Predicting the consequences of species loss using size-structured biodiversity approaches: Consequences of biodiversity loss

Understanding the consequences of species loss in complex ecological communities is one of the great challenges in current biodiversity research. For a long time, this topic has been addressed by traditional biodiversity experiments. Most of these approaches treat species as trait-free, taxonomic units characterizing communities only by species number without accounting for species traits. However, extinctions do not occur at random as there is a clear correlation between extinction risk and species traits. In this review, we assume that large species will be most threatened by extinction and use novel allometric and size-spectrum concepts that include body mass as a primary species trait at the levels of populations and individuals, respectively, to re-assess three classic debates on the relationships between biodiversity and (i) food-web structural complexity, (ii) community dynamic stability, and (iii) ecosystem functioning. Contrasting current expectations, size-structured approaches suggest that the loss of large species, that typically exploit most resource species, may lead to future food webs that are less interwoven and more structured by chains of interactions and compartments. The disruption of natural body-mass distributions maintaining food-web stability may trigger avalanches of secondary extinctions and strong trophic cascades with expected knock-on effects on the functionality of the ecosystems. Therefore, we argue that it is crucial to take into account body size as a species trait when analysing the consequences of biodiversity loss for natural ecosystems. Applying size-structured approaches provides an integrative ecological concept that enables a better understanding of each species’ unique role across communities and the causes and consequences of biodiversity loss.
Adult and offspring size in the ocean: a database of size metrics and conversion factors

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, University of Copenhagen, University of Hawaii, University of Göttingen, Linnaeus University
Authors: Neuheimer, A. B. (Intern), Hartvig, M. (Intern), Heuschele, J. (Intern), Hylander, S. (Intern), Kørboe, T. (Intern), Olsson, K. H. (Intern), Sainmont, J. (Intern), Andersen, K. H. (Intern)
Pages: 1083
Publication date: 2016
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecology
Volume: 97
Issue number: 4
ISSN (Print): 0012-9658
Ratings:
BFI (2018): BFI-level 2
Characteristic sizes of life in the oceans - from bacteria to whales

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Section for Ecosystem based Marine Management
Adult and offspring size in the ocean over 17 orders of magnitude follows two life history strategies

Explaining variability in offspring vs. adult size among groups is a necessary step to determine the evolutionary and environmental constraints shaping variability in life history strategies. This is of particular interest for life in the ocean where a diversity of offspring development strategies is observed along with variability in physical and biological forcing factors in space and time. We compiled adult and offspring size for 407 pelagic marine species covering more than 17 orders of magnitude in body mass including Cephalopoda, Cnidaria, Crustaceans, Ctenophora, Elasmobranchii, Mammalia, Sagittoidea, and Teleost. We find marine life following one of two distinct strategies, with offspring size being either proportional to adult size (e.g., Crustaceans, Elasmobranchii, and Mammalia) or invariant with adult size (e.g., Cephalopoda, Cnidaria, Sagittoidea, Teleosts, and possibly Ctenophora). We discuss where these two strategies occur and how these patterns (along with the relative size of the offspring) may be shaped by physical and biological constraints in the organism’s environment. This adaptive environment along with the evolutionary history of the different groups shape observed life history strategies and possible group-specific responses to changing environmental conditions (e.g., production and distribution).
Integrated assessment of marine biodiversity status using a prototype indicator-based assessment tool

Integrated assessment of the status of marine biodiversity is and has been problematic compared to, for example, assessments of eutrophication and contamination status, mostly as a consequence of the fact that monitoring of marine habitats, communities and species is expensive, often collected at an incorrect spatial scale and/or poorly integrated with existing marine environmental monitoring efforts. The objective of this Method Paper is to introduce and describe a simple
tool for integrated assessment of biodiversity status based on the HELCOM Biodiversity Assessment Tool (BEAT), where interim biodiversity indicators are grouped by themes: broad-scale habitats, communities, and species as well as supporting non-biodiversity indicators. Further, we report the application of an initial indicator-based assessment of biodiversity status of Danish marine waters where we have tentatively classified the biodiversity status of Danish marine waters. The biodiversity status was in no areas classified as “unaffected by human activities.” In all the 22 assessment areas, the status was classified as either “moderately affected by human activities” or “significantly affected by human activities.” Spatial variations in the biodiversity status were in general related to the eutrophication status as well as fishing pressure.

