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A fish and fisheries perspective

MarFish: Causes and consequences of changing marine biodiversity, a fish and fisheries perspective.

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Abstract:

MarFish is a subproject of the EU Network of Excellence MarBEF (Marine Biodiversity and Ecosystem Functioning) and contains 19 participating fisheries and marine institutes from the Mediterranean to the Norwegian Sea. The subproject is investigating the causes and consequences of changes in marine fish biodiversity in European seas. Project objectives are: (1) Detect and identify mechanisms of large-scale and long-term change in biodiversity of fish and other exploited species (e. g., scallops, lobsters); (2) Predict consequences of changes in biodiversity of fish and other exploited communities on ecosystem functioning and human societies. The main activities of the project are networking and scientific research. Networking activities include workshops, training courses, development of a fish biodiversity consensus document for policy makers and a web-based mechanism to facilitate foreign student and research participation on fisheries research cruises. Research activities include analyses which quantify changes in intra- and inter-specific fish biodiversity, changes in distribution/ranges of species and changes in functional roles of species within ecosystems. Examples of some of these activities will be presented in the presentation. Additional information is available at http://www.marbef.org/projects/marfish/index.php.

Introduction:

The documentation of changes in biodiversity of fish and other exploited communities/species in European waters is fragmented. Changes in some seas and species are better documented than others, and the causes for those changes are also better documented in some areas than others. Many key issues of the biodiversity of fish and exploited species need to be addressed but cannot be done effectively at present due to lack of coordinated and integrated effort. These include the following, as identified at a planning workshop at IFREMER, Brest, France (June 14-16, 2004):

What was lost in the past and what may be lost in the future?
– species, populations, genes, alleles, fishermen, fishing-dependent communities?
Why did changes in biodiversity occur and how can we prevent further losses?
Do changes in fish biodiversity affect ecosystem functioning and the supply of ecosystem services?
What are the consequences of actions to prevent losses?
What are the costs (social, political, financial, etc.) to prevent further losses and the benefits of preventive action?

Several institutes participating within MarBEF have proposed five types of coordination and integrative activities to address the questions above and for disseminating results of their investigations:

1) research work tasks, which are designed to stimulate and encourage integration among institutes and disciplines;
2) workshops and training courses dedicated to bringing experts from different institutes and disciplines together to investigate specific topics related to biodiversity changes;
3) regional activities that document large-scale change in fish biodiversity and effects on ecosystem structure and functioning;
4) publication and presentation of results in peer-reviewed journals, reports and conferences/symposia;
5) public outreach activities, such as lectures, seminars and website contributions for the general public about fish biodiversity investigations within MARBEF.

These activities are being conducted within a sub-project of MarBEF called MarFish. MarFish is a "responsive mode project" (RMP) on "Causes and consequences of changing marine biodiversity, a fish and fisheries perspective" within the MARBEF EU network of excellence on Marine Biodiversity and Ecosystem Functioning. RMPs are participant–suggested and –developed projects within MARBEF, and therefore are driven by interests of individual scientists.

MarFish has two overall objectives:

1. Detect and identify mechanisms of large-scale and long-term change in biodiversity of fish and other exploited species (e. g., scallops, lobsters).

2. Predict consequences of changes in biodiversity of fish and other exploited communities on ecosystem functioning and human societies.

Methods:

As both MarBEF and MarFish are networking projects, the activities within the projects are primarily expected to be related to be integrative and collaborative. Such activities will include joint studies and analyses, development of standardised methodologies, workshops, training

courses, visits and exchanges. The network consists of investigators from 19 European institutes (Appendix 1). Expertise within the institutes reflects in the inter-disciplinary nature of the topic and includes both natural and social scientists. The project will continue until early 2009.

