

THEME
SESSION



*Scientific advances
under ICES
Science Plan*



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Theme session Report

Scientific advances under the ICES Science Plan

Conveners: Jos Schilder (The Netherlands), Antonina dos Santos (Portugal), Lena Bergström (Sweden)

Session aims and outline

The theme session “Scientific advances under the ICES Science Plan”, session allowed for discussing and taking the temperature on upcoming science needs and potential priorities for ICES. The session was initiated by flash presentations followed by time for face-to-face participants to discuss. Then, plenary discussions were organized using a so-called “fish bowl” approach. Participants including the audience could enter the discussion in the “bowl” at any point by occupying a free seat on the stage. Discussions were facilitated through mentimeter polls. We used the mentimeter “open question” option to allow for remote participants to chip in to the discussion by sending comments which were broadcasted on large screens in the meeting room. The fish bowl discussion topics were based on statements, sometimes provocative, provided by the participants ahead of the conference. The session was supported by 47 video contributions and 9 posters (based on information in the Whova app). As the session invites contributions on topics that were not represented by other theme sessions, the contributions spanned a wide thematic scope. The discussions were divided in sub-themes: Biodiversity management, Methods and sample design for ecosystem monitoring and fisheries management, and the Human dimension on fisheries management. The session ended with a Kaleidoscopic tribute session to Sarah Kraak run by Martin Pastoors, Dorothy Dankel and Dave Reid.

Key points of scientific consensus and difference

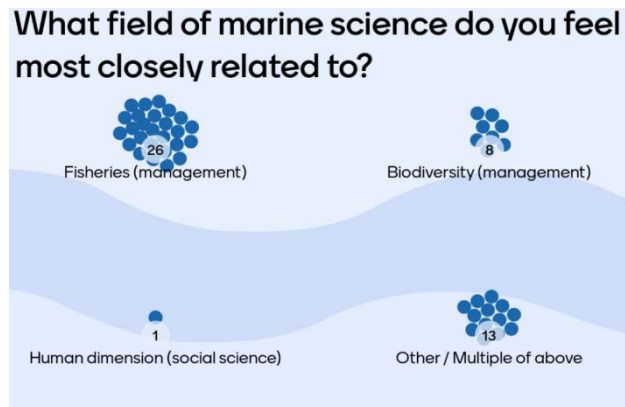
The need to continue the improvement of models in use and to communicate better with stakeholders.

Working together with fishery communities is essential, but requires a specific skill set and, because it depends much on mutual trust, it was perceived that many scientists (being on short contracts) don’t have the necessary time to invest.

Emerging topics and implications for the marine science community

The need of experts on new topics and fields of knowledge to improve advice and trade-offs discussion for a better EBM, including experts on different aspects of policy and interdisciplinary work.

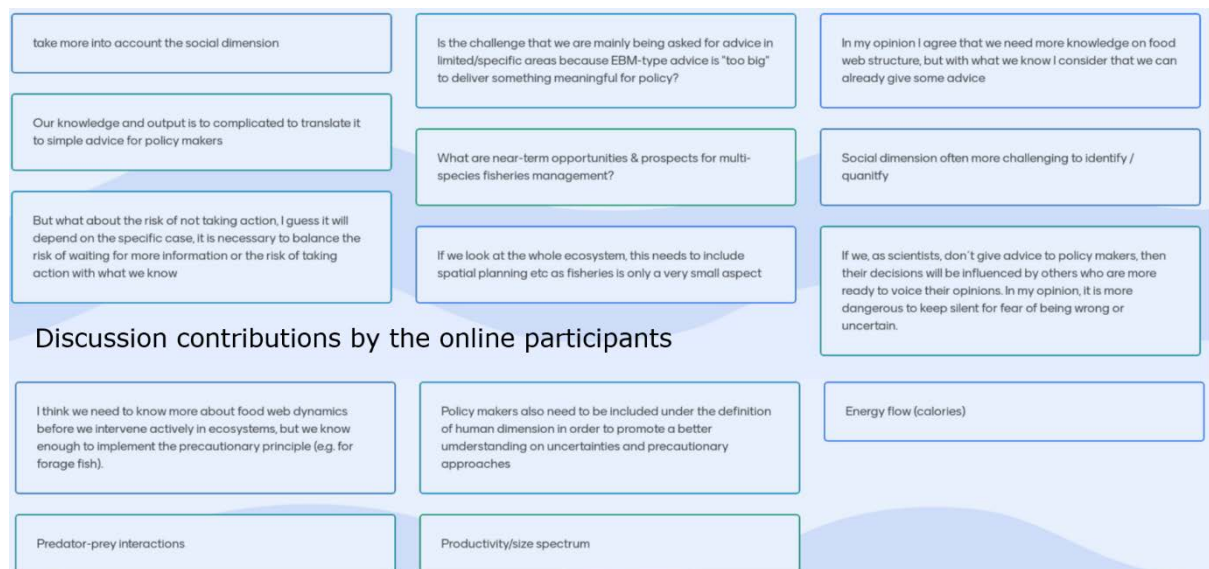
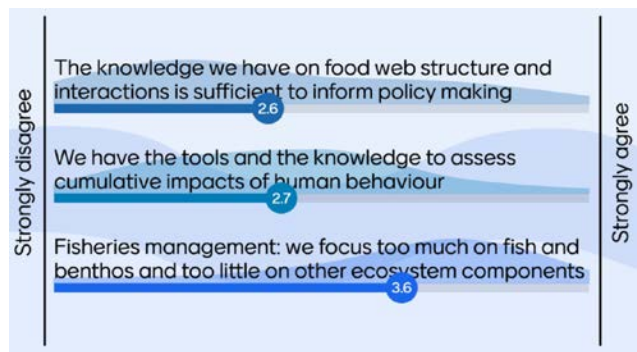
In order to increase fundamental knowledge on ecosystem functioning, the marine science community should generate more knowledge on the base of the food web, such as zooplankton ecology and impacts of human activities on the lowest tiers of marine food webs.

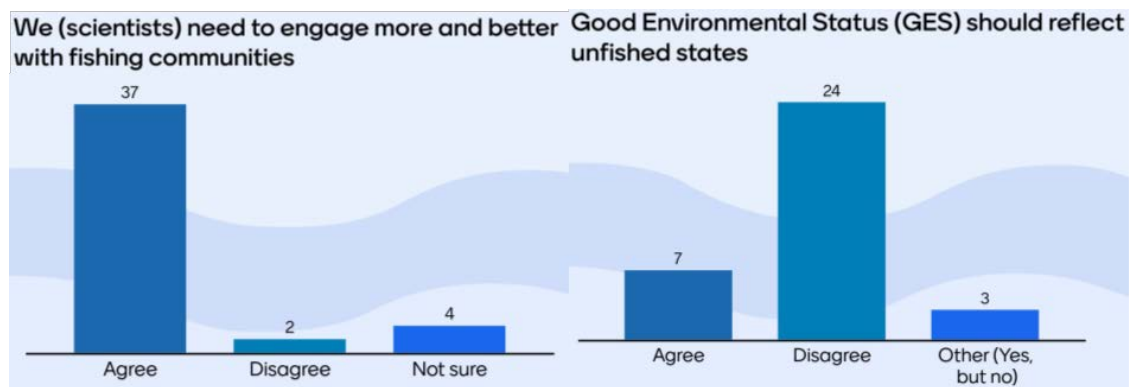


Wednesday

Biodiversity management and Climate

During the first part of this sub-session the participants had quite cold feet. The chair struggled to get a conversation going and to get people on stage (something that went better later on). We had good output on the mentimeter and the remote crowd started sharing views immediately.





The left statement (Scientists need to engage more and better with fishing communities):

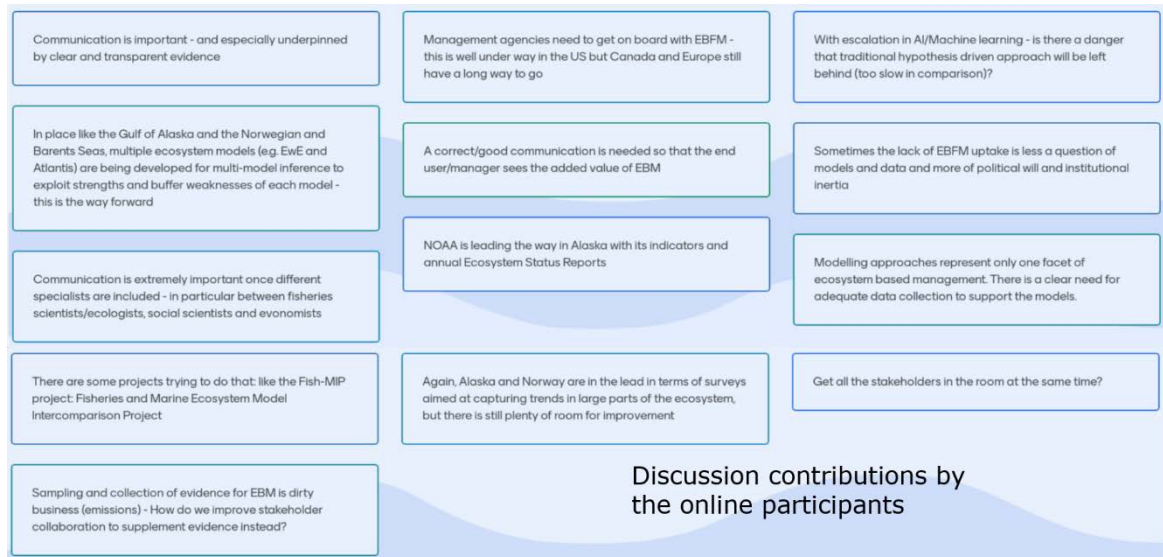
- Hard to disagree with but it is important to think clearly about how this is done. It shouldn't even be up as a question - it should be the mainstream approach. Fishermen are sometimes still thinking researchers are the enemy, and this affects their willingness to provide data.
- One can collaborate with fishermen so that they can help in data collection, monitor salinity, temperatures etc.
- Who should do it? In reality it often depends on building up a good personal relationship. An institution-based organisation to build trust on the long term should be preferred and can also enable long term interaction with feedback.

The right statement (Good environmental status should reflect an unfished state):

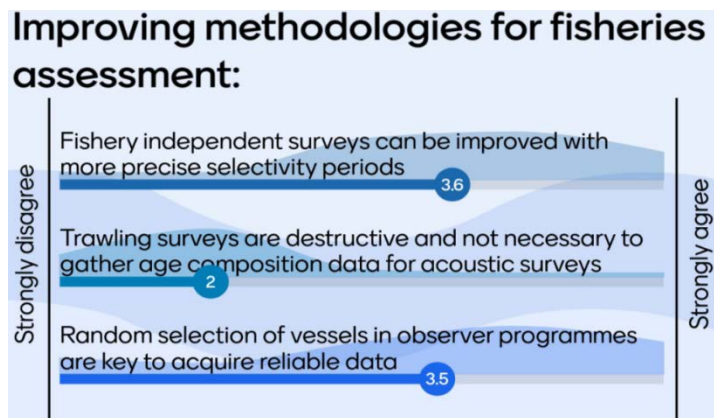
- GES should reflect a sustainable fishing level as a core concept, we don't know what the unfished state was like.
- There is a problem with being inspired by an unfished state - it gives you an illusion of solving the problem but the protein for feeding humans still needs to come from somewhere, so reducing fishing might also involve exporting the problem to seas in other parts of the world and/or the terrestrial realm.

Engagement is essential, it only fails when we don't take perspective and manage expectations	I agree with engaging more and I want to do it, but how we make the time for it. And for example how you engage with a community when you go from one postdoc to another in different places every 2 years	Fishers are the experts!
Agree 100% with the postdoc comment.	Stakeholder buy-in is essential to translation of results into policy	When you engage fishers community, you need a good two way communication. Not only 'take' data, but also take care to communicate what data are used for, the results etc..
If there was no fisher's most of us would have no job. We the scientists are simply one of many tools in the management process	Political will can be a major barrier to fisher engagement	Sometimes language issues can prevent engagement with local fishermen. Especially for foreign students working on a small project.
A barrier can be that sometimes fishers do not like conclusions from Scientist telling them to fish less or not to fish	I had a good experience in projects that local governments and NGOs (apart from fishers associations) were involved in the proposal of the project, to have a more diverse group of stakeholders	In most cases there is no reference point for unfished state
From the ecosystem standpoint, the unfished state is the best baseline, but it is difficult to estimate. That doesn't mean it should be a policy goal - obviously we need to reach a compromise, but MSY is likely not enough.	Also if there is no fishing, you are losing a huge cultural heritage and livelihoods in coastal communities, that not sure if the people that ask to stop fishing is aware of	Unfished states are difficult to reconstruct, especially in long-exploited ecosystems such as European seas.

Discussion contributions by the online participants



We then discussed the possible improvement of the methodologies currently used in fisheries assessment. It was considered that biological samples are still needed to support acoustic surveys but, how far can we go to push the envelope for unmanned cruised systems to work, for example having a trawler follow the acoustic vessel and enable a spatio-temporal model?

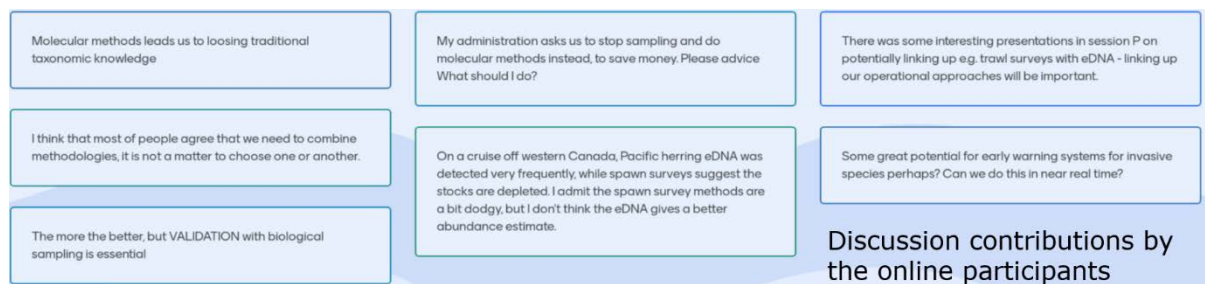
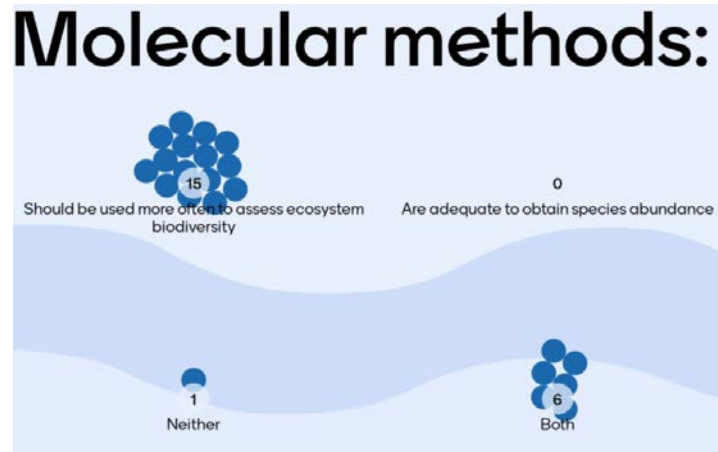


Involving fishermen to collect the needed data is a great idea. They have the boats that are needed and become part of the deal as are involved.



