ocean and adjacent seas, including the Mediterranean Sea, and represents a very important resource from commercial point of view. In the Strait of Sicily the fishing effort together with the high interannual biomass fluctuations, typical of pelagic fish species, highlighted the need to monitor continuously the anchovy stock status. From 1998 to 2010 Daily Egg Production Method (DEPM) application surveys were conducted together with electro-acoustic surveys, in the Strait of Sicily, during the anchovy spawning season, onboard of a research vessel equipped with Simrad EK 500 and EK 60. The anchovy stock abundance estimates and their confidence intervals obtained by the two independent methods were compared during a 10 year time series. The results showed similar trend between the two methods during the study period. This evidence may confirm the accuracy of these independent evaluations of Sicilian anchovy biomass.

Poster session

Theme 4: General Marine Biology

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Latitudinal comparison of the growth of the common goby, *Pomatoschistus microps* (Krøyer, 1838): does countergradient variation occur?

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Abstract

Pomatoschistus microps (Krøyer 1838) (Gobiidae) is found throughout the European Atlantic coast, estuaries and lagoons between the latitude parallels of ca 69°N to 20°N. This wide distributional range might be explained by several factors, namely migratory capacity, food availability, presence of predators among others but it is mainly related to their tolerance to wide-ranging values of temperature and salinity. Being a poikilotherm species the latitudinal thermal gradient would be expected to lower their metabolism in higher latitudes. Conversely several studies have shown the existence of “latitudinal compensation” where animals from higher latitudes show an equal or even higher metabolism than animals from lower latitudes. These studies have focused on different aspects such as food conversion, growth rates, length of the spawning season and vertebral number, just to name a few. Despite the large amount of studies on this species so far growth rates have been only studied by means of cohort analysis. To correctly understand these results we have reared individuals under common-garden conditions. Common-garden experiments are essential for the evaluation of patterns arising with latitude. Three populations (37°N - Faro, Portugal, 41°N - Minho estuary, Portugal and 60°N - Bergen, Norway) of the common goby *P. microps* (Krøyer 1838) (Gobiidae) were chosen and individual growth rates were determined under 4 different controlled temperatures within the range found in the species’ habitat. The effect of temperature, population of origin, fish size and sex was analyzed. Ultimately this might give an insight on climate change effects on *P. microps* populations.

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Fluctuations in settlement and survival of a barnacle *Semibalanus balanoides* at the White Sea intertidal studding by a method photo-registration

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Abstract

During the period of 2004-2011 annual photo-registration of barnacles *S. balanoides* population has been done in mid-July. 6 flat stones were chosen in the White Sea intertidal (Arctic) influenced by tides but shielded from direct wave force. Each stone was marked with a transect of 0.1 m width, the length depended on the stone size and varied from 0.7 to 1.4 m. Within transects barnacle registration was conducted in adjacent 0.1×0.1 m quadrates. Ages were taken into account, determined by comparing photographs for several years. In 2009, a second account was held in September, objective to determine spatial and interannual settling heterogeneity degree; and mortality showing the possible barnacles clusters affinity to specific sites on the substrate. Average adults population density was 48 ind./m². Barnacles live 3-4 years. Settling rate varied from 4 to 100 ind./m² (average on transects), but did not correlate with quadrate location. Settling pikes were recorded in 2005, 2007 and 2009. Settlement intensity slightly correlates with adults population density, and settlers distribution was more uniform than that of adults (> 1 year). Post-settlement mortality during first 2 months is about 5.2 %. Posterior death rate slightly correlates with settling intensity. Age structure shows that spat number decreases 3-4 times during first year, and late population density remains the same. Ice friction influence was not shown, though transects are covered with ice in winter.

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Sample size for quantitative analysis of highly heterogenous *Semibalanus balanoides* barnacles population on sandy with gravel intertidal

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Abstract

Quantitative analysis of barnacles population density conducted in July 2009 is reported. The analysis was taken on sandy with gravel White sea intertidal objective to determine reliable sample size. The area of investigated region is 2578.5 m². This site is 80 m long and 30-40 m wide. The 25×25 quadrat was randomly placed on the ground by tossing it up. In case if it landed inclined, the data was re-counted for its projection onto the ground surface. Barnacles were subdivided into two size categories. First, 1-2 mm in diameter were considered as settlers; and those larger were classified as adults. We analyzed quantitative data from 265 frames. Average density of adults equals 105 individuals per square meter; that of spat is 619 individuals per square meter. If only stones larger than 60 cm² are considered, we can calculate barnacles density relative to stones area, which appeared 900±100 adults per square stone meter and 4700±200 first year barnacles per square meter. Representative data require at least 200 quadrates, since each densely populated stone dramatically affects the mean and standard deviation values.

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Presentation: Poster

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Rapid coastal survey for marine introduced species in Norway

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Abstract

The method Rapid Coastal Survey was applied in Hordaland in 2010 and in Rogaland in 2011. Establishment of marine introduced species in approximately 70 marinas in the two counties was studied. A list of 27 introduced species, some of them already established in the country and some that are expected to arrive, were targeted in this investigation. No new species to Norway was found, but several species already established in Norway were observed at a number of sites. The ascidian *Styela clava*, native to northwest Pacific, was recorded at eleven sites in Rogaland, and was most abundant at sites near Stavanger, where the species was recorded for the first time in 1990. The species was also found in Ølen in Rogaland and at Bømlo in Hordaland. The Japanese wire weed *Sargassum muticum* was recorded on most sites in Rogaland, but was less abundant in Hordaland. Some new data from fieldwork during 2012 will also be presented. The applicability of the method, vectors for dispersal and management of introduced marine species in Norway will be discussed.

Theme 4: General Marine Biology

Presentation: Poster

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Spatial heterogeneity in Atlantic cod larvae off Vesterålen, Northern Norway

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Abstract

Variability in cod ichthyoplankton abundance is expected on small spatial scales in the sea. Large scale sampling may not be efficient to comprehend processes that lead to heterogenic distribution, since variability of the relevant environmental conditions and resources may vary within small spatial scales. Therefore we approached zooplankton samplings in 4 small scaled grids, where stations are set 400m apart. Samplings were carried out during cod's spawning season in April and May 2010 and in May 2011 at 2 different sites on the Norwegian Sea shelf off Vesterålen. Hydrographical data were taken via CTD along with stationary plankton net tows, to allow co-variability analyses of biological and physical variables, such as salinity, temperature, oxygen content and fluorescence. Data of current direction and speed at sampling stations have been available. Hydrographical data reveal clear influence of 2 different water bodies, Atlantic Ocean waters and coastal waters, within the sampling grids. Distribution structure of biological data, such as cod larvae abundance, total fish larvae and fish egg abundances are shown to be patchy. Patches, smaller than 1km in size, are detected for all ichthyoplankton abundances. Fish egg distribution structure correlates with hydrographical data. Whereas correlations of hydrographical structures with fish larvae as well as cod larvae abundance patches are not significant. That drives the conclusion of increasing stronger behavioral impact on abundance patchiness along early fish life stages development.

