COMMON OCEANS PROGRAM

Deep-sea fisheries project

Symposium on applying the Ecosystem Approach to Fisheries Management in ABNJ

11-13 March, 2025

FAO Headquarters - Rome, Italy

ABSTRACTS

More information on the symposium website:
https://eafm-symposium.nafo.int

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Morning

Introducing the symposium

Welcome Remarks

Speaker: **Manuel Barange**
Assistant Director-General and Director, Fisheries and Aquaculture Division, FAO

The Director presented his welcoming speech to the participants of the symposium.

Applying the Ecosystem Approach to Fisheries Management in ABNJ

Speaker: **Tony Thompson**
Deep-sea Fisheries Project, FAO, Rome, Italy

This presentation serves as a background document to the "Applying the Ecosystem Approach to Fisheries Management (EAFM) in the ABNJ" symposium to be held at FAO in Rome, Italy, on 11–13 March 2025. The symposium focuses on the deep-sea (ds)RFMOs who manage demersal and small pelagic species not managed by other organisations. They are also mandated to consider the effects of fishing on the wider ecosystem. The principles are set out in the FAO Ecosystem Approach to Fisheries Guidelines (FAO, 2003), that defines three major components: ecological wellbeing, human wellbeing, and ability to achieve. This symposium focus only on ecological wellbeing. Fletcher (2020), in his review, identified three sub-components: retained species, non-retained (discarded) species, and ecosystems. These will serve to guide the symposium. He concluded that many aspects of EAFM are already being undertaken by the dsRFMOs, but they would benefit from a more coordinated approach and longer-term targets. Day 1 of the symposium focuses on the science to support EAFM, Day 2 on the science-management interface and management, and Day 3 on the implementation of EAFM. The symposium concludes with two panel sessions aimed to identify the science and management responsibility for implementation, and the process considerations for implementation of EAFM by dsRFMOs.

FAO. 2003. The ecosystem approach to fisheries. *FAO Technical Guidelines for Responsible Fisheries.* No. 4, Suppl. 2. Rome, FAO. 2003. 112 p. https://www.fao.org/3/a-y4470e.pdf

Fletcher, W.J. 2020. A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). Rome, FAO. https://www.fao.org/3/cb1509en/CB1509EN.pdf

Biography

Anthony (Tony) Thompson attained his doctorate in parasitology from Aberdeen University in 1983. He then worked at the Pacific Biological Station in Nanaimo, Canada, on stock identification in shrimp and salmon, before moving back to the UK to work at the Fish Lab (now CEFAS), Lowestoft, on early life history stages of marine fish. In 1990, he shifted emphasis and worked in supporting the sustainable fisheries sector in Lake Malawi/Nyassa for ten years, followed by a four year period in Banglandesh promoting the uptake of research into wild and farmed freshwater stocks in five Universities. This was followed by another change in direction to join the Northwest Atlantic Fisheries Organization (NAFO) as the Secretariat's scientific coordinator. Tony took up a consultancy in 2010 with FAO, Rome, working on the Deep-sea project supported by GEF. He is current working on Phase II (2022-2027).

DAY 1 - Science to support EAFM

An introduction to EAFM – how science is working to support EAFM in the North Atlantic

Keynote speaker: **Colm Lordan**
ACOM Chair, ICES, Copenhagen, Denmark

ICES provides advice on fisheries management for over 260 stocks in the North Atlantic advising on between 5-8 million tonnes of catch each year. In addition, ICES provides advice on the impact of fishing in the marine environment and ecosystems through recurrent and special request. ICES has developed fisheries, ecosystem and aquaculture overviews which summaries the main pressures and changes in the ICES ecoregions. This presentation summaries how ICES is developing toward more holistic science and advice for ecosystem-based management. Examples of key advice products such as those on VMEs, trade-offs related to benthic impacts, by-catch of ETP species will be presented and discussed. The recent NEAFC request on ecosystem Approaches to Fisheries Management will also be presented and discussed. Past learnings and future developments such as the ICES Framework for Ecosystem Informed Science and Advice (FEISA) will be discussed.