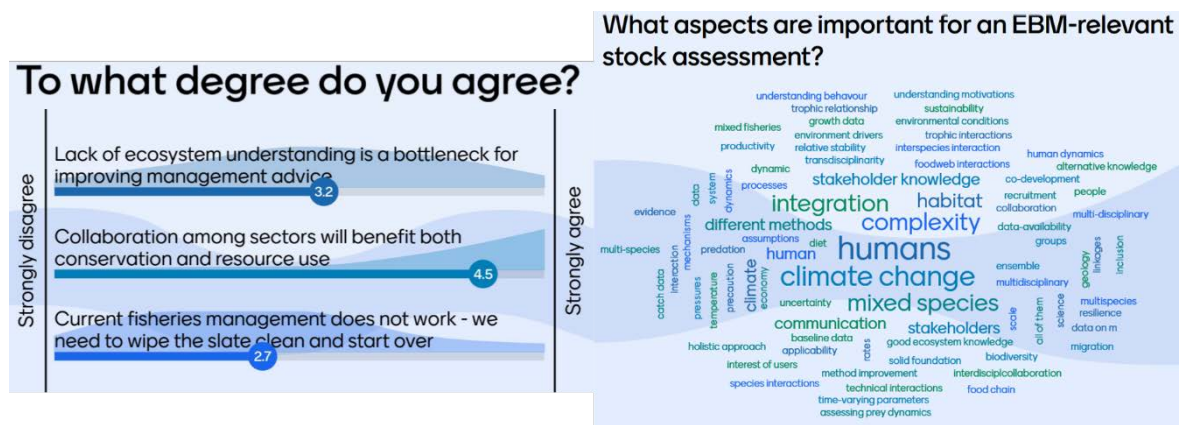
Finally, as we had several talks on DNA metabarcoding methods being used to quantify and assess biodiversity, we discussed this in the third part of the sub-session. While it was agreed that molecular methods should be used more there is a need for a comparative approach and that there is a huge demand for better reference labs.

A first important starting point is a test case to compare existing surveys with molecular sampling. As all methods have their blind spots, it was concluded that the best is to combine methods. In the end it was agreed that the usefulness of molecular methods is improving rapidly for sampling biodiversity, and of invasive species.



Thursday

Human dimension of fisheries management



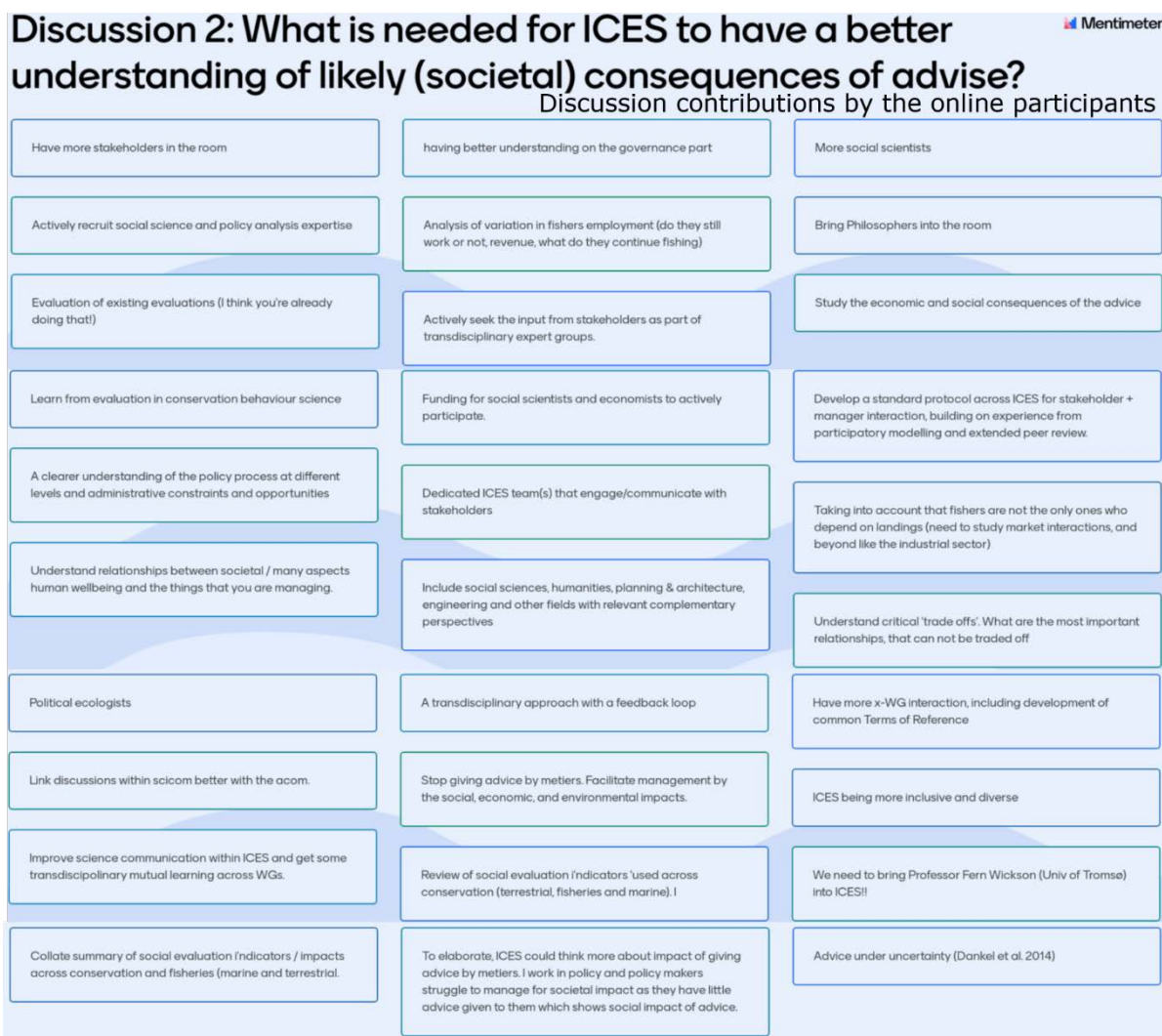
In this part of the session we discussed how ICES can develop to better support EBM and what aspects are important.

The discussion considered the importance of valuing different opinions and talking about them openly. It was also considered to seek different sides of connected aspects and to discuss the core of the work together. It was regarded that possible conflicts can be avoided as we have to be able to discuss all matters that are important for an EBM relevant stock assessment. The discussion evolved to how traditional methodology is sometimes still being used in new areas, using the mesopelagic zone as an example.

It was highlighted that all stakeholders have first- and second-order objectives and may not want to compromise their main objectives but may be able to do so with the second-order ones. Therefore, it is important to work in multidisciplinary mode and in doing so take note that some terms and concepts can have different meanings in different groups.

How can ICES support conflict management in conservation and fisheries?





A question about what is needed for ICES to have a better understanding of (likely) societal consequences of advice prompted large discussion, including from the online attendants, with very different answers. Some requested more stakeholders and political ecologists, others considered that politicians need to be more involved.

The discussion evolved around development needs for both ecosystem-based modelling management and ecosystem-based management, and about the implications or purpose of advice. It was noted that when delivering advice, ICES is giving directions on how to go forward but ICES advice can also be shaped to provide information to support the fulfilment of certain objectives.

Last, we wanted to know in what areas ICES needs more experts. Areas pointed out included scientific ones, such as biology and oceanography, and social sciences including arts and marketing. The most highlighted needs were for more policy experts, philosophy and interdisciplinarity.

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CM 27: Illegal, unregulated and unreported fishing impacts: a systematic review of evidence and proposed future agenda

Andrew J. Temple, Daniel J. Skerrett, Philippa E. C. Howarth, John Pearce, Stephen C. Mangi

Illegal, Unreported and Unregulated (IUU) fishing is a global phenomenon occurring across all fishery types, sectors and geographies. In order to successfully address IUU fishing, fisheries policies, regulations, and management strategies, as well as subsequent monitoring, control and surveillance activities, must be supported by an appropriate evidence base at relevant spatial-temporal scales. Here we present a systematic review of IUU fishing and its impacts at global, and case study regional (Europe and the North East Atlantic) and national (UK) levels in order to determine the extent to which IUU fishing is understood and to identify priority information gaps which undermine current management efforts. The economic and environmental impacts of IUU fishing are well established, as are a wide range of implicit but more difficult to quantify social impacts. However, the amount of public money being spent on combatting IUU fishing is likely at least an order of magnitude lower than the cost of the activities themselves. Data at regional and particularly national levels are often at too low a resolution to provide sufficient evidence capable of supporting effective policy and regulatory actions to address IUU fishing. A contemporary and more granular understanding of IUU fishing is therefore required. We propose a four-step research agenda to improve the understanding of IUU at relevant national spatial-temporal scales and from which to make effective, evidence-based actions: 1) defining intent and goal-setting, 2) risk assessment and prioritisation, 3) estimation of volume, costs and impacts, and 4) economic appraisal of policy and regulatory reform.

Keywords: IUU, environmental impacts, financial costs, social and economic impacts, taxpayer costs, United Kingdom

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CM 44: Vertical-line requirements and North Atlantic right whale entanglement risk reduction for the Gulf of Maine American lobster fishery

N. Willse, E. Summers, Y. Chen

In the US western Atlantic Ocean, North Atlantic right whales *Eubalaena glacialis* are subject to gear entanglement in fixed-gear vertical-line fisheries, with mortality risk increasing with line strength and spatial density. U.S. federal management agencies have mandated vertical-line strength limits (1700 ft-lb breaking strength) to curtail the injury and mortality risk that entanglement poses to right whales. As the most valuable single species fishery in the United States, hardships for the American lobster fishery have widespread economical and cultural effects for the Northeast region. Limiting the strength of vertical lines used in the American lobster *Homarus americanus* trap fishery, could negatively impact the economic resilience of New England fishing communities if it forces purchases of new equipment or increases the incidence of breakoffs and lost gear. We provide a novel look at the spatially distinct vertical-line strength requirements for the Maine American lobster trap fishery. We modeled the hauling load requirements of the fishery using measurements of strain put on vertical lines used in typical lobster trap operations to determine the minimum strength necessary to fish safely and avoid dangerous line breaks. New regulations on minimum trawl lengths (number of traps fished per vertical line) taking effect in 2022 will cause increases in lobster fishery vertical line loads across all fishing grounds, considerably increasing with depth and distance from shore. Our models indicated that inshore areas can safely be fished with vertical lines within the recommended whale-safe 1700 ft-lb breaking strength specification, while the offshore lobster fishery will need a suite of measures beyond line strength reductions to reduce entanglement risk and mortality of right whales. We provide guidelines for the minimum line strength necessary for fishery operations that can be used to inform management goals that balance the needs for a sustainable lobster fishery and conservation of right whales. Guidance for right whale entanglement risk reduction that minimizes detrimental effects on regional fisheries has applications for the global issue of cetacean entanglement.

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CM 50: How can we assess the age or size structure within exploited fish populations?

Wolfgang Nikolaus Probst¹

Fishing is a human activity that has multiple impacts on exploited fish stocks and ecosystems. It reduces the biomass of a fish stock, but also alters age and size distribution within the stock. Thereby fishing affects the productivity of a stock, but also ecological functions that different age and size classes fulfil. The EU Marine Strategy Framework Directive (MSFD) aims to account for both impacts by extending traditional fisheries management of the Common Fisheries Policy (CFP) with age and size-based indicators. The CFP stock indicators are centred around the impacts of fishing effort on stock size and productivity. This is reflected by the use of two indicators, fishing mortality (F) and spawning stock biomass (SSB). F and SSB guide management authorities to the setting of sustainable catch quotas, but remains unclear if and how these two indicators can help to mitigate negative impacts on the age or size structure of a stock, as selectivity as another major influence of fishing, is not accounted for. Since its implementation in 2008 scientist have aimed to develop age- or size-based indicators (ASBI) to assess the combined influence of fishing mortality and selectivity. The major impairment for the operationalisation of ASBI is the derivation of adequate reference points. What is a healthy age- and size distribution? And how can a healthy age- or size distribution comply with the MSY-targets of F and SSB? To address these questions, simulations of exploited populations with differing life-history traits were analysed using a fully age- and size-resolved population model. The simultaneous influence of F and selectivity on ASBIs and SSBI is analysed to evaluate which harvesting strategy could achieve the targets of the CFP and MSFD alike. Further the study aims to identify reference points for ASBI to allow their operationalisation for the use within the MSFD. Focus will be set on age based indicators which can readily be implemented using input data for analytical stock assessments.

Keywords: Size-based indicators; age-based indicators; selectivity; fishing mortality; population dynamics; simulation, Marine Strategy Framework Directive; Descriptor 3

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CM 53: Mesopelagic consumption by cetaceans in the Azores archipelago

Sergi Pérez-Jorge, Joshua Pons, Catarina T. Fonseca, Enrique Tejero, Ruth Esteban, Luis Freitas, Ana Cañadas, Jason Roberts, Tina Yack, Jérôme Spitz, Mónica A. Silva

The importance of the mesopelagic community, in oceanic food webs, is increasingly recognized for its critical role in transferring matter and energy from primary producers to top predators, through trophic levels. Mesopelagic organisms constitute the main prey for heavily exploited fish stocks (e.g. tuna, swordfish) and charismatic megafauna (e.g. cetaceans, pelagic sharks), diving to great depths or relying on the diel vertical migration of mesopelagic species. Quantifying predator-prey interactions is crucial to better understand the consequences on energy fluxes of removing prey species from the ecosystem. However, predator consumption estimates are challenging to obtain, due to lack of data on diets and abundances. In this study, prey consumption of 15 cetacean species inhabiting the Azores archipelago was determined by combining new estimates of cetacean abundance, their energetic requirements, and diets from stomach content analyses. Our results revealed that cetaceans only consumed a small percentage of commercial species, indicating that their direct impact on the population dynamics of the exploited fish community is probably low. We also found that mesopelagic species (mainly fish and cephalopods) accounted for the majority of cetaceans' diet, confirming the importance of this prey group. Mesopelagic fish and cephalopods had lower energy densities in comparison with other non-mesopelagic prey, with cephalopods representing the lowest energy prey of all prey groups. This study showed that the cetacean community in the oceanic waters around the Azores is mainly sustained by low energy mesopelagic prey. Potential harvesting of mesopelagic resources raises concerns about the probable consequences for marine top predators.

Keywords: Diet, bioenergetics models, energy requirements, fisheries, ecosystem functioning, mesopelagic species

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CM 70: Is ignoring predation mortality leading to an inability to achieve management goals in Alaska?

