NORDIC MARINE SCIENCE TODAY

Highlights from the Nordic Marine Sciences Conference 2010, Strömstad

Global change in the seas

Management of seas and coastal areas

Mapping, measuring and modelling the seas

Find out more

Page

This Conference Magazine is based on talks and events at the Nordic Marine Sciences Conference in Strömstad, September 13-16 2010.

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Photographs Karin Björk unless otherwise specified

Download pdf: www.shf.se

Print: Responstryck 2010, 2000 copies

Front page photos:
Karin Björk and Lisa Levin/US National Science Foundation (right, middle)

About the Conference

Nordic Marine Sciences Conferences (NMSC:s) are organized approximately every four years by the societies for Marine Sciences in the Nordic countries. Presently there are societies active in Sweden, Denmark, Norway and Finland. The meetings provide an arena for exchanging knowledge and encourage collaboration between researchers of different marine disciplines, management and industry.

The NMSC 2010 in Strömstad was based around three themes: *Global change in the seas, Management of seas* and *coastal areas and Mapping, measuring and modelling the seas.* The conferene gathered a historical record of 260 delegates, of which 99 presented their latest findings during the oral sessions.

More information; visit the Swedish Society for Marine Sciences at www.shf.se

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The Nordic Marine Sciences Conference 2010 was organized by the Swedish Society for Marine Sciences and the University of Gothenburg.

The Conference was sponsored by:
Association of Norwegian Oceanographers
Danish National Council for Oceanography
Mare Novum
Nordic Marine Academy
Nordic Seagrass Network
Strömstad Municipality
Swedish Board of Fisheries
Swedish Environmental Protection Agency
Swedish Institute for the Marine Environment
Swedish Meteorological and Hydrological Institute, SMHI
Swedish Research Council, FORMAS

Marine Science on Track

Marine science in the Nordic countries contributes leading and important research. This conclusion is quite obvious after the Nordic Marine Sciences Conference 2010 in Strömstad. State-of-the-art science in the most urgent marine research issues was presented, covering ocean acidification, coastal planning and management, functions and services of marine ecosystems, adaptations of populations and species under environmental change, oceanographic modelling and population connectivity, to mention some of the topics.

This meeting also manifested a break-through for a more multidisciplinary meeting agenda. While earlier meetings have focused on marine science issues, this time social scientists, environmental economists and researchers in marine law, representative for authorities and concultancy companies contributed to a much appreciated widening of the debate not only during sessions, but also during the always so important coffee breaks.

Thanks to economic support from the Nordic Marine Academy, Formas and other funding agencies, internationally leading scientists were invited and certainly contributed with inspiring key-note presentations and engaged discussions. In addition, a large part of our staff of young researchers and research students were on stage giving interesting talks and poster-presentations.

Nordic marine science is on track addressing urgent threats to the marine environment. Hence, collaboration among scientists of different disciplines and between scientists and end-users seems more important than ever before, to solve the problems. Meeting places like the conference in Strömstad are an essential part in developing new approaches of research and implement research results in policy and management. This conference magazine is one way of bringing insights and highlights from the conference to a wider audience.

Kerstin Johannesson and *Bengt Karlson*, conference conveners

ACIDIC PRESSURE *on marine ecosystems*

Acidification of the oceans is happening here and now. However, large scale predictions of future effects are so far impossible to predict. According to *Sam Dupont,* Dept of Marine Ecology, University of Gothenburg, the impact seems to be extremely species – and even population-specific.

As a consequence of CO_2 emissions to the atmosphere, oceans are becoming more and more acidic. The oceans have already taken up around a third of the CO_2 produced by humankind since the industrial revolution. While this has decreased the amount of CO_2 in the atmosphere somewhat, oceans pay the price in terms of changes in chemistry. When CO_2 is absorbed by the water, it turns into carbonic acid which increase seawater acidity.

Sam Dupont

Ocean acidification is believed to become a serious threat to many organisms and will probably have implications for food webs and ecosystems all over the world. In Scandinavian waters, a doubling in acidity by the end of the century is expected. The rate of change in acidity is extremely fast, some species will in the near future experience conditions that they never experienced over the last hundreds of millenia.

Marine calicifiers are often pointed out as vulnerable to ocean acidification. However, it is still not clear which specific organisms will suffer or benefit from the new conditions in the oceans.

Results from Dupond´s studies using echinoderms as models, indicate that there will be a shift towards more deviant reproduction in the future oceans. This may in turn affect the way ecosystems are organized, favouring species with more "acidic-resilient reproduction". Species producing non-feeding larvae may, for example, benefit while species using the classic mode of reproduction involving a feeding larvae may suffer more.

– Research on acidification is in many ways yet in its infancy, but we certainly do know enough that if we do not cut CO_2 emissions, the marine ecosystems will change, Dupont concludes.