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Colonisation patterns of cockle *Cerastoderma edule* Linnaeus (1758) post-larvae

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Abstract

The common cockle *Cerastoderma edule* is an important bivalve species of soft-sediment intertidal shore communities of north western Europe, and is a commercially exploited species. Cockle populations often have highly patchy distributions and the source of this spatial variability in distribution is currently considered to be generated through early post-settlement processes. The objective of this study was to record initial colonisation patterns and how it changes over time across the shore to inform possible processes creating patchiness. A staggered nested design was used from June 2010 to February 2012 at Traeth Melynog on Anglesey with 75 sample points distributed across 15 transects at exponentially increasing distances, from 0.7 to 133.3 m. All cockle post-larvae sampled were counted and their shell length measured. Settlement of post-larvae occurred in late May to early June and was restricted to the low shore with a peak density of 4,663 post-larvae m² at a mean shell length across all stations of 777 µm ± 43 (S.E.). After June, colonisation of the mid shore, and to a limited extent the high shore, took place resulting in a distribution similar to that of the adult cockles. The low intertidal shore was important for initial benthic colonisation of cockles in 2010 and 2011. This indicates that post-larval up shore redistribution may be significant for population structure and distribution. This has implications for the understanding of post-settlement mortality spatially on a shore through heterogeneous size and density distributions but also temporally as post-larvae redistribute either actively by bysso-pelagic migrations, or passively in scouring currents.

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Diatoms nutritional quality, toxicity and bioactivity tested by a simple sea urchin assay

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Abstract

When performing bioprospecting on marine organisms an efficient pre-screening of extracts could be both timesaving and economical. In the present experiment we used sea urchin (*Strongylocentrotus droebachiensis*) embryology (morphological characters), survival, and success in completing metamorphosis as the main assay markers when testing six common centric spring bloom diatoms, i.e. *Attheya longicornis*, *Chaetoceros furcellatus*, *Chaetoceros socialis*, *Talassiosira gravida*, *Porosira glacialis*, and *Skeletonema marinoi*.

The outcomes of the experiment were compared with results from more extensive assay procedures (cancer, diabetes, anti-inflammation etc.) and chemical analysis.

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Clarifying the taxonomic status of *Pseudocalanus* (Crustacea: Copepoda) in the White Sea

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Abstract

Pseudocalanus species are one of the most dominant constituents of the zooplankton communities throughout the Northern Hemisphere and they play an important role in marine food web. Despite of wide distribution and obvious ecological significance the genus is poorly defined taxonomically. According with B. Frost revision (1989) it consists of seven morphologically very similar species, some of which co-occur in certain habitats. Based on the literature data there is only one *Pseudocalanus* species in the White Sea – *P. minutus*. However, researchers have permanent confusion in the identification of *Pseudocalanus* from this region to species level, and it was considered necessary to clear up taxonomic status of its representatives. Our detail taxonomical analysis of *Pseudocalanus* from the White Sea revealed presence of two species – *P. minutus* and *P. acuspes*. Presence of *P. acuspes* is first time proved for this sea. Characters proposed by Frost (1989) as distinguishing for *Pseudocalanus* species can be well applied to differ between the White Sea specimens of *P. minutus* and *P. acuspes*. A key diagnostic character is P4 coxopod to basipod ratio, which is more than 1.5 in *P. minutus* and less than 1.5 in *P. acuspes*. Additional characters are: size of spiniform processes on postero-ventral margins of pedigerous somites 2 and 3, prosome to urosome ratio, and shape of cephalon in anterior lateral view. In females detailed morphological analysis of oral parts did not reveal any distinguishes between species.

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To see the offspring and die: the case study of *Astarte borealis* population dynamics

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Abstract

We summarize the data of long-term monitoring (1987-2007) of one *A. borealis* population situated in a small inlet in the White Sea. The population was dominated by old specimens and no recruitment was detected till late 1990s. After 1995 mass recruitment of Astartidae juveniles was detected. The species determination of the juveniles was impossible with guide's keys, which applicable for adults' identification only. However special investigation of morphological traits associated with periostracum microsculpture showed that these bivalve juveniles belonged to *A. borealis* species. Therefore we can conclude that the replacement of collapsed cohort with the new generation was observed. The forthcoming of juveniles can be explained by the appearance of some kind of hard substrate that is necessary for astartids eggs development. The numerous dead shells accumulated in the soft sediment after old specimens died provide such a substrate and support renewal of successful recruitment.

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Do benthic ecological quality ratios reflect the distribution of endocrine disrupting chemicals?

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Abstract

Endocrine disrupting chemicals (EDC) are a group of natural and anthropogenic substances that interfere with hormones in the body that are responsible for the maintenance of homeostasis, reproduction, development, and/or behaviour. Their presence in the marine environment, particularly in the food chain, may pose a hazard to human health and to the functioning of marine ecosystems. Under the Water Framework Directive, benthic Ecological Status (ES) is determined by calculating an Ecological Quality Ratio (EQR) from measures of abundance, diversity and the proportion of sensitive species in benthic macrofauna. Here we determine the power of EQR to explain the distribution of EDC in fine sediments from two waterbodies on the south coast of Ireland. The distribution of elevated levels of EDC was limited to areas adjacent to recent construction activity and to very depositional sites. ES as determined by PAH distribution closely matched the ES produced by the macrobenthic EQR Infaunal Quality Index (IQI). This suggests that the IQI EQR may be capable of delineating change in pollution status for some EDC.

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Ecological assessment of the effects on the seafloor of the proposed Atlantic Marine Energy Test Site (AMETS), Co. Mayo, Ireland

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Abstract

Marine renewable energy developments are unusual in seeking out very high energy environments and installing robust structures that remove energy from these areas. The effects on the diverse seafloor habitats at the Atlantic Marine Energy Test Site (AMETS), west coast of Ireland, of the proposed installation of multiple wave energy devices were assessed. Subtidal reefs were characterised by typical communities for the west coast of Ireland and all showed evidence of sand scour and deposition. Subtidal sediments at more than 50m depth were diverse assemblages of High Ecological Status (ES) sensu the Water Framework Directive. At less than 50m ES decreased to Good or Moderate because of large waves perturbing the seafloor. All communities found are adapted to very high energy environments and frequent physical disturbance. Any construction or operational disturbance is likely to lie within the natural variability of these communities.

This study illustrates the value of characterising biotopes and background disturbance levels in high energy sites. The ecological effects of removing energy from habitats that are structured by high levels of ambient disturbance are largely unknown. At the AMETS, it is unlikely that a significant portion of the total wave energy can be harnessed by the currently proposed development. This may not be the case at other suboptimal locations.