**General information**
- State: Published
- Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, NIVA Denmark Water Research, Aarhus University, DHI Denmark, Finnish Environment Institute
- Publication date: 2014
- Main Research Area: Technical/natural sciences

**Size-based predictions of food web patterns**
We employ size-based theoretical arguments to derive simple analytic predictions of ecological patterns and properties of natural communities: size-spectrum exponent, maximum trophic level, and susceptibility to invasive species. The predictions are brought about by assuming that an infinite number of species are continuously distributed on a size-trait axis. It is, however, an open question whether such predictions are valid for a food web with a finite number of species embedded in a network structure. We address this question by comparing the size-based predictions to results from dynamic food web simulations with varying species richness. To this end, we develop a new size- and trait-based food web model that can be simplified into an analytically solvable size-based model. We confirm existing solutions for the size distribution and derive novel predictions for maximum trophic level and invasion resistance. Our results show that the predicted size-spectrum exponent is borne out in the simulated food webs even with few species, albeit with a systematic bias. The predicted maximum trophic level turns out to be an upper limit since simulated food webs may have a lower number of trophic levels, especially for low species richness, due to structural constraints. The size-based model possesses an evolutionary stable state and is therefore un-invadable. In contrast, the food web simulations show that all communities, irrespective of number of species, are equally open to invasions. We use these results to discuss the validity of size-based predictions in the light of the structural constraints imposed by food webs.

**General information**
- State: Published
- Organisations: Department of Applied Mathematics and Computer Science, National Institute of Aquatic Resources, Centre for Ocean Life, Scientific Computing, Section for Marine Ecology and Oceanography
- Authors: Zhang, L. (Intern), Hartvig, M. (Intern), Knudsen, K. (Intern), Andersen, K. H. (Intern)
- Pages: 23-33
- Publication date: 2014
- Main Research Area: Technical/natural sciences
Characteristic sizes of life in the oceans - from bacteria to whales

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Centre for Ocean Life, Section for Ecosystem based Marine Management
Publication date: 2013
Event: Abstract from International Workshop on Trait-based approaches to Ocean Life, Copenhagen, Denmark.
Main Research Area: Technical/natural sciences

Coexistence of structured populations with size-based prey selection

General information
State: Published
Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography
Food for thought: Overconfidence in model projections

There is considerable public and political interest in the state of marine ecosystems and fisheries, but the reliability of some recent projections has been called into question. New information about declining fish stocks, loss of biodiversity, climate impacts, and management failure is frequently reported in the major news media, based on publications in prominent scientific journals. Public and political awareness of the generally negative changes taking place in marine ecosystems is welcome, especially if it results in effective remedial action, but the scientific basis for such action must be reliable and uncertainties arising from models and data shortcomings must be presented fully and transparently. Scientific journals play an important role and should require more detailed analysis and presentation of uncertainties.
Universal temperature and body-mass scaling of feeding rates

Knowledge of feeding rates is the basis to understand interaction strength and subsequently the stability of ecosystems and biodiversity. Feeding rates, as all biological rates, depend on consumer and resource body masses and environmental temperature. Despite five decades of research on functional responses as quantitative models of feeding rates, a unifying framework of how they scale with body masses and temperature is still lacking. This is perplexing, considering that the strength of functional responses (i.e. interaction strengths) is crucially important for the stability of simple consumer-resource systems and the persistence, sustainability and biodiversity of complex communities. Here, we present the largest currently available database on functional response parameters and their scaling with body mass and temperature. Moreover, these data are integrated across ecosystems and metabolic types of species. Surprisingly, we found general temperature dependencies that differed from the Arrhenius terms predicted by metabolic models. Additionally, the body-mass-scaling relationships were more complex than expected and differed across ecosystems and metabolic types. At local scales (taxonomically narrow groups of consumer-resource pairs), we found hump-shaped deviations from the temperature and body-mass-scaling relationships. Despite the complexity of our results, these body-mass-and temperature-scaling models remain useful as a mechanistic basis for predicting the consequences of warming for interaction strengths, population dynamics and network stability across communities differing in their size structure.
Critical threshold size for overwintering sandeels (Ammodytes marinus)

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Deurs, M. V. (Intern), Hartvig, M. (Intern), Steffensen, J. F. (Ekstern)
Pages: 2755-2764
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Marine Biology
Volume: 158
Issue number: 12
ISSN (Print): 0025-3162
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.41 SJR 1.198 SNIP 0.993
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.315 SNIP 0.932 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Food web ecology: individual life-histories and ecological processes shape complex communities