Photo: Sam Dupont

Two species of enchinoderm larvae raised at pH 8.1 (today) and pH 7.7 (scenario for 2100 – a doubling in acidity). The green sea urchin (top) grows slower in acidic conditions resulting in smaller individuals at a given time, while the common sun star (bottom) grows faster under acidic conditions.

DON'T BE FOOLED BY COLD WINTERS

Despite slowly developing a warmer climate, Europe has experienced some very cold and snowy winters in the past century. These cold periods may partly be linked to a variability in sea surface temperature in the North Atlantic, known as the Atlantic Multidecadal Oscillation, AMO.

After studying historical data *Antoon Kuijpers* from the Geological Survey of Denmark and Greenland – together with colleagues from the universities in Aarhus and Gothenburg – has found a link between periods of regional sea surface warming in the North Atlantic and cold winters in Europe.

Since 1997, AMO data indicates that we now may enter a similar climate regime as after the 1930's, with colder winters in the coming twenty to thirty years. But if the historical pattern is presumed, AMO will again change and the winter climate turn milder. Enhanced by a global warming trend, this may lead to fast and significant winter warming by the midth of the present century, Kuijpers warns.

CLIMATIC EFFECTS ON BALTIC SEA COD

A future temperature rise could affect cod stocks along the Swedish coast very differently. The stock in Bornholm might be a winner.

Juvenile cod grow faster in warmer, shallow waters while adults are favoured by conditions at colder depths. *Anders Persson* from Dept of Biology at Lund Unversity has modelled future climatic effects in four cod spawning areas at Bornholm, Arkona, Öresund and Kattegatt.

According to Persson´s models, a water temperature rise of 3 degrees would increase growth opportunities to juvenile cod in all areas. For adults the situation is more complex: In the Bornholm basin, growth opportunities continue to be better, whereas in the other areas adult cod will experience poorer or roughly the same conditions as today.

Photo: Antoon Kuijpers

SATELLITES PICTURE FUTURE OCEANS

Where do observed changes in plankton biomass lead? Satellite remote sensing and macro-ecological theory might provide us with a not so pleasant answer. Model results, to a large part coherent with existing data, suggests that if current trends proceed, future oceans may be dominated by bacteria instead of phytoplankton.

There has been a worldwide and significant decrease in phytoplankton over the past decade. Phytoplankton, the very foundation for marine ecosystems, contains chlorophyll which is important to make the photosynthesis work. It is also critical for the oceans function as converters of CO_2 to oxygen.

– As a consequence of phytoplankton drawback, chlorophyll has decreased significantly since 1998, *Patrik Strömberg* at SMHI states, citing several international studies.

By combining satellite sensing products with a "Community Size Distribution Model", phytoplankton and zooplankton biomass can be estimated. The details of how changes in plankton community structure will affect global ocean systems remain unknown.

– But, modelled results tell us that with current trends, we are confronting enormous changes at a global scale, Strömberg says. This will affect not only fisheries and ecosystem productivity in general, but also the oceans CO_2 net uptake as we might actually end up with oceans starting to produce CO_2.

The results derive from Strömbergs PhD at Plymouth Marine Laboratory, University of Bristol in England 2006-2009.

What´s the most urgent message from science to policymakers?

Philipp Schubert
Leibniz Institute of Marine Sciences
The need to stop the loss of biodiversity. This is a major thing in fisheries as well as in other areas. History has already shown that loss of key-stone-species might have a bigger impact than previously known.

Karin Larsen
Faroe Marine Research Institute
Climate change needs to be addressed in a serious way. All climate models predict changes in the Atlantic inflow of heat and salt water to the Arctic. Although this has not yet been observed, we need to be aware that there is a risk for a sudden change in a warmer world – that we might reach a "point of no return".

Rutger Rosenberg
University of Gothenburg
The dead zones – sea areas with low oxygen concentrations – are spreading rapidly and worldwide. Dead zones are today at least of the size of Great Britain and are growing exponentially. The only solution to this great environmental problem is to reduce the use of fertilizers and input of nutrients to the sea.

Trine Bakkeby
Norwegian Institute for Water Research
We need to understand that all species are complexly interlinked and treat the marine environment as a whole system. An ecosystem approach is needed, even though this may be time consuming and expensive. But the political system needs to find ways to cope with it. We must also find good systems for finansing complex and wholistic research projects lasting for more than three or four years.

Photo: Anders Persson

FISHERY *evolves smaller fish*

There is increasing evidence that intensive fishing can cause evolutionary changes related to growth, sexual maturation and reproduction in exploited fish stocks.

– This need to be considered from a management perspective, says ecologist *Ane Laugen* at Swedish University of Agricultural Sciences.