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Effect of longline aquaculture of the kelp, *Laminaria digitata*, on holdfast macrofaunal diversity

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Abstract

Seaweed aquaculture is an expanding commercial activity in Europe, where kelp is grown for food products, pharmaceutical ingredients and to investigate the potential of biofuel production. Here, we investigate the effect of long line aquaculture of *Laminaria digitata* on the macrofaunal communities associated with the holdfasts.

Cultivated samples had more invertebrate species and higher Shannon diversity than wild samples. The three most dominant phyla on the wild holdfasts were nematodes, polychaetes and molluscs, whereas on the cultivated holdfasts the three most dominant phyla were amphipods, polychaetes and decapods.

Cultivated samples had more filter-feeders than wild samples because of their location in the water column. The increased diversity of fauna among the cultivated holdfasts may be one benefit of seaweed aquaculture to the surrounding ecosystem.

Further research is needed to address other possible issues such as the effect of kelp detritus on the seafloor, hydrodynamic impacts of the long lines and the artificial reef created by the aquaculture installation, which may have positive or negative effects.

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The pattern of vanadium-dependent haloperoxidase activity in the intertidal and subtidal fucoid species

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Abstract

Vanadium-dependent haloperoxidases (HPOs) are unique enzymes occurring in marine macroalgae. Here we compare HPO activity in the different thallus zones of six brown macrophyte species (*Fucus vesiculosus*, *F. serratus*, *F. edentatus*, *F. distichus*, *Ascophyllum nodosum* and *Pelvetia canaliculata*). We examined tissues of 3 vegetative thallus zones (basis, middle zone and apex) and also mature receptacle tissues. Iodo- and bromoperoxidase activities were determined in the reaction with thymol blue (Verhaeghe et al., 2008). For all investigated species the peroxidase activity was substantially higher in the reaction with bromide, than with iodide. The Km values of bromination and iodination were estimated as 25 and 0.16 mM respectively. The HPO activities were highest (up to 0.7 U/g FW for bromination and 0.5 U/g FW for iodination) in *A. nodosum* and *F. vesiculosus* – species inhabiting mid-intertidal zone. The subtidal and high-intertidal species had lower level of peroxidase activity. These data are well consistent with the reactive oxygen species (ROS) content in the algae, hydrogen peroxide level being highest in the mid-intertidal plants. The pattern of HPO activity along the thallus also differs in intertidal and subtidal fucoids. In the intertidal species activity was highest in the basis of the thallus and gradually reduced towards the apex. In the subtidal algae peroxidase activity was almost the same throughout the thallus. In all species the receptacles had 10-fold lower HPO activity than vegetative tissues. Apparently the distribution of HPO activity reflects both ROS metabolism and growth intensity in different tissues of fucoid thalli.

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How does soft sediment macroinfauna vary with environmental conditions – modelling reference conditions along the Norwegian coast

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Abstract

Soft sediments cover most of the ocean seabed and often contain benthic communities with high biological diversity. Sediment-dwelling organisms depend on the substrate that they are attached to or live in, and species composition varies with sediment type. Macrofauna composition and diversity in soft sediments are commonly used as “health indicators” in various pollution monitoring programmes worldwide, and this fauna component has also been selected as one of the main biological quality elements in the European Water Framework Directive (WFD). This presentation shows how soft sediment macroinfauna varies with environmental conditions analysing indices calculated from grab sample data on macroinvertebrates (abundance and composition) collected between 1974 and 2010. Using these statistical relationships and GIS models on geophysical variables (such as depth, slope, wave exposure and terrain structures), we modelled the spatial distribution of soft sediment reference conditions. We focus on the quality index NQI, an index intercalibrated within phase 1 of the WFD. The model selection technique Akaike Information Criterion (AIC) was used to select the best statistical model from a set of candidate Generalised additive models (GAMs). The method and results from this study are considered as a great improvement over earlier approaches, where the same reference values were used in all regions and water types in Norway.

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Population dynamics of *Periphylla periphylla* in a North Norwegian fjord

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Abstract

A population of the jellyfish *Periphylla periphylla* was investigated over a year long period in Vefsnfjorden (65°55'N: 13°06'E), North Norway, in October and November of 2010 and February, May, and August of 2011. In some fjords of western Norway, the jellyfish has reached mass abundance levels hindering fisheries, but there has been no work on the species in northern locations. We studied the abundance, length-frequency distribution, developmental life stages, and distribution of the species in the water column of Vefsnfjorden. Zooplankton samples were collected with use of a Bongo net from the fjord basin to the surface. The water column was divided into three different sampling depths: basin, lower intermediate and upper intermediate. Sampling occurred during daytime and nighttime hours to address possible diel vertical migration patterns in relation to the light regime of North Norway. All collected specimens were measured for coronal dome width and sorted to developmental life stage. Our data suggests that the Vefsnfjorden *P. periphylla* population reproduces in the winter months and has a summer growth period. Growth rates for early developmental stages averaged at 0.013 mm day⁻¹ over the entire study period. Abundances are higher in the winter months and the population experiences loss in the summer, although reasons for the decrease in numbers are unclear. The population is currently in a period of growth with coronal dome width size classes of < 1mm – 30 mm and 70 – 160 mm but is lacking size classes between 30 and 70 mm.

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Biomechanical approach to a structural design of biological beam: The black coral skeleton

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Abstract

Modern-day cnidarians (anemones, hydras, corals and jellyfishes) reflect an intermediate stage in the evolution of animal complexity. Anthozoa is a well-defined class of sea anemones and corals, with several unique features distinct from other cnidarians; it is divided into three subclasses: Alcyonaria (soft body without skeleton), Hexacorallia (calcareous exoskeleton) and Ceriantipatharia (chitinous exoskeleton). The last one includes the order Antipatharia, thorny or black corals.

One of the main issues in the understanding of the adaptive characteristics of black corals has to do with the interaction of the chitinous exoskeleton with the surrounding environment. It is known that the skeleton of these corals can stand high pressures and high flexural stress. To improve the understanding of the chitin role of the antipatharian skeleton, biomechanical tests were carried out on the skeleton of the black corals *Antipathes caribbena* and *Antipathes pennacea*.

Morphological variation was observed by optical microscopy, atomic force microscopy and scanning electron microscope. The biomechanic properties were evaluated by determining the mechanical parameters Young modulus, flexural stiffness and compression modulus by mechanical tests using principles from engineering beam theory and nanoindentation techniques. The results suggest that the microstructural features and the biomechanical properties of the skeleton of these species might contribute to explain the structure-function relationship (bauplan) in the antipatharian skeletal system. It is tempting to establish an evolutive connection between the biomechanical response and the adaptive advantages to the black coral colonies in the deep ocean due to the presence of chitin, but further independent evidence is needed.