Grant D. Adam, Kirstin Holsman, André E. Punt

The majority of tactical fisheries management relies on the use of single-species population dynamics models that explicitly assume the dynamics of individual populations are independent of one another. This is despite a large body of research demonstrating that the life history of fishes is impacted by the dynamics of their predator populations. While time-varying predation mortality is thought to represent a large proportion of mortality for groundfish in Alaska, United States, assessment models, biological reference points, and harvest control rules do not explicitly account for time-varying predation and assume time-invariant (but perhaps age-specific) natural mortality. Previous research has demonstrated that ignoring predator-prey dynamics can lead to a biased perception of stock status and poor predictive performance of assessment models. However, further research is needed to identify the relevance of time-varying predation mortality to single-species management performance while also accounting for the feedback between management strategies and fish populations through continued data collection and assessment. Here we conduct a management strategy evaluation based on two multi-species population dynamics models developed for groundfish in Alaska, United States to assess whether ignoring predation inhibits the performance of single-species management. Specifically, we use the two multi-species models developed for the Gulf of Alaska and Eastern Bering Sea as operating models to evaluate the ability of single-species management strategies to achieve single-species biological reference points, maximize catch, minimize catch variability, and reduce bias in biomass estimates.

Keywords: multispecies, management strategy evaluation, stock assessment, ecosystem-based fisheries management

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CM 91: Accounting for changes in fishery-independent surveys in stock assessment

Cole Carrano and Steven X. Cadrin

Fishery-independent surveys provide a crucial tool for stock assessment and fishery management. The Northeast Fisheries Science Center's spring and fall bottom trawl surveys of the northeast U.S. continental shelf have been conducted annually for over 50 years. The trawl surveys use a stratified random survey design using area and depth zones and provide indices of abundance for stock assessments of many fisheries in the region. In 2009, the *Henry B. Bigelow* (63.6 meters and 3016 horsepower) replaced *Albatross IV* (57 meters and 1130 horsepower) as the primary vessel used in the survey. The *Bigelow* surveys utilize different trawl gear than the *Albatross*, as well as different field protocols. The *Albatross* survey used a relatively small haddock trawl used in the 1960s, rigged with a roller sweep, and the *Bigelow* switched to a much larger 4-seam, 3-bridle box net with rockhopper sweep. Tow speed was reduced from 3.8 knots to 3.0 knots and tow duration from 30 minutes to 20 minutes. A paired-tow experiment was used to estimate calibration factors that account for differences in catchability between the two survey systems, and these calibration factors have been used to derive a single time series of abundance indices for many stocks. Alternatively, modeling the two vessels as different time series eliminates the need for calibration factors and can improve performance of assessment models. We used a statistical catch-at-age model to compare performance of a single calibrated survey series to separate *Albatross* and *Bigelow* time series in applications to several stocks of New England Groundfish. Preliminary results show promising improvements in index fits and variable results for index age composition fitting. Model runs with separate *Albatross* and *Bigelow* series have been accepted for several stock assessments and are considered for others. The multi-stock analyses and comparisons of relative catchability to estimated calibration factors also provide broader understanding of how changes in surveys affect catchability of similar species.

Keywords: fishery-independent surveys, stock assessment, survey catchability

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CM 103: The response of North Sea ecosystem functional groups to warming and changes in fishing

Robert B. Thorpe*, Nina L Arroyo, Georges Safi, Nathalie Niquil, Izaskun Preciado, Michael Heath, Matthew C. Pace, Christopher P. Lynam

Achieving Good Environmental Status (GES) requires managing ecosystems subject to a variety of pressures such as climate change, eutrophication and fishing. However, ecosystem models are generally much better at representing top-down impacts from fishing than bottom-up impacts due to warming or changes in nutrient loading. Bottom-up processes often have to be parameterized with little data or worse still taken as a system input rather than being represented explicitly. In this study we use an end-to-end ecosystem model (StrathE2E2) for the North Sea with 18 broad functional groups, 5 resource pools, and representations of feeding, metabolism, reproduction, active migrations, advection and mixing. Environmental driving data include temperature, irradiance, hydrodynamics and nutrient inputs from rivers, atmosphere and ocean boundaries, so the model is designed to evaluate rigorously top-down and bottom-up impacts and is ideal for looking at possible changes in energy flows and “big picture” ecosystem function. In this study we considered the impacts of warming (2 and 4 deg C) and various levels of fishing, by demersal and pelagic fleets, on the structure and function of the foodweb. A key aim is to demonstrate whether monitoring of broad ecosystem groups could assist in deciding whether GES was being achieved. We found that warming raised primary productivity and increased the size (total biomass) of the ecosystem. Warming raised metabolic demands on omnivorous zooplankton and reduced their abundance, thus favouring benthivorous and piscivorous demersal fish at the expense of planktivorous pelagic fish but otherwise had modest effects on energy pathways and top predators, whereas changes in fishing patterns could materially alter foodweb function and the relative outcomes for top predators. We suggest that GES should be defined in terms of an unfished state and that abundances of broad groupings and the balance between them can help to assess whether indicator outcomes were consistent with GES. Our findings underwrite the need for an ecosystem approach for the management of human activities supported by relevant monitoring. We also highlight the need to improve our basic understanding of bottom-up processes, improve their representation within models, and ensure that our ecosystem models can capture growth limitation by nitrogen and other elements, and not just food/energy uptake.

Keywords: fisheries, North Sea, climate change, ecosystem modelling, MSFD, foodweb indicators, end-to-end models, good environmental status

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CM 105: Sex analysis for marine ecology and conservation in a changing climate

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The United Nations Decade of Ocean Science for Sustainable Development aims at the quantitative understanding of ocean ecosystems and their functioning as the foundation for management and adaptation. The Ocean Decade promotes innovative ways of conducting and using transformative ocean science by encouraging more approaches in designing and executing science. Here we focus on sex analysis to foster inclusion in transformative ocean science for marine conservation. Marine organisms exhibit a variety of sexes (male, female, hermaphrodite) and sex-based differences at individual and population levels. One largely ignored dimension in ocean management is how organisms respond to climate change differently by biological sex. This study explores the utilization of sex analysis in marine ecology and biology. We apply a qualitative literature review to depict model studies of sex analysis in marine research. The aim is to understand the way sex analysis has been applied in the different sub-disciplines, and to answer to research questions at different level of biological diversity. We show, for example, that sex-based intraspecific differences are analyzed in organism and population ecology but generally overlooked in community ecology. In laboratory and in-the-field experiments, the inclusion of males, females and hermaphrodites in different reproductive stages is often thought to produce confounding effects. We highlight the biological, logistic, and technological challenges encountered by scientists in applying sex analysis. We finally propose a series of guidelines to approach sex analysis in different fields of biological and ecological research. Addressing sex analysis in research design and analysis is essential for understanding the response of marine organisms to multiple pressures especially under climate change. Not including sex and sex analysis can lead to the risk of failing in representing environmental processes and ecological dynamics, and indeed in ocean conservation and management.

Keywords: Biological sex, sex-based intraspecific variability, climate change, marine biological research, community ecology, research design and methods, experimental ecology, field and laboratory experiments, mathematical ecology and population modelling, meta-analysis, genetics

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CM 107: Quantitative Metabarcoding

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Amplicon-sequence data from environmental DNA (eDNA) and microbiome studies provides important information for ecology, conservation, management, and health. At present, amplicon-sequencing studies – known also as metabarcoding studies, in which the primary data consist of targeted, amplified fragments of DNA sequenced from many taxa in a mixture – struggle to link genetic observations to underlying biology in a quantitative way, but many applications require quantitative information about the taxa or systems under scrutiny. As these studies proliferate in ecology following decades of microbial and microbiome work using similar techniques, it becomes more important to develop ways of making them quantitative to ensure that their conclusions are adequately supported.

Here we link previously disparate sets of techniques for making such data quantitative, showing that the underlying PCR mechanism explains observed patterns of amplicon data in a general way. By modeling the process through which amplicon-sequence data arises, rather than transforming the data post-hoc, we can estimate the starting proportions of DNA for many taxa simultaneously. This model can be calibrated with a variety of methods, including mock communities and variable-PCR-cycle sequencing runs, which we illustrate using simulations and in a series of empirical examples. Our approach opens the door to a wide range of management and research applications.

Keywords: eDNA, amplification bias, compositional data, PCR

CM 117: Shifting baselines and their implications for assessing dynamic change in fish population abundance in Curonian Lagoon, Baltic Sea (Lithuania)

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It is now well recognised that assessment of fish population status should ideally be based on long term time series to avoid the problem of shifting baselines. However, standardising heterogeneous observations from extensive time series can be challenging.

In this study we present long-term (1950s–2020s) fish catch and scientific monitoring datasets from the Curonian Lagoon adjacent to the Baltic Sea. These datasets include a wide range of fishing gears and data collection methods and encompass periods before and after the onset of intense industrial fishing by the Soviet Union during the 1950s. We present our approach for standardising an index of fish relative abundance and discuss its main challenges. We demonstrate the large changes in relative abundance of key fish species that occurred as the Curonian Lagoon underwent drastic ecological and environmental changes driven by intensive fishing, nutrient run-off and climate change during this period. We also apply a surplus production model to a long (70 year) and a much shorter (30 year, where standard gillnetting methods were used) scientific monitoring dataset and explore how our inferences and perceptions of stock status might be affected by the length of the time series used in the analyses.

Keywords: long-term monitoring, historical dataset, CPUE standardization, population dynamics, baseline, Curonian Lagoon

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CM 133: Local seafood, between taste and deception, using metabarcoding as a tool for opening discussions about sustainably and consummation

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The existence of eDNA Metabarcoding facilities allows often site projects for testing new sample types, questions, and projects. Here we want to present a study that was requested and done in partnership with the local community of a fisherman town. In coastal regions like France, seafood is not only an essential commercial interest; it is an essential part of the cuisine and everyday life, based on century's long culture. Mislabeling of food products in the last decades undermined the trust of the customer in their food choice, while at the same time the term "local" increased affirmation of quality and *beliefs*. We used genetic species identification as a tool to connect to local industry and society, for starting a conversation on seafood content and their sustainability. The test was the local traditional dish of "tielle" a pie filled with cooked octopus and tomato sauce, using metabarcoding for multiple species identification. We found besides locally available species (*Octopus Vulgaris* and *Eledone sp.*), that 18 of 27 tielle included Humboldt squid (*Dosidicus gigas*), with 8 (=31% mislabeled) of them sold as octopus, one even included unlabeled fish. In consequence, 50% of locals stated they lost confidence, and opposite to their belief, their anonymous taste evaluations did not depend on species or price. While the taste is important, they acknowledge different environmental impacts (CO² emissions, stocks evaluations) of the different cephalopods and are willing to include this in their food choice decision. This is motivation to use existing eDNA Metabarcoding pipelines for local citizen science projects, finding problems, evaluating impacts on a social, economic, and environmental level, opening discussions for solutions, and at the same time having fun together.

Keywords: citizen science, mislabeling of food, taste evaluations, octopus, squid

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CM 146: Conceptual modelling: a tool for capturing ocean visions

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The risks that threaten our marine environments are many and varied. How they interact with each other, affect our socio-ecological systems, and change in the context of climate change are generally unknown. Furthermore, our ability to manage, prioritise and predict possible outcomes are severely limited. In most cases, we must simplify and prioritise, in order to act. This requires working with stakeholders to identify the most regionally and contextually relevant priority areas for action. One method that has proven to successfully bridge or compare stakeholder conceptualisations, horizon scanning, and identification of emerging threats, is conceptual mapping.

The Joint ICES/EUROMARINE Workshop on Common Conceptual Mapping Methodologies (WKCCMM) worked to develop a common understanding of conceptual mapping methodologies, their key uses and limitations, and processes for effective conceptual modelling with stakeholders for a variety of applications (e.g. developing food webs, socio-ecological modelling, scoping exercises, rapid/initial management action and/or impact evaluations). WKCCMM involved presentation and discussion of a range of conceptual modelling approaches and contexts through the examination of case studies. These case studies gave rise to a suite of recommendations, including the development of a workflow for Integrated Ecosystem Assessment (IEA) and more generic guidelines and best practices advice for the use of conceptual modelling approaches with stakeholders. Although stakeholders were not able to be included in this workshop, they were very much at the heart of discussions, with the challenges and good practices of stakeholder inclusion addressed through specific examples provided by participants. WKCCMM also investigated how the methodologies can be best used to contribute to IEA and may otherwise be applied for cross-collaboration, knowledge transfer, and inter- and transdisciplinary science throughout European seas and beyond.

Keywords: conceptual mapping, mental modelling, conceptual modelling, stakeholder engagement, best practices, integrated ecosystem assessment

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CM 160: Global crustacean stock assessment modelling: Reconciling available data and complexity

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Despite their growing socio-economic importance globally, relatively little is understood about how crustacean stocks are assessed, which has potential to compromise fishery sustainability, especially under heavy exploitation and environmental changes. To inform stock assessment model application for emergent fisheries, we evaluated model use for crustacean stocks available in the RAM Legacy Database (RAMLDB) and the evolution of model use for four case-study fisheries, emphasizing the relationship between data availability and model complexity. Differences in model use between FAO fishing regions and crustacean species sub-groups were identified. Only 60.9% of crustacean stocks in the RAMLDB identified the model used for assessment. For the remaining stocks, we collected ancillary data to fill the information gaps, amounting to 92.5% of crustacean stocks in RAMLDB. Of these, model complexity varied from count-based to environmentally explicit statistical catch-at-length methods, but tended to be data intensive, likely due to biases towards regions with more developed fishery management programmes. Furthermore, regional comparisons indicated that crustaceans are only well-assessed in a few geographical hotspots. The progression of model use over time was inconsistent between case-study fisheries, being driven by myriad factors including data availability, confidence in biological processes and ecological considerations. Our findings can be used as a resource to help inform model choice for fisheries management. Towards the goal of seeking global best practices for crustacean stock assessments, future work should address knowledge gaps in regional stock assessment model use and conduct comparative studies to evaluate stock-specific costs and benefits relating to model complexity.

Keywords: crustacean, data availability, emerging fisheries, model choice, RAM legacy database, stock assessment

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CM 164: From shallow to deep water: Performance of length-based assessment of data-limited Azores fisheries

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Length-based methods have been applied worldwide to estimate biological reference points and understand the dynamic of fish populations within data-limited stocks. However, few studies have tested the sensitivity of parameters in length-based methods examining stocks with different traits and small-scale multispecies fishery context. In the Azores ecoregion, NE Atlantic (ICES Subdivision 10a2), twenty-two stocks are classified as priority stocks and considered data-limited, and little is known about these current stock statuses. Therefore, this study applied three different length-based assessment methods: 1) the length-based indicators (LBI), 2) the length-based spawning potential ratio (LBSPR) and 3) the length-based bayesian biomass approach (LBB), to predicting the sustainability in small-scale multispecies fisheries in the Azores. Overall, it was possible to apply the three methods used for 18 out of 22 priority stocks (length composition data availability), and showed robustness for 15 out of 18 stocks assessed. Given these results, 50% of the stocks assessed presented a sustainable stock status and the others stocks, classified as possible rebuilding/overfished (28%) or overfishing/overfished (22%) stock status. The sensitivity analysis showed that bias on the source of initial life-history parameters (L_{∞} and M/k), has a strong influence on the reference points derived from these three methods, namely P_{mega} (LBI), SPR and F/M (both LBSPR), B/B_0 and B/B_{MSY} (both LBB). Furthermore, the sensitivity analysis indicated that, among the methods, LBI is more robust than LBSPR and LBB. Our findings also provide management measures recommendations such as, catches and effort should be reduced, minimum size landing and minimum hook size, mainly to be applied for stocks classified as possible rebuilding/overfished or overfishing/overfished stock status. This study highlights the importance of length-based assessment methods to provide rapid assessments, support management measures and guarantee the stock sustainability, particularly in small-scale communities.

Keywords: Small-scale fisheries, data-limited fisheries, stock assessment, LBI, LBSPR, LBB.

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CM 181: Examining the role of a keystone predator (the sea otter, *Enhydra lutris*) in driving spatial and temporal patterns of community diversity and dynamics in nearshore ecosystems

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Sea otters (*Enhydra lutris*) are well-studied keystone predators that greatly influence ecosystem structure and function, most notably that otters facilitate greater kelp abundance through predation of kelp-grazing urchins. In British Columbia, sea otters were reintroduced to the West Coast of Vancouver Island and have since expanded their range. As sea otters recolonize and are reintroduced to coastal areas, including those designated as marine protected areas (MPAs), ecosystems will change and conflicts with human activities (e.g., fisheries) may arise. It is important to better understand how nearshore communities have been changed by otters in the past to set expectations for areas where otters have not yet recolonized. Effective management of sea otter recovery necessitates thorough understanding of their role in driving changes in community state dynamics to anticipate future change and better inform management decisions. To address this, we analyzed nearshore community data, consisting of annual surveys of kelp, urchin, and mobile invertebrate species, from multiple regions across British Columbia. We used non-metric multidimensional scaling (NMDS) analysis, hierarchical cluster analysis, and multi-state Markov models to assess spatial and temporal patterns in nearshore communities and the role of sea otters in driving community dynamics. Furthermore, we examined community diversity and how otters affected both short-term transient dynamics and long-term equilibrium. Lastly, we extended our model to explore the system within a theoretical framework to make projections of community dynamics under different scenarios. Preliminary results suggest additional community states (or relatively long transient states) and mosaics beyond the suggested binary kelp or urchin dominated community states. Furthermore, we find that otter occupation time and regional factors play key roles in driving community state dynamics (i.e., steady-state distribution, turnover time, entropy). The results have important implications for how we view and manage marine systems with recovering keystone predators.

Keywords: community ecology, biodiversity, ecosystem function, sea otters, kelp, urchins, keystone species

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CM 192: A data driven approach to model fishery responses to socio-ecological change in the southern North Sea

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Co-author: Birgit Müller, Christian Möllmann, Vanessa Stelzenmüller

In the past two decades many computer models were developed to simulate the temporal and spatial behavior of fishers. Many of these models assume human behavior purely based on profit maximization, despite a growing body of evidences for more complex behavioral strategies of fishers. We developed an agent-based model (ABM) to simulate temporal and spatial fishing dynamics of individual German fishing vessels in the southern North Sea, while integrating behavioral strategies, such as pursuing social and personal norms, as well as habitual behavior. Our approach started with the analysis of fisheries dependent data, i.e. vessel monitoring (VMS) and logbook data, and combined these with environmental and economic information, such as sea bottom temperatures, oxygen concentration, primary productivity, salinity, as well as fish and oil prices. In addition, we gained insights into the behavior of fishers by interviews with fishery representatives and fishery observer. The strong reliance on empirical data of our model ensures a high degree of realism and enables the applicability to analyze future scenarios. Especially in the North Sea, gaining information about future scenarios is of relevance, as vast offshore windfarm (OWF) extensions and newly established marine protecting areas (MPA) will limit available space for free ranging activities, such as fishing. We applied the ABM to assess the effects of changing fish and fuel prices, climate change, and the loss of fishing grounds due to OWF and MPA expansions on the development and adaptations of German fishing fleets. Among others, our results comprise future scenarios by exploring fishing effort distributions, catch compositions, and profits on fleet level. We tested and parameterized the model by applying a pattern-oriented modelling approach and carrying out a sensitivity analysis. Our model outputs offer guidance for effective area-based management and foster the inclusion of fisher behavior into marine spatial planning. At the ICES ASC, we intend to present the overall model structure, the integration of various data types, the modelling of human behavior, and first results of future scenarios.

Keywords: agent-based model, Consumat approach, fisher behavior, human behavior, marine spatial planning

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CM 199: Ecological impacts of fishing on species and habitats in European seas

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While ecosystem-based fisheries management (EBFM) is required to deal with the complexity and uncertainty of exploiting natural resources, it remains in its infancy, at least in Europe. To make it operational at a pan-European scale, a new collaborative project with 24 partners across Europe, *SEAwise*, aims to develop new insights into key social and ecological interactions of fisheries in the European Atlantic, Mediterranean and Baltic. The first step is to conduct systematic scoping reviews across a series of subjects to create the knowledge base that is needed, drawing from the wealth of information that exists. These subjects cover 'social and economic aspects of fisheries', 'drivers of stock productivity', 'impacts of fisheries on key species and habitats', 'drivers of spatial distributions of fish and fisheries', and 'interactions in European socio-ecological fisheries systems'. Here we present the review of impacts of fisheries on key species and habitats. The overarching objective is to map the available knowledge and evidence of commercial and recreational fishing impacts on species and habitats in European seas; with specific reference to (i) bycatch of protected, endangered and threatened (PET) species, (ii) benthic habitats, (iii) food webs and biodiversity, and (iv) impact from fisheries-related litter and ghost nets. A systematic review (following the PRISMA EcoEvo approach) was undertaken utilising two databases (Scopus and Web of Science). This resulted in 2,055 records (after duplicate removal), which reduced to 734, after screening the title and abstract. These articles were reviewed and relevant data were systematically extracted. Besides information on methodology, spatial and temporal scale and resolution, and quality of the study, data were extracted on the studied species and habitats, the studied fishing pressure and fishing gear, and the reported impact of the pressure on species and habitats (both in direction and strength). This scoping review identified the knowledge and gaps on ecological impacts of fishing on species and habitats in general, but also specified by region, type of pressure, fishery, gear and studied aspects of species and habitats, such as survival, physiology, behaviour and trophic structure. The end product of this review is a public, queryable database, to be drawn upon by any project starting to address the operationalisation of EBFM.

Keywords: fisheries, impact, ecosystem, bycatch, benthic habitat, food webs, diversity, litter, PET

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CM 234: The Potential of Small Fish to Alleviate Micronutrient Deficiencies: The Case of Ghana

First Author: Christiana Sam

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Fish is a rich source of highly digestible protein, long-chain fatty acids (LC-PUFA), omega-3 fatty acids, and micronutrients and fish consumption contributes to food and nutrition security globally (Hicks et al., 2019; Aakre et al., 2020). In recent years, micronutrient deficiency also referred to as “hidden hunger” has been one of the prevalent forms of malnutrition with about one-quarter of the world’s population deficient in essential vitamins and minerals (FAO, 2019). In Ghana, the latest findings from the National Micronutrient Survey conducted in 2017 indicated a high prevalence of micronutrient deficiencies among 6-59 months children with iron and vitamin A deficiencies estimated at 21.5% and 20.8% respectively

The objective of the study was to determine the content of micronutrients available in 11 selected fish species caught on the Dr Fridtjof Nansen Survey in Ghana, 2017 and assess the contribution of each species (per 100 grams) to the daily average requirement (AR) /adequate nutrient intake (AI) based on the European Food Safety Authority (EFSA) for children between the ages of 1-3. The study also estimated the availability of the analysed species in Ghana based on annual fish catches between the period 2000-2017.

The data showed that *Brachydeuterus auritus* and *Cubiceps sp.* (whole-bodied) had the highest mean values of vitamin A1 and iodine with values of 330µg/100g and 533.3µg/100g respectively contributing ≥ 50% to the daily average requirement of vitamin A1 and iodine for children between the ages of 1-3. The whole samples of *Sardinella aurita* and *Engraulis encrasicolus* analysed contained significantly higher content of selected minerals with reported mean values ranging between calcium (779 mg/100g) and iron (4 mg/100g).

The annual landings of small pelagic fishes (marine) between the period 2000-2017 obtained from the Fisheries Commission of Ghana have remained stable with an average of around 250 000 metric tonnes (mt) per year. The average catch of small pelagic fish between the years 2000-2009 and 2010-2017 was estimated at 241308 mt and 208828 mt with a corresponding per capita consumption (PCC) of 11.2kg and 7.6 kg based on the data received.

In conclusion, small fish wholly consumed is a rich dietary source of vitamins A1, A2 and B12 and minerals (iron, zinc, and calcium). The per capita consumption indicates their substantial contribution to food and nutrition security in Ghana.

Keywords: Small fish, Food & Nutrition Security, Micronutrient Deficiency, Ghana

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CM 250: Exploring local cultural connections to the coast using the concept of affective engagement

Tomas Buitendijk, Elisabeth S. Morris-Webb, Tasman P. Crowe

Residents of coastal communities live 'on the edge'. The boundaries of their environments are in constant flux: fisheries are changing, the coastline requires ever-increasing protection against erosion, flooding, and other threats, and the green energy transition is effecting a rapid transformation of near- and off-shore spaces. As people adapt to an unpredictable landscape, it is more important than ever to understand the cultural connections that exist between them and their physical environments, to minimise the negative impacts of environmental change and ensure resilient coastal communities long into the future.

The importance of 'place' has been extensively researched and so too have the various cultural benefits received from people's interactions with coastal environments, including sense of place, aesthetic pleasure, and identity. Whilst strong place attachment together with a perceived threat to a valued coastal site can nurture place-protective behaviour, disruption to place attachment has been found to lead to opposition to coastal development. The current paper contributes to this debate by revisiting the importance of the physical encounter as a foundation of place attachment. Using insights from the environmental humanities (notably new materialist theory) in conjunction with tools developed in psychology, human geography and environmental economics (including place attachment and cultural ecosystem services research), we respond to the following research questions: 'How and why does material interaction with coastal sites influence the cultural identity of local communities?' This is done through an analysis of 'affective engagement', a concept that substantiates both the physical-material and semiotic content of coastal residents' interactions with different local habitats and (infra)structures.

The paper takes a constructivist approach based on Bruno Latour's Actor-Network Theory, and follows Nick Fox and Pam Alldred's call for quantitative/qualitative data integration in new materialist fieldwork. We worked directly with residents of the Wicklow-Arklow coastal area, on the east coast of Ireland, through semi-structured interviews and online questionnaires. The results of the study substantiate key factors that influence individual human-site relationships in coastal environments. Notably, the study informs the development of specific resident typologies based on varying levels of place attachment, with the aim of predicting coastal residents' affective engagement with different sites both now and in the future. Joining local voices with interdisciplinary research, this paper can be used to inform best practice for key decision makers during environmental planning, thus ensuring that proposed changes have a net positive impact on affected coastal communities.

CM 258: Shifting distributions, efforts and spatial management in European seas: a systematic review

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While ecosystem-based fisheries management (EBFM) is required to deal with the complexity and uncertainty of exploiting natural resources, it remains in its infancy, at least in Europe. To make it operational at a pan-European scale, a new collaborative project with 24 partners across Europe, SEAwise, aims to develop new insights into key social and ecological interactions of fisheries in the European Atlantic, Mediterranean and Baltic. The first step is to conduct systematic scoping reviews across a series of subjects to create the knowledge base that is needed, drawing from the wealth of information that exists. These subjects cover “social and economic aspects of fisheries”, “drivers of stock productivity”, “impacts of fisheries on key species and habitats”, “drivers of spatial distributions of fish and fisheries”, and “interactions in European socio-ecological fisheries systems”. Here we present the review of drivers of spatial distributions of fish and fisheries. The overarching objective was to catalogue evidence of spatial shifts in species distribution and fisheries effort as well as the factors that drive these shifts. A secondary objective was to report on the proposed mechanisms by which shifts were induced by external drivers. To fulfil these objectives, a systematic review (following the PRISMA EcoEvo approach) was undertaken utilising two databases (Scopus and Web of Science). This resulted in 934 records, which reduced to 395, after excluding irrelevant records based on title and abstract. The full-text of these 395 articles were then submitted to further screening and ultimately data extraction. Besides information on the diversity of methodology, spatio-temporal scale, and spatio-temporal resolution, we also summarise the reported directions and magnitudes of shifts and the proposed underlying drivers of these shifts. The results, presented based on regional seas and pan-European trends, highlight the need to gather more spatially explicit information and knowledge of species’ responses and the impacts of human activities to support and maintain wild fisheries.

Keywords: species distributions, marine spatial management, marine spatial planning, maritime industry

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CM 266: A systematic review of behavioural economics in fisheries

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Behavioural economics enriches our understanding of fisher behaviour beyond classical theories of profit maximisation or rational choice by studying how other mechanisms such as cognitive biases, social norms, and loss aversion affect behaviour. This field thus holds multiple opportunities for integrated fisheries management and conservation by helping to understand fisher behaviour and decision-making. However, applying these principles successfully in management requires evidence of how these mechanisms unfold in a fisheries context. To provide an overview of potential applications of behavioural economics in fisheries management, we have developed a systematic literature review focusing on the primary question: “Which behavioural economics mechanisms influence fisher behaviour?”. The design of this study is a novel way of answering policy-oriented questions in ICES. Always dedicated to behavioural economics and to engaging early-career researchers, Sarah Kraak was instrumental in initiating and driving this work forward. In her honour, we present our systematic review of these different mechanisms 'in action' in fisheries contexts.

Keywords: behavioural economics, fisheries management, systematic review, behavioural incentives, behavioural interventions, behavioural mechanisms

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CM 273: The role of fun in science, but in a serious manner

MA Pastoors, I de Boois, DJ Dankel

Scientific conferences, and expert presentations within such conference, often have a tendency to be quite serious and detailed on the scientific topics being discussed. While this a well known behavioural pattern among scientists, this food for thought paper discusses some of the attempts that have been carried out during the ICES Annual Science Conferences with the aim to explicitly bring fun into the scientific equation, while at the same time, seriously, improving the capacity to bring messages across. Sarah Kraak was instrumental in initiating and driving several of these initiatives in the ASCs. In her honour, we present here, an opportunistic review of the different approaches that have been explored to bring fun in science but in a serious manner.

This paper is part of the Sarah Kraak Kaleidosope Tribute session at ICES ASC 2022

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CM 274: What drives the management plans in the Northeast Atlantic?

MA Pastoors

Long-term management plans (LTMP) have been introduced into fisheries management in the Northeast Atlantic around 1998, with the introduction of the Precautionary Approach to fisheries management. Since then, there have been a large number of scientific Ex Ante evaluations of the potential impacts of LTMPs, often called Management Strategy Evaluations (MSE) and also frequent changes to the management plans. In this review paper, a reconstruction is being made of the fate of management plans for a limited number of stocks (e.g. North Sea herring, NEA Mackerel, tbc), whereby the focus is not just on the contents of the LTMPs or the MSEs, but also on the incentives for changing management plans. Sarah Kraak has been instrumental in putting the human factor of science and management on the agenda with papers on the development of recovery plans for cod stocks. In her honour, we present this review of the different mechanisms 'in action' that affect the long-term nature of management plans and their evaluations.

This paper is part of the Sarah Kraak Kaleidosope Tribute session at ICES ASC 2022

Keywords: Long term management plan, management strategy evaluation, MSE, reference points, role of experts

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CM 278: Stochastic modelling of fish recruitment productivity in the Celtic Seas ecoregion

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Co-authors: C  il  n Minto, Colm Lordan, Deirdre Brophy, Rich Bell, Jeremy Collie, David Reid

The Northwest European continental shelf is a large ecosystem undergoing major changes, which influence fish productivity. The productivity of many stocks has shown evidence of change over decadal timescales. Varying factors might drive these dynamics in the Celtic Seas, but for many stocks these have not been fully understood nor identified. We study dynamic productivity for 29 stocks in the Celtic Seas by tracking integrated stochastic signals in the relationship between stock size and recruitment using state-space modelling. Our research objectives comprise: (i) comparing survey-derived versus assessment-derived signals; (ii) determining how the structural form of the modelled relationship influences inference; and (iii) identifying common trends and factors explaining stochastic variability. Preliminary results suggest the trends are consistent across structural forms. Our results on non-stationary productivity relationships can contribute to improved management advice for Celtic Seas stocks.

Keywords: time-varying productivity parameters, dynamic reference points, assessment uncertainty, non-stationary ecosystem, Celtic Seas

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CM 296: Coastal Fish Communities – a Comparison of Fishing Methods

Christina Henseler*, Daniel Oesterwind

Seagrass meadows do not only provide important ecosystem services across the globe, but also essential functions for marine organisms including coastal fish. Currently, seagrass meadows experience high levels of anthropogenically and environmentally induced threats such as rising temperatures, human constructions and high nutrient loads. Therefore, monitoring the state and faunal communities associated with these vulnerable habitats has become an important task and is included as a requirement in the Marine Strategy Framework Directive.

To establish sound monitoring programs for faunal communities, such as coastal fish, information on the applicability of sampling methods in habitats is essential. Different active and passive methods might only capture specific fragments of local fish communities, introducing a certain bias into sampling results. In this study, we aim to address this issue by comparing the efficiency of fishing methods in seagrass meadows along the western German Baltic Sea coast. To do so, taxonomic and trait biodiversity were compared between active (beach seine, YOY-trawl) and passive gear (multimesh gillnet, eelfyke, minnow trap), and assessed whether differences between methods vary with season.

Results indicate pronounced discrepancies in the catch efficiency between fishing methods. The gillnet generally performed best in representing fish biodiversity among passive gear, while the minnow trap exhibited the lowest performance. From winter until summer, gillnets and active methods predominantly displayed similar catch per unit efforts (CPUE) and species richness, while Shannon diversity was higher in gillnets. This pattern was reversed in summer and autumn when CPUE was clearly higher in the beach seine and YOY-trawl compared to the gillnet, whereas species richness and Shannon diversity either did not differ between these methods or were higher in the active methods.

These patterns are likely directly linked to differences in taxonomic and trait composition between fishing methods. Active methods were more efficient in catching pipefish, sticklebacks and gobies throughout the year explaining the higher diversity captured with the active methods during summer and autumn, as these species commonly are more abundant in coastal habitats during this time of year. On the contrary, species with a flat body shape as plaice and flounder displayed highest CPUEs in gillnets.

The outcomes of this study will help scientists choose appropriate sampling methods in seagrass meadows depending on the study objective, i.e. with respect to sampling season and targeted species, and will additionally support the development of solid monitoring programs.

Keywords: coastal fish communities, fishing methods, seagrass meadows, biodiversity

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CM 297: Fisheries adaptation to climate change in Portugal: participatory evaluation of measures

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Fisheries are complex and dynamic socio-ecological systems, in which interactions are affected by changes in climatic conditions. To ensure the future sustainability of fisheries, it is essential that their responses to ongoing shifts in climate change are based on the best available scientific and local ecological knowledge to develop and implement consensual Climate Adaptation Plans (CAPs). Recent Portuguese legislation defines national climate policy that mandates the development of sectorial adaptation plans. Considering the socio-cultural importance of fisheries in Portugal, there is an urgent requirement to discuss potential adaptation options for inclusion in these plans with all fishery stakeholders. Thus, our aims were to investigate (i) the degree of inclusion of the fisheries sector in CAPs in Portugal, and (ii) the potential adaptation measures agreed among fishery stakeholders. We conducted a review of approved CAPs documents at state, regional and municipality level. Then, considering the measures reported in the CAPs and proposed in the literature, we conducted a survey and developed a participatory approach to evaluate 30 ecological, social and institutional adaptation measures to climate change in eight fishing communities distributed from north to south continental Portugal that represented contrasting socio-ecological contexts. Stakeholders of the eight fisheries were asked to state whether they agreed, partially agreed or disagreed with the 30 measures previously defined. We found that the national CAP included references to fisheries, but did not specify adaptation measures, whereas at regional and municipal levels, adaptation measures were reported, albeit with a low level of detail. The participatory evaluation and surveys, showed that ecological measures, such as improvement of gear selectivity, temporal fishing closures and minimum landing sizes, were widely agreed by stakeholders, while implementation of marine protected areas was only partially agreed. Agreement of social and institutional measures varied, where participants supported co-management of fisheries, flexibility and agility of administration procedures among other measures, but could not find consensus for the reduction of subsidies and the implementation of the landing obligation. Across all fishing communities the lack of young people was identified as a major concern and was attributed to the poor working conditions. Differences between regions tended to be explained by fishery type and degree of organization capacity. Our results highlight the need to include the fisheries sector in the design of CAPs and the importance of participatory processes in building feasible action plans that account for diversity among fishing stakeholder communities.

Keywords: climate adaptation plans, fishing communities, management measures, Portugal

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CM 298: How to localize the UN Sustainable Development Goals? Eliciting citizen perspectives on sustainable coastal planning in Norway

First author: Fuller, J.L. **Co-authors:** van Putten, I., Kraan, M., Bjørkan, M., Dankel, D.J.

Our planet is under a relentless pressure on natural resources to provide food, energy, space, and materials for housing for a growing human population. Besides the need for sustainable use of natural resources, there is an additional need for social justice, equity and representation of peoples and individuals and their associated values for social development. All countries of the United Nations have formally recognized these realities, which form the impetus of the UN's 2030 Agenda on Sustainable Development. In recent decades, sustainability and resilience have emerged as two key paradigms to understand human-nature relationships, conceptually known as social-ecological systems (SESs). However, sustainability can only be achieved if there is also a "value shift", which changes the collective values of a society, or the inner lives of the individuals who are part of those societies. Knowledge of these values can increase individual participation in problem-solving, generate social legitimacy, and stimulate the "transformational potential" of those values.

To address this challenge for implementing the SDGs, current research points to the idea of transformational changes for sustainability, that can function to localize the SDGs. Enabling approaches for transformational change focus on fostering human agency, values, and capacities to identify shared values to collectively enact pathways to desired futures. Enabling approaches focus on giving spaces for co-learning and discussion at the local level, which can be more accessible to local communities as they can be low cost and build on the capacities and capabilities already present. By stimulating extended peer communities, regional and local authorities can tap into existing potential (i.e., knowledge, skills, energy, motivations) and use that potential to guide solution-oriented discussions and craft ways forward. SDG localization depends on these processes of enabling and empowering local communities to develop their agency and human capacity for change.

This concept of using enabling approaches to achieve a transformational change that localizes the SDGs is strengthened by using mixed empirical methods to test options for enabling approaches. We apply an interview-based ethnography to Q-methodology to study the individual perspectives of a local community on the SDG "proxy" of sustainable coastal planning. This applies one such enabling approach to transformation and explores the idea of SDG localization that is founded in legitimacy and empowerment.

In the context of using sustainable coastal planning as a policy vehicle for localizing the SDGs for Andøya, Norway, this study aims to understand the unique and shared social perspectives on sustainable coastal development by identifying and examining the variable discourses on sustainable coastal planning, framed within the social, economic, and environmental dimensions of sustainability, across all relevant economic sectors on Andøya. In doing so, the study applied Q-methodology to reveal these variable discourses which were then interpreted within the context of localizing the SDGs through sustainable coastal development.

Keywords: Q-methodology, UN Sustainable Development Goals, coastal development, transformations, social change, sustainability

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CM 309: Gender and early career scientist status and differences in participation at an international marine science conference

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Women continue to be under-represented in marine and ocean science. Conference participation is an important part of academic practice and scientific careers. To explore the gender and early-career dimensions of participation in an international marine science conference, preferences of presentation type, as well as acceptance and rejection decisions were investigated, using 5-years of data (2015–2019). The analysis considers if the fate (reject/accept - oral/poster) of the abstracts is influenced by whether the submitter is an early-career scientist, and their gender. For many researchers, an oral presentation has more prestige than a poster presentation. While gender did not show a significant effect on the decisions to downgrade requests for oral presentations to poster presentations, in the sample analysed, women were more often early career scientists, and therefore more women than men have their presentations “downgraded”. Using additional indicators, evidence of a gender gap remains, highlighting the need for further actions as well as monitoring and research into conference participation from a gender perspective.

This paper is part of the Sarah Kraak kaleidoscope tribute session at ICES ASC 2022

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CM 316: The past, present and future of multispecies models for tactical fisheries

Max Grezlik, Melissa Karp, Jason Link, Steve Cadrin

Multispecies models have been applied to fisheries since the 1940s, and decades earlier in general ecology. From first principles, there are several advantages of multispecies models in comparison to single species models for informing tactical fishery management decisions (e.g., catch advice); conversely, there are several reasons why multispecies models are not used operationally. Several early case studies demonstrated possible applications of multispecies models for fisheries management. Subsequent multispecies modeling-related efforts include the International Council for the Exploration of the Sea (ICES) 'year(s) of the stomach', a multispecies model symposium in 1991, periodic reviews every half-decade or so, many working groups and applications, computing advances, exploration in a bioeconomic and portfolio context, model advancements, and formal reviews and considerations of multispecies models. These contributions demonstrate extensive exploration and consideration of multispecies models for fisheries applications. In principle, multispecies models are expected to be more realistic than single species approach for providing direct fishery management advice and meeting management objectives. Yet they are not widely used in an operational, tactical sense for fisheries management. A Multispecies Modeling Applications Workshop was designed to survey and catalog multispecies models by identifying impediments to their use and providing alternative suggestions for addressing the aspects of fish dynamics that these models attempt to provide. The workshop focused on models of multiple species that include important technical or ecological interactions (e.g., 'minimum realistic models' or 'dynamic multispecies models'), and identifying conditions where they may be best suited for operational applications and tactical advice for fishery management. Best practice for applying multispecies models for tactical fishery management involves models of intermediate complexity which consider only the ecosystem components necessary to address the management objective of interest, thereby limiting uncertainty in model projections. More extensive applications in the future require institutional support (e.g., data and expertise) and changes to management protocols (e.g., revised standards, confronting multispecies tradeoffs); these efforts will require increased communication with broad stakeholder groups.

Keywords: Multispecies models, fisheries management, review

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CM 320: Shape your fish stock: Using a length- and age-based population model to find the optimal harvest strategy

Stefanie Haase, Sarah Kraak, Juan Santos, Daniel Stepputtis

Exploitation patterns and rates influence the size and demographic structure of fish stocks. Therefore, quantifying the potential effect of changes in fishing pressure and gear selectivity can aid in the identification of optimal strategies for the management of exploited fish populations. This study uses a dynamic population model to evaluate possible consequences of different management strategies applied to Western Baltic cod (*Gadus morhua*, L.). This stock was taken as case study, as it has been historically subjected to a heavy exploitation. Despite an increased mesh size from 110 mm to 120 mm in bottom trawls in 2010, the stock did not recover under high fishing mortality F , and since 2008 it is below Blim. Accounting for size-dependent selectivity, we apply a length- and age-based population model that simulates how selectivity of bottom trawls, intensity of F , and gillnet proportion affect (i) the SSB, (ii) catches above minimum conservation reference size (MCRS), (iii) catches below MCRS and (iv) the F at the length of full retention in the short- to long-term. Larger meshes result in short-term losses of catches which are compensated in the next years. The SSB increases and catches below MCRS decrease with mesh size. Reduced F leads to increased SSB, but also to short- to medium-term losses in catches above MCRS. For a sustainable management of fish stocks, fishing rate and fishing pattern should not be looked at individually but synergistically to find an optimal harvest strategy.

This paper is part of the Sarah Kraak kaleidoscope tribute session at ICES ASC 2022

Keywords: western Baltic Sea cod, gear selectivity, population-dynamics model, length- and age-based, yield per recruit

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CM 334: The social and economic impact of fisheries management strategies in European marine regions

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While ecosystem-based fisheries management (EBFM) is required to deal with the complexity and uncertainty of exploiting natural resources, it remains in its infancy, at least in Europe. To make it operational at a pan-European scale, a new collaborative project with 24 partners across Europe, SEAwise, aims to develop new insights into key social and ecological interactions of fisheries in the European Atlantic, Mediterranean and Baltic. The first step is to conduct systematic scoping reviews across a series of subjects to create the knowledge base that is needed, drawing from the wealth of information that exists. These subjects cover “social and economic aspects of fisheries”, “drivers of stock productivity”, “impacts of fisheries on key species and habitats”, “drivers of spatial distributions of fish and fisheries”, and “interactions in European socio-ecological fisheries systems”.

Fishing is a human activity that apart from an ecological dimension has various social and economic implications as well. In most countries, those implications are regulated by specific management strategies. In this study, we employ the PRISMA standardised approach to review the fisheries management strategies implemented in the different European marine regions and identify relevant indicators, models and tools that can be used to predict the effectiveness of these strategies, from a social and economic point of view. The results account for different fleet segments and scales, while providing insights across the variety of European contexts. This diversity of results provides a foundation of knowledge to support advice for policymakers and authorities when they are evaluating different management strategies and making consequential decisions.

Keywords: fisheries management, Social, Economic, European marine regions

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CM 354: Analysis of at-sea sampling bias from the Spanish bottom trawl fleet operating in Northwestern Iberian waters

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Co-authors: J. Rodríguez, H. Araujo, I. Salinas, M. Marín, J. Castro

At-sea observer programmes are a valuable independent source of data on fishing activities and key to estimate discards. Nevertheless, in order to ensure the quality of the data provided by these programmes is necessary to minimize bias and achieve a good representation of fishing operations. Major sources of bias are 1. inadequate sampling frame, 2. sampling bias and 3. observer bias, being the first two directly related with the vessel selection method. The Spanish at-sea sampling programme was established in 2003 following the European Data Collection Regulation (DCR) (Council Regulation (EC) No 1543/2000) with the aim of collecting discard volume and length samples from commercial catches on board the Spanish fleet. From 2003 until 2015, the programme was carried out thanks to the collaboration of vessels and fishing associations. In order to avoid the problems mentioned before regarding the possible bias introduced by the vessel selection, in 2016 a simple random sampling with replacement (SRSWR) was implemented, followed by a simple random sampling without replacement (SRSWOR) after 2017. The list of vessels included in this new selection procedure is obtained from the official census of active vessels. The new protocol includes also the recording of the responses given by contacted vessels, fitting their answers into 6 categories: 1. Accept the observer on board; 2. Refuse to take observers on board; 3. Refuse due to objective reasons (e.g. cannot accommodate observers); 4. Observer refuse to go on board; 5. No answer; 6. No contact details.

The aim of this work has been to analyse, in the Spanish bottom trawl fleet operating in ICES Divisions 27.8.c. and 27.9.a., the effect of both sampling designs: ad-hoc sampling from 2003 to 2015 and the simple random sampling implemented in 2016 until now. In a first step, bias from both sampling designs were analysed comparing official landings registered in logbooks versus landings data registered by observers at-sea. This preliminary approach showed significant differences between official and observers landings data during the ad-hoc sampling period, while these differences were not detected after 2016. Other fishery parameters were compared to assess potential bias and the responses given by the vessels were also analysed. We conclude that it is highly recommended to routinely perform analyses to identify and minimize possible bias that can jeopardize the quality of the data obtained by observers at-sea programmes.

Keywords: At-sea sampling, onboard sampling, ICES Division 27.8.c 27.9.a, bottom trawl

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CM 357: Using spatio-temporal models to provide compositional data for acoustic surveys: facilitating autonomous vehicle sampling and inferences on non-target species in a fishery resource survey program

Derek Bolser*, Aaron Berger, Dezhang Chu, Jim Hastie, Julia Clemons, Lorenzo Ciannelli

Pairing compositional (i.e., size, age) data with acoustic data is required to estimate fish biomass-at-age from an acoustic survey. Accordingly, considerable effort is expended to collect biological samples of the species or species complex of interest in most fishery resource survey programs. The need for biological samples limits the use of acoustic data collected by alternative platforms (e.g., autonomous vehicles) or surveys of non-target species for generating biomass-at-age indices for the stock assessment of a target species, even if the target species can reliably be identified in the acoustic data. However, compositional data from sources independent of the acoustic survey could be fit to spatio-temporal species distribution models and replace contemporaneously collected biological samples when their collection is not possible. We evaluated the validity of this procedure by examining a case study with Pacific Hake (*Merluccius productus*; 'hake') on the U.S. West Coast. Specifically, we generated estimates of compositional data with a vector-autoregressive spatio-temporal (VAST) model fit to a combination of fishery-dependent and fishery-independent data that were independent of the hake acoustic trawl (AT) survey. The performance of the VAST model was assessed with simulation testing and comparisons between VAST estimates of age composition and those from midwater trawls in the hake AT survey. The challenges we encountered when fitting the VAST model to a relatively rich dataset (e.g., data coverage, age class resolution, model stability in simulation testing) indicated that this approach may not be suitable in all situations, but our model produced estimates of age composition that were reasonably comparable to midwater trawls (+/- 10% over the entire domain, +/- 2% in data-rich regions). Our approach allows us to use acoustic data collected in an autonomous vehicle (Saildrone) survey and a non-target (coastal pelagic species) survey to estimate hake biomass-at-age, which dramatically increases the amount of data used to understand hake biomass distribution. Ultimately, the ability to differentiate species in the acoustic data and the potential for differences between survey platforms remain major hindrances to using estimates derived from this approach in a stock assessment, but ongoing research is addressing these challenges (e.g., development of machine learning algorithms, broadband acoustics research, inter-vessel comparisons). In an increasingly challenging funding environment, using spatio-temporal models to provide compositional data for acoustic surveys could allow survey programs to maintain historical coverage or leverage acoustic data from other survey programs, ships of opportunity, and autonomous vehicles to expand survey coverage.

Keywords: age composition; spatio-temporal models, acoustic surveys, autonomous vehicles, Pacific Hake

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CM 380: Where do you come from, where do you go: Inferring connectivity and stock mixing from otolith microchemistry

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The prerequisites for sustainable management of fish stocks is knowledge about the stocks geographic distribution and the extent of migration between adjacent management units. In recent decades the use of otolith chemical fingerprints for stock identification purposes has gained increasing interest. Owing to their time-keeping properties and their lifelong record of environmental history, otoliths are a useful tool for studying stock affiliation and individual fish's migration patterns.

Otoliths consist of calcium carbonate, organic matrix and small quantities of trace elements. Trace elements are absorbed primarily from the water across the gill surface and therefore provide a record of environmental conditions experienced by the fish. The chemical composition of the water depends on the geochemistry of the surrounding catchment and therefore provides an area-specific chemical "fingerprint", which is reflected in the fish's otoliths. Otolith chemistry has over the last three decades gained increasing attention as a tool for analysing fish stock dynamics, migration patterns, and connectivity between areas, and plays an increasingly important role as a fisheries management tool.

In this study we will demonstrate the power of this approach to identify the spawning origin and large-scale movement patterns of cod in the transition zone between the North Sea and the Kattegat, by combining genetic population identification with habitat assignments from hatch to capture from otolith microchemistry. This area is an ideal for such studies because the environmental conditions are dominated by a pronounced horizontal salinity gradient and a progressively more coastal-type environment in the Kattegat, Sound and western Baltic Sea compared to the North Sea. The cod stocks in these waters are known to consist of genetically unique populations with overlapping distribution areas. With the current low stock sizes of cod it is crucial to identify each stocks' spatio-temporal distribution for sustainable management.

Here we will show that 1) North Sea cod are spawned in the North Sea and enter the Kattegat before the end of their first winter. 2) Adult North Sea cod remain in the Kattegat without return migrations during that time, 3) Kattegat cod remain predominantly in the Kattegat throughout their lives, 4) Cod caught during the spawning season in the Sound spend variably time in the western Baltic Sea and the Kattegat. These results demonstrate the need for a stock assessment that takes these complex drift/migration patterns into account in order to avoid over-exploitation of the endemic Kattegat cod stock, and provides a first insight into movement patterns of the cod in the Sound.

Keywords: Atlantic cod, migrations, otolith microchemistry, spawning origin, stock mixing, genetics

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CM 387: Modelling effects of noise pollution on marine ecosystems

Maria Skartsæterhagen, Cecilie Hansen

Human impacts are changing the marine ecosystems of the world. In high-latitude ecosystems, retracting sea ice makes the areas even more accessible to human activities. The most important tool to foresee and predict the severity of human activities on marine ecosystem, are ecosystem models. One human pressure often excluded from these models, is the effect of anthropogenic underwater noise. In this work we have used a simple representation of noise pollution in the Atlantis ecosystem model for the Nordic and Barents Seas (NoBa Atlantis) to explore ecosystem effects of underwater noise.

As a pollutant, noise is inherently difficult to model. The main reason is the highly uncertain (for some unknown) vulnerability in different species to this pressure. Even though many species show behavioural changes and stress when exposed to noise, it is not known whether this have effects on the population level (for instance as a result of decreased time for foraging, less successful mating/spawning, more predation mortality). Organisms may also be habituated to noise over time, reducing the effect of the pressure. In addition, underwater noise from different sources have different characteristics and the propagation in water is dependent on underwater topology, temperature and more.

The noise module incorporated in Atlantis fetches the major differences in species reactions to noise, according to existing literature on noise sensitivity. This is a first implementation, and more nuances can hopefully be added on a later stage. Due to the high uncertainty in the ecosystem components response to noise, we have performed a sensitivity analysis (using Morris' method) to explore individual and combined response levels and the connected ecosystem effects to underwater noise. The study gives an overview of ecosystem responses to a range of sensitivity levels in species to noise. This is the first step towards a full-scale study of cumulative effects in the Nordic and Barents Seas.

Keywords: ecosystem model, underwater noise, noise sensitivity, atlantis

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CM 388: Key environmental drivers of productivity for the main commercial fisheries species around Europe

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While ecosystem-based fisheries management (EBFM) is required to deal with the complexity and uncertainty of exploiting natural resources, it remains in its infancy, at least in Europe. To make it operational at a pan-European scale, a new collaborative project with 24 partners across Europe, SEAwisE (<https://www.seawiseproject.org/>), aims to develop new insights into key social and ecological interactions of fisheries in the Western Waters, North Sea, Mediterranean, and Baltic Seas. The first step is to conduct systematic scoping reviews across a series of subjects to create the knowledge base that is needed, drawing from the wealth of information that exists. These subjects cover “social and economic aspects of fisheries”, “drivers of stock productivity”, “impacts of fisheries on key species and habitats”, “drivers of spatial distributions of fish and fisheries”, and “interactions in European socio-ecological fisheries systems”.

In this study, we focus on the impact of environmental drivers on the productivity of commercial species. Physical, biogeochemical, as well as ecological drivers are investigated, and their observed effects on the different aspects of fish productivity, such as reproduction, growth, maturation and survival are detailed. A systematic scoping review was conducted following the PRISMA EcoEvo approach, which led to the extraction of data from 802 relevant scientific articles. The resulting dataset is explored in both regional (Western Waters, North Sea, Mediterranean, and Baltic Seas) and European wide contexts. Here we present the accumulated knowledge of the key drivers, the scales and regional differences in which they have been documented, and synthesise their impacts on the productivity of exploited species, across regions. Ultimately, we highlight significant gaps in our understanding of commercial species productivity.

CM 389: Estimating migration and mortality rates for European sea bass (*Dicentrarchus labrax*) off the French coasts using electronic tagging data

Michel Bertignac, Edel Lheureux, Mickael Drogou and Mathieu Woillez

Recent concerns about the status of the populations of European sea bass (*Dicentrarchus labrax*) highlighted several limitations on the biological knowledge of that species and more specifically about its stock structure. Currently, the International Council for the Exploration of the Sea (ICES) assumes four stocks in its assessments, but these stock limits have been defined more on a practical basis associated with data availability than on biological and ecological knowledge. To better understand the spatial structure of the sea bass population off the French coast, among other methods, a tagging experiment has been carried out with data storage tag from 2010 to 2016. These data were first used in a geolocation model to reconstruct individual trajectories. In the present study, we develop a spatially structured population dynamics model of the tagged fish, discrete in space and time, to analyse these trajectories and estimate migration rates and fishing mortality. Parameter estimations are carried out by maximizing a likelihood functions based on both the location of the recoveries and the trajectories of the tagged fish in the discrete space of the model (i.e. that of the current stock units). Several model configurations are compared including constant or variable fishing mortality, separated commercial and recreational fishing mortality or alternative area boundaries. Results from this study could potentially help in a better definition of stock limits and/or in the incorporation of a spatial structure into the Stock Synthesis assessment model currently used to assess the European sea bass stocks in ICES.

Keywords: DST, geolocation model, exchange rates, spatialized population model, sea bass

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CM 393: Offshore wind energy, marine conservation and fisheries compatibilities using Ecopath with Ecosim model: Canary Islands case study

Couce, L., Abramic, A., Guerra, A., Jiménez, D., Castro, J.J.

The Canary Islands, a Spanish archipelago of volcanic origin located in the Central East Atlantic Ocean, have huge potential for renewable energy. In recent years, with the emergence of new floating technologies, the potential for Offshore Wind Energy (OWE) at the Canary Islands has improved vastly, as there are novel possibilities of installing facilities in deeper waters and going to offshore areas where wind strength is also more elevated.

Canary Islands as a biodiversity hotspot have established an extent network of marine protected areas (NATURA 2000) that manage conservation allowing the fisheries and other compatible maritime activities.

In this study we analyze (in)compatibilities with marine conservation, considering changes in marine biodiversity, positive and negative OWE impacts, as potential conflicts related to fisheries.

We applied Ecospace model to evaluate ecosystem responses to different scenarios: (i) consequences due to mortality changes of marine mammals and seabirds groups driven by killing or dispersion during the OWE exploitation; (ii) effect of floating wind turbines as fish aggregating devices; (iii) installation areas assigned as marine protected areas (MPA) with fishing exclusions within the area; (iv) combined effect of the proposed scenarios. Forcing functions were added to include the effect of climate change, taking into account variations in the consumption of selected functional groups and productivity in the study area.

Our results suggested that the Ecospace model could potentially predict the effects of OWE on marine ecosystems and fishing, and the capabilities and limitations of ecosystem models for use as complementary tools for marine spatial planning were evaluated. We discuss the compatibility of the OWE and fisheries in MPAs, and its potential to affect fisheries management in these areas.

Keywords: Ecopath with Ecosim, Ecospace, offshore wind energy, fishing, Natura 2000, Canary Islands

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CM 399: A method for quantifying benthic-pelagic coupling through a food web modelling approach

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Benthic-pelagic coupling (BPC) is a process of energy exchanges characterized by the combination of downward (pelagic to benthic) and upward (benthic to pelagic) energy pathways. This process is critical in the recycling of organic matter and energy between the benthic and pelagic domains. Trophic interactions between species belonging to different domains are critical in mediating energy exchanges. In addition, environmental characteristics could influence BPC traits at different temporal and spatial scales, as well as fishing activities that impact faunal communities.

In this contribution, a benthic-pelagic coupling index (BPCI) was developed to quantify the importance of species (or species groups) in BPC, focusing on the role of benthic and demersal species in the food web. The analysis was conducted using three mass balance models built using the Ecopath approach in the Calabrian, Apulian, and Gulf of Taranto areas (northern Ionian Sea, central Mediterranean Sea). The models described marine food webs using species aggregated into functional groups (FG), with their biomass ($\text{t km}^{-2} \text{y}^{-1}$) obtained from independent surveys, production and consumption rates (y^{-1}) from literature and empirical data, diet (%) from literature, landings and discards ($\text{t km}^{-2} \text{y}^{-1}$) acquired from official data.

BPCI was calculated for each FG by means consumption flows ($\text{t km}^{-2} \text{y}^{-1}$) estimated from each food web model. BPCI summarizes downward (dQf) and upward (uQf) flows of each FG, acting as both predators and prey. Thus, dQf and uQf were aggregated into pelagic, benthopelagic, demersal and benthic domains. High dQf values indicate the prevalence of pelagic-benthic coupling, while high values of uQf indicate the predominance of benthic-pelagic coupling. Moreover, BPCI allows to classify FGs as direct, mediating or partial couplers between pelagic and benthic domains.

BPCI results highlight the role of demersal species in supporting energy upwelling processes from the benthic to the pelagic domain. In addition, the role of deep faunal species is relevant to energy transfers from bathyal to shelf bottoms. Shrimps and Myctophids show the most important role as couplers in the food web playing an essential role in both downward and upward energy flows. *Aristaeomorpha foliacea*, *Hoplostetys mediterraneus*, Macrourids and *Plesionika martia* were relevant demersal couplers in the bathyal communities of both investigated areas. Differences in geomorphologic traits of the three modelled areas highlight the influence of environmental conditions, such as submarine canyons and the width of shelf platform, on the role of the species and BPC patterns.

Keywords: consumption flows, ecosystem modelling, energy transfers, downward and upward flows, Ecopath, benthopelagic species

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CM 417: Ghost fishing gear composition and hazard revealed through a citizen science initiative

Susanna Huneide Thorbjørnsen, Alf Ring Kleiven, Ann-Elin Synnes, Ingrid Disch Løset

The continued catch of fish and invertebrates by lost fishing gear is termed ghost fishing. It represents an animal welfare issue as well as a resource loss. We investigate the composition and hazard of lost fishing gear along the Norwegian coast using > 12,000 reports on ghost fishing gear recovered by volunteer, recreational divers. We evaluated the relative hazard of the different gear types based on their frequency and catch rate and found the parlor trap to be the most hazardous, followed by gillnets, fyke nets, wrasse traps and square collapsible traps. This can inform management in developing targeted efforts to prevent further gear loss and ghost fishing. Further, the gear types with the highest catch rates were parlour traps, large, square traps, wrasse traps and gillnets. These gear types could be targeted in future clean-up efforts to minimize resource loss. The brown crab (*Cancer pagurus*) was the species most often found in ghost fishing gear. Further, two vulnerable species, the red listed European lobster (*Homarus gammarus*) and the Atlantic cod (*Gadus morhua*), being at an historic low in the Skagerrak/North sea region, were also targeted. Gear hazard rates and catch rates from the Norwegian coast can be relevant to other countries with similar fisheries.

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CM 429: Spatial choice modelling of the Icelandic Northeast Atlantic mackerel fishery – What drives the behaviour?

Sandra Rybicki, Pamela J. Woods, Bjarki Þór Elvarsson, Sveinn Agnarsson, Daði Már Kristófersson

There is an increasing demand to understand the mechanisms driving changes in fishing behaviour in addition to ecosystem dynamics in order to facilitate the evaluation of management decisions and to reduce or avoid drastic and unintended socio-economic consequences. Socio-economic models, that can incorporate social and psychological knowledge, are useful tools to understand how and why short-term individual fishing decisions are made. Most existing studies focus on demersal fisheries, which are usually less selective than pelagic fisheries and target a larger number of species for which they have quota as well as a market channel. Yet, it is important to understand the behaviour of pelagic fisheries, especially in the context of climate change. An expansion of Northeast Atlantic mackerel (*Scomber scombrus*) towards the northwest partly resulting from increased biomass brought a new fishery to Iceland, generating 8% of Iceland's total catch in 2016. In this study, we first investigated the fleet structure in order to identify the major socio-economic attributes affecting vessel behaviour. To understand the impact of biological as well as socio-economic changes on individual fisheries behaviour and to therefore predict expected revenue, we fit a spatial choice model using biomass distribution, expected catch and distances (as a fuel/variable cost indicator), vessel attributes (as fixed costs indicators), fish price and processing type (frozen on board/ landed fresh/ fishmeal) as explanatory variables. The results provide an overview of the socio-economic and biological drivers of the mackerel fishery in Icelandic waters.

Keywords: Atlantic mackerel, bio-economic, spatial choice, expected rent, Iceland

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CM 432: Quantification of age reading error - linking fish aging to stock assessment modelling

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How can emerging techniques utilize age error data in the stock assessment process?

The estimation of the age composition of a stock is fundamental to the evaluation of its status. The age of a fish is estimated from an otolith, a calcified structure found in the fishes head which grows over time. Annual growth structures are laid down in the otolith and observed patterns are used to determine fish age. Routine ageing is conducted in age reading laboratories across the globe. The aim is to deliver age data for stock assessment purposes, for a set of samples that are representative of survey and commercial catches. Age data underpins growth and mortality rates, maturity patterns and eventually stock size. However, age estimation is a subjective process and thus variance between and within readers is expected, this can potentially lead to bias and imprecision in the estimated age composition of the population. The ICES SmartDots platform was developed in 2018 as a tool to support quality assurance procedures aimed at achieving a high level of age data quality. SmartDots age calibration events are image based interactive exercises which can be accessed online by multiple expert and trainee age readers. All registered data is available in a standardized format in the connected reporting environment with R-scripts producing statistical output indicating levels of age reader accuracy and precision. Recent efforts have been focused on incorporating the output (either the raw empirical data or the so-called Age Error Matrices (AEM)) from these exchange events into the stock assessment process. Currently three of the most widely used stock assessment models in the ICES community, SAM, Gadget and SS3 are capable of incorporating ageing error information. The ultimate aim of an ICES SmartDots event is to improve the reliability of the stock assessment. Various fora, from workshops and exchanges to working groups have identified the need for cross disciplinary cooperation between age readers, data quality managers, stock assessors and model developers as being necessary if this goal is to be reached. Guidelines exist for the organization and implementation of age reading events with the aim to produce the required data. A number of case studies have been proposed to cover the entire process, from the exchange event to the assessment process. Improving the reliability of the assessment, while being the ultimate goal will nevertheless enhance the efficiency of regional monitoring programs and support better informed sustainable management practices.

Keywords: age reading error, data quality, SmartDots, stock assessment

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CM 437: MetaZooGene SCOR WG157: toward a new global view of marine zooplankton biodiversity based on DNA metabarcoding and reference DNA sequence databases

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Marine zooplankton biodiversity remains a significant unknown throughout the global ocean. Molecular approaches, including DNA barcoding (use of short DNA sequences for species recognition and discrimination) and metabarcoding (large-scale taxonomic identification of complex samples via analysis of one or few orthologous DNA barcode regions), are expected to significantly revise global estimates of zooplankton diversity. MetaZooGene (see <https://metazoogene.org/>) is an international working group of the Scientific Committee for Oceanic Research (SCOR WG157) focused on continued development of integrative molecular – morphological taxonomic analysis of marine zooplankton biodiversity through international communication, cooperation, and collaboration. The MetaZooGene Barcode Atlas & Database (MZGdb, <https://metazoogene.org/MZGdb>) is an open-access data and metadata portal that is linked to NCBI GenBank and BOLD data repositories. The MZGdb global reference database provides advanced search functions by ocean region and taxonomic group. MetaZooGene (SCOR WG157) deliverables include publications and review papers in open access peer-reviewed journals. Additional goals include dissemination of best practices for DNA barcoding and metabarcoding of marine zooplankton. MetaZooGene has organized a Symposium, *New insights into biodiversity, biogeography, ecology, and evolution of marine zooplankton based on molecular approaches*, immediately following the ICES ASC 2022 (September 23, 2022). The MetaZooGene Symposium will provide a platform for participants to network and discuss interdisciplinary and innovative approaches to future zooplankton research. Early Career Scientists (ECS) are especially welcome and encouraged to participate and submit abstracts.

Keywords: MetaZooGene, zooplankton diversity, DNA barcodes, metabarcoding, ecosystem monitoring

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CM 454: Interactive methods to explore viewpoints in transnational marine spatial planning

Malena Ripken, Xander Keijser, Thomas Klenke, Igor Mayer

Marine Spatial Planning (MSP) has become increasingly important in recent years and, as such, has attained significant interest among the international community. MSP and related marine policy and governance have been characterized by diverse approaches and a lack of transnational cooperation and communication. Nevertheless, MSP can and should be considered a societal process to balance conflicting interests of maritime stakeholders and the marine environment towards healthy, resilient and productive oceans. The identification of mismatches and synergies, with the goal of creating a coherent and coordinated process at different Sea basins, is therefore essential. This study used the interdisciplinary 'Q Methodology' approach to elicit qualitative subjective data from international expert groups in Europe to identify viewpoints related to MSP in order to produce statistically valid results. The 'Q Methodology' combines quantitative and qualitative research characteristics, exploring and identifying viewpoints of actors. Additionally, the 'Living Q' method has been developed as an actor engagement tool and dialogue approach to systematically expand actors' awareness in regard to their viewpoints in an interactive, communicative and playful environment. It has been developed as an innovative advancement of the 'Q Methodology'. We were able to successfully implement and observe the pillars of the 'Living Q' method in action. The 'Living Q' method is an access to transnational MSP and highly valuable to investigate experts' perspectives to eventually add value to future planning processes and policy. Results from both, 'Q Methodology' and 'Living Q' demonstrate that these methods are capable of fostering communication and interaction among participating actors.

Keywords: marine spatial planning, Q Method, Living Q, actor engagement, policy, communication

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CM 465: Incorporating social aspects into trade-offs analysis to aid decision-making in fisheries management

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Understanding the underlying trade-offs in fisheries and marine social-ecological systems is important in designing effective policies and management interventions. The social aspects of fishing are often overlooked – especially in the context of trade-off analyses provided to help decision makers to manage fisheries sustainably. This paper presents the work around trade-offs being done by members of the ICES Working Group on Social Indicators (WGSOCIAL). The goal is to provide guidance in advising fishery managers confronted with multiple objectives at different scales (including ecological, social/cultural, economic and institutional). We look at how social aspects could be incorporated in trade-off analyses across diverse contexts toward sustainable fishery management. More specifically, we investigate potential social considerations in trade-off analyses for decision-making in five different contexts: A) a fishery is conflicting with an endangered/ protected species, with interventions impacting some fleets more than others; B) a proposed spatial marine activity (e.g., marine windfarms, petroleum developments, marine protected areas) conflicts with fishing activities; C) commercial species distributions change as an ecological response to climate change, and vessels are trying to adapt; D) the Total Allowable Catch (TAC) for a specific fish stock is allocated between various fishery participants; and E) managing fisheries via quotas or controlling effort. Finally, we discuss how to facilitate and to promote inclusion of these social aspects in decision-making.

Keywords: trade-off analysis, social aspects, fisheries, decision-making, sustainable management

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CM 471: 21st century fisheries management: Whatever happened to ‘Real Time Incentives’?

Debbi Pedreschi¹, Sarah B.M. Kraak², Hannes Höffle^{3,4}, Audric Vigier³, Amos Barkai⁵, Francois Bastardie⁶, Keith Farnsworth³, David G. Reid¹

First published in 2012, the Real-Time Incentives (RTI) approach is a novel fisheries-management concept in which fishing-mortality rates of multiple species and ecosystem impacts are regulated through a single ‘quota’ of fishing-impact credits, which fishers spend according to spatiotemporally varying tariffs. Species distributions are essentially ‘tracked’ as they change (also helping to alleviate ‘choke’ species issues that arise from mixed fisheries), and improved species biological and ecological knowledge can easily be incorporated. Managers set the tariffs based on target mortality rates of multiple species, using real-time information of the catchabilities of the species caught/impacted. Additional social, economic or ecological information can also be incorporated. The framework facilitates the implementation of the ecosystems approach to fisheries management, providing the innovative fisheries management essential for attaining the goals of “Blue Growth” and socio-ecological sustainability.

As one of the originators of the RTI approach, Sarah Kraak was instrumental in its conceptualisation, development, progression, and promotion. RTI brought together so many of Sarah’s key skills and interests, ranging from complex mathematical modelling, to solving real-world fisheries management problems, engaging stakeholders, and addressing social inequities while accounting for behavioural economics.

Here we present some of the updates and progress of the RTI concept, and where we hope to take it in the future, as a tribute to Sarah’s legacy.

This paper is part of the Sarah Kraak kaleidoscope tribute session at ICES ASC 202

Keywords: real-time incentives, fisheries management, ecosystems approach to fisheries management, spatio-temporal management, innovation.

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CM 476: Enablers and obstacles to conflict resolution in marine conservation: advocacy coalitions, events, brokering and policy-oriented learning in Swedish marine national park planning

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Our seas are under increasing pressure but lag behind in protection. Climate change, intensifying use and biodiversity loss challenge current practices and imply trade-offs between conservation and use. While nature conservation ranks high internationally, national protection attempts often result in controversies, with actors aligning in opposing advocacy coalitions – for and against the proposals. According to policy research, either events altering coalitions' relative power, brokering or policy-oriented learning can be ways to overcome controversies. The latter involves processes whereby actors gain new knowledge and experiences, leading to changed beliefs about the problems and possible solutions. Using interviews, document analysis and long term observation, we explored conflict resolution and its enablers and obstacles through a comparative longitudinal case study of three Swedish national park planning processes with different outcomes: Koster Sea national park, established 2009 and Nämdö archipelago, where national park planning is under way and Sankt Anna archipelago remaining without park. Our results suggest that our analytical perspective, combining the advocacy coalition- and institutional analysis and development frameworks with insights from conflict and participation research is applicable and helps mapping and understanding conflictive processes and draw practical conclusions. We found that external or internal events, combined with either policy learning or negotiated agreements, make important pathways to change. The influence of events on either learning or agreements was promoted by facilitating or brokering individuals. The type of policy beliefs (or conflict content) affects whether negotiations suffice or policy oriented learning is needed. This type of learning is facilitated by contexts where actors from both coalitions depend on the resource and its protection and have experience of collaboration, and where conservation planning is well integrated with other governance processes. Here, engaged key actors with moderate views facilitating interactions and able to identify common interests and deescalate conflicts are important – supported by various forums allowing exchange of knowledge and learning across coalitions. The latter being especially important in marine areas, where it is difficult to see what is happening underneath the surface. Authority actors play an important role for the quality of processes and the kinds of solutions possible. This research deepens our understanding of the preconditions for conflict management in conflictive marine conservation, suggests an analytical framework for further studies and recommendations for practitioners on what to consider when establishing protected areas.

Keywords: advocacy coalitions, conflict resolution, marine conservation, national park planning, policy-oriented learning

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CM 478: Effects of Marine Protected Areas (MPAs) on the diet composition and trophic structure of Mediterranean fishes

Hayley Campbell, Dr Deirdre Brophy, Dr Charlotte Sirot, Dr Joachim Claudet, Ginevra Lilli, Dr
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Ecosystem abundance and diversity has been widely researched in Marine Protected Areas (MPAs), however the effects of protection on ecosystem functioning and trophic structure is not well understood. Trophic dynamics are used as an indicator to identify well-functioning ecosystems. The presence of higher trophic level individuals and top predators signifies a productive ecosystem. This study uses analysis of stable-isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{16}\text{S}$) and stomach-contents to investigate how protection affects the structure and functioning of marine food webs. Mediterranean fishes and their prey were sampled within and outside of three MPAs; Cerbère-Banyuls, Côte Bleue and Bonifacio, along the south coast of France and Corsica from July to September of 2021. The study species included the relatively sedentary benthic *Scorpaena notata* and the more mobile pelagic *Diplodus vulgaris*. Bayesian mixing models are used to determine the relative contribution of prey to the diet of each species across a gradient of protection. The influence of protection on mean trophic position is examined. The research aims to improve understanding of the benefits of MPAs for marine ecosystems and inform MPA design and management.

Keywords: MPAs, Diet, Food Webs, Stable Isotope Analysis, Stomach Content Analysis

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CM 480: What is an indicator? Review of the use of socio-economic indicators to monitor and evaluate the social and economic impacts of fisheries management

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Indicators play a fundamental role as benchmarks, such as in whether for evaluating contributions made by fisheries to sustainable development, monitoring the implementation of international instruments, or when providing scientific advice and strategic planning. The use of appropriate indicators can help confirm and evaluate progress toward the goals we want to achieve. This includes indicators to measure progress on achieving global targets (e.g., Sustainable Development Goals, Aichi targets) and to measure impact of (policy) change, as well as achievement of national and local goals (e.g., improved stock levels, economic viability of a fleet, social inclusion, ethics). Many disparate efforts have looked at the social and economic impacts of fisheries management, as well as the contributions of fisheries management to social sustainability. However, despite the critical role that indicators play in monitoring and evaluation, there is neither a coordinated strategy nor a common set of indicators agreed upon by the scientific community. This publication presents a synthesis of work being done by FAO and the ICES Working Group on Social indicators to map and review the current use of indicators to assess and monitor social and economic sustainability in fisheries. We discuss what has been done over the last decade in the use of social and economic indicators in support of fisheries management and provide a comprehensive and synthetic summary of this use, including both quantitative and qualitative indicators. We provide context for how social and economic indicators can be used to measure fisheries sustainability, how indicators can inform progress towards the SDGs (e.g., nutrition, gender, employment data), and how they can be linked. We also assess what the minimum set of (social) indicators might be in order to measure the contribution of fisheries to (social) sustainable development. Lastly, we explore the role that such indicators have in measuring management performance and informing policy development, as well as the contributions of fisheries management to social and economic sustainability.

Keywords: socio-economic, indicator, fisheries, monitoring, evaluation, sustainability, management performance, policy development

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CM 487: EMODnet Seabed Habitats Products: EUSeaMap Development Pathways

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The European Marine Observation and Data Network (EMODnet) is a network of organisations supported by the EU's integrated maritime policy. These organisations work together to observe the sea, process the data according to international standards, and make that information freely available as interoperable data layers and data products with the overarching aim of facilitating blue growth.

Phase 4 of the EMODnet Seabed Habitats (ESH) project commenced in September 2021, and will run for 2 years through to 2023. The project aims to build on the existing data products hosted on the EMODnet Seabed Habitats Map Viewer and expand geographical coverage of the project to the Caspian Sea and selected EU territories in the Caribbean.

One of the objectives for ESH Phase 4 is to ensure the involvement of Regional Sea Conventions (RSC) and ICES in existing and new regions, so that their needs are met through the activities of the project and to increase the volume of data and data products available. This is achieved through a programme of engagement with RSCs, relevant ICES working groups and expert groups to gather feedback and needs of habitat data requirements and products that will help EU Member States to fulfil reporting requirements.

Deliverables will include an updated version of EUSeaMap, the broad-scale seabed habitat map for Europe. EUSeaMap is currently the only pan-European cartographic product that provides a standardised overview of the spatial distribution of seabed habitats across Europe. It is classified to EUNIS (2007 and 2019) and to the 'benthic broad habitat types' of the Marine Strategy Framework Directive (MSFD). As such, EUSeaMap is of particular use in cross-border ecosystem-based management decision-making. For instance, some EU Member States used it as part of the MSFD assessments in 2012 and 2019, and are using it for the next assessment. Recently, the European Environment Agency used it for the assessment, at a Europe-wide level, of i) cumulative impacts of human pressures on marine ecosystems and ii) the European Marine Protected Area network.

This paper will review the strengths and limitations of EUSeaMap and will identify potential development pathways. Informed through ongoing engagement with RSCs, ICES and expert groups, the project intends to identify other types of products that could supplement EUSeaMap, particularly in these applications for which it currently has limited use, and the conditions that should be met for these products to be implemented.

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CM 500: A continuous probabilistic model for the Rosa Lee phenomenon -or- grow your own lognormal

Cóilín Minto*, Daragh Browne, Shane Murphy, Ronán Cosgrove

Many marine taxa, including most fish, grow continuously with size being a key determinant of biological and extractive processes. Solely age-based models such as the Baranov system ignore length while others assume a constant length-at-age distribution. Where length-at-age is allowed to vary, continuous growth is often approximated using discretized time and length bins with growth transition matrices. Discretized length bins with transition matrices incorporating growth and survival among bins suffer discretization difficulties and only approximate continuous growth and mortality.

We study an alternative system where, for a given cohort, we admit implicit between-individual variability using a probability mass function that grows over time. To do so, we introduce the concept of a probability mass transfer function that provides the instantaneous rate of change of density at length at time.

To illustrate the system, we use lognormal variability around mean von Bertalanffy growth. Length-based natural and fishing mortality are then included. We posit that the system provides a viable alternative to present methods and more naturally links the population model with the true continuous nature of growth and mortality. This work was inspired by Sarah Kraak's interest in -and sharing of- the Rosa Lee phenomenon.

This paper is part of the Sarah Kraak kaleidosope tribute session at ICES ASC 2022

Keywords: growth, selectivity, fishery system, continuous time

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CM 531: Multidecadal trends in Norwegian and Barents Sea ecosystem dynamics since 1950

Szymon Surma*, Georg Skaret, Tony J. Pitcher, Mimi E. Lam

While the Norwegian and Barents Seas (NorBar) are frequently considered separate ecosystems, they are closely linked by physical oceanography (including the Arctic and Atlantic Water masses divided by a highly productive front) and the life histories of several ecologically and commercially important fish stocks. These include Norwegian spring-spawning (NSS) herring (*Clupea harengus*), a key forage fish, as well as Northeast Arctic (NEA) cod (*Gadus morhua*), and saithe (*Pollachius virens*), both major demersal predators. This paper reconstructs NorBar ecosystem dynamics since 1950 and attempts to disentangle the influences of physical forcing, trophic control, and fishing pressure on these dynamics. A mass-balanced ecosystem model was fitted to biomass and catch time series across all trophic levels from phytoplankton to whales. The nature and quality of fits to time series were employed to characterize the effects of climate, trophic interactions, and fisheries on ecosystem dynamics. Ecosystem trends were also quantified using indices of functional diversity (Kempton's Q) and trophic structure. Results revealed mixed control of ecosystem dynamics by climate, predator-prey interactions, and fishing pressure. Depth-integrated (0-200 m) ocean temperature trends directly and strongly influenced fish stock and ecosystem dynamics. The triangular pattern of top-down trophic control involving adult NEA cod, juvenile NSS herring, and capelin in the Barents Sea was confirmed. Top-down and bottom-up control dominated the boreal and polar communities, respectively. The Atlantic Meridional Oscillation was correlated positively with sea surface temperature and primary production and negatively with salinity and wind speed since the mid-1990s, suggesting a positive effect of climate-driven increased stratification on phytoplankton. Functional diversity declined and "fishing down the food web" occurred since 1950. An overall U-shaped trend of initial decline and at least partial recovery, driven largely by ocean temperature, characterized several important NorBar fish stocks (e.g. NEA cod, saithe, Greenland halibut *Reinhardtius hippoglossoides*, blue whiting *Micromesistius poutassou*, and NSS herring), while baleen whale populations experienced gradual recovery. These results suggest that climate change, trophodynamics, and fishing pressure should all be considered in fisheries management in the NorBar ecosystem.

Keywords: Norwegian Sea, Barents Sea, NorBar, climate forcing, trophic interactions, ecosystem dynamics, ecosystem modeling, Ecopath with Ecosim

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CM 532: The seascapes Norwegians value

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The coastline of Norway is among the longest in the world, estimated at over 100,000 km, owing to its numerous peninsulas, inlets, islands, holms, and skerries. Norway's mainland and islands are surrounded by the Skagerrak, North Sea, Norwegian Sea, Barents Sea, and Greenland Sea. Consequently, 80% of the Norwegian population lives close (within 10 km) to the ocean. Thus, historically, marine industries have been key to the country's development and wealth. Culturally, Norway is known as a maritime nation. While few conflicts existed between traditional marine industries, such as fisheries and maritime transport, controversies are brewing with the increased range and spatial expansion of ocean-based industries, such as petroleum, aquaculture, and more recently, offshore windmill farms, seabed mining, and ocean carbon storage. The intensified focus with the Blue Economy on new ocean resources has increased the complexity of coastal and marine spatial planning. In the *Managing Ethical Norwegian Seascape Activities (MENSA)* project, funded by the Research Council of Norway, we aim to develop an integrated ethical approach to the sustainable management of Norwegian seascape activities. To do this, we are analyzing the value-tradeoffs among diverse seascape activities by engaging the values, identities, and knowledge of Norwegian marine stakeholders (e.g., government representatives, scientific experts, industry members, and non-governmental organizations), as well as citizens. Here, we present the preliminary results of a survey of a large representative sample of the Norwegian population. Respondents (n = 1000) were asked about their activities, identities, and values related to the Norwegian seas, as well as their opinions on various current marine resource debates, notably around offshore windmill farms. We show the importance of various dimensions of seascapes (e.g., pleasantness, arousal, and openness) in shaping marine values and identities, both at the individual and community levels, and discuss their relevance to managing marine resources and evaluating policy trade-offs. This research shows that if decision-makers are to design policies that reflect the vision desired by society, then it is important to engage the broader citizenry, and not just marine stakeholders, in public debates and research on the management and use of shared marine resources towards ethical marine governance.

Keywords: seascapes, values, trade-offs, ethical governance

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CM 534: DNA metabarcoding of diet diversity of salps and impacts on the NW Atlantic mesopelagic food web

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Gelatinous zooplankton are important grazers in the mesopelagic food web, but their diet and trophic impacts are unclear. One group, salps (Tunicata), includes species that are efficient filter feeders with extensive vertical migration behaviors that transport energy through the mesopelagic zone. We report results from field expeditions of the Ocean Twilight Zone program in the NW Atlantic Ocean. Diet composition was determined through DNA metabarcoding analysis of gut contents of two salp species: *Salpa aspera* and *S. fusiformis*. Metabarcoding allows highly precise and broad coverage information about the diet of salps, and is yielding new insights into the pathways and dynamics of pelagic food webs. Salps were collected in vertically-stratified tows of a 1-m² MOCNESS in the NW Atlantic Slope Water during March of 2020. DNA was extracted from salp gut contents and sequenced for V4 and V9 hypervariable regions of the 18S rRNA gene. Taxonomic assignment of V4 and V9 sequences and Operational Taxonomic Units (OTUs) were resolved and classified using custom scripts and reference databases. Multivariate statistical analysis was used to compare prey composition between the two salp species in 4 depth strata at 5 stations. DNA metabarcoding analysis of the diets of the two species was used to examine trophic relationships, infer sources of productivity, and evaluate the impacts of salp vertical migration in particle and energy transfer in mesopelagic food webs.

Keywords: MetaZooGene, zooplankton diversity, DNA barcodes, metabarcoding, ecosystem monitoring

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CM 551: How current generation MSP plans are conceptualising social impacts

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Marine/Maritime Spatial Planning (MSP) has become one of the most widely applied area-based management approaches around the world (Ehler et al. 2019). Now that the first plans have been completed by many countries, attention is shifting towards implementing and evaluating MSP plans. Questions are being raised concerning the impact of MSP and whether it is delivering on the ambitious promises it is setting out to achieve.

It is notable that MSP is still largely framed by language surrounding blue growth and biodiversity. While sustainable or balanced maritime development is a commonly stated aim of MSP, plans rarely refer to the social dimension of sustainability. Recent literature has begun to address some aspects related to social sustainability, such as power relations and representation of stakeholders, as well as the distribution of the costs and benefits associated with MSP decisions. Although some MSP plans explicitly aim to enhance the well-being of coastal communities or address certain social groups, no systematic analysis has so far been conducted on how social sustainability or social impacts of MSP are being conceived and implemented by current generation MSP plans.

This paper presents the results of an empirical study on social impacts of maritime spatial plans. Drawing on plans from Europe, North America, Canada and Africa, we analyse how they conceptualise social aspects and “social impact”, including whether they contain explicit social objectives (such as enhanced community well-being). We also analyse whether the plans address specific groups of beneficiaries, e.g. to ensure fairness of participation and /or distribution. Lastly, we describe indicators that have been developed to measure the achievement of social objectives. Our sample covers different types of plans, scales and geographical contexts in order to yield a broad overview of the range of concepts and approaches employed.

The paper draws on a two-part workshop held in October and November 2021 and the work of the ICES Working Group Marine Planning and Coastal Zone Management.

Keywords: marine spatial planning, social impacts, social sustainability

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CM 552: A new laboratory to investigate the impact of multiple drivers on ocean life

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Large- and small-scale changes in the ocean environment are impacting ocean life and ecosystems. From a management and conservation perspective it is important to understand how these changes will affect marine organisms and ecosystems. To achieve this goal, we need to use a variety of complementary research methods including experimentation.

We present a new state-of-the-art experimental laboratory that is well equipped to study how different environmental drivers affect a variety of marine organisms. The laboratory is set-up within the Aquaculture Research Station operated by the Marine and Freshwater Research Institute, Iceland. The station, which is located on the volcanically active Reykjanes peninsula, makes use of fresh groundwater, geothermally heated water (60°C) and borehole seawater that has been naturally filtered through the basalt bedrock.

The laboratory consists of 45 tanks with a diameter of 60 cm, permitting research on a variety of organisms such as fish, invertebrates, and algae. It is possible to alter five temperatures simultaneously (9 tanks per temperature) and manipulate carbon chemistry (CO₂/pH) in each tank separately. First experiments aim to test the impact of temperature and CO₂/pH and the interaction of these drivers on early life stages of fish. Other environmental parameters can be altered in future experiments, such as light, food availability and salinity.

CM 564: Variability in reproductive parameters of European hake, *Merluccius merluccius* in the Portuguese Coast

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Understanding life history parameters and particularly reproductive traits are the basis for assessing population productivity and a priority for stock management. The estimate of the length at which 50% of the population appears sexually mature (L50) is an important parameter of life history. The estimation of this parameter under different maturity ogives and values of length at maturity must be carefully analyzed, as it is a basic feature of biological reproduction and could inform fisheries management decisions to improve selectivity and prevent fishermen to catch undersized fish. This study investigates the annual changes in maturity and reproduction patterns for European hake, *Merluccius merluccius* from three distinct areas of the Portuguese coast, characterized by oceanographic patterns. A total of 8939 specimens were sampled monthly between January 2006 and December 2013. Total lengths (TL) of all sampled individuals ranged from 17.6 cm to 86.1 cm. Preliminary results indicated that the females were larger, ranging from 20 cm to 86.1 cm TL, while males varied from 41.5 cm to 70 cm TL. The sex ratio was dominated by males ranging from 20–40 cm TL, while females were more abundant from 50 to 86 cm TL. The gonadosomatic index values showed similar spawning conditions between males and females; a peak in the first months of the years (January-March) and in summer months (July to August). Hepatosomatic index and Fulton's condition index reached the highest values in the second semester of all years analysed. The length at first maturity (L50) was estimated by macroscopic and histological data over 8 consecutive spawning seasons. An increase of the L50 in females from 27 cm in 2006 to 39 cm in 2013 was observed. Differences in interannual spawning reproduction patterns are analyzed under changing environmental conditions (e.g. Sea Surface Temperature). By using generalized linear and additive models (GLMs and GAMs), changes in length at first maturity, reproductive activity and body condition indices will be explored. Also, for the first time in this area, relative fecundity will be estimated. The analysis of variability reproductive parameters plays a fundamental role in the sustainable management.

Keywords: *Merluccios merluccius*; reproductive variability; Macroscopic maturity scale; Histology

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