Trends toward maturation at younger age and smaller size have been recorded in several exploited fish species such as Atlantic cod, haddock, plaice and grayling. The mechanism behind is that intensive fishing may favor individuals that reach spawning before they are caught, and thus set up evolution towards fish that mature early and small.

– Given that big mature females produce the largest number and best quality of eggs within fish populations, these evolutionary changes could have overall negative consequences for fish recruitment, Laugen says. Consequently, independent from other negative effects of fishing, fishery-induced evolution may change fishery yields and stock sustainability, and more generally the utility of exploited stocks and ecosystems services.

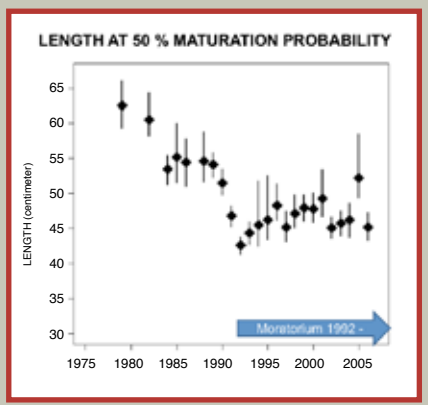
So what can be done?

– The most general advice is to fish less, says Laugen. Numerous models have shown that reduced harvest rates will decrease the rate and amount of evolution. Additionally we should explicitly consider the evolutionary consequences of fishing activities and evaluate its impact on society.

One way to do this is to perform Evolutionary Impact Assessments, EvoIAs. EvoAIs are a set of methods to assess the effects of fisheries-induced evolution on fish stock utility, and to compare the outcome of alternative management options. Utility can be measured as yield in monetary units, but also in terms such as biodiversity, employment and value for recreational fishing and tourism. EvoIAs are conducted in a dialouge between scientists, managers and other stakeholders, thus recognizing that different groups may ascribe a fish stock different utilities. In this way, EvoIAs may facilitate discussions and assist the management of affected stocks.

So far, EvoIAs have been developed for North Sea plaice, and is in progress for North East Arctic Cod and North Sea sole. Moreover, ICES has established a working group to explore the management implications of fisheries-induced evolution.

Ane Laugen



The crash of New Foundland cod was preceeded by a fast decline in maturation bodysize. In 1992 the cod fishery was closed.

Source: Baulier, Lilly, Dieckmann & Heino: Maturation trends in cod stocks off Labrador-Newfoundland revisited: further trends and the role of body condition (in prep).

CHALLENGE FOR FISHERIES

Fish do not swim aimlessly around in a borderless marine environment during their lifetime. In fact, many fish stocks turn out to have directed movements, resulting in population structures on remarkable small geographical scales. Meaning for example, that if a stock is overfished in one area, fish from other areas will not automatically fill the gap.

Recent studies show that common fish species such as cod, herring and sprat are spatially structured into more or less reproductively isolated populations. This is what Prof in marine ecology *Carl André*, University of Gothenburg and his research team has revealed through analysis of DNA and otholit-structures. Locally adapted and genetically different fish populations may be vulnerable to high fishing pressure if they depend upon the conditions in single areas.

– The recognition and understanding of the mechanisms behind population diversity is simply of paramount importance for fishery management, André states.

COLD WINTERS FREEZES PRAWN FISHERY?

After several years of good catches, the prawn fishery in Norway and Sweden was very poor in 2010. Based on historical data, *Jon Albretsen* at the Norwegian Institute of Marine Research, suggests a relationship between cold winters and declines in the prawn fishery.

Photo: Østien Paulsen

The last winter in Scandinavia was cold with persistent northeasterly winds replacing the inflow of moist, warm air from the North Atlantic. The subsequent cooling of the North Sea and Skagerrak surface led to the penetration of dense, cold water into the bottom of the Norwegian Trench.

As a consequence the deep water in Skagerrak was replaced by cold North Sea water, approximately 2 degrees below normal in the traditional prawn fishing fields.

Prawn catches during spring and summer 2010 were about 40 percent lower than previous years. According to Albretsen the situation was similar in the prawn fishery after the cold winter in 1963, with a decrease in catches of 50 to 70 percent in the Skagerrak area. This was followed by a temporarily increase in catches off the Norwegian west-coast, indicating that the prawn stock moved westward and northward, displaced by the cold water masses.

UNSOLVING THE MYSTERIES OF EELS

Recruitment of the European eel has declined since the 1980-ies and is now down to one or a few percent of the historical level. The cause behind this decline is still an open question. Ongoing European research project EELIAD aims to solve some of the mysteries.

The project´s focus is on the oceanic phase of the eel life cycle. One part is to study spawning migration from the European coast to the Sargasso Sea, using satellite and data storage tags.