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Trends in population dynamics and fishery of the deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the Southern Tyrrhenian Sea (South-Western Mediterranean)

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Abstract

The most part of fish stocks are overexploited; today they are constituted of young and small fishes that are mostly caught before they can reproduce. Long-term temporal data have great importance to the EU Fishery Policy, because decisions must be based on robust and sound knowledge on the level of exploitation that stocks can sustain. Deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) is broadly distributed on shelf and slope, although in the Mediterranean its maximum abundance has been observed in the “upper slope” from 200 to 500 metres of depth. The deep-water rose shrimp is a commercially important species for the demersal fishery in the whole Mediterranean. The aim of this paper is to contribute to the exploitation control of this valuable resource. Time series data (1994-2010) come from experimental trawl surveys as well as from commercial landings. The dynamic population study of the rose shrimp was carried out by analyzing Biomass and Density indices per year and bathymetric stratum, population structure, , sex ratio, maturity, total mortality (Z), natural mortality (M), growth parameters, recruits density and exploitation status of the resource (E). The fishing effort was also calculated. The average annual fishing effort is increasing in the western sector of the study area and sharp decline in the time frame considered. The areas where higher yields of biomass and density (western sector) coincide with those in which even the average annual values of fishing effort are higher. Based on the results obtained *P. longirostris* stock showed an over-exploitation status.

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Distribution and population structure of *Pagellus erythrinus* (Linnaeus, 1758) in the Southern Tyrrhenian Sea (Central Mediterranean)

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Abstract

Common pandora, *Pagellus erythrinus* (Linnaeus, 1758) (Pisces: Sparidae) is found throughout the Mediterranean, Black Sea and North Eastern Atlantic; it is a demersal inshore species that lives either on the rocky bottoms or on the muddy, sandy bottoms and debris of the continental platform at 10 - 320 m depth. The abundance in number and weight, spatial distribution, population structure, sex ratio, length-weight relationship, growth pattern and length at first maturity of *Pagellus erythrinus* were analyzed in this study. The data used belongings from 15 bottom trawl surveys carried out in the Southern Tyrrhenian Sea along Calabrian and Sicilian coasts, within the framework of the MEDITS Project. A total of 2166 specimens of *Pagellus erythrinus* were captured; the species appeared in 29% of the 383 hauls analysed, throughout the whole depth range surveyed. In many years the frequency of occurrence of the shelf reached the highest value (100%), whereas in the slope they fell to 17%. Common pandora was captured in a range between 10 and 283 m. The highest mean density (N/Km²) and biomass (kg/km²) index values was obtained in the 10-50 m depth stratum. The length - distribution of the specimens ranged between 5,5 and 54 cm. Protogynous hermaphroditism characterized the species. The sex ratio, calculated according to the formula $F/M+F$, was 0.77. The length-weight relationship for all individuals was described by the following parameters: $a = -4.155$ and $b = 2.905$. The total lengths at first maturity of females and males were 15.6 and 16.9 cm, respectively.

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Prevalence of *Ceratothoa parallela* (Flabellifera: Cymothoidae) (Otto 1828) in the bogue (*Boops boops*) (L. 1758), South Tyrrhenian Sea (Central Mediterranean)

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Abstract

Ceratothoa parallela (Otto, 1828) is a cymothoid isopod parasite of wild fish species in the Mediterranean Sea and North-eastern Atlantic. The aim of the present study is to assess the presence of *Ceratothoa parallela* in *Boops boops* from the Southern Tyrrhenian Sea with some considerations on the fish-parasite relationships. 2420 specimens of bogue examined for the occurrence of isopods. The parasitic prevalence was interpolated and mapped by using GIS software ArcMapTM 9.0. *C. parallela* was found in the buccal cavity of 118/2302 (5.13%) bogues. Most of parasites (88%) was found on younger bogues, corresponding to the age groups 0 and 1. Non-infested specimens of *Boops boops* exhibited a positive allometry ($b = 3.17$) while infested specimens showed an isometric growth ($b = 3.04$). Slight differences between infested and non-infested specimens were detected, i.e. at a given length non-infested specimens weigh more than infested. In this paper the parasite distribution and the relationship with its host are discussed.

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First observation on *Pteroeides spinosum* (Anthozoa: Octocorallia) fields in a Sicilian coastal zone (Central Mediterranean Sea)

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Abstract

Pennatulaceans, commonly known as sea pens, are colonial organisms belonging to the cnidarian class Anthozoa. Despite their cosmopolitan distribution and, despite they represent often an important portion of megafaunal filter feeders, the ecology and biology of the order Pennatulacea remain poorly studied, especially in Mediterranean Sea. Therefore, this note aims to give a first contribution to the knowledge of the distribution of the Mediterranean pennatulacean *Pteroeides spinosum* (Ellis, 1764). Data were collected by ROV from 10 to 180 metres of depth, along five transects, in a Sicilian coastal zone, placed on the southern border of the Strait of Messina (Central Mediterranean Sea). The presence of *P. spinosum* species was recorded in all the transects from 30 to 160 meters on muddy sand, reaching density values of up to 10 specimens per square metre. The density of the organisms was analyzed in order to characterize the distribution according to transect and depth. Moreover, in correspondence of the major density values the sea pens exhibit an ordinate distribution pattern, similar to “crossed rows”; while in correspondence of the minor density they seemed to prefer a patchy distribution. The main results obtained indicate that both depth and transect influence the distribution and suggest a close relationship between the pennatulids distribution and the availability of the organic matter, also of continental origin. Anyway, the information collected during this study will be implemented in order to better understand the main mechanisms involved to regulate the distribution, especially whereas this species can reach high densities values.

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Distribution of *Paramuricea clavata* (Anthozoa: Octocorallia) on artificial bottom in the Strait of Messina (Central Mediterranean Sea): preliminary data

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Abstract

This note represents the first information about the distribution of the gorgonian *Paramuricea clavata* (Risso, 1826) on the wreck known as “Nave di Faro”. It is placed in the Strait of Messina (Central Mediterranean Sea) at 300 meters from the coastline, perpendicular to it, between 32 and 68 metres of depth. The sampling was carried out, in the winter 2011-2012, through Visual Census techniques by scuba diver. Data were analyzed to obtain a distribution map of the densities of the colonies. Moreover, the distribution was described, for each side (North and South) of the wreck, also according to depth range and the position on the bulkhead. The results obtained highlight differences between the two sides of the wreck about the density (mq) and the distribution pattern. In particular, on the Northern side the colonies are generally less thick. They start suddenly and decrease with depth as well as proceeding seaward from the bow to the aft. Differently, on the Southern side they increase more slowly with the depth and are highest in the central portion of the bulkhead. Although these results are from preliminary data, they suggest that the distribution of *P. clavata* on the studied wreck is intimately related with the hydrodynamic regime of the area. In fact, the Strait of Messina, conjunction between Ionian and Tyrrhenian seas, is characterized by important hydrodynamic phenomena as well as tidal currents. In particular the northward one, flows impetuously rich in nutrients, can influence the filter feeders communities, principally of the Southern bulkhead.