Biography
Colm Lordan Is chair of the advisory committee ACOM In ICES since December 2023. He works closely with advice requesters and stakeholders to communicate the advice and to ensure that the scientific advice, underpinning data and evidence address their needs. Prior to taking the helm of ACOM, Colm was based at Marine Institute in Galway, Ireland for more than two decades, working to develop the best available integrated scientific advice, evidence and information for decision-makers. Colm has been involved in ICES assessment and advice work since 1999, chairing over 20 expert groups. He was a member of ACFM in the early 2000s and ACOM Vice-Chair between 2018 and 2021.

He has a broad range of research interests and over 100 publications on topics including mixed fisheries, *Nephrops,* cephalopods, spatial fishing activities, industry data collection, and reference points.

Session 1.1 Retained species

Sustainable Fisheries: Mitigating the Ecological Impacts of Removing Commercially Valuable Fish and Shellfish on Marine Ecosystems

Speaker 1: **Patrícia Gonçalves**
Portuguese Institute for Sea and Atmosphere – IPMA, Portugal

Effective fisheries maintenance is essential for ensuring the long-term health of marine ecosystems and the sustainability of commercial fishing activities. The ecological consequences of removing commercially valuable fish and shellfish highlight the importance of maintaining balanced fisheries. By focusing on the interactions between retained species and their environment, existing research studies underscore the cascading impacts on biodiversity, trophic dynamics, and habitat structures. Understanding these effects is crucial for developing management practices that balance economic benefits with ecological integrity. Additionally, sustainable fisheries maintenance strategies can help mitigate negative impacts and promote the resilience of marine ecosystems. The trade-off between the health of marine ecosystems and the impact of conservation measures on the social and human resources involved in fisheries must also be considered. However, the question still remains: how close are we to integrating these main drivers into routine stock assessment models?

Biography

Patrícia Gonçalves is a marine researcher at the Portuguese Institute of Sea and Atmosphere (IPMA, Portugal). The main focus of her research is in Marine Biology, Fisheries, Stock Assessment, Biological Parameters (e.g., fish growth and reproduction), and Sampling Design. Since 2022, Patrícia has been a member of the NAFO Scientific Council, focusing primarily on stock assessment. She is involved in several workshops and working groups at the International Council for the Exploration of the Sea as a participant (since 2004) and also as a coordinator (since 2007). Additionally, since 2018, coordinates the Descriptor 3 “Commercially exploited fish and shellfish” for the Portuguese mainland subdivision under the Marine Strategy Framework Directive (MSFD).

CCAMLR’s ecosystem approach to fisheries

Speaker 2: **Steve Parker**
Science Officer, CCAMLR

The Convention on the Conservation of Antarctic Marine Living Resources is an international agreement established under the Antarctic Treaty System to conserve Antarctic marine living resources and is an integral part of the Antarctic Treaty system. The Convention applies to all marine living resources within the Antarctic marine ecosystem. CCAMLR’s approach to the conservation of Antarctic marine living resources is defined by Article II of the Convention, which combines two central concepts; a ‘precautionary’ approach, aiming to minimise the risk of long-term effects rather than delaying decisions until all necessary data are available, and (ii) an ‘ecosystem approach’, taking into account the relationships between organisms. The Commission has progressed an ecosystem approach to fisheries through agreeing a combination of precautionary fisheries management targets, pre-emptive measures to constrain effects to small areas, the use of specific gear types with strong bycatch mitigation measures, and extensive data collection through an observer program to better understand ecosystem dynamics. Data collection includes information regarding compliance, fishery operations, biological sampling, ecology of target, dependent and related species, and environmental data needed to support science. Through these approaches, the Commission seeks to manage or avoid significant ecosystem effects.

Biography

Dr Parker took up the post of Science Manager at CCAMLR in 2021. He manages a science team that supports and advises the CCAMLR Scientific Committee on topics such as data collection systems for vessels, scientific observers and ecosystem monitoring programmes, stock assessments, development of marine protected areas, monitoring the effects of climate change, monitoring the ecosystem effects of fishing, and policy development to meet the objective of the CCAMLR Convention.

Dr Parker is originally from the USA where he worked on supporting stock assessment and improving sustainability of commercial and recreational fisheries on the west coast and Alaska. He came to CCAMLR from New Zealand where he worked for 14 years as an Antarctic fisheries scientist advising the New Zealand government on marine ecosystem and fisheries management issues. He is a veteran of eight Antarctic expeditions in the Ross Sea region, working from vessels and from research camps on the sea ice, and has spent many months at sea on research vessels. His Antarctic research focuses on toothfish ecology, ecosystem effects of fishing, survey design, fish tagging and telemetry, and biological inputs into stock assessment.

NEREIDA project: Analysis of VMS and Logbook data to study the bottom fishing footprint in the NAFO Regulatory Area

Speaker 3: **Mar Sacau Cuadrado**
Instituto Español de Oceanografía (IEO-CSIC), Spain

In 2006, the United Nations General Assembly (UNGA) adopted Resolution 61/105 on Sustainable Fisheries, urging states and Regional Fisheries Management Organizations (RFMOs) to take action to protect Vulnerable Marine Ecosystems (VMEs) in the high seas. In response to this call, the Northwest Atlantic Fisheries Organization (NAFO) has led substantial international efforts over the past decade to delineate and protect cold-water corals and sponges. As part of these efforts, fourteen closed areas around the high-seas portion of the Grand Bank and Flemish Cap were adopted to protect deep-sea coral and sponge habitats from the impacts of bottom-contacting fishing gears. These closures are supported by the identification and mapping of VME polygons, as well as the definition and analysis of fishing effort, which is an important step when applying the ecosystem approach to fisheries management.

The NEREIDA project, funded by the European Union through the NAFO Secretariat, conducted an analysis to better understand the distribution and intensity of bottom fishing effort and its overlap with VMEs previously identified by NAFO. The analysis covered a seven-year period (2016–2022) and was primarily based on two key data sources: haul-by-haul logbook information and Vessel Monitoring System (VMS) data. By combining these datasets, comprehensive fishing footprint maps showing the intensity and spatial extent of cumulative fishing and specific fisheries were produced. An overlay analysis was then performed to assess the extent to which VME polygons overlapped with fishing footprints. The results showed that logbook data and VMS are complementary, and when combined, they provide a powerful approach for assessing the spatial distribution of bottom fishing on VMEs, with higher spatial resolution compared to the simple speed filter methodology.

Biography

Mar Sacau is a senior researcher at the Instituto Español de Oceanografía (IEO-CSIC), where she has worked since 2003. As a marine scientist specializing in deep-sea fisheries, her research focuses on the impact of bottom fishing on Vulnerable Marine Ecosystems (VMEs). She analyses the distribution of fishing effort and its overlap with benthic communities, particularly in NAFO-managed waters. She co-chairs WGESA and WGEAFFM, key NAFO working groups focused on ecosystem assessment, and has been a member of its Scientific Council since 2009. In addition, she has led international projects focused on fisheries sustainability, including the NEREIDA Project. Committed to scientific outreach and training, she participates in conferences, engages in workshops on fisheries management and marine conservation, and has taken part in numerous oceanographic research surveys. She collaborates with stakeholders to support science-based decision-making for sustainable fisheries and marine conservation. With extensive experience in research, international collaboration, and policy advising, she provides valuable expertise in deep-sea ecosystem conservation.

Afternoon

Environmental Control on the Productivity of a Heavily Fished Ecosystem

Keynote speaker: **Frederic Cyr**
Fisheries and Marine Institute, Memorial University of Newfoundland

Environmental Control on the Productivity of a Heavily Fished Ecosystem Sustainable fisheries management requires an understanding of the links between environmental conditions and fish stock populations, especially in the context of climate change. From this perspective, identifying phases where ocean climate fluctuations and changes in ecosystem productivity coincide could provide a powerful tool to help inform fisheries management. Using more than 70 years of climate and fisheries data, this study shows that the Newfoundland and Labrador (NL) ecosystem productivity, from primary producers to piscivorous fish, changes in relative synchronicity with the climate of the northern hemisphere over decadal time scales. Such correspondence between the climate and lower and higher trophic levels has not been achieved previously in the Northwest Atlantic in the context of fisheries. This work advances ideas for incorporating environmental knowledge into fisheries management on the NL shelves, or in other regions facing similar dynamics.
Pre-print: https://doi.org/10.21203/rs.3.rs-4108948/v1

Session 1.2 Discarded and vulnerable species

Methods and challenges for identifying vulnerable marine ecosystems as part of an ecosystem approach to fisheries management: perspectives from SPRFMO

Speaker 1: **Ashley A. Rowden**
National Institute of Water & Atmospheric Research (NIWA), NZ

Vulnerable marine ecosystems (VMEs) face a continued threat from fishing, and a likely threat from climate change. However, despite the publication of guidelines and criteria to assist in the identification of VMEs, and scientific studies that have attempted to operationalise these definitions, it is often practically difficult to identify or predict the occurrence of VMEs with a high degree of certainty. As such there is a degree of contention in discussions and actions aimed at effectively protecting VMEs from the threats they face. This presentation will draw on experiences from research conducted for the South Pacific Regional Fisheries Management Organisation (SPRFMO), and make limited comparison with work from other RFMOs, to illustrate this issue. The first part of the presentation will focus on identifying VMEs as well as methods for assessing the impact of the threats they face. The second part of the presentation will highlight how information about VMEs is integrated into SPRFMO's ecosystem approach to fisheries management through its overall 'Bottom Fishery Impact Assessment' and 'Conservation and Management Measures'. Successes and failures to practically identify and protect VMEs will be highlighted to identify potentially useful avenues for future research, and the challenges that remain. The presentation will conclude with reflections on how we can perhaps better integrate current and future understanding of VMEs, and other discarded (non-retained) bycatch species, into ecosystem management for the High Seas.

Biography
Ashley Rowden is a Principal Scientist - Marine Ecology at the National Institute of Water and Atmospheric Research, and a Professor of Marine Biology at Victoria University of Wellington, New Zealand. His research interests are largely focused on examining the drivers and processes that control and maintain biodiversity in the marine environment. Specifically, he's interested in exploring the relationship between the biodiversity of

seafloor fauna and habitat heterogeneity, productivity, and disturbance. To understand these relationships, he has been involved in research in a range of marine habitats from the intertidal to the deepest depth of the ocean. Some of his research has concerned applied aspects of marine science: such as determining the effects of fishing, aquaculture, and seabed mining on seafloor fauna, and the production of habitat suitability models, environmental classifications, and ecological risk assessments for conservation and management purposes, including for fisheries management.

GFCM actions to monitor and mitigate bycatch in the Mediterranean and Black Sea

Speaker 2: **Paolo Carpentieri**
Fishery Resources Monitoring Officer, GFCM

Understanding bycatch, including both discards and incidental catch of vulnerable species (i.e. elasmobranchs, sea turtles, seabirds and marine mammals), as well as dolphin depredation, is crucial. Adopting effective measures to reduce these interactions is key to minimizing their impact, conserving marine ecosystems, and ensuring the long-term biological, economic and social sustainability of the fisheries sector. For the Mediterranean and the Black Sea, information on discards and incidental catches of vulnerable species is still relatively scarce and/or not yet fully available to fishery managers. Systematic data collection and studies are needed to better understand the different types of impacts, fill knowledge gaps, and identify which types of fishing gear have the greatest impact, as well as whether fishing patterns reveal any geographical or seasonal trends allowing to identify high risk-areas.

In this context the General Fisheries Commission for the Mediterranean (GFCM) has made significant progress, including through adopting ad-hoc recommendations, publishing protocols with standardized methodologies, implementing monitoring programmes and awareness campaigns, launching different pilot projects on the implementation of adequate monitoring, testing and development of mitigation measures to reduce the bycatch. Additionally, the GFCM recently endorsed the resolution on “Regional Plan of Action to Monitor and Mitigate Interactions Between Fisheries and Vulnerable Species in the Mediterranean and the Black Sea”. This plan emphasizes the need for the development of effective monitoring programs and the testing of mitigation measures by 2030, with specific goals to reduce dolphin depredation, incidental captures of vulnerable species, and related fishing mortality.

Biography

Paolo Carpentieri is the Fishery Resources Monitoring Officer at the General Fisheries Commission for the Mediterranean (GFCM). With extensive experience in resource monitoring and data collection, he plays a key role in supporting GFCM's initiatives. His work focuses on planning, organizing, and overseeing the implementation of discards monitoring programmes, the incidental catch of vulnerable species, and the testing of selectivity and mitigation measures. Additionally, he contributes to the implementation of scientific surveys at sea (both pelagic-acoustic and demersal), and to the integration of eDNA into fisheries monitoring.

Recent steps towards incorporating assessment of impacts to vulnerable and discarded bycatch species into ecosystem-based management of fisheries in the NPFC Convention Area and pathways for future improvement

Speaker 3: **Chris Rooper,** Canada

Research Scientist, Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, British Columbia, Canada

Abstract: Fisheries in the North Pacific Fisheries Commission (NPFC) Convention area focus on small pelagic species in the Kurioshio-current ecosystem (e.g. Pacific saury, Japanese sardine, mackerels and squids) and bottom fishes at seamounts (e.g. Sablefish, North Pacific Armorhead and Splendid Alfonsino). To date, most of the ecosystem research and ecosystem-based management in this region has focused on mitigating risk and preventing bottom-fishing impacts to vulnerable marine ecosystems (VME) at seamounts. The primary tools used in managing VME have been related to identifying areas of high probability of VME presence through modeling, underwater camera surveys and mapping areas of elevated VME species bycatch to identify and implement spatial closures. This has been a process that has generally followed examples from other RFMOs (primarily NAFO and SPRFMO), but has suffered from a paucity of ecosystem data. Concern for other ecosystem components, such as discarded fish bycatch species, has increased in recent years due in part to perceived changes in the ecosystem and fisheries characteristics. For instance, much of the effort targeting Pacific saury and sardine has shifted eastward into the Convention Area following changes in fish distribution and abundance. Some measures have been put in place to protect specific components of the bycatch, for example in 2024 a ban on Pacific salmon retention was enacted in the Convention Area. These measures are one way to address and mitigate ecosystem risks, but the impact of the fisheries both in terms of directed bycatch and removal of species, as well as indirect impacts of removing a large biomass of small pelagic fish from the system are largely unknown. Systematic data collection and sharing, both in terms of scientific surveys and better data on discarded bycatch (including VME species) in the fishery are needed to more fully evaluate the impacts of these fisheries on the North Pacific ecosystem. These new or enhanced data could then support better and more robust analysis tools, such as ecosystem models, that can integrate information and serve managers more effectively, leading to a more fulsome way to assess the impacts of removing all bycatch on the ecosystem and the services it provides.

Biography

Dr. Chris Rooper is a Research Scientist with Fisheries and Oceans Canada at the Pacific Biological Station in Nanaimo, British Columbia, Canada. Dr. Rooper's research is focused on developing and applying new methods for estimating fish and invertebrate abundance, distribution and habitat use. For the last 15 years he has been working with colleagues in Canada, Alaska, and the U.S. West Coast to apply advanced stereo-optic technologies to conducting in situ surveys of deep-sea corals and sponges and rockfishes. His research has integrated fisheries acoustics and stereo-optics to conduct non-lethal surveys of small pelagic and other fishes, as well as studying their behaviour and role in the ecosystem. Much of this work has been done to support or validate species distribution modeling and ecosystem approaches to fisheries management. More recently, Dr. Rooper has been working with colleagues to collect data on international fisheries in the North Pacific that can be used in stock assessment, modeling vulnerable species, and risk management. Dr. Rooper received his B.S. from Oregon State University, M.Sc. from the University of Alaska, Fairbanks and Ph.D. from the University of Washington.

Session 1.3: Ecosystem effects and spatial management

Setting thresholds for good ecosystem state in marine seabed systems

Speaker 1: **Jan Geert Hiddink**
Bangor University, UK

One of the aims of environmental management is to achieve good ecosystem state. The ecosystem approach to fisheries management requires balancing the state of the wider ecosystem with fisheries yield. Assessing the ecosystem state needs to be informed by thresholds above which state is defined as good for both the quality that defines good state, and the extent of the habitat that needs to be in such a quality. Operationalizing such thresholds has been carried out using a wide variety of approaches, with, often, haphazard and subjective outcomes. Here, we review approaches for setting good-state thresholds and evaluate their strengths and weaknesses for application to marine seabed ecosystems. Only two approaches defined a current ecologically meaningful good state and estimated thresholds quantitatively from data, while two other approaches (avoid collapse and allow recovery) would result in a state that could recover to good in the future. Other methods were subjective in the choice of threshold or based on statistically detectable thresholds rather than thresholds between good and not good or degraded state. We argue that the most objective method for setting a good-state threshold is based on maintaining the state within the range of natural variation in undisturbed systems. Preliminary time-series analyses of marine seabed community biomass suggest this threshold is located between 54 and 79% of the undisturbed state.

Biography

Jan Geert Hiddink is a professor in Marine Biology at Bangor University, UK. His current research focuses on understanding the impacts of human activities, particularly fishing, on marine seabed ecosystems. A key area of his work examines how bottom trawling affects seabed habitats, biodiversity and carbon stocks. He collaborates internationally to develop sustainable fisheries management practices by assessing the ecological footprint of trawling and designing strategies to mitigate its negative effects. He is a member of the SPFRMO Scientific Committee and chair of the ICES Working Group on Fisheries Benthic Impact and Trade-offs.

Unseen but Connected: Exploring how Connectivity affects the EAFM

Speaker 2: **Ellen Kenchington**
Senior research scientist, Bedford Institute of Oceanography, Department of Fisheries and Oceans, Canada, Dartmouth, Nova Scotia, Canada

Movement is a key property of connectivity occurring over a range of spatial scales, and can be active or passive; the former involving directed movement behaviour as seen in migration corridors or foraging ranges, while the latter involves transport by physical processes that displace organisms and their larvae or eggs. Dispersal drives population dynamics, community structure, adaptation and speciation and so is an essential component to consider in an EAFM. In NAFO, connectivity has been considered in a number of different contexts and applications. The spatial structure of physical and biological features helped to inform the establishment of three nested spatial scales that were identified as relevant for the development of ecosystem summaries and management plans: Bioregion, Ecosystem Production Unit (EPU), and Ecoregion. Genetic connectivity has also helped to determine stock structure in a number of species including Northern shrimp, Atlantic cod, Greenland halibut, Redfish, Capelin and others. For sessile and sedentary benthic species such as the coral and sponge vulnerable marine ecosystem (VME) indicators, connectivity within and among high density patches is a key process influencing colonization. In such species, connectivity is governed by larval transport, predominantly mediated through ocean bottom currents. However, protection of vulnerable marine ecosystems (VMEs) in the high seas has focused on identifying concentrations of indicator species and prohibiting the operation of bottom-contact fishing gears where those occur in significant concentrations. Most VME indicator species have planktonic larvae and depend on dispersal networks for inter-generational persistence. Yet, connectivity amongst patches of VME has seldom been considered when spatial management measures are introduced. Recently, NAFO has used 3-D Lagrangian particle tracking and agent-based models to examine connectivity networks of both the closed areas and the VMEs in support of an EAFM. As part of the 5-year reassessment of VME fishery closures, the projected connectivity among closures for similar species and habitats and the proportion of the biomass protected, together inform the assessment of the protection status of the VMES and the need for management actions. Connectivity networks were constructed and the effects of habitat loss simulated by systematic removal of whole patches, to determine the importance of each patch to connectivity within its respective network. A wide variation in connectedness showed that some patches are much more critical than others to the long-term persistence of the VMEs, providing a foundation for prioritization of conservation actions. Further, connectivity is a key element of the Kunming-Montreal Global Biodiversity Framework (KM-GBF) and one of the criteria for evaluating closed areas as Other Effective Area-Based Conservation Measures (OECMs). The connectivity work undertaken by NAFO informed the grouping of area closures to protect Large-Sized Sponge and Sea Pen VMEs in their OECM evaluations.

Biography

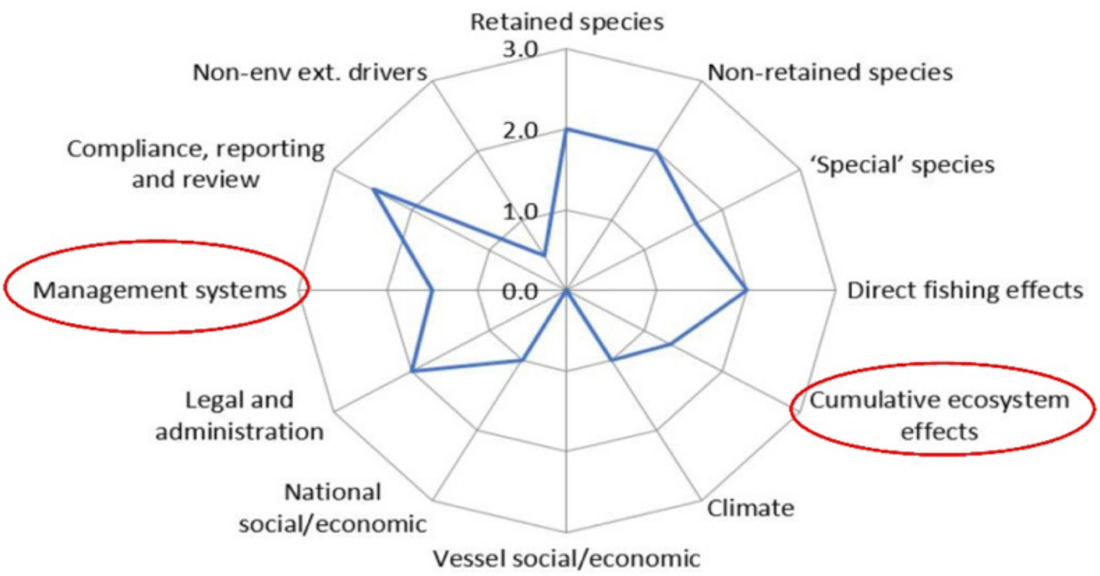
Ellen Kenchington is a senior research scientist with the Department of Fisheries and Oceans, Canada, based at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. She is a national and international authority on marine biodiversity and the impacts of fishing, and has participated in numerous related expert panels and committees. Her work in delineating deep-sea habitat has been an essential element of the successful international process to identify vulnerable marine ecosystems in response to international policy. She is a long-standing member of the NAFO Scientific Council Working Group on Ecosystem Science and Assessment (WG-ESA), and of the joint ICES/NAFO Working Group on Deep-water Ecology (WGDEC).

Implementing the Ecosystem Approach in SIOFA

Speaker 3: Marco Milardi
Science Officer, SIOFA Secretariat, La Reunion

The Southern Indian Ocean Fisheries Agreement (SIOFA) has progressively integrated the ecosystem approach to fisheries management (enshrined in Article 4a of the Agreement) to ensure the sustainable use of marine resources. A component of this approach is the development of an ecosystem summary by the Secretariat, providing a synthesized overview of ecological interactions, species distributions, and potential fishing impacts. This summary informs the Scientific Committee’s recommendations, supporting evidence-based decision-making. In applying the ecosystem approach, SIOFA has implemented measures to mitigate ecosystem effects, in particular the impact of fisheries on sharks, seabirds and vulnerable marine ecosystems (VMEs). For sharks, risk assessments guide conservation efforts, while for seabirds and VMEs, bycatch mitigation measures align with international best practices. VME management focuses on spatial management through the identification and protection of ecologically significant habitats, integrating precautionary measures to minimize bottom fishing impacts. By synthesizing ecological data and fostering adaptive management, SIOFA advances ecosystem-based fisheries governance. Continued refinement of the ecosystem summary and risk-based management strategies will be essential to balancing conservation and sustainable resource use in the region.

Summary of EAF implementation by SIOFA (where 1 = Partly; 2 = Mostly; and 3 = Fully)



Reproduced from: A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). 2020. W.J. (Rick) Fletcher, ABNJ Deep Seas Project, FAO

Biography

Dr. Marco Milardi serves as the Science Officer for the Southern Indian Ocean Fisheries Agreement (SIOFA). In this role, he coordinates international fisheries science efforts, focusing on data collection and analysis to inform conservation and management measures. Dr. Milardi holds a habilitation as a Full Professor in Ecology, reflecting his extensive expertise in ecological research. His work is instrumental in promoting sustainable fishing practices and ensuring the long-term health of marine ecosystems in the region.