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hartvig, M. (Intern)
Number of pages: 152
Publication date: 2011

Publication information
Food web framework for size-structured populations

We synthesise traditional unstructured food webs, allometric body size scaling, trait-based modelling, and physiologically structured modelling to provide a novel and ecologically relevant tool for size-structured food webs. The framework allows food web models to include ontogenetic growth and life-history omnivory at the individual level by resolving the population structure of each species as a size-spectrum. Each species is characterised by the trait ‘size at maturation’, and all model parameters are made species independent through scaling with individual body size and size at maturation. Parameter values are determined from cross-species analysis of fish communities as life-history omnivory is widespread in aquatic systems, but may be reparameterised for other systems. An ensemble of food webs is generated and the resulting communities are analysed at four levels of organisation: community level, species level, trait level, and individual level. The model may be solved analytically by assuming that the community spectrum follows a power law. The analytical solution provides a baseline expectation of the results of complex food web simulations, and agrees well with the predictions of the full model on biomass distribution as a function of individual size, biomass distribution as a function of size at maturation, and relation between predator–prey mass ratio of preferred and eaten food. The full model additionally predicts the diversity distribution as a function of size at maturation.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Hartvig, M. (Intern), Andersen, K. H. (Intern), Beyer, J. (Intern)
Pages: 113-122
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: Journal of Theoretical Biology
Volume: 272
Issue number: 1
ISSN (Print): 0022-5193
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.918 SNIP 0.932 CiteScore 2.16
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.084 SNIP 1.017 CiteScore 2.21
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.07 SNIP 1.048 CiteScore 2.25
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.04 SNIP 1.044 CiteScore 2.44
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.939 SNIP 1.04 CiteScore 2.5
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Damped trophic cascades driven by fishing in model marine ecosystems

The largest perturbation on upper trophic levels of many marine ecosystems stems from fishing. The reaction of the ecosystem goes beyond the trophic levels directly targeted by the fishery. This reaction has been described either as a change in slope of the overall size spectrum or as a trophic cascade triggered by the removal of top predators. Here we use a novel size- and trait-based model to explore how marine ecosystems might react to perturbations from different types of fishing pressure. The model explicitly resolves the whole life history of fish, from larvae to adults. The results show that fishing does not change the overall slope of the size spectrum, but depletes the largest individuals and induces trophic cascades. A trophic cascade can propagate both up and down in trophic levels driven by a combination of changes in predation mortality and food limitation. The cascade is damped as it comes further away from the perturbed trophic level. Fishing on several trophic levels leads to a disappearance of the signature of the trophic cascade. Differences in fishing patterns among ecosystems might influence whether a trophic cascade is observed.

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Andersen, K. H. (Intern), Pedersen, M. (Intern)
Pages: 795-802
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Royal Society of London. Proceedings. Biological Sciences
Volume: 277
Issue number: 1682
ISSN (Print): 0962-8452
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.89 SJR 2.541 SNIP 1.474
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.948 SNIP 1.535 CiteScore 4.08
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.916 SNIP 1.673 CiteScore 4.18
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 3.091 SNIP 1.762 CiteScore 5.08
ISI indexed (2013): ISI indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.947 SNIP 1.881 CiteScore 4.99
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.234 SNIP 1.789 CiteScore 5.02
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.894 SNIP 1.61
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 2.581 SNIP 1.389
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 2.364 SNIP 1.372
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 2.475 SNIP 1.447
Scopus rating (2006): SJR 2.925 SNIP 1.713
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 2.633 SNIP 1.52
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 2.872 SNIP 1.699
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 2.891 SNIP 1.561
Scopus rating (2002): SJR 3.005 SNIP 1.5
Scopus rating (2001): SJR 2.688 SNIP 1.32
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 2.458 SNIP 1.359
Scopus rating (1999): SJR 2.434 SNIP 1.726

Original language: English
size spectrum, community model, ecosystem approach to fisheries management
DOIs:
10.1098/rspb.2009.1512
Source: orbit
Source-ID: 252523
Publication: Research - peer-review › Journal article – Annual report year: 2010
How community ecology links natural mortality, growth, and production of fish populations

