A trait-based approach to understanding marine communities composition, assembly and diversity

A species occurs and thrives in a community thanks to its capacity to grow, reproduce and feed in its surrounding environment. Understanding how and why some species thrive in particular areas has often been touched upon by studying the species composition of communities. Traditionally, communities are characterised by their taxonomic diversity, such as their species richness or the evenness in their abundances. However, there is growing evidence that it is not the taxonomic identity of the species per se that control its presence and abundance in a given environment but its characteristics. Species traits refer to quantitatively or qualitatively measurable characteristics of a species. Characterizing species by their key traits can permit an understanding of general mechanisms and unravel the processes affecting coexistence in communities. The aim of this thesis was to apply the trait-based approach to study the composition of marine communities located in the European Seas and relate their spatial patterns to environmental and anthropogenic pressures.

The species composition of communities can be constrained by several processes, such as competition and the environment. Using a trait-based approach, we studied the diversity and the processes influencing the composition of demersal fish communities in the Baltic Sea. While species richness was sharply decreasing from the saline Kattegat to the brackish Gdansk Bay, trait richness tended to decrease at a lower rate. We found that the species co-occurring in the Eastern Baltic Sea were in general more ecologically similar, in terms of their traits, than expected by random chance alone with a strong influence of the environment and notably the salinity gradient on the distribution and trait composition of the communities. While traits are increasingly used in community ecology, they are often selected and used without a consistent framework. We made use of a theoretical framework that defines life history strategies as a combination of key traits and their trade-offs to investigate large-scale patterns and drivers of fish community composition across European Seas. We assembled an extensive number of surveys in the European seas and collected reproductive traits for more than 300 fish species present in these surveys. Based on their traits, fish species could be categorized into three strategies that reflect the evolutionary and environmental constraints acting on the species. The strategies’ prevalence exhibited strong geographical patterns which could be explained by spatial variability in annual sea surface temperature, temperature seasonality, depth and fishing intensity. Due to their tight coupling to the environment, notably temperature and fishing, life history strategies could be a suitable tool to monitor and understand community changes in response to natural and anthropogenic stressors, including climate change. Spatial patterns of community mean traits and their relationship with the environment are generally assessed on a single taxonomic group. As a result, it is still unclear whether the relationship found for one taxonomic group can be generalised to other taxonomic groups that compose the ecosystem. Yet, understanding the responses of these different groups to environmental pressures is a prerequisite to conserve and manage ecosystems. We studied the spatial pattern of community traits of three key taxonomic groups in the North Sea: copepods, benthos, and fish. We extracted the community composition of these groups from three scientific surveys covering the entire North Sea and combined them with key life history traits common to all three groups: adult size, offspring size and fecundity. While many of the traits co-varied in space and notably demonstrated a latitudinal gradient, none of the traits had a consistent, either positive or negative, relationship across all taxa. The spatial trait-variability could be explained by taxon-specific habitat condition. Thus, trait responses to environmental gradient cannot be generalized across these marine taxonomic groups, pointing toward potential complex responses of multi-taxa communities to environmental changes.

This thesis highlights the value of using traits to understand why communities are composed of a specific set of species and how the mean traits of these communities varies along environmental and anthropogenic gradient. This thesis stresses the utility of the trait-based approach, due to its generality, to compare communities at different scales, from different regions as well as communities composed of different taxonomic entities. The trait-based approach still has a lot to offer to unravel the processes controlling the
composition of communities and species distribution, and its use in marine ecology has yet to be extended to other
domains, such as understanding the impacts of functional traits composition on the ecosystem functioning in the marine
realm.

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**Climate-mediated changes in marine ecosystem regulation during El Niño**
The degree to which ecosystems are regulated through bottom-up, top-down or direct physical processes represents a
long-standing issue in ecology, with important consequences for resource management and conservation. In marine
ecosystems, the role of bottom-up and top-down forcing has been shown to vary over spatio-temporal scales, often linked
to highly variable and heterogeneously distributed environmental conditions. Ecosystem dynamics in the Northeast Pacific
have been suggested to be predominately bottom-up regulated. However, it remains unknown to what extent top-down
regulation occurs, or whether the relative importance of bottom-up and top-down forcing may shift in response to climate
change. In this study, we investigate the effects and relative importance of bottom-up, top-down and physical forcing
during changing climate conditions on ecosystem regulation in the Southern California Current System (SCCS) using a
generalized food web model. This statistical approach is based on non-linear threshold models and a long-term data set
(~60 year) covering multiple trophic levels from phytoplankton to predatory fish. We found bottom-up control to be the
primary mode of ecosystem regulation. However, our results also demonstrate an alternative mode of regulation
represented by interacting bottom-up and top-down forcing, analogous to wasp-waist dynamics, but occurring across
multiple trophic levels and only during periods of reduced bottom-up forcing (i.e., weak upwelling, low nutrient
concentrations and primary production). The shifts in ecosystem regulation are caused by changes in ocean-atmosphere
forcing and triggered by highly variable climate conditions associated with El Niño. Furthermore, we show that biota
respond differently to major El Niño events during positive or negative phases of the Pacific Decadal Oscillation (PDO), as
well as highlight potential concerns for marine and fisheries management by demonstrating increased sensitivity of pelagic
fish to exploitation during El Niño. This article is protected by copyright. All rights reserved.

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Community ecology in 3D: Tensor decomposition reveals spatio-temporal dynamics of large ecological communities

Understanding spatio-temporal dynamics of biotic communities containing large numbers of species is crucial to guide ecosystem management and conservation efforts. However, traditional approaches usually focus on studying community dynamics either in space or in time, often failing to fully account for interlinked spatio-temporal changes. In this study, we demonstrate and promote the use of tensor decomposition for disentangling spatio-temporal community dynamics in long-term monitoring data. Tensor decomposition builds on traditional multivariate statistics (e.g. Principal Component Analysis) but extends it to multiple dimensions. This extension allows for the synchronized study of multiple ecological variables measured repeatedly in time and space. We applied this comprehensive approach to explore the spatio-temporal dynamics of 65 demersal fish species in the North Sea, a marine ecosystem strongly altered by human activities and climate change. Our case study demonstrates how tensor decomposition can successfully (i) characterize the main spatio-temporal patterns and trends in species abundances, (ii) identify sub-communities of species that share similar spatial distribution and temporal dynamics, and (iii) reveal external drivers of change. Our results revealed a strong spatial structure in fish assemblages persistent over time and linked to differences in depth, primary production and seasonality. Furthermore, we simultaneously characterized important temporal distribution changes related to the low frequency temperature variability inherent in the Atlantic Multidecadal Oscillation. Finally, we identified six major sub-communities
composed of species sharing similar spatial distribution patterns and temporal dynamics. Our case study demonstrates the application and benefits of using tensor decomposition for studying complex community data sets usually derived from large-scale monitoring programs.

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Web of Science (2011): Indexed yes
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Scopus rating (2010): SJR 2.631 SNIP 1.161
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BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.473 SNIP 0.985
Web of Science (2009): Indexed yes
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Scopus rating (2008): SJR 2.323 SNIP 0.96
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From traits to life-history strategies: Deconstructing fish community composition across European seas

The life history of a species is determined by trade-offs between growth, survival and reproduction to maximize fitness in a given environment. Following a theoretical model, we investigate whether the composition of marine fish communities can be understood in terms of a set of lifehistory strategies and whether the prevalence of the strategies follows specific spatial patterns that can be related to the environment.
Gender-specific feeding rates in planktonic copepods with different feeding behavior

Planktonic copepods have sexually dimorphic behaviors, which can cause differences in feeding efficiency between genders. Copepod feeding rates have been studied extensively but most studies have focused only on females. In this study, we experimentally quantified feeding rates of males and females in copepods with different feeding behavior: ambush feeding (Oithona nana), feeding-current feeding (Temora longicornis) and cruising feeding (Centropages hamatus). We hypothesize that carbon-specific maximum ingestion rates are similar between genders, but that maximum clearance rates are lower for male copepods, particularly in ambush feeders, where the males must sacrifice feeding for mate searching. We conducted gender-specific functional feeding response experiments using prey of different size and motility. In most cases, gender-specific maximum ingestion and clearance rates were largely explained by the difference in size between sexes, independent of the feeding strategy. However, maximum clearance rates of males were approximately two times higher than for females in the ambush feeding copepod O. nana feeding on an optimal motile prey (Oxyrrhis marina), as hypothesized. We conclude that the conflict between mate searching and feeding can cause significant difference in feeding efficiency between copepod genders in ambush feeders but not in feeding-current and cruising feeders.