– Results so far show that predation on the adult eels is unexpectedly high, says *Håkan Westerberg* from Swedish Board of Fisheries. Almost 40 percent of eels tagged in Bay of Biscaya and 17 percent from Ireland have been taken by sharks or other big fish before they left the continental shelf.

More information: www.eeliad.com

Håkan Westerberg

Eel with satellite tag. Photo: Kim Aarestrup

MANAGING HOME-BOUND LOBSTERS

Managing local populations of lobster makes a difference. Results from sixteen years of research at the lobster no-take zone Kåvra on the Swedish west coast are unambiguous.

Research in the 2.2 km^2 reserve Kåvra outside Lysekil includes tagging of more than 4000 adult lobster individuals and satellite tracking of lobster larvae. *Vidar Øresland* at the Swedish Board of Fisheries, reports that only 1.4 percent of tagged lobsters have been recaptured more than 1 km outside the reserve. This indicates that adult lobsters have a very limited migration.

Studies on lobster larvae have been conducted by tracking water currents at relevant depths during the larval period. The results suggest that lobster larvae along the Swedish west coast are mainly locally produced. Thus local populations probably benefit from restrictions that prohibits catching egg-carrying females, since the larvae produced in the area have substantial impact on local recruitment.

The Intergovermental Oceanographic Commisson, IOC, celebrates 50 years of successfull collaboration.

Invited speakers inspire the deletates.

AROUND

Lisa Sundqvist was awarded the Dyrssen Prize for the best degree project thesis 2010.

Pam Fredman, head of University of Gothenburg, opens the conference.

Stimulating discussions during postersessions.

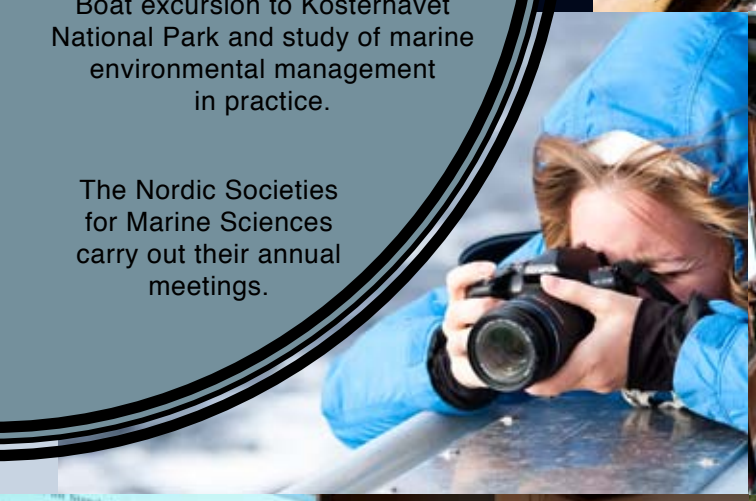
Close up contact at the Lovén Centre on Tjärnö.

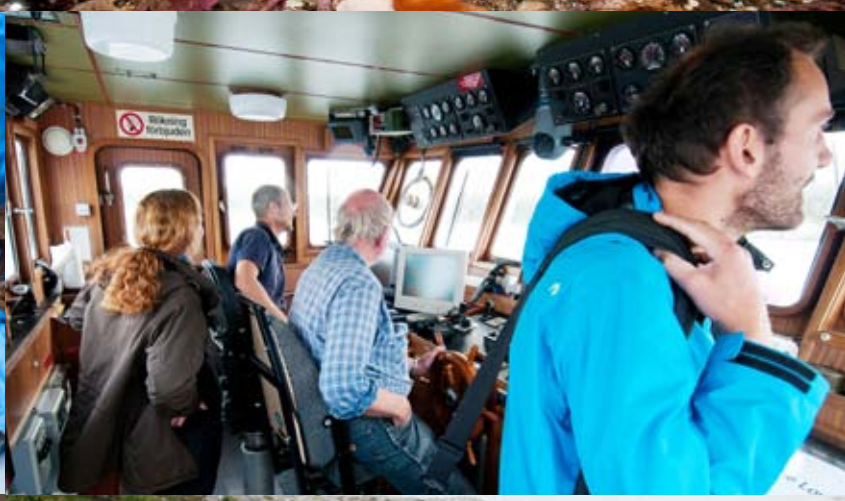
THE CLOCK

NMSC 2010

Boat excursion to Kosterhavet National Park and study of marine environmental management in practice.

The Nordic Societies for Marine Sciences carry out their annual meetings.





Time to rethink biodiversity

PRIORITIES?

– It is time to rethink the priorities in conservation management, Prof in marine ecology *Kerstin Johannesson*, University of Gothenburg, argues. A shift from focusing on rare species towards more common ones with important functions for ecosystems may very well be the best way to both buffer for future global change as well as protect biodiversity.

In safeguarding marine biodiversity, should we continue to focus on rare species which if they are lost will be gone forever? Or should we focus on managing more common species?