General information
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources
Authors: Andersen, K. H. (Intern), Farnsworth, K. (Ekstern), Pedersen, M. (Intern), Gislason, H. (Intern), Beyer, J. (Intern)
Pages: 1978-1984
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Journal of Marine Science
Volume: 66
Issue number: 9
ISSN (Print): 1054-3139
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 2.63
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): CiteScore 2.18
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): CiteScore 2.62
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): CiteScore 2.46
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): CiteScore 2.35
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): CiteScore 2.32
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Web of Science (2006): Indexed yes
Web of Science (2005): Indexed yes
Web of Science (2004): Indexed yes
Web of Science (2003): Indexed yes
Web of Science (2002): Indexed yes
Web of Science (2001): Indexed yes
Web of Science (2000): Indexed yes
Life-history constraints on the success of the many small eggs reproductive strategy

The reproductive strategy of most fishes is to produce a large number of tiny eggs, leading to a huge difference between egg size and asymptotic body size. The viability of this strategy is examined by calculating the life-time reproductive success R0 as a function of the asymptotic body size. A simple criterion for the optimality of producing small eggs is found, depending on the rate of predation relative to the specific rate of consumption. Secondly it is shown that the success of the reproductive strategy is increasing with asymptotic body size. Finally the existence of both upper and lower limits on the allowed asymptotic sizes is demonstrated. A metabolic upper limit to asymptotic body size for all higher animals is derived.
Two-axis MOEMS Sun Sensor and MEMS Electron Emitter developed at MIC for DTUsat

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, Technical University of Denmark
Authors: Fléron, R. (Intern), Pedersen, M. (Intern), Hales, J. H. (Intern), Bidstrup, P. R. (Ekstern), Torp, A. (Ekstern)
Publication date: 2003

Host publication information
Title of host publication: Proceedings of ESA's 4th Round Table on Micro/Nano Technologies for Space
Main Research Area: Technical/natural sciences
Conference: ESA's 4th Round Table on Micro/Nano Technologies for Space, 01/01/2003
Links:
http://hvig.dk/publications/
Source: orbit
Source-ID: 276928
Publication: Research › Article in proceedings – Annual report year: 2003

SETI and astrobiology: Contact – a youth perspective

General information
State: Published
Organisations: Section for Population Ecology and Genetics, National Institute of Aquatic Resources
Authors: Lynch, K. (Ekstern), Leiber, P. (Ekstern), Pedersen, M. (Intern), Tilu, M. (Ekstern), Longazo, T. (Ekstern), Miller, L. (Ekstern), Palmer, S. (Ekstern), Zhang, M. (Ekstern)
Publication date: 2002

Host publication information
Title of host publication: Proceedings of World Space Congress
Main Research Area: Technical/natural sciences
Conference: World Space Congress 2002, 01/01/2002
Links:
http://hvig.dk/publications/
Source: orbit
Source-ID: 276932
Publication: Research › Article in proceedings – Annual report year: 2002

Two-axis MOEMS Sun Sensor for Pico Satellites

General information
State: Published
Organisations: Department of Micro- and Nanotechnology
Authors: Hales, J. H. (Intern), Pedersen, M. (Intern)
Publication date: 2002
Projects:

Centre for Macroeoclogy, Evolution and Climate (CMEC) (38784)
This project investigated large scale patterns and variations of life in the ocean, focussing primarily on fishes. The theme used fishes to investigate how processes associated with climate change and human impacts (e.g., fishing and eutrophication) influence fish life histories, biodiversity and the dynamics of populations and species over large time and space scales. Studies have focussed on key processes affecting life histories and distribution of populations and species, including reproduction, mortality, and migration.

The project had one full-time PhD student, and 5 postdoctoral scientists. The relatively high number of postdocs in a short period was due to their success at finding permanent jobs as tenure-track assistant professors, or as research scientists or managers in either industry or academia.