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Scopus rating (2014): SJR 1.095 SNIP 1.255 CiteScore 2.24
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Global patterns in marine predatory fish

Large teleost (bony) fish are a dominant group of predators in the oceans and constitute a major source of food and livelihood for humans. These species differ markedly in morphology and feeding habits across oceanic regions; large pelagic species such as tunas and billfish typically occur in the tropics, whereas demersal species of gadoids and flatfish dominate boreal and temperate regions. Despite their importance for fisheries and the structuring of marine ecosystems, the underlying factors determining the global distribution and productivity of these two groups of teleost predators are poorly known. Here, we show how latitudinal differences in predatory fish can essentially be explained by the inflow of energy at the base of the pelagic and benthic food chain. A low productive benthic energy pathway favours large pelagic species, whereas equal productivities support large demersal generalists that outcompete the pelagic specialists. Our findings demonstrate the vulnerability of large teleost predators to ecosystem-wide changes in energy flows and hence provide key insight to predict the responses of these important marine resources under global change.
Global patterns in the productivity of marine fish along parallel pathways of energy

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Oceans and Arctic, University of Tasmania
Authors: van Denderen, P. D. (Intern), Lindegren, M. (Intern), MacKenzie, B. (Intern), Watson, R. (Ekstern), Andersen, K. H. (Intern)
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Impacts of climate change on pelagic fisheries

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Living Resources
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Marine fish traits follow fast-slow continuum along coastal-offshore gradient

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Productivity and recovery of forage fish under climate change and fishing: North Sea sandeel as a case study
Forage fish occupy a central position in marine food-webs worldwide by mediating the transfer of energy and organic matter from lower to higher trophic levels. The lesser sandeel (Ammodytes marinus) is one of the ecologically and economically most important forage fish species in the North-east Atlantic, acting as a key prey for predatory fish and seabirds, as well as supporting a large commercial fishery. In this case study, we investigate the underlying factors affecting recruitment and how these in turn affect productivity of the North Sea sandeel using long-term data and modelling. Our results demonstrate how sandeel productivity in the central North Sea (Dogger Bank) depends on a combination of external and internal regulatory factors, including fishing and climate effects, as well as density dependence and food availability of the preferred zooplankton prey (Calanus finmarchicus and Temora longicornis). Furthermore, our model scenarios suggest that while fishing largely contributed to the abrupt stock decline during the late 1990s and the following period of low biomass, a complete recovery of the stock to the highly productive levels of the early 1980s would only be possible through changes in the surrounding ecosystem, involving lower temperatures and improved feeding conditions. To that end, we stress the need for ecosystem-based management accounting for multiple internal and external factors occurring within the broader context of the ecosystem in which forage fish species, such as sandeel, play an important and integral part.

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Scopus rating (2015): CiteScore 2.4
Web of Science (2015): Indexed yes
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Scopus rating (2014): CiteScore 2.61
Temporal and spatial differences between taxonomic and trait biodiversity in a large marine ecosystem: Causes and consequences

Biodiversity is a multifaceted concept, yet most biodiversity studies have taken a taxonomic approach, implying that all species are equally important. However, species do not contribute equally to ecosystem processes and differ markedly in their responses to changing environments. This recognition has led to the exploration of other components of biodiversity, notably the diversity of ecologically important traits. Recent studies taking into account both taxonomic and trait diversity have revealed that the two biodiversity components may exhibit pronounced temporal and spatial differences. These apparent incongruences indicate that the two components may respond differently to environmental drivers and that changes in one component might not affect the other. Such incongruences may provide insight into the structuring of communities through community assembly processes, and the resilience of ecosystems to change. Here we examine temporal and spatial patterns and drivers of multiple marine biodiversity indicators using the North Sea fish community as a case study. Based on long-term spatially resolved survey data on fish species occurrences and biomasses from 1983 to 2014 and an extensive trait dataset we: (i) investigate temporal and spatial incongruences between taxonomy and trait-based indicators of both richness and evenness; (ii) examine the underlying environmental drivers and, (iii) interpret the results in the context of assembly rules acting on community composition. Our study shows that taxonomy and trait-based biodiversity indicators differ in time and space and that these differences are correlated to natural and anthropogenic drivers, notably temperature, depth and substrate richness. Our findings show that trait-based biodiversity indicators add information regarding community composition and ecosystem structure compared to and in conjunction with taxonomy-based indicators. These results emphasize the importance of examining and monitoring multiple indicators of biodiversity in ecological studies as well as for conservation and ecosystem-based management purposes.

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The importance of benthic-pelagic coupling for marine ecosystem functioning in a changing world

Benthic-pelagic coupling is manifested as the exchange of energy, mass, or nutrients between benthic and pelagic habitats. It plays a prominent role in aquatic ecosystems and it is crucial to functions from nutrient cycling to energy transfer in food webs. Coastal and estuarine ecosystem structure and function is strongly affected by anthropogenic
pressures, however there are large gaps in our understanding of the responses of inorganic nutrient and organic matter fluxes between benthic habitats and the water column. We illustrate the varied nature of physical and biological benthic-pelagic coupling processes and their potential sensitivity to three anthropogenic pressures - climate change, nutrient loading, and fishing - using the Baltic Sea as a case study, and summarize current knowledge on the exchange of inorganic nutrients and organic material between habitats. Traditionally measured benthic-pelagic coupling processes (e.g. nutrient exchange and sedimentation of organic material) are to some extent quantifiable but the magnitude and variability of biological processes are rarely assessed, preventing quantitative comparisons. Changing oxygen conditions will continue to have widespread effects on the processes that govern inorganic and organic matter exchange among habitats while climate change and nutrient load reductions may have large effects on organic matter sedimentation. Many biological processes (predation, bioturbation) are expected to be sensitive to anthropogenic drivers but the outcomes for ecosystem function are largely unknown. We emphasize how improved empirical and experimental understanding of benthic-pelagic coupling processes and their variability are necessary to inform models that can quantify the feedbacks among processes and ecosystem responses to a changing world. This article is protected by copyright. All rights reserved.
Trophic impact of Atlantic bluefin tuna migrations in the North Sea

Large highly migratory predators can have major impacts on local marine ecosystems by reducing prey populations and leading to trophic cascades that affect the entire fish community. These trophic interactions are typically non-linear and can alter both the migratory behaviour of the predator and the stability of the fish community. The impact of a migrating top-predator is investigated here for Atlantic bluefin tuna in the North Sea. Bluefin tuna has been absent from the region for half-century, but recent years have seen recovery of migrations and a return of bluefin tuna in the area. We use a size spectrum model to analyse the trophic impact of the returning tuna on the entire fish community, under scenarios with varying levels of tuna consumption and fishing mortality on the prey. We show that with high level of prey fishing mortality in the North Sea, the effect of a tuna re-colonization results in only limited trophic cascades. However, high tuna consumption or changes in fishing mortality may result in a sudden recruitment failure of small-pelagic fish due to cascading effects on the fish community. In present-day conditions, the level of tuna consumption that triggers recruitment failure is lower at increasing fishing mortalities on their prey, providing indications for the future sustainable management of both small-pelagics and bluefin tuna in the area.
From traits to life history strategies: deconstructing fish community composition across European Seas

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Section for Marine Ecology and Oceanography, Thünen Institute of Sea Fisheries
Global patterns in the feeding ecology of large marine fish

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Marine ecosystem connectivity mediated by migrant–resident interactions and the concomitant cross-system flux of lipids

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BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.37 SNIP 0.886 CiteScore 2.37
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.876 SNIP 0.725 CiteScore 1.66
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Web of Science (2013): Indexed yes
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Patterns and drivers of fish community assembly in a large marine ecosystem

The presence and survival of the species in a community depend on their abilities to maximize fitness in a given environment. The study of the processes that control survival and co-existence, termed ‘assembly rules’, follows various mechanisms, primarily related to biotic or abiotic factors. To determine assembly rules, ecological similarities of co-occurring species are often investigated. This can be evaluated using trait-based indices summarizing the species’ niches in a given community. In order to investigate the underlying processes shaping community assembly in marine ecosystems, we investigated the patterns and drivers of fish community composition in the Baltic Sea, a semi-enclosed sea characterized by a pronounced environmental gradient. Our results showed a marked decline in species- and functional richness, largely explained by decreasing salinities. In addition, habitat complexity and oxygen were found to be significant drivers. Furthermore, we showed that the trait composition of the fish community in the western Baltic Sea is more similar than expected by random chance alone. This implies that environmental filtering, acting along the salinity gradient, is the dominant factor shaping community composition. However, community composition in the eastern part, an area beyond the steep decline in salinity, was characterized by fewer species with largely different trait characteristics, indicating that community assembly is also affected by biotic interactions. Our results add to the knowledge base of key abiotic drivers impacting marine fish communities and their vulnerability to environmental changes, a key concern for fisheries and marine ecosystem management.
Reproductive traits (Fecundity, egg diameter, parental care) of marine European fish

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Resilience and stability of a pelagic marine ecosystem
The accelerating loss of biodiversity and ecosystem services worldwide has accentuated a long-standing debate on the role of diversity in stabilizing ecological communities and has given rise to a field of research on biodiversity and ecosystem functioning (BEF). Although broad consensus has been reached regarding the positive BEF relationship, a number of important challenges remain unanswered. These primarily concern the underlying mechanisms by which diversity increases resilience and community stability, particularly the relative importance of statistical averaging and functional complementarity. Our understanding of these mechanisms relies heavily on theoretical and experimental studies, yet the degree to which theory adequately explains the dynamics and stability of natural ecosystems is largely unknown, especially in marine ecosystems. Using modelling and a unique 60-year dataset covering multiple trophic levels, we show that the pronounced multi-decadal variability of the Southern California Current System (SCCS) does not represent fundamental changes in ecosystem functioning, but a linear response to key environmental drivers channelled through bottom-up and physical control. Furthermore, we show strong temporal asynchrony between key species or functional groups within multiple trophic levels caused by opposite responses to these drivers. We argue that functional complementarity is the primary mechanism reducing community variability and promoting resilience and stability in the SCCS.

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Spatial structuration of life history traits: congruence between multiple taxa and environmental drivers in the North Sea

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Spatio-temporal changes in life-history traits of the North Sea fish community under climate change and fishing

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Beyond ocean connectivity: embracing advances on early life stages and adult connectivity to assessment and management challenges

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Authors: Deurs, M. V. (Intern), Lindegren, M. (Intern), Persson, A. (Ekstern), Jacobsen, C. (Ekstern), Nilsson, A. (Ekstern)
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Climate and fishing steer ecosystem regeneration to uncertain economic futures

Overfishing of large predatory fish populations has resulted in lasting restructurings of entire marine food webs worldwide, with serious socio-economic consequences. Fortunately, some degraded ecosystems show signs of recovery. A key challenge for ecosystem management is to anticipate the degree to which recovery is possible. By applying a statistical food-web model, using the Baltic Sea as a case study, we show that under current temperature and salinity conditions, complete recovery of this heavily altered ecosystem will be impossible. Instead, the ecosystem regenerates towards a new ecological baseline. This new baseline is characterized by lower and more variable biomass of cod, the commercially most important fish stock in the Baltic Sea, even under very low exploitation pressure. Furthermore, a socio-economic assessment shows that this signal is amplified at the level of societal costs, owing to increased uncertainty in biomass and reduced consumer surplus. Specifically, the combined economic losses amount to approximately 120 million € per year, which equals half of today's maximum economic yield for the Baltic cod fishery. Our analyses suggest that shifts in ecological and economic baselines can lead to higher economic uncertainty and costs for exploited ecosystems, in particular, under climate change.

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Organisations: National Institute of Aquatic Resources, Centre for Ocean Life, Swedish University of Agricultural Sciences, Stockholm University, Instituto Español de Oceanografía, University of Hamburg, Christian-Albrechts-Universität zu Kiel, University of Oslo
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Environmental filtering drives functional diversity of fish assemblages in a temperate system.

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Environmental filtering drives functional diversity of fish assemblages in a temperate system.

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Authors: Pécuchet, L. (Intern), Hidalgo, M. (Ekstern), Lindegren, M. (Intern)
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The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Section for Ecosystem based Marine Management, Section for Marine Living Resources, Section for Monitoring and Data, Centre for Ocean Life, Aarhus University
Authors: Palacz, A. (Intern), Nielsen, J. R. (Intern), Christensen, A. (Intern), Gislason, H. (Intern), Bastardie, F. (Intern), Geitner, K. (Intern), Maar, M. (Ekstern), Lindegren, M. (Intern), Hufnagl, M. (Intern), Fulton, E. (Ekstern)
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A demonstration of an integrated ecosystem assessment and advice for Baltic Sea fish stocks

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A metacommunity perspective on source-sink dynamics and management: the Baltic Sea as a case study

The degree to which metapopulation processes influence fish stock dynamics is a largely unresolved issue in marine science and management, especially for highly mobile species such as Atlantic cod (Gadus morhua) and herring (Clupea harengus). The Baltic Sea comprises a heterogeneous oceanographic environment that structures the spatial and temporal distribution of the dominant species cod, herring, and sprat (Sprattus sprattus). Despite local differences, the stocks are traditionally managed as homogeneous units. Here, we present a metacommunity-perspective on source–sink dynamics of Baltic Sea fish stocks by using a spatially disaggregated statistical food web model. The model is fitted to area-specific time series of multiple abiotic and biotic variables using state-space methods. Our analysis reveals pronounced net fluxes between areas, indicative of source–sink dynamics, as well as area-specific differences in species interactions (i.e., density dependence, competition, and predator–prey) and the degree of fishing and climate impact on survival and recruitment. Furthermore, model simulations show that decreasing exploitation pressure in the source area for cod (without reallocating fishing effort) produces an increase in neighboring sink habitats, but a decline of prey species in response to increased predation. Our approach provides valuable insight concerning metacommunity-structuring of marine fish and may serve as an important tool for implementing sustainable management strategies under the ecosystem approach to marine and fisheries management.

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Scopus rating (2010): SJR 2.784 SNIP 1.675
Assessing social - ecological trade-offs to advance ecosystem-based fisheries management.
Modern resource management faces trade-offs in the provision of various ecosystem goods and services to humanity. For fisheries management to develop into an ecosystem-based approach, the goal is not only to maximize economic profits, but to consider equally important conservation and social equity goals. We introduce such a triple-bottom line approach to the management of multi-species fisheries using the Baltic Sea as a case study. We apply a coupled ecological-economic optimization model to address the actual fisheries management challenge of trading-off the recovery of collapsed cod stocks versus the health of ecologically important forage fish populations. Management strategies based on profit maximization would rebuild the cod stock to high levels but may cause the risk of stock collapse for forage species with low market value, such as Baltic sprat (Fig. 1A). Economically efficient conservation efforts to protect sprat would be borne almost exclusively by the forage fishery as sprat fishing effort and profits would strongly be reduced. Unless compensation is paid, this would challenge equity between fishing sectors (Fig. 1B). Optimizing equity while respecting sprat biomass precautionary levels would reduce potential profits of the overall Baltic fishery, but may offer an acceptable balance between overall profits, species conservation and social equity (Fig. 1C). Our case study shows a practical example of how an ecosystem-based fisheries management will be able to offer society options to solve common conflicts between different resource uses. Adding equity considerations to the traditional trade-off between economy and ecology will greatly enhance credibility and hence compliance to management decisions, a further footstep towards healthy fish stocks and sustainable fisheries in the world ocean.
Forecasting fish stock dynamics under climate change: Baltic herring (Clupea harengus) as a case study

Climate change and anthropogenic disturbances may affect marine populations and ecosystems through multiple pathways. In this study we present a framework in which we integrate existing models and knowledge on basic regulatory processes to investigate the potential impact of future scenarios of fisheries exploitation and climate change on the temporal dynamics of the central Baltic herring stock. Alternative scenarios of increasing sea surface temperature and decreasing salinity of the Baltic Sea from a global climate model were combined with two alternative fishing scenarios, and their direct and ecosystem-mediated effects (i.e., through predation by cod and competition with sprat) on the herring population were evaluated for the period 2010-2050. Gradual increase in temperature has a positive impact on the long-term productivity of the herring stock, but it has the potential to enhance the recovery of the herring stock only in combination with sustainable fisheries management (i.e., Fmsy). Conversely, projections of herring spawning stock biomass (SSB) were generally low under elevated fishing mortality levels (Fhigh), comparable with those experienced by the stock during the 1990s. Under the combined effects of long-term warming and high fishing mortality uncertainty in herring SSB projections was higher and increasing for the duration of the forecasts, suggesting a synergistic effect of fishery exploitation and climate forcing on fish populations dynamics. Our study shows that simulations of long-term fish dynamics can be an informative tool to derive expectations of the potential long-term impact of alternative future scenarios of exploitation and climate change.

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Implementing ecosystem-based fisheries management: from single-species to integrated ecosystem assessment and advice for Baltic Sea fish stocks
Theory behind ecosystem-based management (EBM) and ecosystem-based fisheries management (EBFM) is now well developed. However, the implementation of EBFM exemplified by fisheries management in Europe is still largely based on single-species assessments and ignores the wider ecosystem context and impact. The reason for the lack or slow implementation of EBM and specifically EBFM is a lack of a coherent strategy. Such a strategy is offered by recently developed integrated ecosystem assessments (IEAs), a formal synthesis tool to quantitatively analyse information on relevant natural and socio-economic factors, in relation to specified management objectives. Here, we focus on implementing the IEA approach for Baltic Sea fish stocks. We combine both tactical and strategic management aspects into a single strategy that supports the present Baltic Sea fish stock advice, conducted by the International Council for the Exploration of the Sea (ICES). We first review the state of the art in the development of IEA within the current management framework. We then outline and discuss an approach that integrates fish stock advice and IEAs for the Baltic Sea. We intentionally focus on the central Baltic Sea and its three major fish stocks cod (Gadus morhua), herring (Clupea harengus), and sprat (Sprattus sprattus), but emphasize that our approach may be applied to other parts and stocks of the Baltic, as well as other ocean areas.

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Stockholm University, Lund University, University of Hamburg, Finnish Environment Institute, Scripps Institution of Oceanography, University of Kiel
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Sea surface temperature variability at the Scripps Institution of Oceanography Pier

Sea surface temperature (SST) has been measured from near the end of the SIO pier daily since 1916. It is one of the world’s longest instrumental time series of SST. It is widely used in studies of climate and marine ecosystems and in fisheries management. We hypothesized that a discontinuity exists in 1988, when the old pier was replaced with the present pier. A regression of annual mean SST at SIO (SSTSIO) on the Pacific Decadal Oscillation index for 1916-1987 was used to predict annual mean SST (SSTSIO, PDO) for 1916-present. The residual (ResSSTSIO = SSTSIO - SSTSIO, PDO) time series shows a positive discontinuity in 1988, when the present SIO pier was first used to measure SSTSIO. No discontinuity in 1988 was observed for ResSST at 12 other shore stations or nearby waters. Use of the first principal component of other shore station time series of annual mean SST as the predictor yields similar results. SSTSIO measured over three days shows a diel cycle and short-term variability consistent with rip current transport of warm surf zone water to the end of the SIO pier. We hypothesize that rip current transport increased with the change from the old to the present pier and contributed to the observed discontinuity in SIO pier SST. We estimate an artifact of +0.45°C due to both rapid (1988 pier change) and gradual processes. Adjusting the SIO pier SST time series for this artifact reduces the long-term trend from +1.1°C/century to +0.6°C/century, consistent with the global rate of change of SST over the past century.
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

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Authors: Palacz, A. (Intern), Nielsen, J. R. (Intern), Christensen, A. (Intern), Gislason, H. (Intern), Bastardie, F. (Intern), Geitner, K. (Intern), Maar, M. (Ekstern), Lindegren, M. (Intern), Hufnagl, M. (Intern), Fulton, E. (Ekstern)
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Biological ensemble modeling to evaluate potential futures of living marine resources
Natural resource management requires approaches to understand and handle sources of uncertainty in future responses of complex systems to human activities. Here we present one such approach, the "biological ensemble modeling approach," using the Eastern Baltic cod (Gadus morhua callarias) as an example. The core of the approach is to expose an ensemble of models with different ecological assumptions to climate forcing, using multiple realizations of each climate scenario. We simulated the long-term response of cod to future fishing and climate change in seven ecological models ranging from single-species to food web models. These models were analyzed using the "biological ensemble modeling approach" by which we (1) identified a key ecological mechanism explaining the differences in simulated cod responses between models, (2) disentangled the uncertainty caused by differences in ecological model assumptions from the statistical uncertainty of climate trajectories, and (3) identified results common for the whole model ensemble. Species interactions greatly influenced the simulated response of cod to fishing and climate, as well as the degree to which the statistical uncertainty of climate trajectories carried through to uncertainty of cod responses. Models ignoring the feedback
from prey on cod showed large interannual fluctuations in cod dynamics and were more sensitive to the underlying uncertainty of climate forcing than models accounting for such stabilizing predator–prey feedbacks. Yet in all models, intense fishing prevented recovery, and climate change further decreased the cod population. Our study demonstrates how the biological ensemble modeling approach makes it possible to evaluate the relative importance of different sources of uncertainty in future species responses, as well as to seek scientific conclusions and sustainable management solutions robust to uncertainty of food web processes in the face of climate change.

**General information**

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Organisations: National Institute of Aquatic Resources, Section for Marine Ecology and Oceanography, Finnish Game and Fisheries Research Institute, Lund University, Stockholm University, University of Hamburg
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Climate, fishing, and fluctuations of sardine and anchovy in the California Current
Since the days of Elton, population cycles have challenged ecologists and resource managers. Although the underlying mechanisms remain debated, theory holds that both density-dependent and density-independent processes shape the dynamics. One striking example is the large-scale fluctuations of sardine and anchovy observed across the major upwelling areas of the world. Despite a long history of research, the causes of these fluctuations remain unresolved and heavily debated, with significant implications for fisheries management. We here model the underlying causes of these fluctuations, using the California Current Ecosystem as a case study, and show that the dynamics, accurately reproduced since A.D. 1661 onward, are explained by interacting density-dependent processes (i.e., through species-specific life-history traits) and climate forcing. Furthermore, we demonstrate how fishing modifies the dynamics and show that the sardine collapse of the 1950s was largely unavoidable given poor recruitment conditions. Our approach provides unique insight into the origin of sardine-anchovy fluctuations and a knowledge base for sustainable fisheries management in the California Current Ecosystem and beyond.

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Climate-induced response of commercially important flatfish species during the 20th century

The consequence of elevated ocean temperatures on commercial fish stocks is addressed using time series of commercial landings (1906–2004) and juvenile survey catch data (1904–2006) collected around Denmark. We analyze (i) whether warm-water sole (Solea solea) has increased relative to Boreal plaice (Pleuronectes platessa) and (ii) whether two related warm-water species (turbot, Psetta maxima and brill, Scophthalmus rhombus) show similar responses to increasing temperature or, alternatively, whether turbot (which has a broader juvenile diet) has been favored. Since the early 1980s, both sole and turbot have constituted an increasing part of the commercial landings and survey catches, as compared with plaice and brill, respectively. These changes in species composition were linked to sea surface temperatures, Northern Hemisphere temperature anomalies (NHA) and the North Atlantic Oscillation. NHA was closely related and explained 43% of the observed variation in sole survey catches relative to the plaice catches and almost 38% of the observed variation in the sole landings relative to the plaice landings. For the less common species, turbot and brill, none of the global change indicators explained more than 15% of the variation, although all showed a positive relationship. Survey catch per unit effort increased significantly for both sole and turbot around the early 1980s, whereas catch per unit effort for plaice and brill remained constant. The results indicate that the abundance of warm-water species is likely to increase with increasing temperature but also that species with similar life histories might react differently according to degree of specialization.

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Organisations: National Institute of Aquatic Resources, Section for Coastal Ecology, Centre for Ocean Life
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Swedish coastal herring fisheries in the wake of an ITQ system

The European common fisheries policy (CFP) advocates measures to sustain small-scale fisheries; hence, in the European Commission’s proposal for a reformed CFP, these are exempted from a mandatory system with tradable fishing concessions. This opens up for management actions designed for small-scale fisheries, but also implies new management issues. This article provides insights into the topic based on a Swedish small-scale herring fishery in the western Baltic Sea that was exempted from an ITQ-system. The fishery has been profitable since the system was introduced, and the increasing effort of both incumbent fishermen and new entrants implies a situation where fishermen compete for a limited quota. The migratory pattern of the herring implies high densities in the southern parts of the fishing areas during spring and in the northern parts during autumn. This forms the basis for two different fisheries in the area, as well as for the current management proposal to divide the quota into a spring and an autumn part. This and other management proposals are discussed in the paper. The main conclusion from the case study is that, when exempting a fishery from tradable fishing concessions, it is important to build other institutions dealing with the fundamental problem of access to the quota. Failure to do so might result in an over-capacity issue and threaten the long-run development of an otherwise successful small-scale fishery. (C) 2012 Elsevier Ltd. All rights reserved.
Temperature dependence of Pacific sardine (Sardinops sagax) recruitment in the California Current Ecosystem revisited and revised

Small pelagic fish typically show highly variable population dynamics due, in large part, to climate variability. Despite this sensitivity to climate, few stocks of pelagic species are managed with consideration of the environment. The Pacific sardine (Sardinops sagax) represents a notable exception, for which sea surface temperature (SST) from the Scripps Institution of Oceanography (SIO) pier has been used, until recently, to adjust exploitation pressure under warm (favorable) and cold (unfavorable) climate conditions. Recently, the previously established temperature-recruitment relationship was reassessed using different methods, resulting in abandonment of the temperature-sensitive harvest control rule in 2012. In this study, we revisit the previous temperature-recruitment relationship using the original methodology and an updated data set from 1981 to 2010. In contrast to the recent reassessment, we find temperature explains significant variability in recruitment and recruitment success. We also show that mean annual SST averaged over the present California Cooperative Oceanic Fisheries Investigations area is a better predictor of recruitment variability than SST at the SIO pier. We propose that sustainable management of the Pacific sardine should consider climate variability and that the basis for this be periodically updated and revised to inform management with the best available science.

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Authors: Lindegren, M. (Intern), Checkley, D. M. (Ekstern)
Pages: 245-252
Threshold-dependent climate effects and high mortality limit recruitment and recovery of the Kattegat cod

Cod in the Kattegat is one of the most dramatic examples of stock collapse, where despite large management efforts, almost no signs of recovery have been observed. We investigate how multiple physical and biological factors could potentially influence recruitment and recovery of Kattegat cod, using non-additive threshold models. In contrast to previous studies on recruitment dynamics of Kattegat cod Gadus morhua, we found that recruitment variability may be explained by a combination of the size of the spawning stock and external conditions (i.e. sea surface temperature and oxygen concentrations), but only during periods of low stock size. Our results indicate that the long-term decrease and the present poor state of the Kattegat cod stock is likely caused by high total mortality rates and stock-size dependent effects of climate which together are currently preventing recovery. In addition, we illustrate how only a drastic reduction in total mortalities, primarily by limiting unintended bycatch and discards, may promote a recovery of the stock. This knowledge is important for evaluating the success or failure of various management measures which have been employed to recover the stock and for developing future management strategies which can take the environmental and/or ecosystem impacts into account.
Towards sustainable fisheries of the Öresund cod (Gadus morhua) through sub-stock-specific assessment and management recommendations

Fisheries management traditionally relies on stock assessments assuming discrete populations within large administrative areas. However, failing to account for sub-stock structuring may result in overestimation of the stocks' true harvest potential and unsustainable exploitation of small stock elements. Atlantic cod (Gadus morhua) frequently occurs in spatially segregated populations, some of which exhibit fine-scaled stock structuring within current management boundaries. Here we use the locally spawning cod stock in the Sound ("Öresund") as a case study, and perform a sub-stock-specific assessment to evaluate biological and economic effects of managing the Sound cod as a separate stock. Our results indicate that reducing exploitation pressure, particularly through technical regulations i.e. increasing gill-net mesh sizes, would not only enhance the stock age distribution, but yield long-term net benefits to the local gill-net fishery. Furthermore, our study emphasizes the need for developing sub-stock-specific management recommendations in order to ensure the maintenance of fisheries resources in general, and the persistence of sub-stock structuring in particular.

General information
State: Published
Organisations: National Institute of Aquatic Resources, Lund University
Authors: Lindegren, M. (Intern), Waldo, S. (Ekstern), Nilsson, P. A. (Ekstern), Svedäng, H. (Ekstern), Persson, A. (Ekstern)
Pages: 1140-1150
Publication date: 2013
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Journal of Marine Science
Alien invasions and the game of hide and seek in Patagonia

The introduction, establishment and spread of alien species is a major threat to biodiversity and the provision of ecosystem services for human wellbeing. In order to reduce further loss of biodiversity and maintain productive and sustainable ecosystems, understanding the ecological mechanisms underlying species invasions and avoiding potentially harmful effects on native communities is urgently needed, but largely lacking. We here demonstrate, by means of hydroacoustics and advanced spatial modelling, how native fish species as a result of previous exposure to native predators may successfully respond to invasive novel predators through a complicated game of hide and seek, minimizing
spatio-temporal overlap with predators, and potentially facilitating coexistence between native prey species (Galaxiids) and introduced novel predators (Salmonids) in a deep Andean lake, Patagonia.

**General information**

State: Published
Organisations: University of California, San Diego, Lund University, Universidad Nacional del Comahue
Authors: Lindegren, M. (Intern), Vigliano, P. (Ekstern), Nilsson, P. A. (Ekstern)
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**

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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 3.11 SJR 1.201 SNIP 1.092
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 1.414 SNIP 1.131 CiteScore 3.32
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 1.545 SNIP 1.141 CiteScore 3.54
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 1.74 SNIP 1.147 CiteScore 3.94
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 1.945 SNIP 1.142 CiteScore 4.15
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 2.369 SNIP 1.23 CiteScore 4.58
ISI indexed (2011): ISI indexed no
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 2.631 SNIP 1.161
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 2.473 SNIP 0.985
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 2.323 SNIP 0.96
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 1.289 SNIP 0.525
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Andean lake Argentina, South America Neotropical region, Lake Gutierrez Argentina, South America Neotropical region, Patagonia Argentina, South America Neotropical region, biodiversity, ecological mechanism, ecosystem provision, habitat selection, prey-predator interaction, species distribution, species invasion, Pisces Vertebrata Chordata Animalia (Animals, Chordates, Fish, Nonhuman Vertebrates, Vertebrates) - Osteichthyes [85206] Oncorhynchus mykiss species rainbow trout common Salmo trutta species brown trout common Salvelinus fontinalis species brook trout common Galaxias maculatus species Galaxias platei species Percichthys trucha species Odontesthes hatcheri species Olivaichthys viedmensis species
Early detection of ecosystem regime shifts: A multiple method evaluation for management application

Critical transitions between alternative stable states have been shown to occur across an array of complex systems. While our ability to identify abrupt regime shifts in natural ecosystems has improved, detection of potential early-warning signals previous to such shifts is still very limited. Using real monitoring data of a key ecosystem component, we here apply multiple early-warning indicators in order to assess their ability to forewarn a major ecosystem regime shift in the Central Baltic Sea. We show that some indicators and methods can result in clear early-warning signals, while other methods may have limited utility in ecosystem-based management as they show no or weak potential for early-warning. We therefore propose a multiple method approach for early detection of ecosystem regime shifts in monitoring data that may be useful in informing timely management actions in the face of ecosystem change.
Impact of climate change on fish population dynamics in the Baltic Sea: a dynamical downscaling investigation

Understanding how climate change, exploitation and eutrophication will affect populations and ecosystems of the Baltic Sea can be facilitated with models which realistically combine these forcings into common frameworks. Here, we evaluate sensitivity of fish recruitment and population dynamics to past and future environmental forcings provided by three ocean-biogeochemical models of the Baltic Sea. Modeled temperature explained nearly as much variability in reproductive success of sprat (Sprattus sprattus; Clupeidae) as measured temperatures during 1973-2005, and both the spawner biomass and the temperature have influenced recruitment for at least 50 years. The three Baltic Sea models estimate relatively similar developments (increases) in biomass and fishery yield during twenty-first century climate change (ca. 28 % range among models). However, this uncertainty is exceeded by the one associated with the fish population model, and by the source of global climate data used by regional models. Knowledge of processes and biases could reduce these uncertainties

General information
State: Published
Organisations: National Institute of Aquatic Resources, Section for Ocean Ecology and Climate, Section for Management Systems, Section for Population Ecology and Genetics
Authors: Mackenzie, B. R. (Intern), Meier, H. E. M. (Ekstern), Lindegren, M. (Intern), Neuenfeldt, S. (Intern), Eero, M. (Intern), Blenckner, T. (Ekstern), Tomczak, M. T. (Intern), Niiranen, S. (Ekstern)
Pages: 626-636
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Ambio
Volume: 41
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ISSN (Print): 0044-7447
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 1
**Nutrient reduction and climate change cause a potential shift from pelagic to benthic pathways in a eutrophic marine ecosystem**

The degree to which marine ecosystems may support the pelagic or benthic food chain has been shown to vary across natural and anthropogenic gradients for e.g., in temperature and nutrient availability. Moreover, such external forcing may not only affect the flux of organic matter but could trigger large and abrupt changes, i.e., trophic cascades and ecological regime shifts, which once having occurred may prove potentially irreversible. In this study, we investigate the state and regulatory pathways of the Kattegat; a eutrophied and heavily exploited marine ecosystem, specifically testing for the occurrence of regime shifts and the relative importance of multiple drivers, e.g., climate change, eutrophication and commercial fishing on ecosystem dynamics and trophic pathways. Using multivariate statistics and nonlinear regression on a comprehensive data set, covering abiotic factors and biotic variables across all trophic levels, we here propose a potential regime shift from pelagic to benthic regulatory pathways: a possible first sign of recovery from eutrophication likely triggered by drastic nutrient reductions (involving both nitrogen and phosphorus), in combination with climate-driven
changes in local environmental conditions (e.g., temperature and oxygen concentrations)

**General information**

State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Stockholm University, University of Oslo
Authors: Lindegren, M. (Intern), Blenckner, T. (Ekstern), Stenseth, N. (Ekstern)
Pages: 3491-3503
Publication date: 2012
Main Research Area: Technical/natural sciences

**Publication information**

Journal: Global Change Biology
Volume: 18
Issue number: 12
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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 8.75 SJR 4.768 SNIP 2.615
- Web of Science (2016): Indexed yes
- BFI (2015): BFI-level 2
- Scopus rating (2015): SJR 5.239 SNIP 2.585 CiteScore 8.48
- Web of Science (2015): Indexed yes
- BFI (2014): BFI-level 2
- Scopus rating (2014): SJR 4.636 SNIP 2.693 CiteScore 8.33
- Web of Science (2014): Indexed yes
- BFI (2013): BFI-level 2
- Scopus rating (2013): SJR 4.624 SNIP 2.655 CiteScore 8.4
- ISI indexed (2013): ISI indexed yes
- Web of Science (2013): Indexed yes
- BFI (2012): BFI-level 2
- Scopus rating (2012): SJR 4.228 SNIP 2.388 CiteScore 7.2
- ISI indexed (2012): ISI indexed yes
- Web of Science (2012): Indexed yes
- BFI (2011): BFI-level 2
- Scopus rating (2011): SJR 4.385 SNIP 2.23 CiteScore 6.86
- ISI indexed (2011): ISI indexed yes
- Web of Science (2011): Indexed yes
- BFI (2010): BFI-level 2
- Scopus rating (2010): SJR 4.394 SNIP 2.257
- Web of Science (2010): Indexed yes
- BFI (2009): BFI-level 2
- Scopus rating (2009): SJR 4.127 SNIP 2.178
- Web of Science (2009): Indexed yes
- BFI (2008): BFI-level 2
- Scopus rating (2008): SJR 3.934 SNIP 2.203
- Web of Science (2008): Indexed yes
- Scopus rating (2007): SJR 3.09 SNIP 1.837
- Web of Science (2007): Indexed yes
- Scopus rating (2006): SJR 3.148 SNIP 1.897
- Scopus rating (2005): SJR 2.529 SNIP 1.877
- Web of Science (2005): Indexed yes
Predator transitory spillover induces trophic cascades in ecological sinks
Understanding the effects of cross-system fluxes is fundamental in ecosystem ecology and biological conservation. Source-sink dynamics and spillover processes may link adjacent ecosystems by movement of organisms across system boundaries. However, effects of temporal variability in these cross-system fluxes on a whole marine ecosystem structure have not yet been presented. Here we show, using 35 y of multitrophic data series from the Baltic Sea, that transitory spillover of the top-predator cod from its main distribution area produces cascading effects in the whole food web of an adjacent and semi-isolated ecosystem. At varying population size, cod expand/contract their distribution range and invade/retreat from the neighboring Gulf of Riga, thereby affecting the local prey population of herring and, indirectly, zooplankton and phytoplankton via top-down control. The Gulf of Riga can be considered for cod a “true sink” habitat, where in the absence of immigration from the source areas of the central Baltic Sea the cod population goes extinct due to the absence of suitable spawning grounds. Our results add a metaecosystem perspective to the ongoing intense scientific debate on the key role of top predators in structuring natural systems. The integration of regional and local processes is central to predict species and ecosystem responses to future climate changes and ongoing anthropogenic disturbances

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Casini, M. (Ekstern), Blenckner, T. (Ekstern), Möllmann, C. (Ekstern), Gårdmark, A. (Ekstern), Lindegren, M. (Intern), Llope, M. (Ekstern), Kornilovs, G. (Ekstern), Plikshs, M. (Ekstern), Stenseth, N. C. (Ekstern)
Pages: 8185-8189
Publication date: 2012
Main Research Area: Technical/natural sciences

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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 8.56 SJR 6.321 SNIP 2.629
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 6.767 SNIP 2.682 CiteScore 8.84
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 6.853 SNIP 2.725 CiteScore 8.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 6.989 SNIP 2.73 CiteScore 9.5
ISI indexed (2013): ISI indexed yes
The state and relative importance of drivers of fish population dynamics: An indicator-based approach

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Institute Management
Authors: Eero, M. (Intern), Lindegren, M. (Intern), Köster, F. (Intern)
Pages: 248-252
Publication date: 2012
Main Research Area: Technical/natural sciences

Publication information
Journal: Ecological Indicators
Volume: 15
Issue number: 1
Applying the shiftogram approach for identifying ecosystem changes - the Baltic Sea as a multivariate test case

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Gröger, J. (Ekstern), Möllmann, C. (Ekstern), Blenckner, T. (Ekstern), Gårdmark, A. (Ekstern), Lindegren, M. (Intern), Müller-Karulis, B. (Ekstern), Axe, P. (Ekstern), Plikshs, M. (Ekstern), Kornilovs, G. (Ekstern)
Publication date: 2011
Event: Abstract from ICES Council Meeting 2011, Gdansk, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 286994
Publication: Research - peer-review › Journal article – Annual report year: 2011
Beauty is in the eye of the beholder: Management of Baltic cod stock requires an ecosystem approach

In a recent ‘As We See It’ article, Cardinale & Svedäng (2011; Mar Ecol Prog Ser 425:297–301) used the example of the Eastern Baltic (EB) cod stock to argue that the concept of ecosystem regime shifts, especially the potential existence of alternative stable states (or dynamic regimes), blurs the fact that human exploitation (i.e. fishing) is the strongest impact on marine ecosystems. They further concluded that single-species approaches to resource management are functioning and that ecosystem-based approaches are not necessary. We (1) argue that the recent increase in the EB cod stock is inherently uncertain, (2) discuss the critique of the regime shift concept, and (3) describe why the EB cod stock dynamics demonstrates the need for an ecosystem approach to fisheries management.

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, University of Hamburg, Stockholm University, Swedish Board of Fisheries
Authors: Möllmann, C. (Ekstern), Blenckner, T. (Ekstern), Casini, M. (Ekstern), Gårdmark, A. (Ekstern), Lindegren, M. (Intern)
Pages: 293-297
Publication date: 2011
Main Research Area: Technical/natural sciences

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Volume: 431
ISSN (Print): 0171-8630
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Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.56
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 2.75
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 2.79
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.9
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.85
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Web of Science (2008): Indexed yes
Web of Science (2007): Indexed yes
Biological ensemble modelling to improve marine science and ecosystem-based management advice

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Population Ecology and Genetics
Authors: Gårdmark, A. (Ekstern), Lindegren, M. (Intern), Neuenfeldt, S. (Intern), Blenckner, T. (Ekstern), Aaro, E. (Ekstern), Heikinheimo, O. (Ekstern), Müller-Karulis, B. (Ekstern), Niiranen, S. (Ekstern), Tomczak, M. (Ekstern), Wikström, A. (Ekstern), Möllmann, C. (Ekstern)
Publication date: 2011
Event: Abstract from ICES Council Meeting 2011, Gdansk, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314450
Publication: Research › Conference abstract for conference — Annual report year: 2011

Effects of mammal predation on small pelagic fish

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Population Ecology and Genetics
Authors: Gårdmark, A. (Ekstern), Östman, Ö. (Ekstern), Lundström, K. (Ekstern), Karlsson, O. (Ekstern), Pönni, J. (Ekstern), Lindegren, M. (Intern), Nielsen, A. (Intern), Kaljuste, O. (Ekstern), Aho, T. (Ekstern)
Publication date: 2011
Event: Abstract from ICES Council Meeting 2011, Gdansk, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314451
Publication: Research › Conference abstract for conference — Annual report year: 2011

Fishery- and climate-induced changes in predator distribution trigger a spatial reallocation of its prey: the cod–sprat dynamics in the Baltic Sea

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Casini, M. (Ekstern), Bergström, U. (Ekstern), Bartolino, V. (Ekstern), Aro, E. (Ekstern), Lindegren, M. (Intern), Axe, P. (Ekstern), Meier, M. (Ekstern)
Publication date: 2011
Event: Abstract from ICES Council Meeting 2011, Gdansk, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314453
Publication: Research › Conference abstract for conference — Annual report year: 2011


**Interacting trophic forcing and the population dynamics of herring**

Small pelagic fish occupy a central position in marine ecosystems worldwide, largely by determining the energy transfer from lower trophic levels to predators at the top of the food web, including humans. Population dynamics of small pelagic fish may therefore be regulated neither strictly bottom-up nor top-down, but rather through multiple external and internal drivers. While in many studies single drivers have been identified, potential synergies of multiple factors, as well as their relative importance in regulating population dynamics of small pelagic fish, is a largely unresolved issue. Using a statistical, age-structured modeling approach, we demonstrate the relative importance and influence of bottom-up (e.g., climate, zooplankton availability) and top-down (i.e., fishing and predation) factors on the population dynamics of Bothnian Sea herring (Clupea harengus) throughout its life cycle. Our results indicate significant bottom-up effects of zooplankton and interspecific competition from sprat (Sprattus sprattus), particularly on younger age classes of herring. Although top-down forcing through fishing and predation by grey seals (Halichoerus grypus) and Atlantic cod (Gadus morhua) also was evident, these factors were less important than resource availability and interspecific competition. Understanding key ecological processes and interactions is fundamental to ecosystem-based management practices necessary to promote sustainable exploitation of small pelagic fish.

**General information**

- State: Published
- Organisations: Section for Management Systems, National Institute of Aquatic Resources
- Authors: Lindegren, M. (Intern), Ostman, O. (Ekstern), Gardmark, A. (Ekstern)
- Pages: 1407-1413
- Publication date: 2011
- Main Research Area: Technical/natural sciences

**Publication information**

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- Volume: 92
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- ISSN (Print): 0012-9658
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  - 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 4.8 SJR 3.255 SNIP 1.76
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 2
  - Scopus rating (2015): SJR 3.934 SNIP 1.931 CiteScore 5.24
  - Web of Science (2015): Indexed yes
  - BFI (2014): BFI-level 2
  - Scopus rating (2014): SJR 3.694 SNIP 1.987 CiteScore 5.09
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 2
  - Scopus rating (2013): SJR 3.679 SNIP 2.071 CiteScore 5.43
  - ISI indexed (2013): ISI indexed yes
  - Web of Science (2013): Indexed yes
  - BFI (2012): BFI-level 2
  - Scopus rating (2012): SJR 4.041 SNIP 2.107 CiteScore 5.38
  - ISI indexed (2012): ISI indexed yes
  - BFI (2011): BFI-level 2
  - Scopus rating (2011): SJR 4.242 SNIP 1.934 CiteScore 5.03
  - ISI indexed (2011): ISI indexed yes
  - Web of Science (2011): Indexed yes
  - BFI (2010): BFI-level 2
  - Scopus rating (2010): SJR 4.001 SNIP 2.048
  - BFI (2009): BFI-level 2
  - Scopus rating (2009): SJR 3.766 SNIP 1.942
The times they are a-changin': but can they change back?

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern), Möllmann, C. (Ekstern), Gårdmark, A. (Ekstern), Blenckner, T. (Ekstern)
Pages: 32-38
Publication date: 2011
Main Research Area: Technical/natural sciences

Publication information
Journal: ICES Insight
Volume: 48
ISSN (Print): 1995-7815
Ratings:
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ISI indexed (2011): ISI indexed no
Original language: English
Links:
Source: orbit
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Publication: Communication › Journal article – Annual report year: 2011

Towards holistic ecosystem assessments - achievements of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB)

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Möllmann, C. (Ekstern), Bergström, L. (Ekstern), Blenckner, T. (Ekstern), Flinkman, J. (Ekstern), Gårdmark, A. (Ekstern), Lindegren, M. (Intern), Müller-Karulis, B. (Ekstern)
Publication date: 2011
Event: Abstract from ICES Council Meeting 2011, Gdansk, Poland.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 314455
Publication: Research › Conference abstract for conference – Annual report year: 2011
Biomanipulation - a tool in marine ecosystem management and restoration?

Widespread losses of production and conservation values make large-scale ecosystem restoration increasingly urgent. Ecological restoration by means of biomanipulation, i.e., by fishing out planktivores as to reduce the predation pressure on herbivorous zooplankton, has proven an effective tool in restoring degraded lakes and coastal ecosystems. Whether biomanipulation may prove a useful restoration method in open and structurally complex marine ecosystems is however still unknown. To promote a recovery of the collapsed stock of Eastern Baltic cod (Gadus morhua), large-scale biomanipulation of sprat (Sprattus sprattus), the main planktivore in the Baltic Sea, has been suggested as a possible management approach. We study the effect of biomanipulation on sprat using a statistical food-web model which integrates internal interactions between the main fish species of the Central Baltic Sea with external forcing through commercial fishing, zooplankton and climate. By running multiple, stochastic simulations of reductions in sprat spawning stock biomass (SSB) only minor increases in cod SSB were detected, none of which brought the cod significantly above ecologically safe levels. On the contrary, reductions in cod fishing mortality and/or improved climatic conditions would promote a significant recovery of the stock. By this we demonstrate that an ecosystem-scale biomanipulation with the main focus of reinstating the dominance of cod in the Baltic Sea may likely be ecologically ineffective, operationally difficult and costly. We argue that reducing exploitation pressure on Eastern Baltic cod to ecologically sound levels is a far more appealing management strategy in promoting a long-term recovery and a sustainable fishery of the stock.

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, University of Hamburg, Lund University
Authors: Lindegren, M. (Intern), Möllmann, C. (Ekstern), Hansson, L. (Ekstern)
Pages: 2237-2248
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Main Research Area: Technical/natural sciences

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Journal: Ecological Applications
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Ratings:
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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 4.4 SJR 2.265 SNIP 1.576
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 2.76 SNIP 1.759 CiteScore 4.63
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 2.593 SNIP 1.842 CiteScore 4.59
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 2.676 SNIP 1.863 CiteScore 4.77
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 2.965 SNIP 1.937 CiteScore 4.55
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 3.286 SNIP 1.975 CiteScore 4.86
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 2.784 SNIP 1.675
Web of Science (2010): Indexed yes
Climate- and fishery-induced changes in predator distribution trigger a spatial reallocation of its prey: the Baltic Sea case study

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Casini, M. (Ekstern), Bergström, U. (Ekstern), Lindegren, M. (Intern), Axe, P. (Ekstern)
Publication date: 2010
Main Research Area: Technical/natural sciences
Links:
http://www.ices.dk/products/CMdocs/CM-2010/C/C0210.pdf
Source: orbit
Source-ID: 268792
Publication: Research › Conference abstract for conference – Annual report year: 2010

Climate-induced synchronous regime shifts along environmental and diversity gradients in Baltic Sea sub-systems

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Blenckner, T. (Ekstern), Diekmann, R. (Ekstern), Möllmann, C. (Ekstern), Gårdmark, A. (Ekstern), Casini, M. (Ekstern), Bergström, L. (Ekstern), Flinkman, J. (Ekstern), Müller-Karulis, B. (Ekstern), Lindegren, M. (Intern), Kornilovs, G. (Ekstern), Plikss, M. (Ekstern)
Publication date: 2010
Main Research Area: Technical/natural sciences
Links:
http://www.ices.dk/products/cmdocsindex.asp
Source: orbit
Source-ID: 256645
Publication: Research › Conference abstract for conference – Annual report year: 2010

Cod and future climate change

General information
Good decision making for fisheries and marine ecosystems requires a capacity to anticipate the consequences of management under different scenarios of climate change. The necessary ecological forecasting calls for ecosystem-based models capable of integrating multiple drivers across trophic levels and properly including uncertainty. The methodology presented here assesses the combined impacts of climate and fishing on marine food-web dynamics and provides estimates of the confidence envelope of the forecasts. It is applied to cod (Gadus morhua) in the Baltic Sea, which is vulnerable to climate-related decline in salinity owing to both direct and indirect effects (i.e. through species interactions) on early-life survival. A stochastic food web-model driven by regional climate scenarios is used to produce quantitative forecasts of cod dynamics in the twenty-first century. The forecasts show how exploitation would have to be adjusted in order to achieve sustainable management under different climate scenarios.
Integrated ecosystem assessments of seven Baltic Sea areas covering the last three decades

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern), Diekmann, R. (ed.) (Ekstern), Möllmann, C. (ed.) (Ekstern)
Number of pages: 90
Publication date: 2010

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea (ICES)
Original language: English

Series: ICES Cooperative Research Report
Number: 302
ISSN: 0074-431X
Main Research Area: Technical/natural sciences

Bibliographical note
Martin Lindegren has authored: p. 7-16 and p. 73-74

Making the ecosystem approach operational-Can regime shifts in ecological- and governance systems facilitate the transition?
Effectively reducing cumulative impacts on marine ecosystems requires co-evolution between science, policy and practice. Here, long-term social–ecological changes in the Baltic Sea are described, illustrating how the process of making the ecosystem approach operational in a large marine ecosystem can be stimulated. The existing multi-level governance institutions are specifically set up for dealing with individual sectors, but do not adequately support an operational application of the ecosystem approach. The review of ecosystem services in relation to regime shifts and resilience of the Baltic Sea sub-basins, and their driving forces, points to a number of challenges. There is however a movement towards a new governance regime. Bottom-up pilot initiatives can lead to a diffusion of innovation within the existing governance framework. Top-down, enabling EU legislation, can help stimulating innovations and re-organizing governance structures at drainage basin level to the Baltic Sea catchment as a whole. Experimentation and innovation at local to the regional levels is critical for a transition to ecosystem-based management. Establishing science-based learning platforms at sub-basin scales could facilitate this process.

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Österblom, H. (Ekstern), Gårdmark, A. (Ekstern), Bergström, L. (Ekstern), Müller-Karulis, B. (Ekstern), Folke, C. (Ekstern), Lindegren, M. (Intern), Casini, M. (Ekstern), Olsson, P. (Ekstern), Diekmann, R. (Ekstern), Blenckner, T. (Ekstern), Humborg, C. (Ekstern), Möllmann, C. (Ekstern)
Pages: 1290-1299
Publication date: 2010
Main Research Area: Technical/natural sciences

Publication information
Journal: Marine Policy
Volume: 34
Issue number: 6
ISSN (Print): 0308-597X
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
Modelling the effects of climate change, species interactions and fisheries - towards Ecosystem-based Fisheries Management in the Central Baltic Sea

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern)
Publication date: 2010

Publication information
Place of publication: Copenhagen, Denmark
Publisher: Faculty of Science, Copenhagen University and National Institute of Aquatic Resources, Technical University of Denmark (DTU)
Regime shifts, resilience and recovery of a cod stock

In the North and Baltic seas Atlantic cod Gadus morhua stocks collapsed as part of the major factors inducing large-scale ecosystem regime shifts. Determining the relative contribution of overfishing and climate variability in causing these shifts has proven difficult. While facing similar climatic conditions, the Sound (i.e. a narrow strait located between the North and Baltic seas) differs from its neighbouring areas in the magnitude of fishing pressure as it is subjected to a local trawl fishing ban since 1932. By means of 3 independent multivariate analyses, we investigated the state and development of the Sound ecosystem, specifically testing for the occurrence of regime shifts and their potential drivers. By comparing the ecosystem development of the Sound with the neighbouring North and Baltic seas, we were able to demonstrate the positive effect of the trawl fishing ban on the resilience of the local cod stock to environmental change. The recovery and healthy condition of the Sound cod stock illustrate the need for adaptive marine management strategies that maximize ecosystem resilience.
Report of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB), 19-23 April, Copenhagen

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern)
Number of pages: 94
Publication date: 2010

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea (ICES)
Original language: English

Series: ICES CM
Number: SSGRSP:02
Main Research Area: Technical/natural sciences

Bibliographical note
Martin Lindegren has authored: p. 21-25, 46-60
Source: orbit

**General information**
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern)
Number of pages: 48
Publication date: 2010

**Publication information**
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea (ICES)
Original language: English

**Bibliographical note**
Martin Lindegren has authored: p. 13-14 and p. 17-23
Source: orbit
Source-ID: 272841
Publication: Research › Report – Annual report year: 2010

An ecosystem-based framework for tracking performance of fish stocks and related forcings using fuzzy-logic approach

**General information**
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Institute Management
Authors: Eero, M. (Intern), Jarre, A. (Intern), Ojaveer, H. (Ekstern), Tomczak, M. (Intern), Lindegren, M. (Intern), Köster, F. (Intern)
Publication date: 2009
Event: Abstract from ICES/PICES/UNCOVER Symposium 2009 on Rebuilding Depleted Fish Stocks, Warnemünde/Rostock, Germany.
Main Research Area: Technical/natural sciences
Links: http://www.academia.edu/3478438/Stock-based_vs._fleet-based_evaluation_of_the_multi-annual_management_plan_for_the_cod_stocks_in_the_Baltic_Sea
Source: orbit
Source-ID: 284726
Publication: Research › Conference abstract for conference – Annual report year: 2009

Biological ensemble modelling of the Eastern Baltic cod future

**General information**
State: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Management Systems
Authors: Gårdmark, A. (Ekstern), Möllmann, C. (Ekstern), Neuenfeldt, S. (Intern), Blenckner, T. (Ekstern), Lindegren, M. (Intern), Aro, E. (Ekstern), Bastardie, F. (Intern), Heikinheimo, O. (Ekstern), Müller-Karulis, B. (Ekstern), Niiranen, S. (Ekstern), Tomczak, M. (Intern), van Leeuwen, A. (Ekstern), Wikström, A. (Ekstern)
Publication date: 2009

**Host publication information**
Title of host publication: Book of Abstracts
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 254190
Preventing the collapse of the Baltic cod stock through an ecosystem-based management approach

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Fisheries Advice
Authors: Lindegren, M. (Intern), Möllmann, C. (Ekstern), Nielsen, A. (Intern), Stenseth, N. C. (Ekstern)
Pages: 14722-14727
Publication date: 2009
Main Research Area: Technical/natural sciences

Publication information
Volume: 106
Issue number: 34
ISSN (Print): 0027-8424
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BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
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Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 8.56 SJR 6.321 SNIP 2.629
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): SJR 6.767 SNIP 2.682 CiteScore 8.84
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): SJR 6.853 SNIP 2.725 CiteScore 8.86
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): SJR 6.989 SNIP 2.73 CiteScore 9.5
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): SJR 6.792 SNIP 2.682 CiteScore 9.49
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): SJR 6.771 SNIP 2.636 CiteScore 9.31
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 6.769 SNIP 2.529
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 6.913 SNIP 2.544
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 2
Scopus rating (2008): SJR 6.899 SNIP 2.445
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 6.766 SNIP 2.441
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 6.734 SNIP 2.434
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 6.784 SNIP 2.551
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 7.026 SNIP 2.622
Web of Science (2004): Indexed yes
Scopus rating (2003): SJR 7.018 SNIP 2.501
Web of Science (2003): Indexed yes
Scopus rating (2002): SJR 7.183 SNIP 2.471
Web of Science (2002): Indexed yes
Scopus rating (2001): SJR 7.192 SNIP 2.463
Web of Science (2001): Indexed yes
Scopus rating (2000): SJR 7.731 SNIP 2.475
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 8.271 SNIP 2.446
Original language: English
DOIs:
10.1073/pnas.0906620106
Source: orbit
Source-ID: 249992
Publication: Research - peer-review › Journal article – Annual report year: 2009

Report of the Working Group on Integrated Assessment of the Baltic Sea (WGIAB), 16-20 March, Rostock Germany

General information
State: Published
Organisations: Unknown
Authors: Lindegren, M. (Intern)
Number of pages: 85
Publication date: 2009

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea (ICES)
Original language: English

Series: ICES CM
Number: BCC:02
Main Research Area: Technical/natural sciences

Bibliographical note
Martin Lindegren has authored: p. 26-47, 77
Source: orbit
Source-ID: 272834
Publication: Research › Report – Annual report year: 2009

Report of the workshop on combining climatic scenarios and medium-term predictions for Baltic herring and sprat stocks (WKCSMPB)

General information
State: Published
Organisations: National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern)
Number of pages: 52
Publication date: 2009

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea (ICES)
Original language: English

Series: ICES CM
Number: BCC:03
Main Research Area: Technical/natural sciences
Report of the Working Group on Integrated Assessment of the Baltic Sea (WGIAB)

General information
State: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Authors: Lindegren, M. (Intern)
Number of pages: 145
Publication date: 2008

Publication information
Place of publication: Copenhagen
Publisher: International Council for the Exploration of the Sea
Original language: English
Series: ICES CM 2008/BCC
Number: 04
Main Research Area: Technical/natural sciences
Links:
http://www.ices.dk/products/CMdocs/CM-2008/BCC/wgiab08.pdf

Bibliographical note
Martin Lindegren has written p. 13, 30-42 and 116-118
Source: orbit
Source-ID: 268957
Publication: Research › Report – Annual report year: 2008

Projects:

Determining the influence of benthic substrate on Biodiversity-Ecosystem Function relationships in coral reef ecosystems
National Institute of Aquatic Resources
Period: 01/04/2017 → 31/03/2020
Number of participants: 4
Phd Student:
Maginnis, Neil (Intern)
Supervisor:
Keith, Sally A. (Ekstern)
Wisz, Mary (Intern)
Main Supervisor:
Lindegren, Martin (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Understanding the biodiversity-ecosystem functioning relationship in marine food webs through large-scale observations and modelling
National Institute of Aquatic Resources
Period: 15/02/2017 → 14/02/2020
Number of participants: 3
Phd Student:
Maureaud, Aurore (Intern)
Supervisor:
Andersen, Ken Haste (Intern)
A trait-based approach for predicting fish community structure, function and services under climate change and exploitation

National Institute of Aquatic Resources
Period: 15/03/2016 → 14/03/2019
Number of participants: 3
Phd Student:
Beukhof, Esther (Intern)
Supervisor:
Andersen, Ken Haste (Intern)
Main Supervisor:
Lindegren, Martin (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Density-dependent processes in marine fish stocks

National Institute of Aquatic Resources
Period: 15/11/2015 → 14/11/2018
Number of participants: 3
Phd Student:
vан Gemert, Rob (Intern)
Supervisor:
Lindegren, Martin (Intern)
Main Supervisor:
Andersen, Ken Haste (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Marie Curie (EU-stipendium)
Project: PhD

Marine management of ecosystem dynamics under climate change (MARmaED) (39300)
MARmaED is an EU Initial Training Network that unifies specific and complementary competences in marine sciences from Norway, Finland, Denmark, the Netherlands, Germany and France to investigate how the cumulative stress from biodiversity loss, climate change and harvesting will affect Europe’s complex marine systems and the consequences for optimal resource management. MARmaED incorporates feedbacks between the socioeconomic and the ecological systems that give rise to critical transitions.

This project is coordinated by University of Oslo, Norway.

The project is funded by EU, Marie Curie.

National Institute of Aquatic Resources
Centre for Ocean Life
University of Oslo
University of Hamburg
Åbo Academy University
Wageningen University
University of Helsinki
University of Bergen
Météo-France
Period: 01/10/2015 → 01/10/2019
Number of participants: 4
Research area: Marine Populations and Ecosystem Dynamics
Project participant:
Lindegren, Martin (Intern)
Phd Student:
van Gemert, Rob (Intern)
Beukhof, Esther (Intern)
Project Manager, academic:
Andersen, Ken Haste (Intern)

Functional diversity in marine ecosystems - linking biodiversity to ecosystem integrity
National Institute of Aquatic Resources
Period: 01/09/2015 → 02/12/2018
Number of participants: 4
Phd Student:
Dencker, Tim Spaanaheden (Intern)
Supervisor:
Grønkjær, Peter (Ekstern)
Payne, Mark (Intern)
Main Supervisor:
Lindegren, Martin (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

A trait-based approach towards understanding benthic-pelagic pathways in marine ecosystems
National Institute of Aquatic Resources
Period: 15/12/2013 → 06/06/2017
Number of participants: 7
Phd Student:
Pécuchet, Lauréne (Intern)
Supervisor:
Andersen, Ken Haste (Intern)
Payne, Mark (Intern)
Main Supervisor:
Lindegren, Martin (Intern)
Examiner:
MacKenzie, Brian (Intern)
Nordström, Marie C. (Ekstern)
Primicerio, Raul (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet
Project: PhD

Centre for Macroecology, 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.

The Baltic Sea is subject to several major human impacts, and three of the most important are fishing, eutrophication and climate change. Understanding and projecting how these impacts will affect the food web and its fish populations in future is therefore challenging, and requires modelling approaches which include climatic-hydrographic forcing, nutrient loading scenarios and likely fishing intensities.

ECOSUPPORT was a project whose objective was to develop an advanced modelling tool for conducting scenario simulations of how these human impacts affect the marine ecosystem and fish populations. The project coupled several different types of models so that end-to-end ecosystem models were developed which to understand how human impacts could influence the Baltic food web and fish populations. The models to be linked included regional climate models, oceanographic-lower trophic level ecosystem models (Nutrient-Phytoplankton-Zooplankton-Detritus) and fish population models. Key project results included new scenario simulations how regionally downscaled global climate model outputs would affect the development of Baltic cod populations under scenarios of climate change and seal (predator) population growth, and under different combinations of eutrophication, exploitation and climate change. These simulations included
all key elements of the foodweb via an Ecopath model which included competitive and predatory interactions between the major fish species in the Baltic. The results demonstrated the vulnerability of the cod population to successful implementation of key ecosystem management policies for the Baltic Sea, including those related to exploitation and nutrient loading. Additional model scenarios focused on the sprat population which is a key intermediary link in the Baltic foodweb as prey and predator for cod and of zooplankton. These scenarios illustrated the range of future biomass and yields under assumed ranges of climate change and natural mortality.

One of the major novelties of the project was the availability of 3 different NPZD models, which enable estimation of output uncertainties to different model parameterizations and assumptions in the lower trophic levels and physical oceanographic processes, and to compare these with uncertainties due to fish population dynamics (e.g., recruitment variability). These comparisons suggest that the biological uncertainty associated with fish population dynamics was larger than that associated with the choice of the oceanographic NPZD model.

Partners in the project are the above mentioned and five other marine research institutes around the Baltic Sea.

The project is coordinated by Swedish Meteorological and Hydrographic Institute, Sweden.

The project was funded by EU, BONUS (Science for a Better Future of the Baltic Sea Region), ERA-NET.

National Institute of Aquatic Resources
Centre for Ocean Life
Swedish Meteorological and Hydrographic Institute (SMHI)
Leibniz-Institute for Baltic Sea Research
GKSS-Research Centre
University of Gothenburg
Stockholm University

Period: 01/01/2009 → 31/12/2011
Number of participants: 4

Research areas: Oceanography & Marine Populations and Ecosystem Dynamics & Ecosystem based Marine Management

Contact person:
MacKenzie, Brian (Intern)
Project participant:
Eero, Margit (Intern)
Lindegren, Martin (Intern)
Neuenfeldt, Stefan (Intern)

**Elucidating the structure and functioning of marine ecosystems through synthesis and comparative analysis (META-OCEANS) (38154)**

This project was an EU Marie Curie Early Stage Training PhD network. The project was designed to improve and apply meta-analytical methods to oceanographic and fishery research questions.

There are significant gaps in knowledge regarding the structure of marine food webs, the ecological roles of taxa of different sizes and the factors controlling linkages between different functional groups. Moreover, marine ecosystems continue to suffer from the impacts of human society superimposed on naturally and anthropogenically induced climate variability. These impacts include exploitation, eutrophication, pollution, species transfers and habitat alteration; they cause changes in the structure, function and biodiversity of marine ecosystems. However, the ability of marine scientists to predict the magnitude and direction of how marine taxa, functional groups and entire ecosystems respond to these changes, remains fragmentary. As a result, when asked by society for advice about how marine ecosystems will respond to different kinds of perturbations (including management actions), the marine science community can often only provide answers with high levels of uncertainty.

Students were trained in the use of meta-analysis techniques for marine ecological problems. The statistical methods were comparative and involved regression analysis, time series analysis, Bayesian analysis and trophic modelling. Students attended seminars organized by network scientists and visited scientists in partner institutes to attain additional training.

Meta-analyses approaches make use of existing data, produced in the context of different specific analyses, but which gain new value when assembled and re-analysed in a broader perspective. Meta-analyses involve several stages: (1) data mining; (2) quality control, (3) data analysis, and (4) validation. Students were trained in all these steps.

DTU Aqua had two PhD students involved in the project. These projects used Bayesian and meta-analytical methods to
show that standardized estimates of maximum population growth rate for all assessed cod stocks vary spatially across the Atlantic and in a dome-shaped relationship with temperature, and that extremely good or bad recruitment occurs in years with extreme temperatures. In addition, new time series-based ways of forecasting cod population dynamics under climate change-exploitation scenarios were developed and the role of a trawling ban on a local cod population was shown to override temperature or other climate effects on stock productivity. Both projects produced papers in high impact journals (2 in Proc. Roy. Soc., 1 in PNAS), as well as in other leading fishery-marine ecology journals (MEPS, ICES, JMS, etc.) s in other leading fishery-marine ecology journals (MEPS, ICES JMS, etc.).

This project was coordinated by AZTI Tecnalia, Spain.

This project was funded by EU, Marie Curie.

National Institute of Aquatic Resources
Centre for Ocean Life
AZTI-Tecnalia
Plymouth Marine Laboratory
National Center for Scientific Research
CSIC
University of Bergen

Period: 01/03/2006 → 09/12/2011
Number of participants: 3
Research areas: Oceanography & Marine Populations and Ecosystem Dynamics
Phd Student:
Lindegren, Martin (Intern)
Mantzouni, Irene (Intern)
Project Manager, academic:
MacKenzie, Brian (Intern)
Project