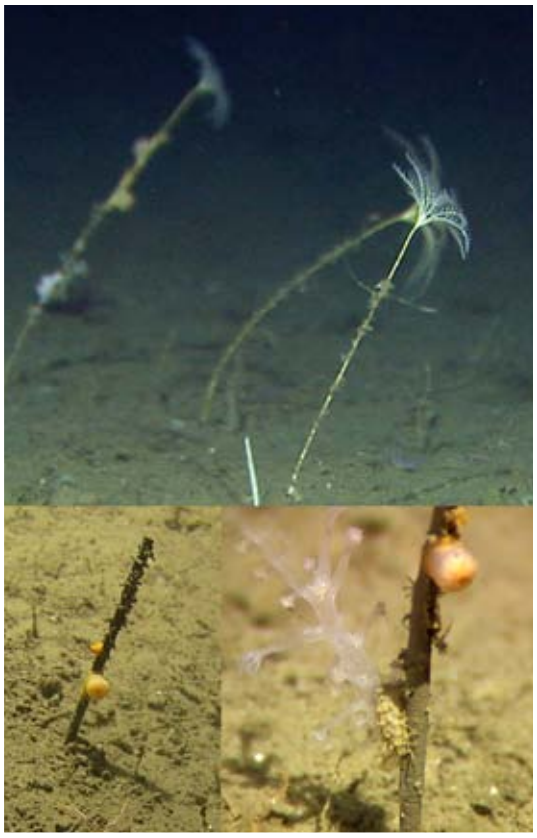
Johannesson strikes for the second approach and thereby puts several question-marks behind today´s species-focus in conservation. Key arguments are that rare species often are extremely costly to monitor just because they are hard to find, and that no data exists that prove rare species to be important to ecosystem functions.

With limited resources for nature conservation, given the objective of securing life-sustaining systems on the planet, Johannesson claims that we are likely to be better off with a shift in focus from rare species towards common ones with important ecosystem functions.

– Protection of common species and their genetic diversity has – in several studies – shown to positively correlate with various ecosystem functions, Johannesson states. Hence, loss of local populations of common species might have adverse effects beyond loss of single rare species. In addition, loss of genetic diversity within common species may for example decrease the potential for evolutionary modifications to meet changes in the marine environment, and risk future extinction of ecosystem key species.

More focus is needed to assess levels of local adaptation in populations of the most common species, especially those with functionally important roles. This – concludes Johannesson – may in fact also be the best way to protect rare species as they will benefit from healthy ecosystems sustained by genetic diversity of the common species.

Kerstin Johannesson



CONNECTIVITY – A MATTER OF SURVIVAL

When selecting protected areas, one important criterium should be how well organisms can disperse between areas – their connectivity. Today, this is largely neglected, according to Prof in marine ecology *Per Jonsson,* University of Gothenburg.

The adult stage of many marine organisms is immobile and therefore dispersal among areas often depends on the inflow of microscopic spores and larvae. Hence, this connectivity is vital for the persistence of populations we want to protect. Jonsson and his colleagues have developed a method for identifying how well different areas are connected to each other, using ocean circulation models and larval behavioural models.

– The present Natura 2000 network in shallow areas of the Baltic Sea was selected with no information about connectivity, Jonsson says. It is not surprising that the overlap with a modelled optimal network, based on best possible connectivity, is only about 15 percent.

Photos: MARAENO – Inst of Marine Research

VULNERABLE HABITATS OF THE DEEP

In the deep sea, benthic corals, sponges and sea pens provide valuable habitats to many other organisms. Thus, they increase local biodiversity significantly.

– Results from video-observations off northern Norway, conducted by the MAREANO-mapping program, show that the importance of habitat forming species increases with depth, says *Lene Buhl Mortensen* from the Institute of Marine Research in Bergen. When the complexity of the surrounding geological substrate and food supply decline, the three-dimensional structures of corals and other organisms offer crucial substrate for attachment, shelter and feeding.

The distribution and nature of habitat forming organisms in the deep sea is still poorly understood. The situation is urgent, Buhl Mortensen claims:

– Benthic species are particularly vulnerable to physical disturbance; already today fisheries are expanding deeper and deeper, and the oil industry is just waiting to move out their riggs.

More information: www.maraeno.no

SEAGRASS GENETICS AND CONSERVATION

Seagrasses are among the world´s most productive ecosystems and very important as fish nurseries. Seagrass meadows are also among the most threatened ecosystems, suffering a more than 20 percent habitat loss over the past 20 years.

In the Nordic Seagrass Network, scientists from many disciplines cooperate to map the distribution of eelgrass-meadows, their connectivity and genetic diversity.