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Immunostimulation affects cultivated kelp

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Abstract

Large amounts of kelps are cultivated commercially all over the world, mostly in Asia. So far kelps are mainly produced for alimentation purposes, but their potential for fast growth makes them an outstanding renewable marine resource, e.g. for the production of bioethanol or biogas. In this light kelp cultivation is widely expected to expand in the near future. Extensive kelp mariculture has to fight with infectious bacteria, herbivores and epiphytes. The aim of our study was to investigate if a stimulation of the kelp immune system leads to a deterrent effect on such enemies. In our work we treated *Saccharina* sporophytes under outdoor conditions -in Germany and China- with oligoguluronic acid, a non-toxic oligosaccharide derived from the alginate cell wall matrix of kelps. Oligoguluronic acid is known to induce defense reactions against pathogens at nano- to micromolar concentrations through activation of specific algal receptors. We here show that crustacean and mollusc grazers are also deterred by oligoguluronic acid, as well as microfoulers. We detected a significant reduction in the cell number of surface associated bacteria after the treatment, as analyzed by fluorescence in situ hybridization (FISH) directly on algal surfaces. We also found a significant increase of the bacterial settlement inhibiting pigment fucoxanthin on kelp surfaces. The results indicate that immunostimulation allows to control various enemies of kelps.

Theme 4: General Marine Biology

Presentation: Poster

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3 – 7 September 2012

Meso-zooplankton production and biomass variability in the North, Irish and Celtic Seas

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Abstract

The chitinolytic enzyme chitobiase (N-acetyl- β -D-glucosaminidase) is expressed during the pre-moult phase of crustaceans and is released into the ambient water after shedding of the exuvium. Chitobiase activity was used as a measure of crustacean (meso-) zooplankton production in sea water samples from the Southern Bight of the North Sea (2000), the Irish and Celtic seas (2008, 2010 and 2011). The relationship between chitin content (glucosamine) and crustacean dry weight was used to estimate water column (meso-) zooplankton biomass, based on vertical hauls with 50 μ m and 200 μ m nets. Sampling sites ranged from intermittently stratified coastal sites receiving varying levels of anthropogenic nutrients to deep, seasonally stratified regions of the shelf. We present data on the seasonal and spatial variability in zooplankton production and biomass. At all stations the lowest estimates of crustacean biomass were recorded during the winter months; December and January, <150 mg C m⁻². Highest biomass estimates were in July the North Sea (5,255 mg C m⁻²) and in May (4,146 mg C m⁻²) in the Irish and Celtic seas. Estimates of production in the North Sea varied between 56 and 990 mg C m⁻² day⁻¹. The range was greater in the Irish and Celtic seas; 8 to 1140 mg C m⁻² day⁻¹. The seasonal and spatial variation in production and biomass will be discussed in the context of hydrodynamic conditions, and the utility of measuring crustacean production by means of the chitinolytic enzyme chitobiase will be examined.

Theme 4: General Marine Biology

Presentation: Poster

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Genetic consequences of landlocking for mussels *Mytilus edulis* L. and cod *Gadus morhua kildinensis* Derjugin from marine lake Mogilnoe (Kildin Island, the Barents Sea)

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Abstract

Mogilnoe is a small anchialine lake inhabited by marine animals and plants. The ecosystem of the Lake is traditionally considered as biologically isolated from the Sea while lacustrine cod is traditionally considered as an endemic subspecies, a product of in situ evolution (Derjugin, 1925). To check these hypotheses we performed a genetic survey of lacustrine populations of blue mussels and kildin cod. Comparative analysis of lacustrine mussels (9 allozyme loci, nucleotide polymorphisms of portions of male and female COI mitochondrial genes) and cod (pantophysin locus, 3 allozyme and 7 microsatellite loci) with presumably ancestral populations from the adjacent Sea revealed significant differences. F_{st} value for mussels was $0,05 \pm 0,019$, for the cod F_{st} was $0,12 \pm 0,033$. Average loss of gene diversity in the lacustrine mussel population was 29% for allozymes and 34% for COI. Average loss of gene diversity in the lacustrine cod was 38%. The Beaumont and Nichols' neutrality test (Beaumont, Nichols, 1996) showed that none of individual mussel nuclear loci have significant different F_{st} values than expected under a neutral model. The same test performed for cod revealed that phosphoglucose isomerase (GPI-2) allozyme locus is under selection. Specifically, the dominant marine allele was virtually absent from the lacustrine sample while 75% of lacustrine fishes bear the allele not found in our maritime samples at all. We conclude that our data does not contradict neither the hypothesis of strong biological isolation of lacustrine populations nor the hypothesis of adaptive divergence of Kildin cod from conspecific populations from the Sea.

Theme 4: General Marine Biology

Presentation: Poster

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The simple conchological feature allows discriminating of *Mytilus edulis* L. and *M. trossulus* Gould in the White Sea hybrid zone

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Abstract

Blue mussels *M. edulis* (Me) and *M. trossulus* (Mt) can be fairly distinguished by a complex of molecular markers. However morphological approaches for distinguishing of two species have also been suggested. Here we test the hypothesis of Zolotarev and Shurova (1997) that Mt in some populations has a prismatic layer under the ligament (there is a distinguishable dark blue stripe under the ligament on the inner side of each valve) while Me has a nacreous layer just beneath the ligament. Mussel samples from the White Sea hybrid zone were genotyped by semi-diagnostic allozyme loci Pgi, Pgm, Odh and Est-D (sample size N=656) or by RFLP of diagnostic Internal transcribed spacer (ITS) locus (N=55). Homozygotes at the species-specific ITS alleles and genotypes with 7-8 species specific alleles at four allozyme loci were treated as pure Me or Mt while other genotypes - as hybrids. Among mussels with a nacreous layer under the ligament 8% were Mt, 71% Me and 21% - hybrids according to allozyme identification. According to ITS identification the proportion was 46, 51 and 3% respectively. Among mussels with a prismatic layer under the ligament 67% were Mt, 11% Me and 23% - hybrids according to allozyme identification. According to ITS identification the proportion was 94%, 0% and 6% correspondingly. We conclude that the conchological trait under consideration is suitable for preliminary identification of *Mytilus edulis* and *M. trossulus* in the White Sea populations.