Results and Discussion:

Some activities and achievements so far include:

-submission and publication of peer-reviewed publications and other scientific dissemination products
-execution of two workshops and a training course
-several invited presentations at the Paris International Biodiversity Conference, Paris, France, January 2005.
-preparation of a Marbef-Marfish consensus fish biodiversity policy document and its dissemination to fishery managers, scientists and decisionmakers
-organisation of a Theme Session at the 2007 ICES Annual Science Conference on fish biodiversity.
-development of a new networking and matchmaking program for participation in fishery research cruises by international students and colleagues via the Marbef newsletter and website.
-public outreach to stakeholders via the Marbef Newsletter, interviews with journalists and seminars with industry and the public
-annual meetings (Charlottenlund, Denmark, Sept., 2005; Parnu, Estonia, September, 2006; IJmuiden, Netherlands, September, 2007).

In this report, we outline briefly some of the activities which have occurred in the past 12-16 months, and those planned for the next 12-18 months.

Scientific outputs and products. The group has produced 19 peer-reviewed publications and 16 other scientific dissemination products on fish biodiversity topics (e. g., changes in abundance and distribution of species and populations). These are listed in Appendix 1. Most of these products describe changes in abundance and distribution of species and populations at regional scales.

Two other dissemination products have been produced. One is a policy document presenting a Marfish consensus view of the state of fish biodiversity and its importance to management of fisheries and ecosystems. This document has been submitted for publication as a Viewpoint to the journal Fisheries Research and has been circulated to DG Fish and DG Research, as well as within the European fisheries research community. The full text of the statement can be found at the Marfish website (http://www.marbef.org/projects/marfish/news.php).

The second product is a special volume of Fisheries Research related to long-term changes in fish and marine animal populations in the North-Baltic-Barents and White Seas. This volume will contain 12-14 articles from the Census of Marine Life's History of Marine Animal Populations project and is being co-guest edited by Henn Ojaveer and Brian MacKenzie. Most articles are now online at the journal website and the volume is expected to be printed in late 2007.

Workshops and training courses. Three events have been held so far and one is planned for spring 2008. All events are described below.

Training course on *methods for describing biodiversity*. This course was held in Pärnu, Estonia, Aug. 29, 2006, and was lead by D. Bekkevold (DTU-DIFRES), N. Dulvy (CEFAS), E. E. Nielsen (DTU-DIFRES).

The training course aimed at providing students in fish biology and fisheries with basic knowledge about genetic diversity in fishes and elucidate why such issues are relevant in relation to fisheries management and conservation of populations, species and communities. The one-day intensive course started with three key-note presentations: "Exploitation and extinction risk in marine fishes" by Nick Dulvy (CEFAS), "Documenting and predicting biodiversity trends in exploited fishes" by Einar Eg Nielsen (DIFRES) and "What population genetics can do for you! - The role of GSI (genetic stock identification) methods in practical fisheries management" by Dorte Bekkevold (DIFRES). The three presentations provided participants with an overview of the field of protection of biodiversity in fishes and outlined recent methodological developments in the description and conservation of genetic diversity in fishes. A special emphasis was put on genetic tools and their application in management of commercially exploited species, and subjects ranged from monitoring inter- (species level) as well as intra-specific (population/stock level) biodiversity in marine fishes to evolutionary effects of selective fishing. Following keynote presentations, case studies with tight links to practical management questions were discussed among participants. Participants included (host) Dr. Henn Ojaveer, Anu Albert, Aare Verliin, Kristiina Jurgens, Timo Arula (all Estonian Marine Institute) and Meelis Tambets (University of Tartu)

Workshop on trajectories of European marine biodiversity. The workshop was held Aug. 30-31, 2006 in Pärnu, Estonia. The workshop was hosted by Drs. Henn Ojaveer, Estonian Marine Institute and organised by Nick Dulvy (CEFAS), Einar E. Nielsen (DIFRES), Dorte Bekkevold (DIFRES), and Mikko Heino (IMR).

The aim of the workshop was to enable fish and fisheries ecologists and population geneticists to interact and discuss procedures for integrating analyses of patterns and change in biodiversity and genetic variation into fisheries management. Further, the workshop was aimed at planning and preparing a document directed at policy makers, containing a statement co-authored by the participants on the importance of fish biodiversity for management of fisheries and ecosystems, identifying research needs and data gaps (draft title "Importance of fish biodiversity for the management of fisheries and ecosystems"). The structure of the workshop was keynote presentations on the topics "Fish biodiversity and environmental variability" (by Brian Mackenzie), "Extinctions in the sea: causes, consequences and implications for biodiversity" (by Nick Dulvy), "Tracking historical changes in biodiversity employing genetic analysis" (by Einar Eg Nielsen), "Use of genetic methods in real-time management of fish biodiversity" (by Dorte Bekkevold) and "Fisheries-induced selection" (by Mikko Heino). Keynote presentations were followed by extended discussions and group writing of a draft of the policy directed document, which will be finalised ultimo 2006. Jan Geert Hiddink and Brian MacKenzie lead in coordinating text input from authors and finalising the document.

Workshop on Long term spatial impact of natural variability and human induced changes in marine ecosystems. The workshop was held Feb. 22-24, 2007 at Roskilde University Centre, Roskilde, Denmark, and was chaired by Bo Poulsen (RUC), Pascal Lorance (IFREMER), Anne Husum Marboe (RUC).

This workshop brought together multiple disciplines, time series and spatially resolved data spanning the last millennia, with the intent to gain new insights into the driving forces of marine resource exploitation. The following hypotheses were considered and analysed for various datasets :

1) Pre-modern resource exploitation is restrained by the natural resource availability, which sets it apart from modern exploitation.

The past therefore serves as a rear window for fishing operations, where the slight human impact on biodiversity and abundance is

1a. illustrative for natural variability of ecosystems

1b. highlighting economic regimes of sustainable harvesting of common resources

2) For reasons of technology and market development, modern resource exploitation has profound impact on marine biodiversity, abundance and spatial distribution of marine species. Modern resource exploitation is limited almost solely by economic and political boundaries and less so by catching power.
3) The fundamental shift from pre-modern to modern resource exploitation took place gradually from c. 1830-1950 depending on the targeted species and the timing of modern fishing technology in different regions.
4) Recognizing the points of departure from one mode of production to another lends insights into:

4a. Time frame and spatial boundaries for using past references as
indicators for natural variability
baselines for the recovery of fish stocks
trajectories for historical exploitation patterns

These hypotheses lead to formulation of over arching questions:

Is the above statements useful to distinguish between different historical stages of marine ecosystems and their exploitation?
At what time, and for what reasons did the mode of exploitation shift in different settings?
What species are most likely to reveal indications of the above change?

Workshop on ecosystem functioning relevant for fish biodiversity and fisheries
Leaders: Adriaan Rijnsdorp (IMARES), Remment ter Hofstede (IMARES). This workshop is planned for spring 2008.

Workshop topic and background: The functional aspects of fish within marine ecosystems is most commonly considered by fisheries scientists in terms of direct predator-prey interactions (e. g., quantities and types of prey consumed). However broader issues related to the role of fish (or other exploited species such as lobsters or marine mammals) in marine ecosystems, including cascading effects on food webs, are poorly understood and documented. Moreover, the concepts of ecosystem functioning and ecosystem metabolism are unfamiliar within the fisheries community and they require clarification and in some cases introduction. Metrics of ecosystem functioning and metabolism relevant to fish biodiversity need to be discussed, defined and identified. These might include total yields, yields by functional or size group, slope/intercept of size spectra of fish communities, etc.

Workshop discussions and analyses will introduce broader ecological concepts to the fisheries research community and facilitate the integration of marine ecological principles with fisheries ecology. The workshop objective will be to discuss these concepts and develop a consensus of how they apply to fish ecology.

Other networking activities:

The project has facilitated some exchanges and short visits of personnel among institutes, and promoted national and international collaborations which were previously weak or non-existent. Visits include stays at institutes and participation on foreign cruises. Samples have also been sent across regions to promote integration and understanding over larger spatial scales (e. g., anchovy samples for genetic analyses from the Kattegat-western Baltic Sea have been sent to anchovy genetics experts in Greece).

Activities in fall 2007-2008:

Future activities in the remainder of the project will be similar to those which have been conducted so far: analyses and interpretation of fish biodiversity changes, preparation of joint scientific papers and dissemination of results within the scientific community and to stakeholders.

The principle networking event of 2008 will be the workshop on functional aspects of fish biodiversity held in spring 2008.

Conclusion:

The network is developing new insights into changes in fish biodiversity and their causes. Several of the network's activities will likely have long-term impacts in terms of scientific knowledge, training of new expertise and transfer of knowledge, lasting collaborations across disciplines and regions, and the development of new management and conservation policies for fish populations and ecosystem structure and functioning. These activities can be expected to promote and improve the maintenance or recovery of fish biodiversity in European seas.

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Appendix 1. Participating institutes and scientists of MarFish (MarBEF RMP project investigating marine fish biodiversity).

Institute Name	Researchers (post-docs, employed scientists)
Alfred Wegener Institute for Polar and Marine Research	Harald Asmus
Centre for Environment, Fisheries & Aquatic Sciences	Nick Dulvy Michaela Schratzberger Jim Ellis
Danish Institute for Fisheries Research	Brian MacKenzie Dorte Bekkevold Josianne Støttrup Einar Eg Neilsen Margit Eero
Ecological Consultancy Services Limited	Chris Emblow Roisin Nash
Estonian Marine Institute, University of Tartu	Henn Ojaveer Toomas Saat Markus Vetemaa Redik Eschbaum Ain Lankov Anu Albert
French Research Institute for Exploitation of the Sea	Pascal Lorance Fabian Blanchard Olivier Thébaud Olivier Guyader Jean Boucher
Institute for Marine Research, Bergen, Norway	Mikko Heino Olav Rune Godo Geir Huse
Institute of Oceanogr. & Fisheries, Split, Croatia	Sanja Matic-Skoko
Leibniz Institute of Marine Sciences at Kiel University	Uwe Piatkowski Rainer Froese Reinhold Hanel Rüdiger Voss Rabea Dieckmann
Marine Biological Laboratory, Plymouth	Stephen Hawkins David Sims Jon Parr Dan Lear
Netherlands Institute for Fisheries Research	Remment ter Hofstede A.D. Rijnsdorp L. Teal
Plymouth Marine Laboratory	Mel Austen Paul Somerfield
Roskilde University Centre	Poul Holm Bo Poulsen Anne Husum Marboe
Sir Alistair Hardy Foundation for Ocean Sciences	Alistair Lindley P. C. Reid A.N. Richardson Priscilla Licandro M. Edwards
University of Azores	Ricardo Serrao Santos Gui Menezes
University of Groningen	Jeanine Olsen Wytze T. Stam James A. Coyer Galice Hoarau
University of Hull	David J Starkey Michaela Barnard John Nicholls
University of St. Andrews, Scotland	Paddy Pomeroy
University of Wales at Bangor	Michel J Kaiser J Hiddink Martin Taylor H Hinz EA Richardson

Appendix 2. Dissemination products from MarFish during Feb. 2006-Feb. 2007.