According to Prof *Jeanine Olsen* from Centre for Ecological and Evolutionary Studies, University of Groningen, this very basic knowledge can inform management on many issues. For example, about differential vulnerability to temperature and salinity, local resilience of a meadow and long-term effects of climate change. Such data can also guide managers in choosing source material for restoration projects, as well as for selecting the necessary size of management areas.

– Costs are relatively low and a baseline survey only needs to be done once in most cases, Olsen says.

Research gaps – what kind of knowledge is still missing?

Cathy Hill
The County Administrative Board, Stockholm
We need to know more about underwater landscapes. When we plan for conservation and management, information on our underwater biotopes is crucial.

Christoffer Boström
Åbo Akademi University, Finland
Taxonomy is turning out as a threatened research area due to a retiring generation of experts and low interest from research financers. Being able to identify individual species is of fundamental importance if we want to understand ecosystem structure and function, and consequences of species loss.

Cecilia Lindblad
Swedish Environmental Protection Agency
We have a lot of knowledge but are not always using it in an efficient way. What we really need is more cooperation between researchers from different diciplines – biologists, oceano-graphers, chemists, physicists etcetera.

Torgeir Bakke
Norwegian Institute for Water Research
The biology of individual species is still poorly known. For example, we monitor between 100 and 300 species of coastal and shelf fauna, but we only know the slightest about just a few. With better knowledge we could interpret the results from fauna investigations in a much better way.

Sea urchin harvest

RESTORES KELP

In the early 1970´s, invasion of green sea urchins turned many kelp forests on the Norwegian northwest coast into desert like barren grounds. Now Japaneese passion for sea urchin gonads might help restore valuable kelp areas.

Hege Gundersen

The high biodiversity of kelp forests make them important food- and nursery areas for fish, sea birds and seals. According to *Hege Gundersen* from Norwegian Institute for Water Research, NIVA, the estimated loss for commercial fisheries caused by lost kelp forests amounts to 1.5 million € every year.

A kelp forest restoration project has recently started, based on the idea to harvest sea urchins for the commercial market. In Japan, sea urchin gonads are a delicacy and a national dish, but local sea urchins are heavily over-harvested. The project aims to cause re-growth of kelp forests on a total of 3 500 km^2 along the Norwegian coast. The commercial value of the harvested sea urchin gonads could be at least 4 billion €.

Preliminary results are promising: Models have been used to locate and map areas with high sea urchin densities in the three northernmost counties of Norway. Harvesting strips of 100 m per year can cause gradual re-growth of the kelp, and after 2 to 4 years recovered kelp forest have reached a biomass the size of fully grown kelp forests.

Photos: Hartvig Christie

MARINE MONITORING IN THE FRONT-LINE

The city of Helsingborg has Sweden´s most elaborate local marine monitoring program. *Anders Tengberg* from Dept of Chemistry at University of Gothenburg emphasizes the importance of long and intense time series of observations.

The marine program in Helsingborg has been running for more than 15 years. It includes bottom fauna sampling, sediment chemistry, mussels for toxins and hourly river run-off and bottom water monitoring.

The monitoring has provided solid background data, thus making it easier to follow the effects of pollutant discharges, as well as the recovery afterwards. The program has also discovered, traced and stopped toxic industrial pollution at several occasions.

– Since marine environments are dynamic, collecting hydrographic data only once a month will most likely miss periods of for example low salinity, high temperature or low oxygen levels, Tengberg says. And these periods are essential for understanding changes in the bottom fauna and ecosystem.

More information: www.oresundsvand.dk

ON THE ROAD TO GOOD WATER STATUS?

Implementation of the Water Framework Directive is well on the way in Scandinavian countries, bringing good water status by 2015 as a common goal. However, when establishing legal tools to meet the objective, several differences occur.

Lena Gipperth, Dept of Law, University of Gothenburg, conducted in spring 2010 a comparative study of key concepts in the Water Framework Directive, Scandinavian scope.

One identified difference is that in Sweden, decisions about the "environmental quality standards", tools to measure the status in various water bodies, are decided on a regional level. In the other countries concerned, this is done at the national level.

Obviously, the future has yet to show what effects this and other differences will create.

– The directive is still not fully implemented. If its goals will be achieved certainly will depend on how the legislation will be applied, Gipperth states.

More information: www.lst.se/vattenmyndigheten/amnen/Vasterhavet/

MANAGEMENT OF THE PACIFIC OYSTER

How should invasive species as the Pacific oyster be managed? The impact of the ice-winter 2010 bring new information on possible management strategies.

The Pacific oyster is now established in many areas in Scandinavia. Its fully impact on ecosystems is not yet revealed, however the oyster obviously outcompetes blue mussels and is often found in large numbers in areas where previously the native blue mussel was abundant. This is negative not only for the mussels, but also for eiders and other seabirds which depend on mussels for food.