Key results by DTU Aqua colleagues in the project include the following:
- A pan-Atlantic analysis and discovery of how temperature affects reproductive timing in cod, with evidence for local adaptation of cod thermal physiology and counter-gradient evolution. Our ongoing work is now investigating the consequences of this adaptation for match-mismatch of cod larval production with the timing of the peak production of major zooplankton prey species (e.g., *Calanus finmarchicus*, *Pseudocalanus* sp.)
- New estimates of the numbers, locations and volumes of the mesopelagic provinces of the world’s oceans, and based for the first time on the dynamics of ocean primary productivity, C sedimentation and photic zones. These new habitat descriptors of the mesopelagic ocean will provide new contexts for studies of ocean biodiversity, and the distribution and productivity of mesopelagic fishes and other biota.
- New models of fish lifetime reproductive output which demonstrated that a fish’s annual reproductive output was strongly related to maximum body size. Moreover, indeterminate spawners had ca. 10-fold higher reproductive output per unit weight than determinate spawners suggesting possible differences in survival rates among the early life history stages between these two groups of fishes.
- Estimates of how climate change will affect the spawning locations and timing for herring in the North Sea, based on climate change scenarios, lab studies of temperature effects on egg survival rate and substrate requirements for herring egg deposition
- Global patterns in taxonomic and functional descriptors of fish biodiversity and how these are inter-related and affected by ocean conditions (e.g., primary production, ecosystem size). Ongoing work is relating these patterns to biodiversity protection (e.g., MPA coverage).

The project was coordinated by University of Copenhagen, Denmark.
The project was funded by the Danish National Research Foundation.

National Institute of Aquatic Resources

Section for Marine Ecology and Oceanography

University of Copenhagen

Period: 01/01/2010 → 31/12/2015

Number of participants: 7

Research areas: Oceanography & Marine Populations and Ecosystem Dynamics

Contact person:

MacKenzie, Brian (Intern)
Project participant:
Lindegren, Martin (Intern)
Mantzouni, Irene (Intern)
Neuheimer, Anna (Intern)
Hartvig, Martin (Intern)
Reygondeau, Gabriel (Intern)
Development and demonstration of Marine Strategy Framework Directive (MSFD) tools for harmonization of the initial assessment in the eastern parts of the Greater North Sea sub-region (HARMONY) (38894)

The HARMONY project has developed and made available a toolbox supporting national MSFD implementation with special focus on issues of a transnational relevance and importance. It builds on cooperation among member states sharing the Greater North Sea sub-region through active involvement in several OSPAR groups. The tools are based on respecting the needs for national flexibility, while ensuring the necessary regional harmonization of key elements under the marine strategies.

The project partnership met these challenges through four development/harmonization activities and a coordination and information activity:
1) To develop and demonstrate a tool supporting an analysis of essential features and characteristics leading towards an integrated assessment building upon the criteria identified in the Commission Decision, while ensuring the necessary linkage to existing work under the Regional Sea Conventions as well as existing EU legislation (WFD, Natura 2000).
2) To develop and demonstrate a tool (a pressure and an impact index) supporting an analysis of the predominant pressures and impacts on the ecosystems, including those impacts of human activities for the Greater North Sea Marine sub-region.
3) Provide examples on the linkage of effects and human pressures to informed ecosystem-based marine strategies (based on activities 1 and 2).
4) To establish and support the active cooperation among member states sharing the Greater North Sea sub-region enabling comparisons and harmonization, where relevant and possible, between national efforts in preparing the initial assessment, elaborate the criteria including identification of indicators and target setting, and further on, the preparation of the monitoring program and the program of measures within the Greater North Sea sub-region.

DTU Aqua has focused on biodiversity of fish and fish populations, mapping fishing pressures and ecosystem components of the project working area (North Sea).

The project was coordinated by Department of Bioscience, Aarhus University, Denmark.

The project was funded by the Danish Ministry of Environment.

National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Aarhus University
DHI Denmark
Climate and Pollution Agency
Norwegian Institute for Water Research
Institute of Marine Research
Havs- och Vattenmyndigheten
Swedish Meteorological and Hydrological Institute
German Federal Environment Agency
Period: 01/01/2010 → 01/01/2012
Number of participants: 4
Research area: Ecosystem based Marine Management
Contact person:
Sørensen, Thomas Kirk (Intern)
Project participant:
Rindorf, Anna (Intern)
Hartvig, Martin (Intern)
Project Manager, organisational:
Vinther, Morten (Intern)

Activities:
ICES - 2nd ICES/PICES Conference for Early Career Scientists – Oceans of Change (External organisation)
Period: 2012 → …
Martin Hartvig (Participant)
National Institute of Aquatic Resources
Section for Population Ecology and Genetics
Degree of recognition: International

Related external organisation
ICES - 2nd ICES/PICES Conference for Early Career Scientists – Oceans of Change
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar