Classifying grey seal behaviour in relation to environmental variability and commercial fishing activity - a multivariate hidden Markov model

Classifying movement behaviour of marine predators in relation to anthropogenic activity and environmental conditions is important to guide marine conservation. We studied the relationship between grey seal (Halichoerus grypus) behaviour and environmental variability in the southwestern Baltic Sea where seal-fishery conflicts are increasing. We used multiple environmental covariates and proximity to active fishing nets within a multivariate hidden Markov model (HMM) to quantify changes in movement behaviour of grey seals while at sea. Dive depth, dive duration, surface duration, horizontal displacement, and turning angle were used to identify travelling, resting and foraging states. The likelihood of seals foraging increased in deeper, colder, more saline waters, which are sites with increased primary productivity and possibly prey densities. Proximity to active fishing net also had a pronounced effect on state occupancy. The probability of seals foraging was highest.

Opening of the Norway pout box: will it change the ecological impacts of the North Sea Norway pout fishery?

The small-mesh Norway pout (Trisopterus esmarkii) fishery intensified in the northern North Sea during the 1970s. Concerns about juvenile gadoid bycatch led to the “Norway pout box” closure along the Scottish coast in 1977. To assess the justification of the box today and the potential current impacts of opening the box, we evaluate the closure effects on selected fish stocks by analysing high-resolution research survey and commercial fishery data. The species- and size-specific distribution patterns in relation to environmental influencing factors are analysed for Norway pout and important bycatch species inside and outside the box. Relative distribution of benthic habitats is compared between inside–outside areas according to fish occurrence and fishery spatial footprint. No area differences in fish size composition are observed. However, species abundance depends significantly on habitat and depth whose area distribution is not homogenous. The current fishery is mainly in deeper, muddy seabeds. Haddock (Melanogrammus aeglefinus) and whiting (Merlangius merlangus) density is higher in shallow and sandy habitats, with a relatively larger area coverage inside the box. If a box opening implies relatively more fishery in those habitats, then increased bycatch can be expected. Consequently, closure of certain benthic habitats may instead be better management, opening new fishing opportunities without risk.
Sustainability Impact Assessment (SIA) in fisheries. Implementation in EU fishing regions

An Impact Assessment (IA) is a process aimed at structuring and supporting the development of policies. Besides the fact that IA assumes different features when applied to different sectors, really it should help policy makers in evaluating the contribution to the fisheries sustainability of new regulations. The recent improvements and development around the IA methodologies go more and more toward the concept of a Sustainability Impact Assessment (SIA). The evolution of IA in the fishery sector has followed the general and increasing need in having a more and more integrated type of analysis, focusing on the three dimensions of sustainability (environmental, economic and social). This paper synthesizes the methodology developed under the EU FP7 SOCIOEC project,1 whose main objective was the application of the most recent EU guidelines on IA to the current (and future) EU fishery management. The result is an integrated approach taking into account the main pillars of sustainability and a strong stakeholders’ involvement. A clear step-by-step procedure based on both qualitative and quantitative type of analyses has been defined, the last step being the “rating” phase, an essential step in a SIA, that provides the possibility to assess the results of different policy options (allowing policy makers to select the most appropriate one) in terms of acceptability, effectiveness, coherence and efficiency. The overall methodology has been tested on different EU regions, fisheries and management measures.
Bottom trawl fishing footprints on the world’s continental shelves

Bottom trawlers land around 19 million tons of fish and invertebrates annually, almost one-quarter of wild marine landings. The extent of bottom trawling footprint (seabed area trawled at least once in a specified region and time period) is often contested but poorly described. We quantify footprints using high-resolution satellite vessel monitoring system (VMS) and logbook data on 24 continental shelves and slopes to 1,000-m depth over at least 2 years. Trawling footprint varied markedly among regions: from 50% in some European seas. Overall, 14% of the 7.8 million-km² study area was trawled, and 86% was not trawled. Trawling activity was aggregated; the most intensively trawled areas accounting for 90% of activity comprised 77% of footprint on average. Regional swept area ratio (SAR; ratio of total swept area trawled annually to total area of region, a metric of trawling intensity) and footprint area were related, providing an approach to estimate regional trawling footprints when high-resolution spatial data are unavailable. If SAR was ≤0.1, as in 8 of 24 regions, there was >95% probability that >90% of seabed was not trawled. If SAR was 7.9, equal to the highest SAR recorded, there was >95% probability that >70% of seabed was trawled. Footprints were smaller and SAR was ≤0.25 in regions where fishing rates consistently met international sustainability benchmarks for fish stocks, implying collateral environmental benefits from sustainable fishing.

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Bottom trawling effects on marine macrobenthos: Changes in ecological functioning interpreted by a biological multiple traits approach

General information
Challenges in implementing stock assessment, economic fishery analysis, and risk assessment for sustainable management strategies of data poor stocks

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Decision support tools for maritime spatial planning: Lessons learned from a case study in central Mediterranean waters

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Contributors: Maina, I., Gadolou, E., Bastardie, F., Kavadas, S., Vassilopoulou, V.
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Effects of chronic bottom trawling on soft-seafloor macrofauna in the Kattegat

Impact studies of chronic bottom trawling aiming to reveal long-term effects on benthic organisms are often hampered by the lack of comparable untrawled conditions and the difficulty in assessing the spatial distribution of trawling intensity. We sampled soft-seafloor macrofauna over a precise trawling gradient in the Kattegat using hourly vessel monitoring systems and logbooks. The gradient included the establishment of a marine protected area (MPA), where trawling intensity declined sharply to zero. Our results show shifts in the macrofauna assemblage and non-linear responses, with decreases in the number and diversity of species at low to medium trawling intensities. The benthic community was dominated by burrowing brittle stars, of which one species, Amphiura chiajei, increased in abundance from low to medium trawling intensities. We interpret this positive response to increasing trawling intensities as a consequence of reduction in predation by benthivorous flatfish and Norway lobster Nephrops norvegicus, which are significant catches of the fishery. The response was supported by a corresponding trend towards lower abundance of the dominating brittle stars following enforcement of the MPA and presumably an increase in benthivore density and predation pressure within the MPA. We conclude that chronic bottom trawling reduces diversity and may boost the abundances of species resistant to bottom trawling. The results emphasize the need to consider food web effects when assessing the impact of bottom trawling.
Individual transferable quotas, does one size fit all? Sustainability analysis of an alternative model for quota allocation in a small-scale coastal fishery

The introduction of vessel-based Individual Transferable Quotas (ITQs) in Danish demersal fisheries in 2007 caused significant structural changes in the fleet, towards fewer and larger vessels deploying otter trawls. Mainly smaller coastal vessels deploying Danish seines and gillnets reduced in numbers. The ecosystem effects of this structural change were investigated by comparing the sustainability of a local, small-scale, coastal fishery (Thorupstrand) using Danish seines and gillnets with that of demersal trawling by larger vessels using the same fishing grounds. The fisheries were compared using six ecological and socio-economic indicators: 1) discards (food web), 2) by-catch incidences (food web/biodiversity), 3) seabed impacts, 4) fuel use efficiency, 5) quality of fish landed (food provision), and 6) social and cultural gains and drawbacks (social and cultural features). Except for by-catch of vulnerable species, the fisheries using Danish seines and gillnets scored better in all indicators when compared to otter trawls. Additional commercial and cultural benefits of establishing a local fishery guild with share-owned quotas and land-based facilities were investigated. The results and lessons learned are discussed in the context of an ecosystem approach to fisheries management and the current reform of the common fisheries policy of the European Union.
Integrated ecological-economic fisheries models - evaluation, review and challenges for implementation
Marine ecosystems evolve under many interconnected and area-specific pressures. In order to fulfill society's intensifying and diversifying needs whilst ensuring ecologically sustainable development, more effective marine spatial planning and broader-scope management of marine resources is necessary. Integrated ecological–socioeconomic fisheries models (IESFM) of marine systems are needed to evaluate impacts and sustainability of potential management actions and understand, and anticipate ecological, economic, and social dynamics at a range of scales from local to national and regional. To make these models most effective, it is important to determine how model characteristics and methods of communicating results influence the model implementation, the nature of the advice that can be provided and the impact on decisions taken by managers. This paper presents a global review and comparative evaluation of 35 IESFM’s applied to marine fisheries and marine ecosystem resources to identify the characteristics that determine their usefulness, effectiveness and implementation. The focus is on fully integrated models that allow for feedbacks between ecological and human processes though not all the models reviewed achieve that

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Integration of fisheries into marine spatial planning: Quo vadis?
The relationship between fisheries and marine spatial planning (MSP) is still widely unsettled. While several scientific studies highlight the strong relation between fisheries and MSP, as well as ways in which fisheries could be included in MSP, the actual integration of fisheries into MSP often fails. In this article, we review the state of the art and latest progress in research on various challenges in the integration of fisheries into MSP. The reviewed studies address a wide range of integration challenges, starting with techniques to analyse where fishermen actually fish, assessing the drivers for fishermen's behaviour, seasonal dynamics and long-term spatial changes of commercial fish species under various anthropogenic pressures along their successive life stages, the effects of spatial competition on fisheries and projections on those spaces that might become important fishing areas in the future, and finally, examining how fisheries could benefit from MSP. This paper gives an overview of the latest developments on concepts, tools, and methods. It becomes apparent that the spatial and temporal dynamics of fish and fisheries, as well as the definition of spatial preferences, remain major challenges, but that an integration of fisheries is already possible today
Macrobenthos biodiversity indicators – individual density and species density revisited

Modelling spatial interactions among fish communities, fishers and other marine activities: comparing five European case-studies

The Baltic Sea Atlantis: An integrated end-to-end modelling framework evaluating ecosystem-wide effects of human-induced pressures

Achieving good environmental status in the Baltic Sea region requires decision support tools which are based on scientific knowledge across multiple disciplines. Such tools should integrate the complexity of the ecosystem and enable exploration of different natural and anthropogenic pressures such as climate change, eutrophication and fishing pressures in order to compare alternative management strategies. We present a new framework, with a Baltic implementation of the spatially-explicit end-to-end Atlantis ecosystem model linked to two external models, to explore the different pressures on the marine ecosystem. The HBM-ERGOM initializes the Atlantis model with high-resolution physical-chemical-biological and hydrodynamic information while the FISHRENT model analyses the fisheries economics of the output of commercial fish
biomass for the Atlantis terminal projection year. The Baltic Atlantis model composes 29 subareas, 9 vertical layers and 30 biological functional groups. The balanced calibration provides realistic levels of biomass for, among others, known stock sizes of top predators and of key fish species. Furthermore, it gives realistic levels of phytoplankton biomass and shows reasonable diet compositions and geographical distribution patterns for the functional groups. By simulating several scenarios of nutrient load reductions on the ecosystem and testing sensitivity to different fishing pressures, we show that the model is sensitive to those changes and capable of evaluating the impacts on different trophic levels, fish stocks, and fisheries associated with changed benthic oxygen conditions. We conclude that the Baltic Atlantis forms an initial basis for strategic management evaluation suited for conducting medium to long term ecosystem assessments which are of importance for a number of pan-Baltic stakeholders in relation to anthropogenic pressures such as eutrophication, climate change and fishing pressure, as well as changed biological interactions between functional groups.

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The effect of trawling intensity on taxonomic and functional diversity in benthic communities: Does size matter?

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Contributors: McLaverty, C., Dinesen, G. E., Gislason, H., Bastardie, F., Eigaard, O. R.
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Analysis of marine protected areas – in the Danish part of the North Sea and the Central Baltic around Bornholm: Part 1: The coherence of the present network of MPAs

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Differences in biological traits composition of benthic assemblages between unimpacted habitats

There is an implicit requirement under contemporary policy drivers to understand the characteristics of benthic communities under anthropogenically-unimpacted scenarios. We used a trait-based approach on a large dataset from across the European shelf to determine how functional characteristics of unimpacted benthic assemblages vary between different sedimentary habitats.

Assemblages in deep, muddy environments unaffected by anthropogenic disturbance show increased proportions of downward conveyors and surface deposit-feeders, while burrowing, diffusive mixing, scavenging and predation traits assume greater numerical proportions in shallower habitats. Deep, coarser sediments are numerically more dominated by sessile, upward conveyors and suspension feeders. In contrast, unimpacted assemblages of coarse sediments in shallower regions are proportionally dominated by the diffusive mixers, burrowers, scavengers and predators. Finally, assemblages of gravelly sediments exhibit a relatively greater numerical dominance of non-bioturbators and asexual reproducers. These findings may be used to form the basis of ranking habitats...
Effects of changes in stock productivity and mixing on sustainable fishing and economic viability

Within the new FMSY European paradigm, this paper shows how a combination of changes in fish stock mixing, non-stationarity in productivity, and constraints on unit stock concepts undermine the effective management of fisheries, especially when management reference points are not adjusted accordingly. Recent changes in stock structures, conditions and stock mixing between eastern and western Baltic cod can jeopardize the reliability of stock assessments and of the fishery economy. We modelled how different management, individual vessel decision-making, and stock growth and mixing scenarios have induced alternative individual vessel spatial effort allocation and economic performance by affecting fishing costs and by changing the relative stock abundance and size distribution. Stock mixing heavily influences profit and stock abundance for stocks that have experienced increased fishing mortality (F) levels. Western cod F has increased from a higher total allowed catches (TAC) advised in the medium-term due to the westward migration of eastern cod while eastern cod F has increased from reduced growth in the east. Greater pressures on western cod and decreased eastern cod growth and conditions greatly reduce the overall cod spawning stock biomass, thus changing the landing size composition and associated fishery profits. As a cumulative effect, fishing efforts are redirected towards western areas depending on management (quotas). However, total profits are less affected when traditional fishing opportunities and switching possibilities for other species and areas are maintained. Our evaluation indicates that current management mechanisms cannot correct for potential detrimental effects on cod fisheries when effort re-allocation changes landing origins. By investigating different economic starting conditions we further show that Baltic cod mis-management could have resulted in unintended unequal (skewed) impacts and serious consequences for certain fleets and fishing communities compared with others. Our management strategy evaluation is instrumental in capturing non-linear effects of different recommendations on sustainability and economic viability, and we show that fixed F-values management is likely not an attainable or sufficient goal in ensuring the sustainability and viability of fisheries and stocks given changing biological conditions.
Evaluation of sustainable exploitation of major Baltic fish stocks based on an integrated end-to-end modeling framework

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Fisheries Impact Evaluation Tool (FIT) with application to assess the bottom fishing footprint in Western Baltic sea (ICES Subdivisions 22-24)

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Fish size composition in space - A spatially explicit size spectrum model of the Celtic Sea fish community for testing novel management approaches

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Guidelines for setting environmental targets for benthic habitats

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Contributors: Korpinen, S., Zweifel, U., Bastardie, F., van Denderen, P. D., Hoppe, K., Kauppi, P., Milardi, M., Nielsen, J. R., Noren, K., Nygaard, H., Sköld, M., Valanko, S., Zettler, M.
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 Hvordan påvirker bundtrawlfiskeriet Kattegats bundfauna? En analyse af ændringer i densitet og artsrigdom og en diskussion af potentielle indikatorer

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Contributors: Gislason, H., Dinesen, G. E., Bastardie, F., Egekvist, J., Eiggaard, O. R.
Is a single dimension enough to explain fishers' decision-making?

Lost in translation? Multi-metric macrobenthos indicators and bottom trawling

The member states of the European Union use multi-metric macrobenthos indicators to monitor the ecological status of their marine waters in relation to the Water Framework and Marine Strategy Framework Directives. The indicators translate the general descriptors of ecological quality in the directives into a single value of ecological status by combining indices of species diversity, species sensitivity and density. Studies and inter-calibration exercises have shown that the indicators respond to chemical pollution and organic enrichment, but little is known about their response to bottom trawling. We use linear mixed effects models to analyze how bottom trawling intensity affects the indicators used in the Danish (Danish Quality Index, DKI) and Swedish (Benthic Quality Index, BQI) environmental monitoring programs in the Kattegat, the sea area between Sweden and Denmark. Using year and station as random variables and trawling intensity, habitat type, salinity and depth as fixed variables we find a significant negative relationship between the BQI indicator and bottom trawling, while the DKI is related significantly to salinity, but not to trawling intensity. Among the indicator components, the species diversity and sensitivity indices used in the DKI are not significantly linked to trawling, and trawling only affects the BQI when species sensitivities are derived from rarefied samples. Because the number of species recorded per sample (species density) is limited by the number of individuals per sample (density), we expect species density and density to be positively correlated. This correlation was confirmed by a simulation model and by statistical analysis of the bottom samples in which log species density was highly significantly related to log density (\( r = 0.75, df = 144, p \))

Lost in translation? Multi-metric macrobenthos indicators and bottom trawling

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New policies may call for new approaches: the case of the Swedish Norway lobster (Nephrops norvegicus) fisheries in the Kattegat and Skagerrak

The European Common Fisheries Policy has in its 2013 reform increased in complexity, such as a call for coherence with the Marine Strategy Framework Directive and a landing obligation, posing new requirements and challenges to managers, scientists and the fishing industry. Therefore, re-evaluations of current practice are important as a basis for management actions. The Swedish fishery for Norway lobster (Nephrops norvegicus) in the Kattegat–Skagerrak area provides an interesting case study of relevance to emerging policies. Sprung from an unbalance in available fish- and Nephrops quotas and an ambition to protect coastal areas, the current fishery has been directed towards three separate fisheries (mixed trawling, directed trawling using a sorting grid and creeling). Studying direct and indirect effects from alternative Swedish quota allocations among gear types is therefore interesting. Accordingly, a screening study was conducted, taking into consideration area-gear interactions in catch rates, to compare the three different fisheries regarding quantified pressures on the target species, the by-catch species, and on the seafloor, as well as to qualitatively discuss social and economic dimensions. In the next step, alternative quota allocations were studied. In Swedish fisheries, we show that creeling offers a substantial reduction of fishing mortality of both undersized Nephrops and fish and a reduced seafloor pressure per landed kilo of Nephrops. Given that the fishing areas in many cases may be interchangeable between gears, allocating a larger quota share to creels in the Swedish fishery would therefore contribute to the integration of fisheries- and environmental management as called for in the new policies

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Physical loss and damage to seabed habitats

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Predicting the population-level impact of mitigating harbor porpoise bycatch with pingers and time-area fishing closures

Unintentional mortality of higher trophic-level species in commercial fisheries (bycatch) represents a major conservation concern as it may influence the long-term persistence of populations. An increasingly common strategy to mitigate bycatch of harbor porpoises (Phocoena phocoena), a small and protected marine top predator, involves the use of pingers (acoustic alarms that emit underwater noise) and time-area fishing closures. Although these mitigation measures can reduce harbor porpoise bycatch in gillnet fisheries considerably, inference about the long-term population-level consequences is currently lacking. We developed a spatially explicit individual-based simulation model (IBM) with the aim to evaluate the effectiveness of these two bycatch mitigation measures. We quantified both the direct positive effects (i.e., reduced bycatch) and any indirect negative effects (i.e., reduced foraging efficiency) on the population size using the inner Danish waters as a biological system. The model incorporated empirical data on gillnet fishing effort and noise avoidance behavior by free-ranging harbor porpoises exposed to randomized high-frequency (20- to 160-kHz) pinger signals. The IBM simulations revealed a synergistic relationship between the implementation of time-area fishing closures and pinger deployment. Time-area fishing closures reduced bycatch rates substantially but not completely. In contrast, widespread pinger deployment resulted in total mitigation of bycatch but frequent and recurrent noise avoidance behavior in high-quality foraging habitat negatively affected individual survival and the total population size. When both bycatch mitigation measures were implemented simultaneously, the negative impact of pinger noise-induced sub-lethal behavioral effects on the population was largely eliminated with a positive effect on the population size that was larger than when the mitigation measures were used independently. Our study highlights that conservationists and policy makers need to consider and balance both the direct and indirect effects of harbor porpoise bycatch mitigation measures before enforcing their widespread implementation. Individual-based simulation models, such as the one presented here, offer an efficient and dynamic framework to evaluate the impact of human activities on the long-term survival of marine populations and can serve as a basis to design adaptive management strategies that satisfy both ecological and socioeconomic demands on marine ecosystems.
Scavenging strategies of hagfish in the Kattegat

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Spatial planning for aquaculture: the Georeferenced Interactions Database (GRID)

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Spatial Planning for Fisheries in the Adriatic Sea, – the ECOAST project

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Contributors: Grati, F., Bolognini, L., Bastardie, F.
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Spatial planning for fisheries in the Northern Adriatic: working toward viable and sustainable fishing

Given the great overfishing of the demersal resources in the Northern Adriatic Sea (geographical sub-area [GSA] 17), along with the fishing pressure in marine habitats, evidence strongly supports the need to evaluate appropriate management approaches. Several fishing activities operate simultaneously in the area, and the need to minimize conflicts among them is also a social concern. We applied a spatially and temporally explicit fish and fisheries model to assess the impact of a suite of spatial plans suggested by practitioners that could reduce the pressure on the four demersal stocks of high commercial interest in the GSA 17 and that could promote space sharing between mutually exclusive activities. We found that excluding trawlers from some areas has lowered the effective fishing effort, resulting in some economic losses but providing benefit to the set netters. Not every simulated fishing vessel is impacted in the same way because some fishing communities experienced different economic opportunities, particularly when a 6-nautical mile buffer zone from the coast was implemented in the vicinity of important fishing grounds. Along this buffer zone, the four stocks were only slightly benefiting from the protection of the area and from fewer discards. In contrast, assuming a change in the ability of the population to disperse led to a large effect: Some fish became accessible in the coastal waters, therefore increasing the landings for rangelimited fishers, but the discard rate of fish also increased, greatly impairing the long-term biomass levels. Our evaluation, however, confirmed that no effort is displaced onto vulnerable benthic habitats and to grounds not suitable for the continued operation of fishing. We conclude that the tested spatial management is helpful, but not sufficient to ensure sustainable fishing in the area, and therefore, additional management measures should be taken. Our test platform investigates the interaction between fish and fisheries at a fine geographical scale and simulates data for varying fishing methods and from different harbor communities in a unified framework. We contribute to the development of effective science-based inputs to facilitate policy improvement and better governance while evaluating trade-offs in fisheries management and marine spatial planning.

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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Italian National Research Council, University of Bologna, Studiofuga
Stable isotopes reveal the effect of trawl fisheries on the diet of commercially exploited species

Bottom trawling can change food availability for benthivorous demersal species by (i) changing benthic prey composition through physical seabed impacts and (ii) by removing overall benthic consumer biomass increasing the net availability of benthic prey for remaining individuals. Thus trawling may both negatively and positively influence the quantity and quality of food available. Using δ 13C and δ 15N we investigated potential diet changes of three commercially exploited species across trawling gradients in the Kattegat (plaice, dab and Norway lobster (Nephrops)) and the Irish Sea (Nephrops). In the Kattegat, trawling affected primarily the biomass of benthic consumers, lowering competition. Nephrops showed significant positive relationships for δ 13C and a domed relationship for δ 15N with trawling. In the Irish Sea, intense trawling had a negative effect on benthic prey. δ 13C and δ 15N thus showed the inverse relationships to those observed in the Kattegat. Plaice from the Kattegat, showed a significant relationship with trawling intensity for δ 13C, but not for δ 15N. No relationship was found for dab. Changes of δ 13C and δ 15N correlated with changes in condition of species. The results show that the removal of demersal competitors and benthos by trawling can change the diets of commercial species, ultimately affecting their body condition.

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The footprint of bottom trawling in European waters: distribution, intensity, and seabed integrity

Mapping trawling pressure on the benthic habitats is needed as background to support an ecosystem approach to fisheries management. The extent and intensity of bottom trawling on the European continental shelf (0-1000 m) was analysed from logbook statistics and vessel monitoring system data for 2010-2012 at a grid cell resolution of 1 x 1 min longitude and latitude. Trawling intensity profiles with seabed impact at the surface and subsurface level are presented for 14 management areas in the North-east Atlantic, Baltic Sea and Mediterranean Sea. The footprint of the management areas ranged between 53-99% and 6-94% for the depth zone from 0 to 200 m (Shallow) and from 201 to 1000 m (Deep), respectively. The footprint was estimated as the total area of all grid cells that were trawled fully or partially. Excluding the untrawled proportions reduced the footprint estimates to 28-85% and 2-77%. Largest footprints per unit landings were observed off Portugal and in the Mediterranean Sea. Mean trawling intensity ranged between 0.5 and 8.5 times per year, but was less in the Deep zone with a maximum intensity of 6.4. Highest intensities were recorded in the Skagerrak-Kattegat, Iberian Portuguese area, Tyrrhenian Sea and Adriatic Sea. Bottom trawling was highly aggregated. For the Shallow zone the seabed area where 90% of the effort occurred comprised between 17% and 63% (median 36%) of the management area. Footprints were high over a broad range of soft sediment habitats. Using the longevity distribution of the untrawled infaunal community, the seabed integrity was estimated as the proportion of the biomass of benthic taxa where the trawling interval at the subsurface level exceeds their life span. Seabed integrity was low (< 0.1) in large parts of the European continental shelves, although smaller pockets of seabed with higher integrity values occur. The methods developed here integrate official fishing effort statistics and industry-based gear information to provide high-resolution pressure maps and indicators, which greatly improve the basis for assessing and managing benthic pressure from bottom trawling. Further they provide quantitative estimates of trawling impact on a continuous scale by which managers can steer

General information

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Bottom trawling affects fish condition through changes in the ratio of prey availability to density of competitors
1. Bottom-trawl fisheries are widespread and cause mortality of benthic invertebrates, which in turn may lead to a decrease in the availability of prey for target fish species. Exploitation also reduces the abundance of the fish species themselves. Modelling studies have shown that bottom trawling could lead to both increases and decreases in fish
production, but so far empirical evidence to test these ideas has been very limited. We hypothesize that the effect of bottom trawling on the food intake and condition of fish depends on how the ratio of prey to consumers changes with increasing fishing pressure. 2. We assessed the impact of bottom trawling on the food availability, condition and stomach contents of three flatfishes and the Norway lobster in an area in the Kattegat hat is characterized by a steep commercial bottom-trawling gradient due to the establishment of an area closed to all fisheries, but otherwise has homogeneous environmental conditions. 3. For plaice, prey biomass initially decreased at a slower rate with trawling than the biomass of fish, and as a result, the amount of food available per plaice increased before decreasing at trawling frequencies >5 times year 1. This pattern was mirrored in both the condition and stomach contents of plaice and for long-rough dab. 4. No effect of trawling on dab prey and condition was found. Conversely, the condition of the main target species – Norway lobster – increased as its biomass decreased with increased trawling intensities. 5. Together, these results support the idea that when the abundance of the prey declines in response to exploitation, the ratio of the prey to consumer biomass will determine whether exploitation will result in an increase or a decrease in the food intake and condition of the predator. 6. Synthesis and applications. Our study indicates that fish production may be maximized by keeping bottom-trawling intensities relatively low, although this may negatively affect the economically more important Nephrops fishery. The effects of bottom trawls may be mitigated by switching to gears, which affect prey availability to a lesser extent, such as pots or creels.

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Co-location of passive gear fisheries in offshore wind farms in the German EEZ of the North Sea: A first socio-economic scoping
Monotonous size selection curves have traditionally been sufficient to describe the size selection in the end of a bottom trawl. Such modelling is a good approximation when the size selective system consists of a single selective device. However, in some fisheries the demands for species and size selectivity have motivated the development of selective systems in trawl fisheries that utilize more than one selective device simultaneously. An example can be found in the Swedish demersal trawl fishery targeting Norway lobster (Nephrops norvegicus), which simultaneously aims at avoiding catches of Atlantic cod (Gadhus morhua). In this fishery, the selective system consists of a Nordmøre type sorting grid followed by a size selective square mesh codend. The size selection curve for this system has a characteristic bell-shaped curvature, which cannot be sufficiently described by a monotonous selection curve. An approach that can handle a bell shaped curvature is to use a more flexible empirical size selection model. However, such models primarily use a curve fitting procedure, and do not allow the possibility to investigate the contribution of the individual parts of the selection system. Therefore, we choose to use a structural-based model that directly models the contributions of the individual selectivity devices to the overall performance of the system. We demonstrate that this approach can appropriately describe the empirical size selection data for both Nephrops and cod in a system composed of a sorting grid followed by a size selective codend. Furthermore, this approach provides a direct quantification of the selective pro cesses of the individual parts of the system to the overall size selection in the fishing gear. In addition, we demonstrate how this approach can provide fisheries managers with a new tool when trying to develop more sustainable fisheries through improving fishing gear size and species selectivity.
Estimating seabed pressure from demersal trawls, seines, and dredges based on gear design and dimensions

This study assesses the seabed pressure of towed fishing gears and models the physical impact (area and depth of seabed penetration) from trip-based information of vessel size, gear type, and catch. Traditionally fishing pressures are calculated top-down by making use of large-scale statistics such as logbook data. Here, we take a different approach starting from the gear itself (design and dimensions) to estimate the physical interactions with the seabed at the level of the individual fishing operation. We defined 14 distinct towed gear groups in European waters (eight otter trawl groups, three beam trawl groups, two demersal seine groups, and one dredge group), for which we established gear “footprints”. The footprint of a gear is defined as the relative contribution from individual larger gear components, such as trawl doors, sweeps, and groundgear, to the total area and severity of the gear’s impact. An industry-based survey covering 13 countries provided the basis for estimating the relative impact-area contributions from individual gear components, whereas sediment penetration was estimated based on a literature review. For each gear group, a vessel size–gear size relationship was estimated to enable the prediction of gear footprint area and sediment penetration from vessel size. Application of these relationships with average vessel sizes and towing speeds provided hourly swept-area estimates by métier. Scottish seining has the largest overall gear footprint of ∼1.6 km² h⁻¹ of which 0.08 km² has an impact at the subsurface level (sediment penetration ≥ 2 cm). Beam trawling for flatfish ranks low when comparing overall footprint size/hour but ranks substantially higher when comparing only impact at the subsurface level (0.19 km²h⁻¹). These results have substantial implications for the definition, estimation, and monitoring of fishing pressure indicators, which are discussed in the context of an ecosystem approach to fisheries management.
Individual Stress Level Analyses (ISLA) communicate impact of spatial management options on national or local fisheries communities to decision makers.

Towards a framework for the quantitative assessment of trawling impact on the seabed and benthic ecosystem

A framework to assess the impact of mobile fishing gear on the seabed and benthic ecosystem is presented. The framework that can be used at regional and local scales provides indicators for both trawling pressure and ecological impact. It builds on high-resolution maps of trawling intensity and considers the physical effects of trawl gears on the seabed, on marine taxa, and on the functioning of the benthic ecosystem. Within the framework, a reductionist approach is applied that breaks down a fishing gear into its components, and a number of biological traits are chosen to determine either the vulnerability of the benthos to the impact of that gear component, or to provide a proxy for their ecological role. The approach considers gear elements, such as otter boards, twin trawl clump, and groundrope, and sweeps that herd the fish. The physical impact of these elements on the seabed, comprising scraping of the seabed, sediment mobilization, and penetration, is a function of the mass, size, and speed of the individual component. The impact of the elements on the benthic community is quantified using a biological-trait approach that considers the vulnerability of the benthic community to trawl impact (e.g. sediment position, morphology), the recovery rate (e.g. longevity, maturation age, reproductive characteristics, dispersal), and their ecological role. The framework is explored to compare the indicators for pressure and ecological impact of bottom trawling in three main seabed habitat types in the North Sea. Preliminary results show that the Sublittoral mud (EUNIS A5.3) is affected the most due to the combined effect of intensive fishing and large proportions of long-lived taxa.
An integrated end-to-end modeling framework for testing ecosystem-wide effects of human-induced pressures in the Baltic Sea

We present an integrated end-to-end modeling framework that enables whole-of ecosystem climate, eutrophication, and spatial management scenario exploration in the Baltic Sea. The framework is built around the Baltic implementation of the spatially-explicit end-to-end ATLANTIS model, linked to the high-resolution coupled physical-biological model HBM-ERGOM and the fisheries bio-economic FishRent model. We investigate ecosystem-wide responses to changes in human-induced pressures by simulating several eutrophication scenarios that are relevant to existing Baltic Sea management plans (e.g. EU BSAP, EU CFP). We further present the structure and calibration of the Baltic ATLANTIS model and the operational linkage to the other models. Using the results of eutrophication scenarios, and focusing on the relative changes in fish and fishery production, we discuss the robustness of the model linking with respect to the underlying assumptions, strengths and weaknesses of individual models. Furthermore, we describe how to possibly expand the framework to account for spatial impacts and economic consequences, for instance by linking to the individual-vessel based DISPLACE modeling approach. We conclude that the proposed model integration and management scenario evaluation scheme lays the foundations for developing a robust framework for management strategy evaluation that is of strategic importance to stakeholders from around the Baltic Sea.

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Causes and consequences of technical, biological and spatial interactions in fisheries management modelled from the individual distribution of fishing effort

Our individual-vessel based bio-economic modeling approach (www.displace-project.org) evaluates the harvesting dynamics using information about fishing ground preferences and experienced vessel-specific catch rates. The assessment computes the daily decision-making of the fishing vessels and the individual or overall economic and stock status indicators together with the size-based spatial distribution dynamics of the main fishery resources. In this application to the western Baltic Sea sprat, herring and cod fisheries of Danish, Swedish and German commercial vessels...
the biological interactions (fish predation mortality) are included by a dynamic coupling to the Stochastic Multi Species model (SMS) on annual basis, under the mitigation from the "yet to be implemented" NATURA 2000 zonation in the area. The spatial technical interactions between vessels revealed to be the predominant factors affecting the fishery profit and the energy efficiency while species interactions play a minor role, albeit increasing the final profit estimates. Interestingly, the zonation affects the profit depending on the biological interactions from a spatial effect on the size composition of the stocks, therefore the fish size composition in the landings originating from different fishing areas. Such a model coupling contributes to the integration of different spatial activities in certain sea areas considering the combined effects of technical and biological interactions and dynamics for reducing potential inefficient management and use of space according to the aims of both EU CFP regulation (No 1380/2013) and EU MSP (2014/89/EU) directive
is strongly reduced with the new zonation, and some of the vessels suffer decreased profits. The DISPLACE model serves as a spatially explicit bioeconomic benchmark tool for management strategy evaluations for capturing tactical decision-making in reaction to MSP

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Organisations: National Institute of Aquatic Resources, Section for Ecosystem based Marine Management, Aarhus University
Contributors: Thoya, P., Bastardie, F., Dinesen, G. E., Hansen, J. L., Nielsen, J. R.
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**Detecting ecological-economic effects of marine spatial plans from displacing the bottom fishing pressure**

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**Effects of recent changes in stock conditions and mixing on sustainability and economic viability of the fishery – The Danish fisheries for Baltic cod**

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Integration of fisheries in marine spatial planning: Quo vadis?

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Management of fishery: Importance of fish food web dynamics in coupling of multispecies and bio-economic fisheries management evaluation models

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New policies may call for new approaches: the case of Swedish Norway lobster (Nephrops norvegicus) fisheries in the Kattegat and Skagerrak

General information
New policies will require new approaches: the case of the Swedish Norway Lobster (Nephrops norvegicus) fisheries in the Kattegat and Skagerrak

Sustainability, fuel use, and profitability: interlinked consequences of stock dynamics and choices of individual vessel spatial effort allocation within the Western Baltic

Sustainable development of the Nephrops fishery in the Kattegat-Skagerrak region
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

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Research output: Contribution to conference › Poster – Annual report year: 2015 › Research

A statistical model for estimation of fish density including correlation in size, space, time and between species from research survey data
Trawl survey data with high spatial and seasonal coverage were analysed using a variant of the Log Gaussian Cox Process (LGCP) statistical model to estimate unbiased relative fish densities. The model estimates correlations between observations according to time, space, and fish size and includes zero observations and over-dispersion. The model utilises the fact the correlation between numbers of fish caught increases when the distance in space and time between the fish decreases, and the correlation between size groups in a haul increases when the difference in size decreases. Here the model is extended in two ways. Instead of assuming a natural scale size correlation, the model is further developed to allow for a transformed length scale. Furthermore, in the present application, the spatial- and size-dependent correlation between species was included. For cod (Gadus morhua) and whiting (Merlangius merlangus), a common structured size correlation was fitted, and a separable structure between the time and space-size correlation was found for each species, whereas more complex structures were required to describe the correlation between species (and space-size). The within-species time correlation is strong, whereas the correlations between the species are weaker over time but strong within the year.

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Contributors: Nielsen, J. R., Kristensen, K., Lewy, P., Bastardie, F.
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Bibliographical note

Estimation of seafloor impact from demersal trawls, seines and dredges based on gear design and dimensions
This study estimates the seafloor impact of towed fishing gears from a bottom-up perspective. Traditionally fishing pressure, often in terms of indicators, is calculated top-down using the fishing effort information available in large-scale statistics such as logbook and VMS data. Here we take a different approach using the gear itself (design and dimensions) for understanding and estimation of the physical interactions with the seafloor at the individual fishing operation level. With reference to the métier groupings of EU logbooks, we defined 17 distinct towed gear groups in European waters (11 otter trawl groups, 3 beam trawl groups, 2 demersal seine groups, and 1 dredge group), for which we established seafloor “footprints”. The footprint of a gear was defined as the relative contribution from individual larger gear components, such as the trawl doors, sweeps and ground gear, to the total area and severity of the gear impact. An industry-based vessel and gear survey covering 13 different countries provided the basis for estimating the relative impact-area contributions from individual gear components, whereas seafloor penetration and resuspension was estimated for different sediment types based on a review of the scientific literature. For each defined gear group a vessel-size (kW or total length) – gear size (total gear width or circumference) relationship was estimated to enable the prediction of gear footprint area and sediment penetration from vessel size. The implications for the definition and monitoring of fishing pressure indicators are far-reaching, and are discussed in context of an ecosystem approach to fisheries management (EAFM)

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High-resolution mapping of European fishing pressure on the benthic habitats

Mapping and monitoring of pressure from fishery on the marine benthic environment is necessary to support an ecosystem approach to fisheries management (EAFM). In many cases this need is not reflected in official fisheries statistics and logbooks, where focus typically is on catch rather than effort. Consequently, most logbook information is not well suited for quantitative estimation of seafloor impact (swept area and impact severity) of the different gears and trips. We present a method to overcome this information deficiency of official statistics and develop high-resolution large-scale maps of benthic fishing pressure covering the EU, Norwegian and Turkish waters. First individual logbook observations from 13 countries were assigned to 17 different functional gear groups (métiers) based on target species and gear type information. Secondly, relationships between gear width and vessel size (e.g., trawl door spread and vessel kW) for each métier were used to assign quantitative information of bottom contact to each logbook trip by translating vessel size information into measures of gear size. Thirdly the extended logbook data was merged with high-resolution activity data (VMS) and gear width estimates were assigned to individual interpolated vessel tracks based on VMS data. The outcome was European wide high-resolution fishing intensity maps (total yearly swept area within grid cells of 1°x1 minutes longitude and latitude) for 2010, 2011 and 2012. Finally the high-resolution fishing pressure maps were overlaid with existing marine habitat maps to identify areas of potential ecosystem service conflicts.

How spatial planning constrains cross-border fisheries: the bio-economic DISPLACE evaluation on the Baltic Sea

Mapping and monitoring of pressure from fishery on the marine benthic environment is necessary to support an ecosystem approach to fisheries management (EAFM). In many cases this need is not reflected in official fisheries statistics and logbooks, where focus typically is on catch rather than effort. Consequently, most logbook information is not well suited for quantitative estimation of seafloor impact (swept area and impact severity) of the different gears and trips. We present a method to overcome this information deficiency of official statistics and develop high-resolution large-scale maps of benthic fishing pressure covering the EU, Norwegian and Turkish waters. First individual logbook observations from 13 countries were assigned to 17 different functional gear groups (métiers) based on target species and gear type information. Secondly, relationships between gear width and vessel size (e.g., trawl door spread and vessel kW) for each métier were used to assign quantitative information of bottom contact to each logbook trip by translating vessel size information into measures of gear size. Thirdly the extended logbook data was merged with high-resolution activity data (VMS) and gear width estimates were assigned to individual interpolated vessel tracks based on VMS data. The outcome was European wide high-resolution fishing intensity maps (total yearly swept area within grid cells of 1°x1 minutes longitude and latitude) for 2010, 2011 and 2012. Finally the high-resolution fishing pressure maps were overlaid with existing marine habitat maps to identify areas of potential ecosystem service conflicts.
Impact assessment of a fisheries closure with effort and landings spatial analyses: A case study in the Western Baltic Sea

Commercial fisheries in the Western Baltic Sea (WBS; ICES Subdivisions 22–24) are dominated by Danish and German vessels. By combining and processing logbook and Vessel Monitoring System (VMS) data for Germany and Denmark, we compare patterns of spatial effort allocation and the origin of the landings before (2005–2007) and during (2008–2010) implementation of the EU long-term management plan (LTMP) for cod. This management plan is likely to have affected the temporal and spatial extent of fisheries in the WBS. Changes that took place between 2005 and 2010 on the large scale of the WBS were therefore considered when selecting an appropriate stable reference period to inform and evaluate small-scale effort-displacement scenarios in the Fehmarn Belt. The WBS fisheries appear not to have been restricted by effort limits until 2010, but rather by total allowable catches (TACs) for cod. The amount of cod landed in the WBS decreased, and the origin of these landings shifted farther east without affecting the seasonal effort allocation. Landings of cod have also decreased in the Fehmarn Belt area, and since 2008, sprat has been the species most landed there. The planned construction of the Fehmarn Belt Fixed Link connecting Denmark and Germany could lead to the temporal closure of fishing activities. Three different effort-displacement scenarios were tested to determine how lost landings, caused by a fishing closure of a corridor near the link during construction, could be counteracted by moving the activities to a nearfield area. To compensate for lost landings, the best strategy appears to be redistributing fishing effort of sprat-targeting métiers to areas that have had relatively high catch rates (landings per unit of effort (LPUE)) or with large absolute sprat landings, assuming spatial stability of sprat distribution in the area. Because high effort did not lead to large sprat landings in all locations, effort displacement to high effort areas may not compensate for lost sprat landings, particularly for mixed fishery métiers that also landed herring.

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Impact of deep-sea fishery for Greenland halibut (Reinhardtius hippoglossoides) on non-commercial fish species off West Greenland

Since the late 1980s, a deep-sea fishery for Greenland halibut (Reinhardtius hippoglossoides) has been developing gradually in West Greenland. Deep-sea fish species are generally long-lived and characterized by late age of maturity, low fecundity, and slow growth, features that probably cause low resilience following overexploitation. In order to evaluate whether populations of nine potential bycatch species are negatively affected by the commercial fishery for Greenland halibut, scientific data from bottom-trawl surveys conducted in the same area and period as the commercial fishery were analysed. During the period 1988–2011, population abundance and size composition changed as catch and effort in the Greenland halibut fishery increased. Two species showed a significant decrease in abundance, and four populations showed a significant reduction in mean weight of individuals (p < 0.05). Correlation analyses show that most of the observed trends in abundance are probably not related to increasing fishing effort for Greenland halibut. The analysis did, however, show that most of the observed decreases in mean weight were significantly correlated with fishing effort during the 24-year period.

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Importance of food web dynamics in coupling of multispecies models and bio-economic fisheries management evaluation models

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Indirect effects of otter trawling on the condition and trophic level of Nephrops and flatfish in the Kattegat
The fishing gear used in bottom trawl fisheries cause mortality of benthic invertebrates and this can decrease the long-term availability of prey to exploited fish species by reducing the abundance of benthic invertebrates. Alternatively, low trawling levels could increase food production for species that feed on small invertebrates that are released from competition with large invertebrates by trawling. Both outcomes may have consequences for biodiversity, the food-web and the sustainability of fisheries. We assessed the impact of bottom trawling on the food availability of fish by comparing the condition (as weight-at-length) and trophic level of the fish Pleuronectes platessa, Limanda limanda, Hippoglossoides platessoides and the crustacean Nephrops norvegicus in an area with strong variation in commercial otter-trawling effort owing to the presence of MPAs with different levels of protection in the Kattegat (Sweden and Denmark). The results show that the abundance and body size of Nephrops was much higher in the fully closed areas, whereas that of the flatfish was less affected. The condition and trophic level for Nephrops were highest on intensively trawled areas suggesting that trawling reduces competition and increases food availability for Nephrops. In contrast, the condition of the flatfish species was the highest at low levels of trawling. This study therefore suggests that high effort levels of bottom trawling have a negative effect on the prey availability and thus on the condition of some of the target species, but not others, and that low levels of trawling might positively affect food availability for some flatfish species. Alternatively, flatfishes might avoid areas with high densities of large Nephrops

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Supporting bio-economic evaluation of spatial planning constraining fishing activities: be quantitative, spatially-explicit, vessel-oriented, stochastic, and dynamically coupled to fish populations
The Baltic ATLANTIS model: Implementing a holistic framework to evaluate ecosystem wide responses to changes in climate and anthropogenic forcing

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Cod recovery as a new challenge for fisheries management: experience from the Baltic Sea

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Critical report of current fisheries management measures implemented for the North Sea mixed demersal fisheries

The present report is an EU-FP7-SOCIOEC Report giving an overview and critical evaluation of the current management measures implemented for the North Sea mixed demersal fisheries and the fish stocks involved in this. Also, this involves review and critical evaluation of the scientific advice supporting the fisheries management for the North Sea mixed demersal fisheries and the stocks involved herein. Management of the demersal roundfish and flatfish fisheries in the North Sea is conducted mainly through the EU Common Fisheries Policy (CFP) and the yearly EU-Norway Bilateral Fishery Agreements. The prevailing management system and principle has been landing quotas (TAC, Total Allowable Catch) mainly based on the EU principle of relative stability in the international sharing of the TAC. Also, general effort limitations and technical measures are set for the EU and Norwegian fisheries on top of the TAC regulations. Technical measures have mainly aimed at reducing the retention and discard of the juveniles through gear measures and to protect the spawners and/or recruits in the fish populations through closures. Furthermore, the management is based on a set of national measures especially concerning control and enforcement measures, national distribution of the overall TAC, individual special technical measures, allocation (distribution) of national TACs to different fisheries and vessels including the share to e.g. Individual Transferable Quotas (ITQs) or Vessel Quota Shares (VQSs). The management of the North Sea demersal fisheries has changed quite a lot over the last decades following the need to rebuild the fish stocks, and in particular the North Sea cod stock in relation to the present case study. The CFP has been increasing focus towards implementing multi-annual or long term management plans (MAMPS, LTMPs) partly to avoid the annual political battles over setting the TAC. There has furthermore been a trend during the last decade to move away from the Precautionary Approach and towards Maximum Sustainable Yield as the overarching management objective and Harvest Control Rules (HCRs) based on this. There have been introduced increasingly restrictive fisheries-based effort limitations with possibilities for exemption or for less drastic effort reductions provided that cod avoidance behavior can be demonstrated. Although the decision-makers under the CFP have had a reputation of consistently setting TACs way above the scientific advice, the development in recent years has been towards this gap being reduced. Management of the fisheries has undergone a number of structural and behavioral changes, and these have already yielded some positive results as the state of the demersal stocks in the North Sea have globally improved. The status of main demersal stocks has considerably improved over the last decade. Fishing mortality has globally decreased and biomass has increased, and most of the assessed demersal stocks are now within sustainable limits. Some issues remain
with North Sea cod, for which recovery is slower. At present, cod is the limiting species for all the North Sea demersal fisheries. Over a time span from the 1960s landings of demersal stocks have declined with an accelerating decrease since the mid-1990s in line with the falling stock sizes and regulated reductions in total allowable catches (TACs). A clear decrease in the mean fishing mortality (F) is observed in the 2000-2010 period with current F values between Fmsy and Fpa, and the spawning stock biomass (SSB) has on average been above Bpa for the period 1983-2010 for the assessed stocks. The effort in the central North Sea and along the Norwegian waters has decreased as well as the number of operating fishing vessels (capacity). Overall, the nominal effort (kW-days) by European fleets using demersal trawl, seine, beam trawl and gillnet in the North Sea, Skagerrak and the Eastern Channel have been substantially reduced (-20% between 2003 and 2011). Since 2000, the total fish biomass for exploited stocks in the North Sea is about 4.5 million tonnes with an increasing trend in the most recent years. Despite the decrease of landings and fishing mortality in the last recent decade, the overall recruitment has shown a clear decreasing trend from 1985-2010. The recent increase in SSB during the last decade, which is likely due to lower landings and fishing mortality levels in the last 15 years, indicate inclinations of the North Sea ecosystem to recover. However, this has not converted in higher recruitment levels in the most recent years in which there may be a time delay. There is a clear trend that both the gross profit and the net profit has improved from 2008-2010 for the main fleets of the North Sea with the only exception of the Dutch beam trawlers 18-24m, for which the gross profit decreased by nearly 90%. The positive development in economic performance measures can be a result of the structural changes that have recently occurred in many fisheries. There are fewer vessels sharing the available resources (reduction in over-capacity). Especially, the movement towards right-based systems is expected to have had positive effects on reducing the over-capacity and improving the economic performance of many fleets. Historically, EU subsidies over the years have contributed to making the fleet more efficient, so the success of the CFP in the area of developing an efficient fleet has historically contributed to its failure in relation to conserve fish stocks, as overcapacity is consistently mentioned as one of the fundamental reasons for the conservation failure historically. Employment in fishing as a social indicator is shrinking, not least for the North Sea, and has been so for many years. There are multiple explanations for this: i) individual vessels are getting more efficient, ii) consolidation of fleets whereby fewer vessels catch the available resources with noticeable decrease in number of operating fishing vessels, and iii) decreasing fishing opportunities in the shape of lower quotas. The raw number of fishers tells a story of a sector that in reality, at least in the prosperous countries around the North Sea, provides only few jobs. Despite the above trends indicating positive effects of the most recent fisheries management of the North Sea mixed demersal fisheries there are a row of general problems in the present management. Population dynamics with respect to recruitment variations, sub-populations and changes in distribution of several demersal North Sea stocks influenced by environmental factors besides fishery are not fully understood and taken into consideration in management (and management advice). Also, biological multi-species interactions between the stocks are not fully taken into account in the management of the stocks when setting the MSY management and exploitation limits for the stocks. Management is not based on broader ecosystem and multi-species objectives, but based mainly on single stock objectives. Also technical interactions between fisheries are not taken fully into account in management of the North Sea demersal fisheries. The fisheries targeting cod, whiting, haddock, saithe, flayfish and Nephrops in the North Sea and Kattegat-Skagerrak are mixed demersal fisheries for towed gears. Mixed fisheries considerations are of primary importance for the management of North Sea species. Single stock management is a cause of discarding in mixed fisheries, because individual stock management objectives may not be consistent with each other. As such, the TAC of one species may be exhausted before the TAC of another, leading to catches of valuable fish that cannot be landed resulting in over-quotas discard. Overall, present management and fisheries policy is characterized by the CFP having in many ways taken form of a classical intergovernmentalist, state-centric command-and-control, top-down management system, where member states’ ministers in the Council have exercised strong control over the fisheries management measures which have been developed and adopted on the background of proposals from the Commission and the Parliament, though since the ratification of the Lisbon Treaty the Parliament has assumed a role of co-legislator alongside the Council. EC has identified the lack of stakeholder involvement as one of the major weaknesses of the CFP, recognizing that this fact clearly undermine its legitimacy. Establishment of the Regional Advisory Councils (RACs) with the 2003 CFP can be seen as the first formal attempt to generate a network of multi-national, multi-interest advisory organizations with a strong regional focus among other involving resource users in the decision making. However, the RACs have at present only an advisory function on decisions and are not formally integrated directly in management on a regional basis, i.e. the RAC system is primarily intended to provide a regional stakeholder perspective to the Commission’s deliberations rather than providing stakeholders with real decision-making authority. RACs constitute, nevertheless, a move towards regionalization of the fisheries policy. Present management is, furthermore, characterized by a high degree of complexity, bureaucracy, and examples of micro-management where different management systems and measures are implemented in parallel making evaluation of impact of the individual measures very complicated and the system suffers from lack of transparency. With respect to the complexity the different management measures are acting top of each other with impact on the same fisheries and stocks at the same time (and with time overlap in their implementation) creating a very complex management and associated advisory system, where it is difficult to distinguish specific effects and impacts of each individual measures implemented. Accordingly, it is also very difficult to make scientific management evaluation and advice associated to the individual measures.
Improved management based on stock identification of eastern and western Baltic cod

The objective of this project was to establish an empirically founded knowledge base for the sustainable exploitation of the western Baltic cod stock by including the complex stock structure and migration patterns.

Stock mapping: Extensive immigration of “Eastern” cod into the Arkona Basin (SD 24) within the “Western” cod’s management unit was documented using high-powered genetic tools. The majority (91%) of all spawning fish caught in SD 24 in 2011 were “Eastern” cod and only 9% were from the “Western” stock. The results suggest that the stock structure in the Arkona Basin is highly influenced by mixing of genetically separate stocks.

Trends in mixing: Since the 1980’s where cod in SD 24 consisted primarily of “Western” type, the proportion of “Eastern” cod has increased, particularly since 2005. Throughout that period, the immigration of “Eastern” cod into SD 24 consisted primarily of adult, older fish. The changes in biological characteristics (mean size at age, condition and maturity) observed in that area since 2005 are thus a direct consequence of the extensive immigration of “Eastern” cod. As no seasonal signals in stock mixing were observed, the immigration is not associated with a change in “Eastern” cod’s spawning behaviour.

Management: The stock mixing proportions were successfully implemented in DTU Aqua’s modeling framework for management scenarios. “Eastern” immigrants into SD 24 lead the management procedure to advice for higher TACs that enhance the pressure on the fishing mortality level in SD 22. The fishing mortality level in SD 22 in this situation will need to be lowered i.e. by allocating more effort and catch from SD 22 to SD 24. Higher landings are expected if effort is re-directed/re-allocated to SD 24, profiting from the “Eastern” immigrants. By lowering the fishing mortality in SD 22, the SSB in SD 22 is also preserved, which is assumed to be the main source of recruits for the whole “western” stock (i.e. SD 22 + SD 24). In conclusion: Within the frame of this project we showed that substantial immigration “Eastern” cod into SD 24 has occurred and that these stock dynamics should be incorporated in evaluations of future management plans.

Integrating individual trip planning in energy efficiency – Building decision tree models for Danish fisheries

Danish fishermen have provided information on dynamics in their fuel consumption, running costs, and fishing patterns through a web-based questionnaire. This detailed documentation of the fishing practices is used in spatial modelling tools to improve advice and research for fisheries. The tools integrate detailed information on vessel distribution, catch and fuel consumption for different fisheries with a detailed resource distribution of targeted stocks from research surveys to evaluate the optimum consumption and efficiency to reduce fuel costs and the costs of displacement of effort. The energy efficiency for the value of catch per unit of fuel consumed is analysed by merging the questionnaire, logbook and VMS (vessel monitoring system) information. Logic decision trees and conditional behaviour probabilities are established from the responses of fishermen regarding a range of sequential hypothetical conditions influencing their
trip decisions, covering the duration of fishing time, choice of fishing ground(s), when to stop fishing and return to port, and the choice of the port for landing. Fleet-based energy and economy efficiency are linked to the decision (choice) dynamics. Larger fuel-intensive but efficient vessels conducting pelagic or industrial fishing are more inclined to base their decision on fish price only, while numerous smaller and less efficient vessels conducting demersal mixed or crustacean fishery usually consider other flexible factors, e.g., the potential for a large catch, weather, previous knowledge and experience, and the distance to/from port, which affect the number and duration of trips and the fuel consumption. Integration of the results into our recently developed spatially explicit individual-based fishing vessel model (IBM) incorporate the variability and predict the adaptations of individual fishermen to resource availability dynamics, increasing fuel prices, changes in regulations, and the consequences of socioeconomic external pressures on harvested stocks. A new methodology is described here to obtain quantitative information on the fishermen’s micro-scale decisions initially required

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Localisation of nursery areas based on comparative analyses of the horizontal and vertical distribution patterns of juvenile Baltic cod (Gadus morhua)
Knowledge of the spatial distribution of juvenile cod is essential for obtaining precise recruitment data to conduct sustainable management of the eastern and western Baltic cod stocks. In this study, the horizontal and vertical distribution and density patterns of settled juvenile 0- and 1-group Baltic cod are determined, and their nursery areas are localised according to the environmental factors affecting them. Comparative statistical analyses of biological, hydrographic and hydroacoustic data are carried out based on standard ICES demersal trawl surveys and special integrated trawl and acoustic research surveys. Horizontal distribution maps for the 2001–2010 cohorts of juvenile cod are further generated by applying a statistical log-Gaussian Cox process model to the standard trawl survey data. The analyses indicate size-dependent horizontal and distinct vertical and diurnal distribution patterns related to the seabed topography, water layer depth, and the presence of hydrographic frontal zones (pycnoclines) as well as intraspecific patterns in relation to the presence of adult cod. The extent of the nursery areas also depends on the cod year class strength. Juvenile cod (≥3 cm) are present in all areas of the central Baltic Sea (CBS), showing broad dispersal. However, their highest density in the Baltic Basins is found at localities with a 40–70 m bottom depth in waters with oxygen concentrations above 2 ml O2.l−1 and temperatures above 5°C. The smallest juveniles are also found in deep sea localities down to a 100 m depth and at oxygen concentrations between 2–4 ml O2.l−1. The vertical, diurnally stratified and repeated trawling and hydroacoustic target strength-depth distributions obtained from the special surveys show juvenile cod concentrations in frontal zone water layers (pycnocline). However, the analyses indicate that in the CBS, juvenile cod of all sizes do not appear to aggregate in dense schooling patterns, which differs from what has been reported from the North Sea

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Challenges and opportunities for fleet- and métier-based approaches for fisheries management under the European Common Fishery Policy

The inconsistency of single-species objectives in a mixed-fisheries context has repeatedly been highlighted as a key issue in the current European Common Fishery Policy, and it has long been suggested that this issue would be better addressed through fleet (group of vessels) and métier (type of activity) based approaches. Since the late 1980s, when such approaches were first introduced, there have been substantial developments in this area of science, to the point where the concepts of fleet and métier now underpin the whole EC Data Collection Framework. However, their implementation in the management system has been slow and difficult, being hampered by a number of intrinsic issues. Mixed fisheries are an ongoing "governance headache" combining management complexity, scientific uncertainty and political sensitivity. This paper summarises the current state of play for fleet-based approaches in EU fisheries management, and highlights our views on both their potential and the challenges they face in the context of the future CFP. As a convenient layer between the current single-stock level and the level of the individual vessel, fleet/métier-approaches could potentially address a wide range of issues, especially with regards to the policy emphasis on ecosystem-based fisheries management. However, the rigid categorisation they induce may not properly address the flexibility of individual vessels, and should therefore be supplemented by more detailed considerations at the local scale.

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Coupled economic – ecological models for EBFM

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DISPLACE: a dynamic, individual-based model for spatial fishing planning and effort displacement: Integrating underlying fish population models

We previously developed a spatially explicit, individual-based model (IBM) evaluating the bio-economic efficiency of fishing vessel movements between regions according to the catching and targeting of different species based on the most recent high resolution spatial fishery data. The main purpose was to test the effects of alternative fishing effort allocation scenarios related to fuel consumption, energy efficiency (value per litre of fuel), sustainable fish stock harvesting, and profitability of the fisheries. The assumption here was constant underlying resource availability. Now, an advanced version couples the vessel model to selected size-based population models and considers the underlying resource dynamics in the distribution and density patterns of the targeted stocks for the cases of Danish and German vessels harvesting the North Sea and Baltic fish stocks. The stochastic fishing process includes direct and local depletion by stock that is specific to the vessel catching power, which is proportional to the encountered size-based population on the visited ground and is based on stock assessment and research survey data. The impact of the potential fishing effort displacement by vessels on the fish stocks, with resulting fishing mortality, and the vessels’ economic consequences are evaluated on high spatial and seasonal disaggregation levels by simulating different individual choices of vessel speed, fishing grounds and ports. All tested scenarios led to increased overall energy efficiency, except for the fishing closures that increased fuel consumption and costs for most of the vessels due to increased travel distance. On an individual scale, the simulations led to gains and losses due to either the technical interactions between vessels exploiting the same stocks or to the alteration of individual fishing patterns. We demonstrate that integrating the spatial activity of vessels and local fish stock abundance dynamics allow for interactions and more realistic predictions of fishermen behaviour, revenues and stock abundance.

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Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2012 › Research

Do Norway pout (Trisopterus esmarkii) die from spawning stress? Mortality of Norway pout in relation to growth, maturity and density in the North Sea, Skagerrak and Kattegat

The mortality patterns of Norway pout (NP) are not well understood. It has been suggested that NP undergo heavy spawning mortality, and this paper summarizes and provides new evidence in support of this hypothesis. The very low–absent fishing activity in recent years provides a unique opportunity to analyse the natural life-history traits of cohorts in the NP stock in the North Sea. Based on the ICES trawl survey abundance indices, cohort mortality is found to significantly increase with age. We argue that this cannot be explained by selectiveness in the fishery, potential size-specific migrations out of the area, higher predation pressure on older individuals, or differences in survey catchability by NP age from before to after spawning and that it is higher in the main spawning areas than outside. We found that natural mortality (M) is significantly correlated with sexual maturity, sex, growth, and intraspecific stock density. All of this is consistent with a greater mortality occurring mainly from the first to the second quarter of the year, i.e. spawning mortality, which is discussed as being a major direct and indirect cause of stock mortality.

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Public Sector Consultancy
Impact assessment (IA) of alternative HCRs to the current multiannual Baltic Sea plan on the bio-economy of fleets – coupling the SMS model to the FLR Baltic model

General information
Publication status: Published
Organisations: National Institute of Aquatic Resources, Section for Management Systems, Section for Public Sector Consultancy
Contributors: Bastardie, F., Vinther, M., Nielsen, J. R.
Pages: 85-118
Publication date: 2012

Host publication information
Title of host publication: Scientific, Technical and Economic Committee for Fisheries. Multispecies management plans for the Baltic (STECF-12-06)
Place of publication: Luxembourg
Publisher: Publications Office of the European Union
URLs:

Regional métier definition: A comparative investigation of statistical methods using a workflow applied to the international otter trawl fisheries in the North Sea
The European Common Fisheries Policy recognizes the importance of accounting for heterogeneity in fishing practices, and métier-based sampling is now at the core of the EU Data Collection Framework. The implementation of such an approach would require Member States to agree on the standard regional métier definitions and on practical rules to categorize logbook records into métiers. Several alternative approaches have been used in the past to categorize landings profiles, but no consensus has yet emerged. A generic open-source workflow is developed to test and compare a selection of methods, including principal components analysis (PCA), hierarchical agglomerative clustering (HAC), K-means, and Clustering LARge Applications (CLARA), and to provide simple allocation rules. This workflow is applied to a unique regional dataset consisting of bottom-trawl logbooks of five North Sea countries. No method proved to be infallible, but combining PCA with either CLARA or HAC performed best. For 2008, a hierarchical classification with 14 species assemblages is proposed. Discriminant analysis proved more robust than simple ordination methods for allocating a new logbook record into an existing métier. The whole approach is directly operational and could contribute to defining more objective and consistent métiers across European fisheries

General information
Transforming knowledge into quantitative modelling: Danish fishers respond to a web-based survey on dynamics in fuel consumption and fishing patterns

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Contributors: Bastardie, F., Nielsen, J. R., Andersen, B. S., Eigaard, O. R.
Publication date: 2012
Event: Abstract from World Fisheries Congress, Edinburgh, United Kingdom.
Research output: Contribution to conference › Conference abstract for conference – Annual report year: 2012 › Research

Use of high resolution spatial analysis of effort and landings for supplementing impact assessment on Western Baltic fisheries

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Contributors: Miethe, T., Bastardie, F., von Dorrien, C., Nielsen, J. R.
Publication date: 2012
Event: Poster session presented at World Fisheries Congress, Edinburgh, United Kingdom.
Research output: Contribution to conference › Poster – Annual report year: 2012 › Research

VMStools: Open-source software for the processing, analysis and visualization of fisheries logbook and VMS data
VMStools is a package of open-source software, build using the freeware environment R, specifically developed for the processing, analysis and visualisation of landings (logbooks) and vessel location data (VMS) from commercial fisheries. Analyses start with standardized data formats for logbook (EFLALO) and VMS (TACSAT), enabling users to conduct a variety of analyses using generic algorithms. Embedded functionality handles erroneous data point detection and removal, métier identification through the use of clustering techniques, linking logbook and VMS data together in order to distinguish fishing from other activities, provide high-resolution maps of both fishing effort and -landings, interpolate vessel tracks, calculate indicators of fishing impact as listed under the Data Collection Framework at different spatio-temporal scales. Finally data can be transformed into other existing formats, for example to populate regional databases like FishFrame. This paper describes workflow examples of these features while online material allows a head start to perform these analyses. This software incorporates state-of-the art VMS and logbook analysing methods standardizing the process towards obtaining pan-European, or even worldwide indicators of fishing distribution and impact as required for spatial
Evaluation of effort and TAC quota uptake and capacity use by country as well as efficiency of effort measures according to fishing mortality and fishing power in the Western and Eastern Baltic cod fishery during 2005-2010 in relation to the multi-annual cod management plan

Stock-based and fleet-based evaluation of the multi-annual management plan for the cod stocks in the Baltic Sea with respect to cod stock mixing and TAC vs. effort regulation under different constraints and stock conditions
Detailed mapping of fishing effort and landings by coupling fishing logbooks with satellite-recorded vessel geo-localisation

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Public Sector Consultancy
Contributors: Bastardie, F., Nielsen, J. R., Ulrich, C., Egekvist, J., Degel, H.
Publication date: 2010
Peer-reviewed: No
Source: orbit
Source-ID: 268926
Research output: Contribution to conference » Poster – Annual report year: 2010 » Research

Detailed mapping of fishing effort and landings by coupling fishing logbooks with satellite-recorded vessel geo-location

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Public Sector Consultancy
Contributors: Bastardie, F., Nielsen, J. R., Ulrich, C., Egekvist, J., Degel, H.
Pages: 41-53
Publication date: 2010
Peer-reviewed: Yes
Publication information
Journal: Fisheries Research
Volume: 106
Issue number: 1
ISSN (Print): 0165-7836
Ratings:
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.063 SNIP 1.107
Web of Science (2010): Impact factor 1.656
Web of Science (2010): Indexed yes
Original language: English
DOIs:
10.1016/j.fishres.2010.06.016
Source: orbit
Source-ID: 264656
Research output: Contribution to journal » Journal article – Annual report year: 2010 » Research » peer-review

Effect of fishing effort allocation scenarios on energy efficiency and profitability: An individual based model applied to Danish fisheries

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Contributors: Bastardie, F., Nielsen, J. R., Andersen, B. S., Eigaard, O. R.
Publication date: 2010
Peer-reviewed: No
Source: orbit
Source-ID: 268928
Effect of fishing effort displacement scenarios on energy efficiency: an individual based model applied to the Danish fisheries

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Contributors: Bastardie, F., Nielsen, J. R., Andersen, B. S., Eigaard, O. R.
Publication date: 2010
Peer-reviewed: No
Event: Poster session presented at Conference on Climate Change Effects on Fish and Fisheries, Sendai, Japan, 25-29 April.
Source: orbit
Source-ID: 268927

Effects of fishing effort allocation scenarios on energy efficiency and profitability: an individual-based model applied to Danish fisheries

Global concerns about CO2 emissions, national CO2 quotas, and rising fuel prices are incentives for the commercial fishing fleet industry to change their fishing practices and reduce fuel consumption, which constitutes a significant part of fishing costs. Vessel-based fuel consumption, energy efficiency (quantity of fish caught per litre of fuel used), and profitability are factors that we simulated in developing a spatially explicit individual-based model (IBM) for fishing vessel movements. The observed spatial and seasonal patterns of fishing effort for each fishing activity are evaluated against three alternative effort allocation scenarios for the assumed fishermen's adaptation to these factors: (A) preferring nearby fishing grounds rather than distant grounds with potentially larger catches and higher values, (B) shifting to other fisheries targeting resources located closer to the harbour, and (C) allocating effort towards optimising the expected area-specific profit per trip. The model is informed by data from each Danish fishing vessel >15 m after coupling its high resolution spatial and temporal effort data (VMS) with data from logbook landing declarations, sales slips, vessel engine specifications, and fish and fuel prices. The outcomes of scenarios A and B indicate a trade-off between fuel savings and energy efficiency improvements when effort is displaced closer to the harbour compared to reductions in total landing amounts and profit. Scenario C indicates that historic effort allocation has actually been sub-optimal because increased profits from decreased fuel consumption and larger landings could have been obtained by applying a different spatial effort allocation. Based on recent advances in VMS and logbooks data analyses, this paper contributes to improve the modelling of fishing effort allocation, fuel consumption and catch distribution on a much disaggregated level compared to the fleet-based models we developed so far.

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources
Contributors: Bastardie, F., Nielsen, J. R., Andersen, B. S., Eigaard, O. R.
Pages: 501-516
Publication date: 2010
Peer-reviewed: Yes

Publication information
Journal: Fisheries Research
Volume: 106
Issue number: 3
ISSN (Print): 0165-7836
Ratings:
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 1.063 SNIP 1.107
Web of Science (2010): Impact factor 1.656
Web of Science (2010): Indexed yes
Original language: English
DOIs: 10.1016/j.fishres.2010.09.025
Source: orbit
Source-ID: 267358

Research output: Contribution to journal › Journal article – Annual report year: 2010 › Research › peer-review
Stock-based vs. fleet-based evaluation of the multi-annual management plan for the cod stocks in the Baltic Sea

This study evaluated the EU 2008 multi-annual plan for Baltic cod stock recovery. The plan combines harvest control rules that set TACs with reductions in direct effort (E) and fishing mortality (F). Performance and robustness of the plan are tested with a management strategy evaluation model (MSE). Stochastic simulations are carried out under different scenarios of recruitment and sources of uncertainties. Under the different magnitudes of errors investigated, the plan in its current design is likely to reach precautionary targets for the Eastern and the Western Baltic cod stocks by 2015. It is, however, more sensitive to implementation errors (e.g. catch misreporting) than to observation errors (e.g. data collection) when the (i) current settings of the ICES single-stock assessment model are maintained, (ii) intended fishing effort reduction is fully complied with, and (iii) biological parameters are assumed constant. For the Eastern Baltic stock, additional sources of uncertainties from fishery adaptation to the plan are tested using a fleet-based and spatially explicit version of the model which leads to higher reductions in F and no significant change in management robustness. The relative difference between both approaches is mainly due to differences in exploitation patterns in catching the same amount of fish. The effort control is demonstrated to be more efficient when supplemented with a TAC and avoids unintended effects from fishery responses, e.g. spatial effort reallocation. Medium term economic evaluation of fishery performance shows an initial reduction in profit with effort and TAC reductions, but profit is always positive. (C) 2009 Elsevier B.V. All rights reserved.

The eastern Baltic cod fishery: a fleet-based management strategy evaluation framework to assess the cod recovery plan of 2008


A model-based evaluation of Marine Protected Areas: the example of eastern Baltic cod (Gadus morhua callarias L.)

The eastern Baltic cod stock collapsed as a consequence of climate-driven adverse hydrographic conditions and overfishing and has remained at historically low levels. Spatio-temporal fishing closures [Marine Protected Areas (MPAs)] have been implemented since 1995, to protect and restore the spawning stock. However, no signs of recovery have been observed yet, either suggesting that MPAs are an inappropriate management measure or pointing towards suboptimal closure design. We used the spatially explicit fishery simulation model ISIS-Fish to evaluate proposed and implemented fishery closures, combining an age-structured population module with a multifleet exploitation module and a management module in a single model environment. The model is parameterized based on (i) the large amount of biological knowledge available for cod and (ii) an analysis of existing spatially disaggregated fishery data. As the population dynamics of eastern Baltic cod depend strongly on the climate-driven hydrographic regime, we considered two production regimes of the stock. MPAs were only effective for stock recovery when they reduced overall fishing effort. The performance of MPAs needs to be evaluated relative to environmental regimes, especially for stocks facing strong environmental variability.

Biological ensemble modelling of the Eastern Baltic cod future

General information
Publication status: Published
Organisations: Section for Population- and Ecosystem Dynamics, National Institute of Aquatic Resources, Section for Management Systems
Publication date: 2009
Host publication information
Title of host publication: Book of Abstracts
Source: orbit
Source-ID: 254190
Research output: Chapter in Book/Report/Conference proceeding → Conference abstract in proceedings – Annual report year: 2009 → Research
Evaluating biological robustness of innovative management alternatives

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Fisheries Advice
Contributors: Bastardie, F., Baudron, A., Bilocca, R., Boje, J., Bult, T. P., Garcia, D., Hintzen, N. T., Nielsen, J. R., Petursdottir, G., Sanchez, S., Ulrich, C.
Number of pages: 269
Pages: 119-142
Publication date: 2009

Host publication information
Title of host publication: Comparative Evaluations of Innovative Fisheries Management.
Place of publication: Dordrecht
Publisher: Springer Science+Business Media
Editors: Hauge, K. H., Wilson, D. C.
URLs:
http://www.worldcat.org/oclc/320197711
Source: orbit
Source-ID: 251220

Evaluation of the multiannual plan for the cod stocks in the Baltic Sea

General information
Publication status: Published
Organisations: Section for Management Systems, National Institute of Aquatic Resources, Section for Public Sector Consultancy, Section for Monitoring
Contributors: Bastardie, F., Vinther, M., Nielsen, J. R., Ulrich, C., Storr-Paulsen, M.
Number of pages: 29
Publication date: 2009

Host publication information
Title of host publication: Book of Abstracts
URLs:
Source: orbit
Source-ID: 314574
Research output: Chapter in Book/Report/Conference proceeding – Conference abstract in proceedings – Annual report year: 2010 – Research

Encapsulating root and soil heterogeneity in models using the concept of functional architecture

General information
Publication status: Published
Organisations: French National Institute for Agricultural Research, Université d'Avignon et des Pays de Vaucluse
Contributors: Pierret, A., Doussan, C., Capowiez, Y., Bastardie, F., Pagés, L.
Pages: 269-281
Publication date: 2007
Peer-reviewed: Yes

Publication information
Journal: Vadose Zone Journal
Volume: 6
Issue number: 2
ISSN (Print): 1539-1663
Ratings:
Scopus rating (2007): SJR 0.978 SNIP 1.116
Web of Science (2007): Indexed yes
Original language: English
Effect of sludge and municipal solid waste composts disposal on earthworm communities under crop field conditions

General information
Publication status: Published
Organisations: AgroParisTech, Université d’Avignon et des Pays de Vaucluse
Contributors: Capowiez, Y., Bastardie, F., Bodineau, G., Houot, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at Effect of sludge and municipal solid waste composts disposal on earthworm communities under crop field conditions, Krakow, Poland.

Sublethal effects of imidacloprid on the burrowing behaviour of two earthworm species: modifications of the 3D burrow systems in artificial cores and consequences on gas diffusion in soil

General information
Publication status: Published
Organisations: Université d’Avignon et des Pays de Vaucluse, INRA Institut National de La Recherche Agronomique
Contributors: Capowiez, Y., Bastardie, F., Costagliola, G.
Pages: 285-293
Publication date: 2006
Peer-reviewed: Yes

Three-d simulations of burrow systems made by earthworm communities and study of some physical consequences

General information
Publication status: Published
Organisations: Unknown
Contributors: Bastardie, F., Capowiez, Y., Ruy, S.
Publication date: 2006
Peer-reviewed: No
Event: Poster session presented at International Symposium on Earthworm Ecology, Krakow, Poland.

3D characterisation of earthworm burrow systems from natural soil cores collected on a 12 year old pasture
To link earthworm burrow distribution with the spatial variability of soil functions, accurate mapping of their spatial burrowing patterns is required. Eight natural soil cores (25 cm in diameter; up to 60 cm long) were collected from a pasture in spring 2001–2003. Earthworm populations were sampled on the first date and the anecic species Nicodrilus giardi was found to be dominant (55% of the average density of 101 worms m⁻²). Soil cores were imaged using medical X-ray tomography equipment. These tomography images served as a basis for 3D reconstructions generated using specifically written software. Finally, the reconstructed burrow systems were measured and analysed using mathematical morphological approaches. The 3D reconstructions thus derived showed dense systems of interconnected burrows. A
number of burrows extending vertically from the top to the bottom of the cores, but most were short, disconnected burrows. These two classes of burrows could not be linked with the activity of a particular species. In addition to the visual appraisal of the burrow system shape, structural parameters such as burrow volume, burrow wall surface area, burrow length density, topology and burrow angles were computed from the 3D reconstructions. Total burrow length density ranged from 687 to 1212 m m⁻³. Burrow volume density represented less than 2.5% of total soil volume and ranged from 13.3 × 10³ to 24.2 × 10³ cm³ m⁻³. Inspite of the apparently high continuity of burrows, only 9–43% of the volume was connected to the soil surface. Total burrow wall area ranged from 7721 to 12764 cm² m⁻³ while surface-connected burrow wall surface area ranged from 1069 to 7237 cm² m⁻³. The drilosphere volumes (i.e. a 2 mm thick sheath around burrows) were estimated to range from 44.9 × 10³ to 52.9 × 10³ cm³ m⁻³. Earthworm activity was found to vary throughout the year as revealed by changes in burrowing patterns. The burrow systems in spring 2001 were denser than that in others years, and the burrow systems in spring 2003 appeared to be partially re-filled close to the surface. This temporal variability demonstrates that it is virtually impossible to obtain true replicates of burrow systems of a given earthworm community without knowing (1) which burrows were created by which species and (2) the burrows age. However, the accurate description and quantification of earthworm burrow systems using powerful image processing tools allows a detailed discussion of the potential impact of earthworms on soil functions under natural conditions.

A radio-labelled study of earthworm behaviours in artificial soil cores in term of ecological types

General information
Publication status: Published
Organisations: Laboratoire Fonctionnement des Ecosystèmes et Biologie de la Conservation
Contributors: Bastardie, F., Capowiez, Y., Renault, P., Cluzeau, D.
Pages: 320-327
Publication date: 2005
Peer-reviewed: Yes

Publication information
Journal: Biology and Fertility of Soils
Volume: 41
Issue number: 5
ISSN (Print): 0178-2762
Ratings:
Scopus rating (2005): SJR 1.032 SNIP 1.255
Web of Science (2005): Indexed yes
Original language: English
DOI:s:
10.1007/s00374-005-0847-6
Source: orbit
Source-ID: 264801
Research output: Contribution to journal › Journal article – Annual report year: 2005 › Research › peer-review
X-ray tomographic and hydraulic characterization of burrowing by three earthworm species in repacked soil cores

General information
Publication status: Published
Organisations: Laboratoire Fonctionnement des Ecosystèmes et Biologie de la Conservation
Contributors: Bastardie, F., Capowiez, Y., de Dreuzy, J., Cluzeau, D.
Pages: 3-16
Publication date: 2003
Peer-reviewed: Yes

Publication information
Journal: Applied Soil Ecology
Volume: 24
Issue number: 1
ISSN (Print): 0929-1393
Ratings:
Web of Science (2003): Indexed yes
Original language: English
DOIs:
10.1016/S0929-1393(03)00071-4
Source: orbit
Source-ID: 264805
Research output: Contribution to journal › Journal article – Annual report year: 2003 › Research › peer-review

3D simulation of earthworm burrow systems by the way of "multi-agent" method

General information
Publication status: Published
Organisations: National Institute of Aquatic Resources, Section for Management Systems
Contributors: Bastardie, F.
Publication date: 2002
Peer-reviewed: No
Event:
Research output: Contribution to conference › Poster – Annual report year: 2002 › Research

A new simulation for modelling the topology of earthworm burrow systems and their effects on macropore flow in experimental soils

General information
Publication status: Published
Organisations: IPREM, Université de Rennes, INRA Institut National de La Recherche Agronomique
Contributors: Bastardie, F., Cannavacciuolo, M., Capowiez, Y., de Dreuzy, J., Bellido, A., Cluzeau, D.
Pages: 161-169
Publication date: 2002
Peer-reviewed: Yes

Publication information
Journal: Biology and Fertility of Soils
Volume: 36
Issue number: 2
ISSN (Print): 0178-2762
Ratings:
Scopus rating (2002): SJR 1.06 SNIP 1.117
Web of Science (2002): Indexed yes
Original language: English
DOIs:
10.1007/s00374-002-0514-0
Source: orbit
Source-ID: 264809
Research output: Contribution to journal › Journal article – Annual report year: 2002 › Research › peer-review
Studying boundary effects on animal movement in heterogeneous landscapes: the case of Abax ater (Coleoptera: Carabidae) in hedgerow network landscapes

General information
Publication status: Published
Organisations: Centre National de la Recherche Scientifique
Contributors: Martin, M., Bastardie, F., Richard, D., Burel, F.
Pages: 1029-1035
Publication date: 2001
Peer-reviewed: Yes

Publication information
Journal: Comptes Rendus de l'Académie des Sciences - Series III - Sciences de la Vie
Volume: 324
Issue number: 11
ISSN (Print): 0764-4469
Ratings:
Scopus rating (2001): SJR 0.541 SNIP 0.674
Original language: English
DOIs:
10.1016/S0764-4469(01)01379-8
Source: orbit
Source-ID: 264811
Research output: Contribution to journal › Journal article – Annual report year: 2001 › Research › peer-review

Projects:

Protecting bycaught species in mixed fisheries (PROBYFISH) (39549)
PROBYFISH aims to develop a modelling framework and a support tool to assess whether proposals for regionalised management measures in the North Sea, Southwestern and Northwestern waters are in accordance with the objectives of the CFP. The project approaches this aim by developing agreed and robust methods to define target and bycatch species, identifying the bycatch species for which TAC management of target species would be sufficient, identifying measures that will lead to the sustainable development of the bycatch stocks (technical, spatial etc), producing agreed reference levels to safeguard stocks and combining the results of all activities in a user-friendly and flexible tool.

The project is coordinated by DTU Aqua and is funded by EU Executive Agency for Small and Medium-sized Enterprises (EASME).
Rindorf, A., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Ulrich, C., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Kokkalis, A., Project Participant, Section for Ecosystem based Marine Management
Haslund, O. H., Project Participant, National Institute of Aquatic Resources
24/05/2018 → 23/05/2021
Keywords: Research areas: Fisheries Management & Ecosystem based Marine Management
Project: Research

Sand banks and fisheries impact in relation to EU fisheries and environmental policy (39519)
Objective of the project: The project will improve the knowledge base for ongoing and upcoming Natura 2000 and MSFD implementations in the North Sea. For nature-type 'sand banks', in particular Danish sandeel and plaice fishing will be affected. Activities in the project: The key activities of the project are targeted method developments and knowledge production in relation to EU fisheries and environmental policy: 1) Development of a gear and sediment-specific model for bottom impact from all types of mobile bottom-contacting fishing gears in the North Sea. 2) Field trials to document short-term impact on sandbank fauna from demersal seine fishery. 3) Analyses of data from the seine gear field trials and of existing data for the impact of sandbanks from trawlers, including impact differences between bottom and floating trawl doors. 4) Estimation of sediment impact from natural disturbance on sand banks (e.g. tide and wave impact) as well as scaling of these in relation to physical effects of different types of gear. 5) Integrated analysis of the impact of different fisheries and other pressure factors on sand banks. 6) Dissemination. Project Expected Effects: The project's results and method developments can be used directly in the management to separate different fisheries with regard to bottom impact; e.g. by nature conservation via area restrictions. Activity 4 and 5 will generate management tools that can quantitatively address descriptor 6 under the Marine Strategy Framework Directive relative to sand banks.

The project is coordinated by DTU Aqua and is funded by the European Maritime and Fisheries Fund (EMFF) and the
Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology & Marine Living Resources & Fisheries Technology & Fisheries Management
Project: Research

Fishery and Fisheries Ecosystem Impac Modelling
Rufener, M., PhD Student, National Institute of Aquatic Resources
Bastardie, F., Main Supervisor
Dinesen, G. E., Supervisor
Kristensen, K., Supervisor
Nielsen, J. R., Supervisor
Samfinansieret - Andet
01/06/2017 → 31/05/2020
Award relations: Fishery and Fisheries Ecosystem Impac Modelling
Project: PhD

The effect of bottom trawling on marine bottom fauna and eelgrass (ØB Bundfauna) (39192)
The project provided input to the analysis of the impact of fishing on the ecological quality of the Danish marine environment to the Danish Nature Agency in relation to the water plans needed in connection with the implementation of the Water Framework Directive.
It contained three subprojects:
- Quantifying the area of seabed swept by Danish bottom trawl fisheries.
- Quantifying the impact of bottom trawling on marine benthos.
- Quantifying the possible interaction between bottom trawling and the depth distribution of eelgrass (Zostera marina).
This project was coordinated by DTU Aqua.
The Project was funded by the Danish Nature Agency.
Gislason, H., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
Dinesen, G. E., Project Manager, National Institute of Aquatic Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Egekvist, J., Project Participant, National Institute of Aquatic Resources
Sørensen, T. K., Project Participant, National Institute of Aquatic Resources
Serensen, T. K., Project Participant, National Institute of Aquatic Resources
01/05/2014 → 31/12/2015
Keywords: Research areas: Ecosystem based Marine Management & Coastal Ecology & Fisheries Management
Collaborators: Aarhus University
Project: Research

Baltic Sea project to boost regional coherence of marine strategies through improved data flow, assessments, and knowledge Base for development of measures (BalticBOOST) (39312)
General objectives
The general objective of the project is to enhance regional coherence in the accomplishment of the 2018 reporting under the EU MSFD by developing joint tools, defining data needs and to set up data arrangements to support indicator-based assessments of the state of and pressures on the Baltic Sea. The project take steps towards development of joint environmental targets for pressures affecting seabed habitats by developing a knowledge base and principles for defining such targets. The project addresses in particular MSFD Descriptors 1, 6, 8 and 11.
BalticBOOST is based on five themes with one or several work packages: Theme 1 (Biodiversity), Theme 2 (Hazardous substances), Theme 3 (Physical loss and damage to seabed habitats), Theme 4 (Noise), and Theme 5 (Joint documentation of Programmes of Measures).
Management Strategy Framework: Provision of formal considerations, evaluations, recommendations and reporting of provision and further development of model software to carry out MSE according to MSY in the short to medium term.

- Input or output based harvest control rules according to short term forecast for the 5 major fish stocks. Also, this involves identification of biological reference points (biomass- and fishing mortality based reference points) and identification of considering several prospective harvest control rules in the short to medium term according to MSY. This involves available in cooperation with AZTI which includes a Stock Summary Sheet for each of the stocks.

- Templates for assessment and advice are developed on the basis of the data and knowledge stock production model using the above data to estimate MSY (Maximum Sustainable Yield) sustainability reference levels parameters, performing yield per recruit analyses, and conducting stock assessments with application of a stochastic.

- Stocks out of the appointed 13 major stocks exploited by SA in the area. The work include estimation of fish stock growth and management advice. A service contract according has been signed between KFUPM/RI and AZTI. A sub-contract to this Theme as well as future assessment of pressures impacting the Baltic Sea (WP 3.3). A shared component across Themes 1-3 is improving access to high quality data to carry out future assessments feeding into the MSFD reporting. This involves alignment of the formats of reported data to relevant international or European data format and making the resultant spatial data products (indicator maps) available as INSPIRE compliant (OGC WMS/WFS) web map services.

- Theme 5, Joint documentation of Programmes of Measures (PoMs), provides support for HELCOM GEAR, the working group responsible for regional coordination in the implementation of the HELCOM BSAP and the MSFD. Support is provided to the agreed development of a joint document on regional coordinated PoMs and a system to follow-up actions agreed by HELCOM.

Tasks and Deliverables

DTU Aqua is involved in Theme 3, WP3.1 and especially WP3.2, where we will develop methods for assessing and apply fishing intensity maps according to fishing gear (footprint), explore benthic sensitivity indicators of fishery, and evaluate fishing impact according to MSFD indicators, all with focus on the Femern Belt Case Study. DTU Aqua is responsible for and coordinating the Technical WP3.2 (coordinator Prof. J. Rasmus Nielsen).

This project is coordinated by DTU Aqua. The project is funded by EU, Calls for proposals/tenders (DG ENV/MSFD Action Plans/2014).

Nielsen, J. R., Project Coordinator, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management

Bastardie, F., Project Participant, National Institute of Aquatic Resources

Bossier, S., PhD Student, National Institute of Aquatic Resources

Geitner, K., Project Participant, National Institute of Aquatic Resources

15/09/2015 → 31/12/2016

Keywords: Research area: Fisheries Management


Project: Research

Tender for scientific support to the Saudi Arabian fisheries sector (SaudiTender I) (39153)

Objective

The general aim of the Fisheries Program at the Marine Studies Section, Center for Environment and Water, Research Institute, King Fahd University of Petroleum and Minerals (KFUPM/RI), is to establish a modern system of data collection, biological and ecological assessment, stock assessment modelling, and government management, in order to evaluate the exploitation status and enhance the sustainability of finfish and invertebrate stocks of Saudi Arabia (SA) Exclusive Economic Zone in the Arabian Gulf. The overall principle underlying this effort is the food security of SA, and the duty to carry out the best efforts to guarantee sustainable exploitation of fishery resources and ensure economic viable fisheries. The Program is organized in four main branches, or Work Packages: Population Dynamics and Stock Assessment, Essential Fish Habitats, Environmental Impacts of Fishing Methods, and Management Strategy Framework.

Background

The KFUPM/RI of Saudi Arabia and AZTI-Tecnalia, Marine and Food Research Institute of the Basque Country, Spain, in partnership with DTU-Aqua, runs this project with an extensive collaboration program in fisheries monitoring, research, and management advice. A service contract according has been signed between KFUPM/RI and AZTI. A sub-contract to this service contract has been made between AZTI and DTU Aqua where parts of the service contract forms an integral part of the subcontract and where DTU Aqua is co-responsible for the below listed specific tasks and deliverables.

Tasks and Deliverables

Population Dynamics and Stock Assessment: Provision and further development of suitable model software to carry out stock assessment for data limited fish stocks. Stock assessment models suitable to data-poor fisheries are applied to historical catch and effort data (2002-2012) and to data from the new Data Collection Framework (2013- ) for major stocks. DTU Aqua is responsible for provision of model software to carry out assessments and application of this to 5 major finfish stocks out of the appointed 13 major stocks exploited by SA in the area. The work include estimation of fish stock growth parameters, performing yield per recruit analyses, and conducting stock assessments with application of a stochastic stock production model using the above data to estimate MSY (Maximum Sustainable Yield) sustainability reference levels according to exploitation. Templates for assessment and advice are developed on the basis of the data and knowledge available in cooperation with AZTI which includes a Stock Summary Sheet for each of the stocks.

Management Strategy Evaluation (MSE) for Major Stocks: Conducting and reporting MSE for data-poor fisheries considering several prospective harvest control rules in the short to medium term according to MSY. This involves identification of biological reference points (biomass- and fishing mortality based reference points) and identification of input or output based harvest control rules according to short term forecast for the 5 major fish stocks. Also, this involves provision and further development of model software to carry out MSE according to MSY in the short to medium term.

Management Strategy Framework: Provision of formal considerations, evaluations, recommendations and reporting of
relevant and appropriate management regimes and systems of data collection and stock assessments for scientifically-based advice to the SA Ministry of Agriculture on basis of current fishery system and exploitation of the 13 major stocks. This addresses needs for data, methods, institutional set-up, provision of advice, and possible management systems. This project is coordinated by AZTI Technalia, Spain. The project is funded by AZTI Technalia, Spain as to KFUPM University Saudi Arabia.

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01/05/2015 → 30/06/2017

Keywords: Research area: Fisheries Management
Collaborators: King Fahd University of Petroleum and Minerals, AZTI-Tecnalia
Project: Research

New methodologies for an ecosystem approach to spatial and temporal management of fisheries and aquaculture in coastal areas (ECOAST) (39339)

ECOAST aims to identify, develop and test new methodologies for spatial and temporal management of fisheries and aquaculture in coastal areas. The overall approach will assess the impact of fisheries and aquaculture on coastal ecosystems, including essential fish habitats and conservation priority habitats, as well as synergies and conflicts between human activities.

Building on previous methodologies and experiences the project will evaluate marine spatial planning in seven coastal case study areas having different ecological and socio-economic characteristics: 1) Adriatic Sea (ADR), 2) Ionian Sea (ION), 3) Black Sea (BLK), 4) Tyrrhenian Sea (TYR), 5) Baltic Sea (BAL), 6) Norwegian Fjords (NOR) and 7) NE Atlantic Coasts (ATL).

The project outcomes will produce case specific evaluation of the ecological footprints of aquaculture and fisheries in coastal areas, maps of optimal areas for fisheries and aquaculture, evaluation of compatibility between fisheries, aquaculture and other human activities in coastal areas, as well as implementation of holistic methods and an operational modelling framework to evaluate and predict stakeholder responses to coastal spatial management options covering marine cross sector occupation of space. Several methodologies already exist to assess the impacts on the ecosystem and the socio-economic effects of some spatial management measures, as well as to spatially manage some cross sector marine activities, but none of them integrate all relevant management aspects for coastal areas. Therefore, the holistic methodology will cover in a single system different approaches and management aspects, identifying realistic spatial and temporal potentials and limitations for the integration of fisheries and aquaculture in coastal areas, in order to allow policy makers and stakeholders to evaluate management measures from different points of view and share decisions in a transparent manner on case specific basis. ECOAST results will support the EU and national policies through the provision of tools and data for an ecosystem based allocation of space and sustainable use of marine resources in coastal areas on case specific basis.

This project is coordinated by Institute of Marine Science of the National Research Council, Italy. This project is funded by EU, COFASP, ERA-NET.

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01/03/2016 → 31/12/2018

Keywords: Research area: Fisheries Management
Project: Research

Evaluation of Sustainable Exploitation of Major Baltic Fish Stocks under different Climate, Eutrophication and Fishing Pressures

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Samfinansieret - Andet

01/07/2016 → 10/11/2019

Keywords: Research area: Fisheries Management
Project: Research

Evaluation of Sustainable Exploitation of Major Baltic Fish Stocks under different Climate, Eutrophication and Fishing Pressures

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01/07/2016 → 10/11/2019

Award relations: Evaluation of Sustainable Exploitation of Major Baltic Fish Stocks under different Climate, Eutrophication and Fishing Pressures
Project: PhD
The project is coordinated by Institute for Marine Resources & Ecosystem Studies (IMARES), Wageningen University, The Netherlands. The project has 33 partners from 12 countries.

The project is aimed at improving our understanding of the role of benthic species in marine ecosystems and their socio-economic consequences. As such, BENTHIS will substantially improve the scientific basis to integrate the role of benthic species in fisheries management.

The project involves the development and testing of innovative technologies to reduce fishing impact. It also seeks to enhance collaboration between the fishing industry and other stakeholders.

The project will focus on fisheries in European waters and the role of benthic species in the ecosystem functioning. Fisheries impacts will be studied on benthic organisms and on the geo-chemistry. The newly acquired knowledge will be synthesized in a number of reports and publications, and will be made available to the fishing industry.

The project was funded by Nordforsk, Nordic Council of Ministers.

The shrimp fisheries in the Skagerrak area of Sweden, Norway and Denmark analyzed using a systems perspective (39191)

In recent years the shrimp stock in the Skagerrak has been drastically reduced. The three countries, who fish on the stock, differ substantially in terms of fleet structure, national quota management, fishing patterns and market. The market situation combined with the quota being fished has led to incentives for discarding of smaller shrimps (high-grading), mainly in the Swedish fishery. Discard of shrimp has been banned in Europe for a few years, and in 2016 more general EU discard ban will be implemented. Therefore the development of more size selective gear is being pushed in several countries.

The developments in the stock, the differences in the three countries' resource utilization and the coming management changes make it very interesting to map and compare environmental and socio-economic aspects of the three countries' shrimp fishing in the Skagerrak. Life Cycle Assessment (LCA) is an ISO-standardized methodology that maps resource consumption and environmental impact of products from a systems perspective. There are now a number of case studies where you look at the role of management in the impact of the product. In these cases the product is mostly followed only during fishing until landing (not during processing, packaging and distribution after landing). A Canadian study compared Canadian and American fishing on the same stock of lobster using LCA and demonstrated significant differences in environmental impacts that mainly depended on the countries' management.

The aim of this study was to quantify a set of indicators that together give a broad picture of the sustainability of the three fisheries to provide an objective basis for a discussion on needed measures. The different indicators concern environmental, economic or social aspects of sustainability and were quantified per tonne of shrimp landed by each country in 2012. The Danish fishery was most efficient in terms of environmental and economic indicators, while the Swedish fishery provided most employment per tonne of shrimp landed. Fuel use in all fisheries was high, also when compared with other shrimp fisheries. Interesting patterns emerged, with smaller vessels being more fuel efficient than larger ones in Sweden and Norway, with the opposite trend in Denmark. The study also demonstrated major data gaps and differences between the countries in how data are collected and made available. Various improvement options in the areas data collection and publication, allocation of quotas and enforcement of regulations resulted and are described in more detail in a scientific paper in ICES Journal of Marine Science in 2016.

This project was coordinated by SIK-SP Food and Bioscience. The project was funded by Nordforsk, Nordic Council of Ministers.

Jørgensen, M. S., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources

The shrimp fisheries in the Skagerrak area of Sweden, Norway and Denmark are managed through a mixed-fishery system with a number of players involved in the stock and the quota management. The project aims to study the sustainability of the three fisheries and to provide an objective basis for discussion on needed measures. The different indicators concern environmental, economic or social aspects of sustainability and were quantified per tonne of shrimp landed by each country in 2012. The Danish fishery was most efficient in terms of environmental and economic indicators, while the Swedish fishery provided most employment per tonne of shrimp landed. Fuel use in all fisheries was high, also when compared with other shrimp fisheries. Interesting patterns emerged, with smaller vessels being more fuel efficient than larger ones in Sweden and Norway, with the opposite trend in Denmark. The study also demonstrated major data gaps and differences between the countries in how data are collected and made available. Various improvement options in the areas data collection and publication, allocation of quotas and enforcement of regulations resulted and are described in more detail in a scientific paper in ICES Journal of Marine Science in 2016.

This project was coordinated by SIK-SP Food and Bioscience. The project was funded by Nordforsk, Nordic Council of Ministers.

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Benthic ecosystem fisheries impact study (BENTHIS) (39021)

There is general concern about the adverse impact of fisheries on benthic ecosystem which may negatively affect the fisheries yield and integrity of the sea bed. In an integrated approach to marine management, there is a need to develop quantitative tools to assess the impact of fisheries on the benthic ecosystem and at the same time collaborate with the fishing industry to develop innovative technologies and new management approaches to reduce the impact on benthic ecosystems. BENTHIS will provide the knowledge to further develop the ecosystem approach to fisheries management as required in the Common Fisheries Policy and the Marine Strategy Framework Directive. It will study the diversity of benthic ecosystem in European waters and the role of benthic species in the ecosystem functioning. Fisheries impacts will be studied on benthic organisms and on the geo-chemistry. The newly acquired knowledge will be synthesized in a number of reports that will be combined into a fishing/seabed habitat risk assessment method that will be applied to fisheries in the Baltic, North Sea, Western waters, Mediterranean and Black Sea. Fisheries will be selected with the fishing industry based on the impact on the benthic ecosystem. BENTHIS will integrate fishing industry partners to collaborate in testing the performance of innovative technologies to reduce fishing impact. Finally, in collaboration with the fishing industry and other stakeholders, new management approaches will be developed and tested on their effects on the ecosystem and their socio-economic consequences. As such BENTHIS will substantially improve the scientific basis to integrate the role of marine benthic ecosystems in fisheries management.

The project has 33 partners from 12 countries.

The project is coordinated by Institute for Marine Resources & Ecosystem Studies (IMARES), Wageningen University, The Netherlands.
Eastern-western Baltic cod: Improved management based on stock discrimination of eastern and western Baltic cod (Øst-Vesttorsk) (38989)

The aim of this project was to improve the management of western Baltic cod by incorporating stock identification routines in order to discriminate between eastern and western Baltic cod stocks. In recent years evidence from fishery patterns and otolith structures have indicated an increasing degree of mixing between the two cod stocks which up until 2013 were managed as two separate stocks. Changes in fishing pressure and patterns would therefore result in a risk for local depletion of the smaller western stock.

Stock identification methods were based on established approaches using genetic discrimination and otolith shape analysis, and improved by linking these methods. This method provides a tool to estimate the degree of stock mixing using the existing otolith archives. This approach documented an increase of eastern Baltic cod from 30% to > 80% in the eastern part of the western Baltic Sea management area. As a consequence of this stock mixing, a new procedure incorporating stock mixing on an annual basis was set in place, with the aim to improve stock exploitation and reduce the risk of local depletion.

The knowledge gained also influenced recent management regulations, particularly a prolongation of spawning closer of the fishery in 2016.

The project was coordinated by Centre for Environment, Fisheries & Aquaculture Science, UK.

The project was funded by the Danish Ministry of Food, Agriculture and Fisheries and the European Fisheries Fund (EFF).

Understanding the mechanisms of stock recovery (UNCOVER) (38104)

The UNCOVER project has produced a rational scientific basis for developing Long-Term Management Plans (LTMP) and recovery strategies for 11 of the ecologically and socioeconomically most important fish stocks/fisheries in the Norwegian and Barents Seas, the North Sea, the Baltic Sea and the Bay of Biscay and Iberian Peninsula.

UNCOVER's objectives were to:
(i) identify changes experienced during stock depletion/collapses,

(ii) to understand prospects for recovery,

(iii) to enhance the scientific understanding of the mechanisms of fish stock/fishery recovery, and

(iv) to formulate recommendations how best to implement LTMPs/recovery plans.

The project recommends that such plans ideally should include:

(i) Consideration of stock-regulating environmental processes,

(ii) Incorporation of fisheries effects on stock structure and reproductive potential,

(iii) Consideration of changes in habitat dynamics due to global change,

(iv) Incorporation of biological and technological multispecies interactions,

(v) Integration of economically optimized harvesting,

(vi) Exploration of the socio-economic implications and political constraints from existing and alternative recovery plans,

(vii) Investigations on the acceptance of plans by stakeholders and specifically incentives for compliance by the fishery,

(viii) Agreements with and among stakeholders.

UNCOVER has provided imperative policy support underpinning the following fundamental areas:

(i) Evolution of the Common Fisheries Policy with respect to several aims of the 'Green Paper';

(ii) Contributing to the Marine Strategy Framework Directive with respect to fish stocks/communities;

(iii) achieving Maximum Sustainable Yield (MSY) for depleted fish stocks. This has been done by contributing to LTMPs/recovery plans for fish stocks/fisheries, demonstrating how to shift from scientific advice based on limit reference points towards setting and attaining targets such as MSY, and furthering ecosystem-based management through incorporating multispecies, environmental and habitat, climate variability/change, and human dimensions into these plans.

The project was coordinated by Institut für Ostseefischerei, Bundesforschungsanstalt für Fischerei, Germany.
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01/01/2006 → 31/12/2010
Keywords: Research areas: Marine Living Resources & Fish Biology
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Project: Research
Integrated management of agriculture, fishery, environment and economy – a strategic research alliance (IMAGE/MAFIA) (38772)

Background and Objectives

Management of terrestrial and aquatic ecosystems is legally defined in several European directives. The scientific basis for implementing the directives has been limited by insufficient models, deficiencies in terms of uncertainties, local and regional aspects and lack of knowledge on the interplay between agriculture, fishery, environmental qualities in all surface waters, and economy. The project aimed to establish an interdisciplinary and international approach designed to establish a body of knowledge to develop tools, models, scenarios and predictions in order to integrate science and management from agriculture, fishery, aquatic environments and economy into a common platform. The main aims were to link the complex interplay between land use in the drainage basins, the transport of nutrients to water bodies, biogeo-chemistry of freshwater and marine water, marine ecosystem dynamics and the removal of biomass and nutrients in marine fisheries all integrated into a management strategy evaluation (MSE) framework consisting of linked catchment area and river-run-off models, marine bio-geo-chemical models, end-to-end marine ecosystem models, fishery models, economic and cost-minimization models, and ecosystem services assessments models. Such a complex model and MSE framework could be used to assess effects of changing market conditions, changed agricultural and fishery support policies, as well as fulfillments of water related directives.

Tasks and Deliverables

The Danish Strategic Research Council financed project IMAGE was a strategic research alliance between central Danish and international fisheries and marine environment based university institutes. The project integrated, educated, and trained new researchers and private and public end-users to develop and work with a number of empirical and dynamic models and management tools, further developed into cross traditional media and science-based decision support systems, to strengthen national and international environmental management. The results published in a high number of scientific peer reviewed articles have provided major scientific progress. The results and research quality included analyses of novel processes and development of new and improved models, integrated prognoses and scenarios for the interplay between changes in the ecological and economic consequences, and a number of science-based decision support tools. The work involved (i) development and implementation of models and management tools, (ii) validating and integrating important new concepts in the models, (iii) developing tools and evaluating their ability to detect and follow changes in environmental basins into ecological and economic consequences, and (iv) strengthening Danish research in linking science, modeling and management of the environment and economy and thereby consolidating a strong international position. The DTU Aqua has focused on further development, implementation and validation of advanced models and fisheries and ecosystem management evaluation tools: Development, calibration and implementation of the Baltic ATLANTIS end-to-end ecosystem and tropho-dynamic model linked to the HBM-ERGOM physical and bio-geo-chemical models and the FISHRENT fishery economic model; Further development and implementation of the bio-economic and individual vessel based multi-stock-multi-fleet DISPLACE simulation model; Dynamic coupling of the Baltic FLR multi-stock-multi-fleet bio-economic model to the SMS-Multi-Species model. The focus has been on biological interactions and integrated fisheries interactions.

Partners

The project had 12 project partners mainly from Danish universities (AU, DTU, KU, SDU) and national fisheries economics and fisheries research institutes (SMHI Sweden), but also from American, Swedish and Finnish universities as well as SMEs (e.g. DHI). The project was coordinated by Aarhus University. DTU Aqua was main project developer, WP4 leader and member of the Project Steering Group.

This project was funded by the Danish Council for Strategic Research.

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01/01/2010 → 31/12/2015

Keywords: Fisheries Management & Ecosystem based Marine Management

Project: Research

Fehmarn Belt science provision project: Fehmarn Belt fish and fisheries and related environmental investigations (38669)

Objectives and Background

The purpose of the project was to investigate main exploited fish stock and fisheries dynamics in relation to the marine environment with focus on the Fehmarn Belt area in the Western Baltic Sea, and to provide science and research based investigations and results, as well as reports and scientific peer reviewed journal papers on this. The work was associated to the scientific baseline investigations (2009-13) and impact assessment of the projection of the Fehmarn Belt Fixed Link between Denmark and Germany involving a science cooperation between DTU Aqua, Thünen-Institute and Femern Bælt A/S in order to generate knowledge on potential impacts of establishment of the fixed link. Focus was on the most important commercial fisheries and fish stocks in the area (cod, herring, and sprat, but also flatfish and eels).

Tasks and Deliverables
The work covered WP0: Prospecting, planning and development of the investigations, producing outline and main contents of the science provision contract and coordination of tasks hereunder with DTU Aqua as inter-national project coordinator; WP1: Review of knowledge: Review, provision of data, and analyses of selected historical data on fish stock and fisheries dynamics; WP2: Extension of existing, standard research surveys and linking to standard survey time series to detect potential effects on important fish stocks; WP3: Evaluation of potential integrated effects on important fish stocks and fisheries; WP4: Evaluation of potential effects of change and variability in hydrographic features and conditions on recruitment for important fish stocks (cod, herring, sprat); WP5: Evaluation of occurrences and migrations as well as separation of spring and autumn spawning herring stock components in the area.

WP1 included provision of state of the art knowledge from historical surveys and review of quality of survey indices, commercial fisheries data, and information on recruitment dynamics with emphasis on fluctuations in distribution and productivity with respect to environmental and anthropogenic drivers of change including species interactions and fisheries.

WP 2 included extension of existing standard surveys in the near field area and analyses of both the standard and extended time series with respect to variability in distribution, density and abundance patterns of relevant stocks, as well as developing advanced scientific survey evaluation models and methods for doing this.

WP 3 analyzed stock and fisheries dynamics by use and development of complex multi-fleet-multi-stock bio-economic management evaluation models performing analyses on a very high spatial and temporal resolution scale using integrated fisheries, stock and survey data. The models evaluated different management options and scenarios relevant for the establishment of the fixed link.

WP 4 evaluated variability in recruitment and important spawning areas according to hydrographic features and in relation to impact of the fixed link among other by use and further development of complex hydro-dynamic models.

WP 5 evaluated herring stock occurrence and migration patterns in the Baltic areas by use of genetic identity markers, otolith micro-structures and information from fisheries and research surveys in order to evaluate impact of the fixed link. The project has besides a long row of project reports produced around 30 scientific peer reviewed journal papers where DTU Aqua are first author on more than half and co-author on more than 20 of the papers.

The project was coordinated by DTU Aqua.

The project was funded by the 3 partners with external Funding from Femern Bælt A/S.

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01/01/2009 → 31/12/2013

Keywords: Research areas: Fisheries Management & Fish Biology & Marine Living Resources & Population Genetics

Collaborators: Femern A/S, Thunen-Institut

Project: Research

Management plans and Danish fishery (2245)

The objectives of the project were with reference to the EU Commissions proposals on multi-annual management plans, to deliver high quality advice on management of the fishing effort in Danish fisheries in the Baltic Sea, the North Sea, the Skagerrak and the Kattegat.

To be able to deliver the advice the project addressed the need for detailed and accurate data on catches, effort and economical performance in the main demersal Danish fisheries in the concerned areas and the need for accurate stock assessment of the economically most important fish and shellfish stocks. The project also developed a systematic method to give a qualified prediction of the selectivity of a trawl based on information on the trawl design.

The project included seven work packages: (i) Description of development in catches, fishing effort and economical performance of the main demersal Danish fisheries including creation of a single database; (ii) Develop a reference fleet system to collect detailed information on catches and fishing effort; (iii) Development of a software to be used to simulate trawl selectivity; (iv) Establish a fisheries independent monitoring survey on Norway lobster in the Skagerrak and the Kattegat; (v) Provide advice on a fishing effort management system for the demersal fisheries in Kattegat including
proposal for enhancement of the cod selectivity in trawl fisheries; (vi) Provide advice on fishing effort in form of days at sea by métier; and (vii) Evaluate the impact of the effort management system in the Baltic Sea on the Danish fishery and the stocks.

The project was coordinated by DTU Aqua.
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01/01/2006 → 31/12/2008
Keywords: Research areas: Fisheries Management & Fisheries Technology
Collaborators: University of Copenhagen
Project: Research

Operational evaluation tools for fisheries management options (EFIMAS) (38094)
Existing models in fisheries management advice (FMA) only consider effects of overall fishing on single fish stocks, while not taking broader ecosystem, social and economic impacts of management decisions into account. Mixed fisheries aspects where several fishing fleets fish on several stocks in the same fishery, spatial planning, and long-term management strategy evaluation are also not considered adequately.

In response to this situation, managers launched EFIMAS aiming to develop alternative management evaluation tools and management strategies that have broader, multi-disciplinary and long-term perspectives. These include social and economic impacts and ecosystem impacts (e.g. by-catch and discards), besides biological consequences on single stocks.

This is a new way of thinking international fisheries research and FMA, by developing conceptual and comprehensive multi-fleet and multi-stock bio-economic simulation tools and management evaluation frameworks (MEF), being spatial and seasonal explicit. A successful implementation of ecosystem, social and economic dynamics and factors on a spatial scale in the advisory process is a major leap towards more holistic and sustainable management within EU waters and fisheries. MEFs enable higher degree of participatory management evaluation by involving various stakeholders in FMA.

EFIMAS, and sister projects, develop and integrates a set of new and existing software tools and simulation models (especially FLR – Fisheries Library in R), generating a more robust Management Strategy Evaluation (MSE) framework, that allows testing plausible hypotheses about dynamics of fish stocks, fisheries and fleets.

The MEF contributes to a conceptual change and paradigm shift in generating advice and management with entire fleets and fisheries as the central units. Here the basic management instrument is the input, i.e. the capacity of fishing fleets, the vessel efficiency, and the effort (activity). This differs from the traditional output based ICES approach, providing advice on single fish stock catch limit from rather uncertain terminal year stock assessments and under strong assumptions on future total stock fishing mortality (F) without much consideration on factors, creating and controlling F and partial Fs by fleet.
The developed frameworks allow simulating and evaluating, respectively, the biological, social and economical consequences of a range of proposed management options and objectives within different management regimes. They can evaluate fleet and mixed fisheries interactions and fisheries behavior, uncertainties in stock and fisheries dynamics, data collection, assessment, modelling, as well as the advisory management and implementation processes. Being capable of evaluating the relative performance of multiple alternative options the MEFs possess strong capacity in performing sensitivity and risk analyses of consequences.

Managing fisheries in a virtual environment provides more reliable scientific advice to stakeholders: In the same way that a pilot might fly in a simulator before flying for real, the simulation tools evaluates the robustness of alternative strategies and virtual regimes to give more holistic FMA in broader context before implementation. This provides managers and stakeholders a better idea of the consequence of a given strategy or intervention before opting for a particular management approach.

The overall evaluation comprises process evaluation (PE) and technical evaluation (TE). PE focuses on participatory management. Here participatory and iterative scenario-based MEF modelling is used to obtain input and cyclic feedback from multiple stakeholders for different options, and to test the general utility of the operational MEF.

Participants: 30 European universities and national fisheries research institutes with biological and economic expertise as listed under www.efimas.org.

The project was coordinated by DTU Aqua.
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01/01/2004 → 31/12/2009
Keywords: Research area: Fisheries Management
Project: Research

Comparative evaluations of innovative solutions in European fisheries management (CEVIS) (38105)

CEVIS is an FP6 project that assessed potential innovations for European fisheries management regimes with respect to four general management objectives: biological robustness, economic efficiency, the cost effectiveness of management activities, and social robustness. CEVIS examines four types of regime-level innovations: the use of participatory approaches to fisheries governance, rights-based regimes, effort-control regimes and decision rule systems. These innovations are assessed in respect to four general management objectives: biological robustness, economic efficiency, the cost effectiveness of management activities, and social robustness. The four regime level innovations measured against the four general management objectives define the CEVIS research’s conceptual framework. The conceptual framework is tested against four European test cases. However, before these case studies begin, the research will take a close look at international cases of innovative fisheries management in other developed countries. Visits will be made to four places outside the EU that have similar fisheries and have implemented these four types of innovations.

The project has built further on the networks and platforms produced under EU FP6 EFIMAS project (38094) which DTU Aqua coordinated, and the DTU Aqua team associated to the project has produced several peer reviewed journal papers under CEVIS and been co-authors to a book published by Elsevier in relation to CEVIS. Besides this, CEVIS has two final products. The first is an Innovation Evaluation Framework made up of indicators of inputs and outcomes in relation to the four general management objectives. This is an aid to fisheries managers wishing to assess the suitability of possible changes in EU fisheries management practice. The second is a report based on the case studies that evaluates this specific set of potential regime-level innovations for use in EU fisheries management. The developed framework makes it possible for managers to evaluate the extent to which any given management system will contribute positively to attaining
Common Fisheries Policy objectives. A range of options for implementing cost-effective and participatory management systems have been provided and finally, the CEVIS project helps fishery managers to be better informed about the ecological, social and economic consequences of implementing any particular management regime.

The project was coordinated by Innovative Fisheries Management (IFM), Aalborg University, Denmark.
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Baodrun, A., Project Participant
Sparre, P. J., Project Participant
01/01/2005 → 31/12/2009
Keywords: Research area: Fisheries Management
Collaborators: Netherlands Institute for Fisheries Research, European Commission - Joint Research Center, Institute of Marine Research, Sea Fisheries Institute, Marine and Food Technological Centre, University of Copenhagen, Marine Scotland, UiT The Arctic University of Norway, Aalborg University, Luleå University of Technology, Öko-Institut
Project: Research

Development of fisheries with minimized emission of greenhouse gases (38688)
Identification of methods and prioritization of areas for actions of minimizing greenhouse gas emissions, optimizing fuel consumption and, thus, improve the economy and reducing the environmental effects of fishing on marine habitats. The focus is on fishing with trawls. Two different strategies (work packages) are considered in the project:

1) Development of new and more energy efficient trawls: This work package targets the development of trawl design with improved relationship between capture efficiency and/or catch value in relation to energy use for towing the gear. In this work package we apply an internationally developed computational model based on fluid mechanics and finite element methods and models to predict the capture efficiency of trawl. Through computer simulations we investigate the predicted ratio between catch value and fuel consumption for different trawl designs. These simulations are accordingly applied to identify the most favorable trawl design with optimized value of the catch in relation to the fuel consumption to tow the trawl. Through international cooperation, we also experimentally examine the consequences on catch efficiency of applying high strength thin twine netting with low drag in sections of trawls.

2) Fisheries tactics and management in relation to energy efficiency in fisheries effort allocation for different fisheries: This work package analyze management options for different types of fisheries, to investigate opportunities and incentives to achieve the same value (and catch) in fisheries with less effort or re-allocation of effort and consequently less fuel consumption. Advanced computer based bio-economic fisheries simulation models are developed and used in fleet and stock-based scenario analyses for energy efficiency in fishery by integrated evaluation of fishing effort, catch, catch composition and utilization, economics, and fuel consumption under given effort allocation schemes. This involves development and implementation of a generic bio-economic Individual Based Model (IBM) that works on individual vessel basis and which can simulate multi-stock-multi-fleet (mixed) fisheries and evaluate on a scale of very high resolution in time and space. This computer based management evaluation tool and simulation model can evaluate economic cost-benefits, biological impacts according to fish stock sustainability, as well energy efficiency according to catch in weight and value per fuel volume consumed and/or in relation to total fuel costs for different management scenarios. The implementation of the IBM model involves additionally development of advanced statistical and computer based models and methods for coupling information from logbook databases with information from VMS tracking (satellite monitoring) databases on vessel and fishing trip basis. Furthermore, it involves development of a web-based questionnaire and platform to obtain information from the Danish fishery on cost dynamics with focus on fuel costs and effort allocation.

The project is coordinated by DTU Aqua.
Herrmann, B., Project Manager, National Institute of Aquatic Resources
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Krag, L. A., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources
Andersen, B. S., Project Participant, National Institute of Aquatic Resources
Eigaard, O. R., Project Participant, National Institute of Aquatic Resources
Madsen, N., Project Participant, National Institute of Aquatic Resources
01/01/2008 → 31/12/2012
Interaction in coastal waters: A roadmap to sustainable integration of aquaculture and fisheries (COEXIST) (38789)

The project aims to provide a roadmap towards improved integration, sustainability and synergies among different activities in the coastal zone.

The project will study interactions between capture fisheries and aquaculture, and evaluate mutual benefits and possible bottlenecks for concomitant development of these activities in the coastal zone within the context of the ecosystem approach to management.

The project will also develop and evaluate different forms of coastal aquaculture and fisheries at different scales and exploit mutual opportunities within a concept of competition for space by multiple users.

Furthermore, the project will address differences in acceptance of activities by society and develop a strategy for communication and involvement of stakeholder as well as for dissemination of results to general and targeted audiences. Six case studies are involved. Individual processes and their interaction will be investigated in each case study using spatial management tools and an array of models.

The project is coordinated by Institute of Marine Research, Norway.

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Stenberg, C., Project Participant, National Institute of Aquatic Resources
Sørensen, T. K., Project Participant, National Institute of Aquatic Resources
Nielsen, J. R., Project Participant, National Institute of Aquatic Resources
Dinesen, G. E., Project Participant, National Institute of Aquatic Resources
Bastardie, F., Project Participant, National Institute of Aquatic Resources

01/01/2010 → 31/12/2012

Socio economic effects of management measures of the future CFP (SOCIOEC) (38940)

Objectives and Background
The main aim of the SOCIOEC FP7-KBBE-2011-5 project under KBBE.2011.1.2-10 (Socio-economic effects of the main management principles of the future CFP: impact of new policy framework and opportunities for the fishing sector) was to evaluate innovative fisheries management measures and develop self- and co-management. It has been important that the project focused on the interpretation of overarching (i.e. EU) objectives in local and regional contexts.

Deliverables and Tasks
In the first step the project developed a coherent and consistent set of objectives for fisheries management, which addressed ecological, economic and social sustainability targets. The objectives were consistent with the aims of the CFP, MSFD and other EU directives, but also understandable by stakeholders and the community and engaged their support. This led to the proposal of a number of innovative management measures, based on existing or new approaches. The second step was to analyze the incentives for compliance provided by these measures through examination of fisher’s responses to and perceptions of measures based on historical analysis, direct consultation and interviews, and how the governance of the measures operated.

Finally, the project examined the impact of the measures that emerge from this process, particularly in terms of their economic and social impacts on the industry and the wider community. All this was done through a generic analysis of the wide range of current and emerging measures in the current CFP and possible measures introduced in the future. This required and has resulted in interdisciplinary work across a range of scientific disciplines (economics, social and natural sciences).

DTU Aqua was involved in the North Sea and Baltic Sea case studies and in the project Steering Group. For the North Sea, DTU Aqua focused on analyses of catch quotas compared to landing quotas in mixed consume fisheries including...
related discard processes. Also, small meshed pelagic fisheries in the North Sea were addressed for efficient management of those. For the Baltic Sea, DTU Aqua focused on evaluation of spatial management measures among other in relation to NATURA 2000 areas and implementation of windmill farms, and larger marine constructions. This resulted in evaluation of success and failures of several management measures, and enabled us to draw conclusions on which measures are best introduced in which circumstances, possibly on a regional basis. On this basis DTU Aqua has produced several peer reviewed journal papers under SOCIOEC. In the CFP we need to distinguish between the basic, overarching regulations of the EU or regional seas level and the specific and local management by Member States in sea areas where self- and co-management schemes are often already informally in place. Here the cooperation with the ACs was essential to derive objectives applicable for the CFP based on the ecological, economic and social drivers and to reconsider management at more regional or local levels. This process involved: (i) investigation of how the objectives regarding ecological, economic and social sustainability could be defined in the short term and ensures the long-term sustainability and viability of fisheries; (ii) analyzing which management measures and at what organization level, created the right incentives to tackle structural failings in the CFP with focus on technical measures, command and control instruments (TACs, quotas, effort), market instruments (transferability of collective or individual rights) and social instruments (self- or co-management possibilities); and (iii) determination of the socio-economic and spatial effects of these management measures.

The project had 30 project participants from European universities and National Fisheries Economics and Fisheries Research Institutes as well as SMEs.
The project was coordinated by Institute of Sea Fisheries, Johann Heinrich von Thünen Federal Research Institute for Rural Areas, Forestry and Fisheries, Germany.
The project was funded by EU, Framework Programme 7.

Nielsen, J. R., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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01/01/2011 → 31/12/2014
Keywords: Research area: Fisheries Management
Project: Research

**VECTORS of change (VECTORS) (38907)**

Marine life makes a substantial contribution to the economy and society of Europe. VECTORS aimed at elucidating the drivers, pressures and vectors that cause change in marine life, the mechanisms by which they do so, the impacts that they have on ecosystem structures and functioning, and on the economics of associated marine sectors and society. VECTORS particularly focused on causes and consequences of invasive alien species, outbreak forming species, and changes in fish distribution and productivity. New and existing knowledge and insight was synthesized and integrated to project changes in marine life, ecosystems and economies under future scenarios for adaptation and mitigation in the light of new technologies, fishing strategies and policy needs. VECTORS also evaluated current forms and mechanisms of marine governance in relation to the vectors of change. Based on its findings, VECTORS outlined solutions and tools for relevant stakeholders and policymakers during the lifetime of the project. The VECTORS consortium included a mixture of natural scientists with knowledge of socio-economic aspects, and social scientists (environmental economists, policy and governance analysts and environmental law specialists) with interests in natural system functioning.

DTU Aqua contributed to VECTORS by developing new statistical models of fish species distributions, by further developing spatially resolved bio-economic models of fishing, and by analyzing fish species richness and distribution in the north Atlantic and the general relationship between changes in fish stock abundance and distribution area. We coordinated the Baltic WP where we implemented the ATLANTIS end-to-end model and performed initial scenario testing. We also analyzed the most important drivers of fish population dynamics in the Baltic, and contributed to the study of invasive species.

VECTORS comprised a total of 37 European Universities, research institutions and professional associations dealing with applied maritime and marine research. The project included marine environmental scientists, fisheries scientists, conservation biologists, sociologists and economists from across the European scientific community providing expertise in marine ecosystems, management, fisheries, maritime transport, tourism and coastal development.

The project was coordinated by Plymouth Marine Laboratory, UK.
The project was funded by EU, Framework Programme 7.

Gislonson, H., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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Lewy, P., Project Participant, National Institute of Aquatic Resources
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Kristensen, K., Project Participant, National Institute of Aquatic Resources
Huwer, B., Project Participant, National Institute of Aquatic Resources

Indicators for fisheries management in Europe (IMAGE) (38225)

The Common Fisheries Policy (CFP) requires the progressive implementation of an ecosystem-based approach to fisheries management (EBFM). To implement effective management, it is essential to develop a framework that allows for the evaluation of different management strategies based on indicators. Indicators can support the decision making process by (i) describing the pressures affecting the ecosystem, the state of the ecosystem and the response of managers, (ii) tracking progress towards meeting management objectives and (iii) communicating trends in complex impacts and management processes to a non-specialist audience. The aim of this project was to develop an indicator-based operational framework that can support ecosystem-based management, and also show how this can be applied to test and evaluate different management strategies or sampling programs.

The principal objectives of IMAGE were:-To develop an operational framework of candidate indicators (ecological, economic, social) that can support ecosystem-based fisheries management at the regional and pan-European scale-To elaborate these indicators in comprehensive dashboards (e.g. current values, trends, reference levels)-To develop methodology to integrate this information into tools supporting the decision-making process-To develop a framework that can evaluate management strategies based on indicators-To advise on how indicators can be used to support EBFM in selected regional case studies based on the RAC areas.

The project consisted of a conceptual phase where the operational framework was designed. This was followed by a phase of methodology development, an implementation phase consisting of regional case studies linked to the RACs and finally a pan-European evaluation and synthesis of the projects results. The results of this project contribute to the development of an effective EBFM in the context of the CFP, while also contributing to the applied science needed to support the emerging European Marine Strategy and Maritime Policy.

The project was coordinated by Institute for Marine Resources and Ecosystem Studies (IMARES), The Netherlands.
Eero, M., Project Manager, National Institute of Aquatic Resources, Section for Ecosystem based Marine Management
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Serensen, T. K., Project Participant, National Institute of Aquatic Resources
Mosegaard, H., Project Participant, National Institute of Aquatic Resources
Thomsen, K., Project Participant, National Institute of Aquatic Resources
Tomczak, M., Project Participant
Jacobsen, J. B., Project Participant
01/01/2006 → 31/12/2009
Keywords: Research area: Ecosystem Based Marine Management
Collaborators: Wageningen IMARES, COISPA Tecnologia & Ricerca, University of Tartu, Aalborg University, Cefas Weymouth Laboratory, IFREMER
Project: Research

Development of tools for logbook and VMS data analysis (38751)

Objectives and Background
The project “Development of tools for logbook and VMS data analysis” was an EU project under studies for carrying out the common fisheries policy (No MARE/2008/10 LoI2). The aim of the project was to develop a set of standard protocols for coupling and simultaneous analyses of EU fisheries logbook and VMS satellite vessel record data.

Tasks and Deliverables
The process began with the construction of standardized data formats for logbook (EFLALO) and VMS (TACSAT). The software for analyzing the data took the form of a fully documented package called vmstools, built using the freeware package, R (http://cran.rproject.org/). Once the data have been imported into R in the correct format, a series of R programs or ‘functions’, linked by ‘scripts’ enable all tasks necessary to be completed in a single software environment. The software can ‘clean’ data and format input data, estimate distances between VMS positions, and métiers can be identified objectively from species assemblages in catch data using multivariate statistical techniques. We have included a range of complimentary methods for determining fishing activity from VMS position registrations. Positions at sea, for example, can be distinguished from vessels in harbor or erroneous positions on land. Position registrations of vessels actually fishing can be separated from those engaged in other activities (e.g. steaming) using their
speed in conjunction with other information such as vessel size and gear being used. Logbook and VMS data can be merged such that high-resolution spatial maps of catches of various commercial species can be generated. Individual vessel tracks can be reconstructed for more realism through different interpolation techniques (both linear and non-linear, i.e. using Hermite spline functions). Further, all the fishing activity indicators required under the Data Collection Framework can be calculated using vmstools. The package can also be used to explore the impact of different spatial (grid size) and temporal aggregations (month, quarterly, annual) which need to be explicitly considered when assessing fishing impact on the sea floor. There are also scripts for displaying results using Google Earth which is a useful aid for dissemination.

The combination of all these routines ‘under one roof’ permitted and permits the construction of ‘Regional’ databases (i.e. FishFrame developed by DTU Aqua - a regional database hosted by one of the project partners) and scripts to produce output suitable for this are included with the vmstools package.

As proof of concept, all analyses performed within each work package have been tested, using the vmstools package, against national datasets with contributions from the French, Danish, Irish, UK and Dutch institutes. As an example, FishFrame has been populated with Dutch and Danish combined VMS and logbook data for 2005-2009. The project demonstrated emphatically that logbook and VMS data from disparate countries with often different data collection regimens can be combined and compared using generic tools and that the output can be sent to regional databases permitting more holistic assessments of fishing activity.

The project has built further on the networks and platforms produced under EU FP6 EFIMAS Project coordinated by DTU Aqua, and the DTU Aqua team associated with the project has produced several peer reviewed journal papers under Lot 2.

The project is coordinated by Institute for Marine Resources and Ecosystem Studies (IMARES), Wageningen UR, The Netherlands. This project is funded by EU, Framework Programme 7.

Keywords: Research areas: Fisheries Management & Marine Living Resources
Collaborators: Wageningen IMARES, Sea Fisheries Institute, Marine Institute, Marine Scotland, Cefas Weymouth Laboratory, IFREMER
Project: Research

MEECE: Marine ecosystem evolution in a changing environment (MEECE) (38131)

In order to advance our understanding and the predictive capacities necessary to resolve how marine ecosystems will respond to global change MEECE employed a combination of data synthesis, numerical simulation and targeted experimentation to further our knowledge of how marine ecosystems will respond to combinations of these climate change and anthropogenic drivers.

A key objective of MEECE was to advance model coupling across trophic levels and create concepts and infrastructure to enable end-to-end modeling, from physics to fish, which has empirically been difficult due to different space and time scales involved, as well as relative emphasis of statistical and mechanistic aspects. Finally MEECE integrated modeling advancements with fishery management perspectives.

The project was coordinated by Plymouth Marine Laboratory, UK, and had 21 partners from the EU. The project was funded by EU, Framework Programme 7.

Keywords: Research areas: Marine Living Resources & Marine Populations and Ecosystem Dynamics & Fisheries Management
Project: Research

Activities:
Modelling spatial interactions among fish communities, fishers and other marine activities: comparing five European case-studies
Period: 14 Jul 2018 → 20 Jul 2018
Francois Bastardie (Guest lecturer)
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management

Description
Degree of recognition: International
Links:
https://figshare.com/articles/To_IIFET_2018_Seattle_US_Session_on_Marine_Spatial_Planning_and_Multiple_Use_Management/6724841

Related event
IIFET 2018
18/07/2018 → 20/07/2018
Seattle, United States
Keywords: Economics, Fisheries, Marine Spatial Planning
Activity: Talks and presentations › Conference presentations

International Council for the Exploration of the Sea (External organisation)
Period: 2015
Francois Bastardie (Participant)
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management

Description
ICES - Working Group on Spatial Fisheries Data - WGSFD
Degree of recognition: International

Related external organisation
International Council for the Exploration of the Sea
Copenhagen, Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

Recent changes in stock conditions and spatial mixing on sustainability and economic viability of the fishery - The Danish Baltic cod fisheries
Period: 2015
Francois Bastardie (Speaker)
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Links:

Related event
ICES MYFISH Symposium: Targets and Limits for Long Term Fisheries Management
27/10/2015 → 30/11/2015
Athens, Greece
Activity: Talks and presentations › Conference presentations

Supporting bio-economic evaluation of spatial planning constraining fishing activities: be quantitative, spatially explicit, vessel-oriented, stochastic, and dynamically coupled to fish
Period: 10 Jul 2014
Francois Bastardie (Speaker)
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management

Description
Oral presentation at IIFET 2014, Brisbane, Australia

Related event
International Institute of Fisheries Economics and Trade Conference 2014
07/07/2014 → 11/07/2014
Brisbane, Australia
Keywords: Fisheries, Impact assessment, Marine Spatial Planning
Activity: Talks and presentations › Conference presentations

How spatial planning constrains transnational fisheries: the bio-economic DISPLACE evaluation on the Baltic Sea
Period: 17 Jun 2014 → 18 Jun 2014
Francois Bastardie (Speaker)
National Institute of Aquatic Resources
Section for Ecosystem based Marine Management
Links:

Related event
Baltic MSP Forum
17/06/2014 → 18/06/2014
Riga, Latvia
Activity: Talks and presentations › Conference presentations

International Council for the Exploration of the Sea (External organisation)
Period: 2012 → …
Francois Bastardie (Participant)
National Institute of Aquatic Resources
Section for Management Systems

Description
ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB)
Degree of recognition: International

Related external organisation
International Council for the Exploration of the Sea
Copenhagen, Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

International Council for the Exploration of the Sea (External organisation)
Period: 2012 → …
Francois Bastardie (Participant)
National Institute of Aquatic Resources
Section for Management Systems

Description
ICES Baltic Fisheries Assessment Working Group (WGBFAS)
Degree of recognition: International

Related external organisation

International Council for the Exploration of the Sea
Copenhagen, Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar

International Council for the Exploration of the Sea (External organisation)
Period: 2012 → …
Francois Bastardie (Participant)
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Section for Management Systems

Description
ICES - Training Course on Analysing and visualization of VMS and EU logbook data using the VMStools R package
Degree of recognition: International

Related external organisation

International Council for the Exploration of the Sea
Copenhagen, Denmark
Activity: Membership › Membership of committees, commissions, boards, councils, associations, organisations, or similar