Theme 4: General Marine Biology

Presentation: Poster

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No place like home: The consequences of previous occupancy for distribution of limpets on rocky shores

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Abstract

In many mobile animals, it is assumed that the habitat patches are differentiated by the resource value to an organism. For many invertebrates, we have no idea which resource axes may be important and, moreover, we do not necessarily understand the value of microhabitat. For non-homing limpets on rocky shores, such as *Cellana tramoserica*, the distribution of animals is often thought to be indicative of food or refuge resources. Using manipulative experiments, we show that the distribution of *C. tramoserica* is actually dependent on the previous occupants of any particular resting site, in that if limpets are removed, incoming limpets will occupy previous resting sites in a much greater proportion than occupying new resting sites. This pattern held also for size-frequency distributions, such that site occupied by small limpets are much more likely to be occupied by incoming small limpets than large ones. From this, we have new evidence that decisions to occupy a microhabitat may not solely be based on resource values but also are associated with public information about previous microhabitat occupants.

Theme 4: General Marine Biology

Presentation: Poster

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Information on Atlantic bluefin tuna (*Thunnus thynnus* L.) from the last “Mattanza” episodes of the Favignana tuna trap (North-west Sicily)

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Abstract

The traditional trap of Favignana island (North-west Sicily) has been one of the most important fishing activities for Atlantic Bluefin tuna since the end of 1800', with relevant industrial, economic and historical impact. In the last few years, following the estimated decline in spawning biomass due to overfishing, strict fishery limitations have been enforced. Tuna biological information, as last product from this activity, were obtained during the last two fishing seasons in May-June 2005 and 2006. Morphometric data were recorded for each specimen, as well as sex and macroscopic maturity stage. Gonad samples for histological examinations and hard structures for age assignment purposes were collected. The data obtained from the present study provided interesting information on Atlantic bluefin tuna population structure and health status. Ancillary information on bycatches are also presented.

Theme 4: General Marine Biology

Presentation: Poster

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Individual and combined toxic effects of mercury, copper and cadmium on *Tigriopus fulvus* (Copepoda, Harpacticoida)

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Abstract

The purpose of this study was to measure the effects of individuals and combined metals (cadmium (Cd), copper (Cu) and mercury (Hg)) on survival (LC50) in a Copepoda Harpacticoida, *Tigriopus fulvus*. *Tigriopus fulvus* was chosen for its sensitivity towards exposure to chemical pollutants of different classes its facility of use and cost effectiveness for laboratory culture. Moreover, this copepod displays a short-term response to changes in seawater quality. The toxicity tests were carried out using nauplii originating from a synchronized culture (24–48 h), from ovigerous females reared in a massive culture obtained from a natural population of *T. fulvus* from the Italian coast. In order to test the toxicity of single chemicals, nauplii were exposed, to five concentrations of each metal in geometric progression plus a control. The concentration range of each toxicant was determined in preliminary tests. Each test was replicated five times. The 48-h LC50 values were computed using probit analysis. The toxicity of mixtures (Cd + Cu, Hg) was also tested and were replicated three times. To identify the kind of interaction among metals, the additive toxicity index (S) was calculated. The results of *T. fulvus* nauplii exposure to the single metals demonstrate that the ranking of toxicity decreases as follows: Hg> Cu> Cd with LC50 values of 0.095, 0.24, 2.12 mg/L respectively. One-way ANOVA showed that the toxicity of all metals had a significant effect ($p<0.05$) on mortality already at the lowest concentrations. Acute toxicity bioassays for mixture tested, showed a synergistic response.

Theme 4: General Marine Biology

Presentation: Poster

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Changes in the fish populations of the Eastern Scheldt due to changes of the tidal regime

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Abstract

This study will focus on changes in long term and seasonal trends of fish populations in the Eastern Schelde during and after the completion of the storm surge barrier. Hereby the system turned into a more stable marine basin. After the storm surge in The Netherlands in 1953, a plan was devised to protect the Dutch coast against future storm surges. Most estuaries in the Southwestern part of the Netherlands were closed. The Eastern Schelde was partially closed. The construction of a barrier started in 1976 and completed in 1986. During and after completion of the storm surge barrier major changes in environmental conditions occurred due to alteration of the tidal regime such as reduction of tide, lower current velocities, and stable salinities. Seasonal fish monitoring in the Eastern Schelde was conducted from 1983 to 1990 and resumed from 1999 to 2001. Twelve stations were sampled along a 40 km transect from west (mouth of the former estuary, where the barrier was built) to east. Clear seasonal differences in densities, biomass and diversity of fish species were observed. Higher values were observed during the summer period, lower in winter or spring. Flatfish were found more near the mouth of the estuary, gobies more inland. During later years, after completion of the storm surge barrier, in general densities changed. For flatfish densities decreased, for gobies increased. For flatfish densities of juveniles decreased more than adults. In our presentation we will discuss the observed seasonal and long-term changes in composition of the fish population in relation to environmental changes and function of the basin as nursery area.

Theme 4: General Marine Biology

Presentation: Poster

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Limpet orientation in response to changes in barnacle cover

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Abstract

How animals behave can lead to habitat selection at the level of the overall habitat (kilometres) or among microhabitats (from centimetres to metres, relative to body size). This selection may be based on animals responding to stimulus from the overall habitat or instead from available microhabitats within habitats. One way individuals may respond to variations in habitat at a very fine scale is by positioning their body to face a specific direction in space ie. their orientation. This behaviour can also be as a response to either habitat or microhabitat scale properties with consequences for fitness and ecological interactions. My study was done on marine molluscs (*Cellana tramoserica*) that attach to, move across, and feed on rocks on intertidal shores. Previous studies have found fewer limpets in areas where barnacles create potentially unfavourable topographic irregularity. My study found that the frequency of limpets orientating head downwards varied with barnacle cover. Manipulative experiments showed that limpet behaviour changed after the removal of barnacles, with a greater proportion of limpets orientating head downwards. My results suggest that the presence of barnacles may physically limit the available orientations limpets are able to adopt, and without these limitations a downwards orientation may be being actively selected over alternate orientations.

Theme 4: General Marine Biology

Presentation: Poster

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Population structure and production of the bivalve *Abra tenuis* (Montagu, 1803) in Vouliagmeni Lake, Greece

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Abstract

The bivalve mollusc *Abra tenuis* has a fragmentary distribution in the Eastern Atlantic occurring from Scotland to Mauritania. In the Mediterranean it has been mentioned only from two sites, one in Tunisia and one in Greece. This paper presents the characteristics of a third Mediterranean *A. tenuis* population from a very particular environment in Greece. Brackish water Vouliagmeni Lake has no direct communication with the adjacent sea. Sea water is supplied by an underwater network of flooded caves. Sampling was carried out at approximately monthly intervals from October 2004 to September 2005. During this period water temperature remained relatively constant ranging between 19.8°C in January to 27.8°C in June, while salinity varied from 14.3 in May to 20.2 in February. *A. tenuis* densities varied from 1000 m⁻² in May to 10680 m⁻² in July. Although there were two peaks of recruitment, one in April and one in July, individuals smaller than 1.5 mm occurred throughout the year suggesting a continuous reproduction. The maximum size observed was 8 mm but only a small percentage of individuals exceeded 6.5 mm, which is smaller than that of almost all other known *A. tenuis* populations. It is suggested that the high temperatures in the lake promote faster maturation and reproduction and, being a monotelic species, *A. tenuis* never reaches its potential maximum size. The total annual biomass production amounted to 25.11 g/m² DW, while the P/B ratio was estimated to 2.3 which is within the range calculated for other bivalves.

Theme 4: General Marine Biology

Presentation: Poster

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The invasion of an artificial lagoon (Lake Veere, The Netherlands) by *Mnemiopsis leidyi*: a guest that permanently settles in the deeper parts of the system?

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Abstract

Lake Veere is a medium-sized artificial lagoon connected with the neighbouring Eastern Scheldt estuary through an inlet. The exotic invader *Mnemiopsis leidyi* was first recorded in Lake Veere in 2007. The species most probably entered the system through the inlet from the Eastern Scheldt. In order to study the population dynamics of the species in the lake, a monthly monitoring programme of jellyfish (*sensu lato*) was started in 2010. The annual variation in abundance of the jellyfish revealed seasonal peaks, or even blooms, of *M. leidyi* in summer/autumn (up to 211 ind m⁻³), that were preceded by peaks of the native *Aurelia aurita* in early spring (with up to 110 ind m⁻³). Analysis of the spatio-temporal patterns in population dynamics revealed that *M. leidyi* entered the system from the Eastern Scheldt at the start of the monitoring, and managed to settle at a few deeper spots, and most likely became a permanent resident in Lake Veere in 2011. Apparently, the invaders survive during winter in the deeper parts of the lake from where 'founding parents' manage to repopulate the lake each year, or even cause an outbreak. After successful settlement it took 2 years for the *M. leidyi* to settle permanently in the most distant deeper parts of the lake from the inlet, overarching a distance of approximately 25 km. Patterns and processes of the outbreaks of *M. leidyi* and *A. aurita*, consequences for the ecosystem functioning, and possible interactions between the species outbreaks are further discussed.

Theme 4: General Marine Biology

Presentation: Poster

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Comparison of sediment grain size analysis techniques to explain variation in macrobenthic coastal communities: A short time series example

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Abstract

Sediment particle size analysis (PSA) is an important tool used to explain the distribution of benthic invertebrates in habitat mapping and assessing habitat quality on the seafloor. Here, we use a three year data set from five stations in Kinsale Harbour, south coast of Ireland, to assess the effect of analysis technique on the amount of macrofaunal variance explained by PSA. The macrofaunal communities changed in association with PSA changes between muddy sand and sandy mud. A combination of laser particle sizing particles <1mm and wet/dry sieving particles >1mm (LPS) explained more macrofaunal variance than using wet and dry sieving alone (WDS). Ecological Status classifications using the Infaunal Quality Index and EUNIS sediment classification were robust to changes in PSA method. LPS reports particles as spheres equivalent to the average particle diameter, whereas WDS selects for the shortest particle axis. LPS derived PSA appears to better reflect the hydrodynamic conditions at a site, which is the factor that often most strongly determines community distribution. Employing the optimal PSA method and sampling strategy will improve benthic monitoring.

Theme 4: General Marine Biology

Presentation: Poster

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Seasonal variation in the picoeukaryote *Micromonas pusilla* in an arctic fjord, Svalbard, as revealed by quantitative PCR

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Abstract

The seasonal variation of the picoeukaryote *Micromonas pusilla* was investigated in Billefjorden, Svalbard by real time quantitative Polymerase Chain Reaction (QPCR). Billefjorden is an arctic sill fjord with annually forming fast ice dominated by cold, locally produced water and limited influenced by the warmer and more saline water of the Isfjorden system. CTD profiles and water samples from four depths (5m, 15m, 35m, 150m) for qPCR, fractionated Chl *a* biomass and nutrient analyses were collected monthly from April to August 2011. The Billefjorden pelagic system in 2011 was characterized by a massive advection of warmer water from outside the sill in early May, and a *Phaeosystis*-dominated bloom that peaked in mid-May. *Micromonas pusilla* was found to be an important picoeukaryote in the post bloom situation in June and July, with cell numbers exceeding 6.5×10^5 cells ml⁻¹. During the *Phaeocystis*-dominated bloom in mid-May, the cell numbers were much lower and *M. pusilla* contributed minimally to the phytoplankton. Although *M. pusilla* is known as an important picoplanktonic primary producer in arctic waters, it only accounted for a limited amount of the picoplanktonic fraction of the Chl *a* biomass, suggesting that other picophytoplankton species also play important roles in the Billefjorden ecosystem.

Theme 4: General Marine Biology

Presentation: Poster

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Physiological responses of deep-water sponges to anthropogenic stress

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Abstract

Global dependence on natural resources from the marine environment is rapidly leading to ecosystem changes due to increased anthropogenic stress. Both bottom trawling and oil drilling activities are common practices along the Norwegian coastline. Both activities result in the suspension of large quantities of sediments. Bottom trawling re-suspends natural sediments into the water column and oil drilling releases large quantities of non-indigenous clay sediments to the marine environment. The impact of anthropogenic stresses on deep-water sponges is unknown. This is surprising, given sponges are important components of deep water benthic communities, contributing significantly (up to 90%) of the benthic biomass and high biodiversity found along the entire Norwegian coastline. This presentation will provide results from lab based studies on the physiological response of the common deep-water sponge (*Geodia barretti*) exposed to different sources of anthropogenic suspended sediments (i.e. from bottom trawling, oil drilling and mining waste). Short term exposure (4 hours) to ecologically relevant concentrations of contrasting suspended sediments can result in a reduction of metabolic activity by more than 80%, primarily as a function of reduced pumping activity. This reduction in pumping and metabolism may have ongoing consequences for feeding, growth, reproduction and survival of deep-water sponges. Therefore, understanding the response of deep-water sponges to sedimentation stress will be critical for the management of deep-water marine ecosystems.

Theme 4: General Marine Biology

Presentation: Poster

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Capacity of tropical seagrass meadows as blue carbon sinks

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Abstract

Coastal habitats such as mangroves, salt marches and seagrasses are more effective in sequestering carbon than their terrestrial counterparts. Hence, these habitats have an important function in climate change mitigation. In a three-year research program, we assess the carbon sink capacity of seagrass meadows along the East African coast (in tropical Tanzania and subtropical Mozambique). We here present results from the first field survey focusing on natural variability of carbon in different types of seagrass habitats dominated by climax species, including *Thalassia hemprichii*, *Enhalus acoroides*, *Thalassodendron ciliatum*, *Cymodoceae rotundata* and *Cymodoceae serrulata*. In each site, a range of seagrass biometrics were measured or estimated, and sources of organic matter and carbon burial rates in the sediments were determined in depth sections using conventional push cores. We hypothesised spatial patterns of variability in carbon content among seagrass habitats as well as across latitudes.

Theme 4: General Marine Biology

Presentation: Poster

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A new potentially harmful dinoflagellate from Norway

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Abstract

A golden brown and weakly armored dinoflagellate (10-12 long, 6-8 micron wide) was isolated from a seawater sample collected in the vicinity of a fish farm in Skipingsdalen, Norway on October 5, 2011. Previous to and during the time of sampling the fish had shown signs of distress and some mortality was recorded. Water samples containing the alga lysed cow red blood cells. A uni-algal culture has been established and its partial large (28S) ribosomal DNA sequence has been determined. It differed from all available sequences and the closest relative appeared to be *Woloszynskia cincta* (98 % similarity). The culture caused hemolysis in cow red blood cells and was toxic to the brine shrimp *Artemia*. Pigment composition has been determined using HPLC.

Theme 4: General Marine Biology

Presentation: Poster

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The invasive comb jellyfish *Mnemiopsis leidyi* in a changing climate: more plankton prey are eaten in warmer waters

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Abstract

More than half a decade ago the ctenophore *Mnemiopsis leidyi* was first sighted in Northern Europe. It has since reoccurred every year in late summer–autumn. Under suitable conditions this comb jellyfish has a high reproduction rate and can form dense populations. Because of high individual predation on mesozooplankton prey *Mnemiopsis leidyi* can rapidly eat much of the standing stock of e.g. copepods. In this study I show how the mortality risk of zooplankton prey depends on water temperature. Laboratory experiments were performed to quantify individual clearance rates as a function of temperature and predator size. These measurements were then used to predict how the potential prey mortality risks caused by present day ctenophore populations would vary with water temperature. The mechanisms responsible for the temperature dependent clearance rate in *Mnemiopsis leidyi* are discussed based on detailed studies of prey capture success and activity of the cilia creating the feeding currents used in the feeding process.

Overview Timetable

Monday 3 September 2012

0800 - 1200 Registration

1200 - 1230 Opening ceremony

1230 - 1315 **Introductory lecture: Jeffrey A. Hutchings (Canada)** - Ecological effects of human activities in the sea – challenges and possibilities

1330 - 1750 **Theme 1: Ecological effects of aquaculture and fisheries**

1330 - 1410 **Keynote speaker: Geir Lasse Taranger (Norway)**: Risk assessment of environmental impact of Norwegian Fish farming

1550 - 1630 **Keynote speaker: Simon Jennings (United Kingdom)**: Towards integration of fisheries and environmental management

1900 - 2100 **Reception** at the Institute of Marine Research, Flødevigen Research Station

Tuesday 4 September 2012

0900 - 1800 **Theme 2: The marine environment and responses to climate changes**

0900 - 0940 **Keynote speaker: Thorsten B.H. Reusch (Germany)**: Evolutionary adaptation to global change? - examples from the base of the marine food web

1220 - 1340 Lunch

1340 - 1420 **Keynote speaker: Katja Phillipart (The Netherlands)**: Changing climate and changing seas: what does it mean for Europe?

1900 - 2100 **Welcome reception**. City Hall. Host: Arendal municipality and Mayor Einar Halvorsen

Wednesday 5 September 2012

0900 - 1500 **Theme 3: Management of coastal resources – Marine Protected Areas**

0900 - 0940 **Keynote speaker: Espen Moland Olsen (Norway)**: Marine protected areas and recruitment in coastal populations: an ecological and evolutionary perspective

1100 - 1140 **Keynote speaker: Einar Eeg Nilsen (Denmark)**: "Genes that matter": Application of spatiotemporal population genomics for identifying ecological structures and local adaptation in the sea

1220 - 1340 Lunch

1520 - 1740 **Theme 4: General Marine Biology**

1740 - 1930 **Poster Session**

Thursday 6 September 2012

0900 - 1240 **Theme 4: General Marine Biology**

0900 - 0940 **Keynote speaker: Lisa Levin (USA)**: Deoxygenation and Acidification of Continental Margins: Oxygen Minimum Zones on the move

1240 - 1400 Lunch

1430-1800 **Yellow submarine**. Buses from Arendal Kulturhus to Hove Campus departure 1415

1900-2300 **Banquet** at Hove Campus.

Friday 7 September 2012

0900 - 1240 **Theme 4: General Marine Biology**

1200 - 1330 Lunch

1330 - 1415 **Finale lecture by Nils Christian Stenseth (Norway)**: Challenges for the Marine Environment for the next decade

1415 – 1445 Awards:

- Best oral presentations – Wiley-Blackwell
- Best poster presentations - Herman Hummel, MARS-network
- Best student presentations - Matthew Frost, MBA of the United Kingdom

1445 – 1500 Closing remarks

List of participants

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Flødevigen Marine Research Station



Flødevigen Marine Research Station near Arendal was founded in 1882, as a “hatchery” for cod fry. Now 126 years old, it is one of the oldest stations of its kind in Europe. The hatching facility was started on the initiative of Gunder Mathiesen Dannevig, who wished to regenerate the cod stocks of the Skagerrak coast, which had been much stronger “in the old days”. During the first thirty years of its existence, the work of the station focused on hatching cod and trying to demonstrate the usefulness of the procedure. This led to what were often lively debates, that have been of great importance for our understanding of recruitment mechanisms in marine fish species. It also meant that the important series of shore net-hauls that continue to this day were properly organised from 1919 onwards. The station developed from being a purely privately financed institution in the direction of a growing dependence on public-sector support, and was finally taken over by the state in 1917. From 1911, G.M. Dannevig’s son Alf was director of the station. Little by little, it assumed the character of a marine biology research station, which in the course of the years worked on a large number of problems in the field and the laboratory. However, it retained its name of “hatchery” until 1957, when a third-generation Dannevig – Gunnar – took over, since when it has been known as the Flødevigen Biological Station. In 1974, the station became part of the Institute of Marine Research. The station was upgraded and expanded in 2011 to further increase its ability to perform research of high international standard.

All-round research

Flødevigen has the equipment and the competence to perform a wide range of research in the field, the laboratory, indoor aquarium facilities and in its large outdoor basins. Today, resource management-oriented and basic research in a wide range of fields is carried out at Flødevigen:

- Coastal zone ecology and mapping of biological resources in the coastal zone
- Environmental conditions on the coast and in the Skagerrak and the North Sea
- Zooplankton and planktonic algae, including the hazardous algae that make shellfish toxic to human beings.
- Coastal resources such as lobsters, eels and coastal cod
- Shrimp, herring, sardines and industrial fish resources in the Skagerrak and the North Sea
- The deep-sea resources of the North-east Atlantic.

Flødevigen hosts the secretariat of the important international MAR-ECO project, which is studying the marine zoology of the Mid-Atlantic Ridge between Iceland and the Azores. You can read more about MAR-ECO at www.mar-eco.no.