– After the ice-winter 2010, population density of oysters was strongly reduced at many sites, says *Per Dolmer*, National Institute of Aquatic Resources, Technical University of Denmark.

Dolmer, comparing the impact of winter mortality to other population control factors, concludes that besides Nature's own way of population control, strategies to manage the oyster may be considered. One active approach is to simply harvest or fish them away in certain areas. Experiments are also being carried out in which blue mussels are put in oyster-sites to see if food limitation will affect the populations.

MUSSEL FARMS – PART OF THE SOLUTION

– Mussel farms will not solve the problems of the Baltic Sea, but it can be a part of the solution, *Susanna Minnhagen* at the Swedish Kalmar Sound Commission, says.

Farming blue mussels is a possible measure against eutrophication in the Baltic. Pioneer farms have been run in the Kalmar Sound during 2006-2009. Results show that harvesting mussels every second year can reduce nitrogen by 1.8 tonnes and phosphorus by 0.12 tonnes per hectare of mussel farm. In addition, the farms can deliver 150 tonnes of mussel biomass.

– Since 2009 we have two full-scale farms with a total size of about two hectares in Kalmar County, Minnhagen says. Efforts are now being made to find a market for the Baltic Seas blue mussel as poultry food or substrate for biogas.

Mussel-farming has a potential to combat eutrophication, Minnhagen states. One advantage is the lower cost of mussel farming, as compared to many other measures with similar effects. Mussel-farming also confront challenges, such as finding the proper water where the mussels grow well, and where ice-wear and farm drift as well as conflicts with other interests can be avoided.

Harvesting blue mussels in the Baltic Sea. Photo: Anna Thore

Lisa Levin

DEEP SEA SECRETS *at risk*

The secrets of deep-sea environments are just started to be unravelled. But there is a growing concern that valuable resources will be lost before we even knew they existed, says Prof *Lisa Levin* from Scripps Institution of Oceanography in California.

More than 60 percent of the earth´s surface is covered by oceans with depths over 200 meters. During the last one hundred years our view of the deep ocean has undergone a massive change. What we thought of as a monotonous, empty and flat sediment terrain has proven to be a patchy landscape of seamounts, canyons and fjords. Vast reefs from cold water corals and sponges host a biodiversity comparable to what is found on tropical reefs, and added to this are the unique ecosystems found in extreme environments at hydrothermal vents and methane seeps.

But now the human footprint is quickly expanding, warns Levin:

– Many deep-sea areas are being fished, and trawling typically occurs to 1000 m depth. There is an increasing deep sea oil- and gas extraction and growing interest in minerals mining. In addition, destructive activities like waste disposal are often unregulated.

Getting to know the deep sea better could be useful in many ways. Enzyme systems that allow organisms to cope in extreme conditions like high temperatures, toxic sulfide and no oxygen are found in animals and bacteria at hydrothermal vents and methane seeps for example.

– Microbes can do weird things, Levin points out. They could provide industry with a whole range of useful applications. Besides that, these ecosystems offer novel understanding of evolutionary processes, stress tolerance and unusual trophic pathways.

– A key message is that we now run the risk that the rate of destruction by human activities will exceed the rate of deep-sea exploration and discovery, Levin concludes.

Invited speakers gave insights to urgent marine research issues.

Meet four of them!

Emmett Duffy

BIODIVERSITY *makes a difference*

– After a long period of debate research now gives us confidence that biodiversity does generally have positive effects on ecosystems functions, prof *Emmett Duffy* from Virginia Institute of Marine Science says. Thus, preserving diversity can benefit important ecosystem services such as fisheries, maintenance of water quality and recreation.

According to Duffy, one challenge is our still poor understanding of how biodiversity affects complex natural ecosystems and the services they provide. So far experimental research on biodiversity benefits has been very simplistic, usually focusing on a small number of species only and by performing experiments on a very small scale.

– The real world is much more complex, Duffy points out.

Recently, some encouraging work in natural ecosystems has been published. Duffy exemplifies this with a study from Alaska, showing how biodiversity can benefit the ecosystem service "recreational fishery": In a landscape of pristine river systems several genetically diverse salmon populations occur. Due to their different genotypes they spawn at different times and places, and thereby prolong the fishing season in the area. The biodiversity thus gives stability and increased economic return to the fishery.

– Because of its many benefits, biodiversity can serve as a critical indicator of ecosystem status, Duffy says, and can also provide a common currency for evaluating human impacts. Therefore, monitoring biodiversity is a good idea. The challenge for research is to integrate observations from natural ecosystems, experiments and simulation models.

Georgia Destouni

Nutrient load: Getting the FIGURES RIGHT

– Current source-focused strategies to reduce nutrient load from land to sea need to be revitalized, says Prof *Georgia Destouni*, Dept of Physical Geography and Quaternary Geology, Stockholm University. All aspects of the hydrological transport of nutrients from land to coastal waters need to be accounted for in order to correctly estimate the effects of measures to combat the nutrient loads.

Despite years of actions to decrease nutrient leakage, concentrations remain essentially constant into Baltic coastal waters. According to Destouni, insufficiently understood inland pathways and lag times of hydrological nutrient transport to the coast could to a large extent explain this:

– For example, studies from the large Swedish Norrström drainage basin show that even if we manage to stabilize nitrogen pollution from inland sources on today's levels, coastal loads to the Baltic Proper would remain high for a long time. The cause is that a large proportion of previous nitrogen leakage from inland sources still remains in the slow subsurface hydrological pathways through soil, groundwater and sediments.

– Model simulations and international data tell that the subsurface persistence of nutrients is substantial, says Destouni, whose conclusions in many ways challenge traditional opinions about soil- and groundwater pollution as being local problems restricted to certain geographical areas.

With support from international studies, Destouni points out the need for adopting additional types of abatement measures and strategies than just the currently preferred, source-focused ones. Due to long-term hydrological transport effects, downstream solutions, such as wetlands, as well as further improvements of sewage water treatment, are needed to quickly reduce nutrient load to coastal waters.

Doug Wilson

Marine GOVERNANCE *– lessons from European fisheries*

It´s today well known that EU´s Common Fisheries Policy (CFP) has not delivered – Europe´s fish stocks are in a seriously bad shape. The reason for this overall failure is, according to sociologist *Doug Wilson*, to be found within the institutional communications that influence the use of scientific advice.

The common sense reason usually given for the failure of the CFP is that managers have ignored scientific advice on fish yields. However, Doug Wilson at Innovative Fisheries Management, Aalborg University, shows data that scientific advice actually has been followed fairly closely. So, what is the problem?

Based on a five year study of ICES, Wilson suggests a deeper problem is that the precautionary principle has been used in the CFP in a distorted fashion. Uncertainties such as, for example the quality of the input data in single-species stock assessments, have been reduced to numbers in assessment models. The ways the CFP uses science, not the desires of scientists, have led to this outcome.

– Yet there is hope for Europe´s fishery, Wilson argues. ICES scientists are seeking reform and an "Ecosystem Approach" to marine management and its complexities is under way. Furthermore, institutional forms are emerging with greater resilience and adaptive capacity in which scientific advice can be safeguarded.

A prerequisite for success is scientific advice with clear limits on impacts and a shift in the burdens of proof from those charged with protecting the ecosystem to those who wish to exploit it.

– The challenge for the scientific community will be to define both the ecosystem level and operational impact limits, and to help users create strategies showing that they are operating within safe limits. There must also be ways to handle the uncertainties; within an ecosystem approach, real precaution is needed, underlines Wilson.

KOSTERHAVET

– *research and management put into practice*

Sweden´s first marine national park, found just outside Strömstad on the Swedish west coast, was highlighted in several presentations at NSMC 2010. The park was established in 2009 after a long story of doubts and debate in the local community.

– When the idea was first presented, more than 30 years ago, it met little enthusiasm by the local residents, says *Andrea Morf* from the School of Global Studies, University of Gothenburg. Major ingredients for a final success have been a sustainable rural development perspective, the use of multiple forums for collaboration, the exchange of knowledge between scientists and users, and not the least, active individuals on various levels functioning as facilitators and mediators.

Balancing nature conservation and local development in the area is a challenge. Tourism, commercial fishing as well as many other ongoing and planned activities both depend upon and put pressure on the marine environment. This put forward the need for proactive planning, as pointed out by *Ingela Isaksson* from the County Administrative Board of Västra Götaland.

Isaksson is the leader of a pilot project where Strömstad and four neighbouring municipalities seek ways for future sustainable management. The aim is to develop collaboration plans on conservation, protection and sustainable use, working through the spatial planning process.

Planning requires good maps, Isaksson says. But mapping the sea bottom using for example divers is very expensive and seldom possible. So how do you map what you can´t see?

One way to do it, is to predict – to model. This is what *Genoveva Gonzalez-Mirelis* and her colleagues at University of Gothenburg have done. Using under-water video transects, GIS and known data such as depth, slope and sediment type, they have produced maps showing the distributions of some key benthic habitats in Kosterhavet.

– Maps like these can be used to address various management questions, says Gonzalez-Mirelis. For example, how much of a certain habitat do we want to conserve, and where to locate special zones.

With more than 6000 species, including 200 not found anywhere else in the country, Kosterhavet is Sweden´s most species-rich marine environment. The 3.9 km^2 area shows an unusually high diversity of biotopes, including cold water coral reefs, untrawled deep soft bottoms and exposed shallow off-shore banks.

Andrea Morf, Ingela Isaksson and Genoveva Gonzales-Mirelis