type	short description event / title publication
Conference	Bekkevold D, Nielsen EE, Hansen MM. Genetic research on commercially exploited fishes in Denmark. Presented at "Genetic research on commercially exploited fish species in Nordic countries" (held at Nordic Council workshop in Öregrund, Sweden)
Conference	EUTRO 2006 Conference, Nyborg, Denmark; 20/06/06 - 23/06/06. Theme session on eutrophication and fish arranged by B. MacKenzie.
Conference	MacKenzie, B. R. 2006. Climate change and marine fish. Presentation at CONWOY Conference (Water and Weather in 100 Years), Roskilde, Denmark, Sept. 19-20, 2006
Posters	Enghoff, I. B., MacKenzie, B. R. The Danish fish fauna during the warm Atlantic period (ca. 7,000-3,900 BC): forerunner of future changes? Presented at CONWOY Conference, Roskilde, Denmark, Sept. 19-20, 2006
Posters	Jacobsen, B., MacKenzie, B. R., Richardson, K. 2006. The influence of climate on the migration of two pelagic fish species Atlantic mackerel, *Scomber scombrus*, and garfish, *Belone belone*, based on fisheries landings data. Poster presentation at CONWOY conference, Roskilde, Denmark, Sept. 19-20, 2006
Press release (press/radio/TV)	Anchovies are coming. DIFRES Press release regarding CONWOY conference on climate change and aquatic ecosystem, Roskilde, Denmark
Publications - book	Bo Poulsen, Accepted. Historical exploitation of North Sea herring stocks – an environmental history of the Dutch herring fisheries, c. 1600-1860. c. 275 p. (book)
Publications - book chapter	Poulsen, B., MacKenzie, B. R., Bager, M., & Holm, P. (2006). Klimaforandringers betydning for fisk og fiskeri I. Vand og vejr om 100 år: klimaforandringer og det danske vandmiljø. (s. 107-121). Viborg: Hovedland.
Publications - MarBEF Newsletter	Dulvy, N. 2006. Extinctions and threat in the sea. MarBEF Newsletter 4: 20-21.
Publications - MarBEF Newsletter	MacKenzie, B. R. 2006. Biodiversity in Paris - MarBEF on the international stage. MarBEF Newsletter 4: 16
Publications - MarBEF Newsletter	MacKenzie, B. R. 2006. Anthropogenic impacts on the Baltic Sea - problems and solutions. MarBEF Newsletter 4: 26-29
Publications - MarBEF Newsletter	Publication of fisheries talks at the Biodiversity conference in Paris in the MarBEF newsletter ISSN 16495519
Publications - peer reviewed journals	Beaumont, N., Austen, M., Atkins, J., Burdon, D., Degraer, S., Dentinho, T., Derous, S., Holm, P., Horton, T., Ierland, E. V., Marboe, A. H., Starkey, D. J., Townsend, M., & Zarcyski, T. Submitted. 'Identification, Definition and Quantification of Goods andServices provided by Marine Biodiversity: Implications for the EcosystemApproach'. *Marine Pollution Bulletin*.
Publications - peer reviewed journals	Eero, M., MacKenzie, B. R., Karlsdottir, H. M., Gaumiga, R. (accepted) Development of international fisheries for cod (Gadus morhua) in the eastern Baltic Sea during 1860-1938. Fisheries Research

Publications - peer reviewed journals	Enghoff, I. B., MacKenzie, B. R., Nielsen, E. E. (accepted) The Danish fish fauna during the warm Atlantic period (ca. 7,000-3,900 BC): forerunner of future changes? Fisheries Research
Publications - peer reviewed journals	Hiddink & ter Hofstede (subm) Climate induced increases in species richness of marine fishes
Publications - peer reviewed journals	MacKenzie, B. R., Bager, M., Ojaveer, H., Awebro, K., Heino, U., Holm, P., Must, A. (accepted) Multi-decadal scale variability in the eastern Baltic cod fishery 1550-1860 – evidence and causes. Fisheries Research
Publications - peer reviewed journals	MacKenzie, B. R., Gislason, H., Möllmann, C., Köster, F. W. (accepted) Impact of 21st century climate change on the Baltic Sea fish community and fisheries. Global Change Biology
Publications - peer reviewed journals	MacKenzie, B. R., Myers, R. A. (accepted) The development of the northern European fishery for north Atlantic bluefin tuna Thunnus thynnus during 1900-1950. Fisheries Research
Publications - peer reviewed journals	MacKenzie, B. R., Schiedek, D. (accepted) Daily ocean monitoring since the 1860s shows record warming of northern European seas. Global Change Biology
Publications - peer reviewed journals	MacKenzie, B. R., Schiedek, D. (accepted) Long-term sea surface temperature baselines – time series, spatial covariation and implicaitons for biological processes. J. Mar. Systems
Publications - peer reviewed journals	Nielsen, E. E., MacKenzie, B. R., Magnussen, E., Meldrup, D. Historical analysis of Pan I in cod (Gadus morhua): no evidence of a recent selective sweep in populations from the southern part of the species distribution. Submitted to Canadian Journal of Fisheries and Aquatic Sciences
Publications - peer reviewed journals	Ojaveer, H., Gollasch, S., Jaanus, A. Kotta, J., Laine, A. Minde, A., Normant, M. and Panov, V. 2007. Chinese mitten crab Eriocheir sinensis in the Baltic Sea - a supply-side invader? Biological invasions (in press).
Publications - peer reviewed journals	Poulsen, B. Submitted. 'Historical evidence for the variability of fish populations prior to industrialized fishing.' *Journal of Marine Systems*.
Publications - peer reviewed journals	Poulsen, B. Submitted. 'Dynamics of movement in a pre-industrial herring fishery'. *Environment and History.*
Publications - peer reviewed journals	Poulsen, B. Sumitted. 'Spatial distribution of Dutch North Sea herring fisheries, c. 1600-1892'. *Journal of Historical Geography*.
Publications - peer reviewed journals	Rijnsdorp, A. D., N. Daan, W. Dekker, J.J. Poos, W.L.T. Van Densen. 2007. Sustainable use of flatfish resources: Addressing the credibility crisis in mixed fisheries management. J. Sea Res. 57: 114-125
Publications - peer-reviewed book chapter	Hammer, C., von Dorrien, C., Ernst, P., Tomas Gröhsler, T., Köster, F., MacKenzie, B., Möllmann, C., Wegner, G., Zimmermann, C. In press. Fish Stock Development under Hydrographic and Hydrochemical Aspects, the History of Baltic Sea Fisheries and its Management. Chapter 20 in State and Evolution of the Baltic Sea, 1952 – 2005 - A Detailed 50-Year Survey of Meteorology and Climate, Physics, Chemistry, Biology, and Marine Environment; Editors R. Feistel, G. Nausch, N. Wasmund.Wiley 2008

Publications - peer-reviewed book chapter	Möllmann, C., MacKenzie, B. R., Köster, F. W. Submitted. Chapter 5: Climate related marine ecosystem change – fish. In BALTEX Assessment of Climate Change for the Baltic Sea Basin (BACC; Eds. Storch, H. v., Dippner, J., Graham, P., Gustafsson, B., Heino, R., Smith, B., Tuomenvirta, H., Vuorinen, I., Vuglinsky, V.) . GKSS Research Centre, Geestacht, Germany
Publications - peer-reviewed book chapter	Poulsen, B. In press. 'Markets, prices and consumption. The herring trade in the North Sea and Baltic region, c. 1600-1850' I. *The dynamics of economic culture in the North Sea- and Baltic Region (ca. 1250-1700)*. Studies of the Groningen Hansa Research Center.
Publications - peer-reviewed book chapter	Poulsen, B. In press. 'Talking Fish - Cooperation and communication in the Dutch North Sea herring fisheries' I. *Beyond the Catch. Interdisciplinary approaches to the North Atlantic fisheries, 1000-1850*. Leiden & Boston: Brill.
Publications - Ph. D. thesis	Poulsen, B. (2006). *Historical exploitation of North Sea herring stocks. An environmental history of the Dutch herring fisheries, c. 1600-1860*. Ph.D.-thesis, University of Southern Denmark.
Publications - report	Hiddink, J. G., B. R. MacKenzie , A. Rijnsdorp, N. Dulvy, E. E. Nielsen, D. Bekkevold, M. Heino, P. Lorance, H. Ojaveer, 2007. MarFISH policy document: Importance of fish biodiversity for the management of fisheries and ecosystems. Available on Marbef website http://www.marbef.org.
Publications - report	Lindley, J. A. et al. 2006. Exceptional abundance of the snake pipefish (Entelurus aequoreus) in the north-eastern Atlantic Ocean. ICES CM 2006, Maastricht, Netherlands
Publications - report	Ojaveer, H., Kotta, 2006. Alien invasive species in the north-eastern Baltic Sea: population dynamics and assessment of ecological impacts. Estonian Marine Institute Report Series No. 14. Tallinn, pp. 52.