DAY 2

Day 2 - Science-management interface and management

Morning

The Ecosystem-Approach to Fisheries Management under International Law

Keynote speakers: **Blaise Kuemlangan**[a] and **Dani Diz**[b]
[a] *Chief, LEGN, FAO, Rome, Italy*
[b] *Associate Professor, Lyell Centre, Heriot-Watt University, Edinburgh, UK,*

Key international treaties support the application of the ecosystem approach to fisheries management (EAFM), and are supplemented by policy instruments, including several FAO guidelines, which help interpret and implement relevant obligations under those treaties. This keynote address will focus on the legal obligations concerning EAFM under the 1982 United Nations Convention on the Law of the Sea and the 1995 Fish Stocks Agreement, and how the relevant provisions contained in these treaties are supplemented by (and incorporate by reference) relevant policy instruments, such as United General Assembly Resolutions on sustainable fisheries with regards to bottom fishing standards, and the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas in relation to the protection of vulnerable marine ecosystems.

Biography
Daniela Diz is an Associate Professor at the Lyell Centre, Heriot-Watt University, UK, specialised in international ocean governance. Dani has over 25 years of experience in the field of environmental law and oceans governance, with her main research area focusing on international marine biodiversity law and policy. She participates as expert at UN and other international meetings related to the law of the sea, marine biodiversity and fisheries, and conducts policy and legal studies related to marine biodiversity conservation and sustainable use to UN agencies, international organisations, governments, and civil society.

Session 2.1: Ecosystem Approach to Fisheries Management – managers' perspectives

Managing the science-management interface

Speaker 1: **Liz Mencher**
NOAA, USA

Past, Present, and Future – the development of EAFM

Speaker 2: **Stefán Ásmundsson**
Special Advisor on Ocean Affairs and Fisheries at the Icelandic Ministry for Foreign Affairs, Iceland

Biography
Stefán Ásmundsson is Special Advisor on Ocean Affairs and Fisheries at the Icelandic Ministry for Foreign Affairs. He is well known in international circles regarding fisheries, ocean affairs and law of the sea after being a prominent participant in many different international fora for twenty-five years. He holds an LLM in International Law and International Relations, where he specialised in the international legal regime for fisheries.

An important part of Mr Ásmundsson's work has been in relation to Regional Fisheries Management Organisations (RFMOs). His role has been most prominent in NEAFC, where he has represented Iceland, is currently President (having also previously served as President of NEAFC 2007-2009) and was Executive Secretary 2011-2017. Mr Ásmundsson has also been an active participant in organisations including NAFO and ICCAT and in coastal State consultations. During 2009-2011 he worked for the European Commission on the reform of the Common Fisheries Policy.

At the global level, Mr Ásmundsson is the Chair of the recently established FAO Sub-Committee on Fisheries Management. He is Iceland's Head of Delegation at FAO COFI and has been an active participant in several FAO Technical Consultations and expert workshops, including as Chair, and was Chair of the FAO-organised Regional Fisheries Bodies' Secretariat Network. Mr Ásmundsson has also worked with a number of other global bodies, including UNEP, DOALOS and CBD. He has been Co-Chair of the CBD-organised Sustainable Ocean Initiative – Global Dialogue since its inception.

A fisheries manager's perspective on EAFM at NAFO

Speaker 3: **Kate Johnson**
Senior policy advisor, Fisheries and Oceans Canada, Ottawa, Canada

Canada is the primary coastal State to NAFO and has a specific stake in the long-term sustainability of NAFO-managed stocks, most of which straddle Canada's EEZ. As such, Canada has taken on a leadership role at NAFO, including to advance EAFM through scientific work, working group discussions and in negotiations at the Commission.

NAFO has a long and varied history of incorporating the ecosystem approach into the management of its fisheries, including:

1) The implementation of measures to reduce bycatch of non-target species, in particular stocks under moratoria and shark species.
2) The definition of NAFO's fishing footprint, which limits bottom fishing to a small segment of the NAFO Regulatory Area, and the establishment of a rigorous exploratory bottom fishing protocol should a Contracting Party vessel wish to fish outside of that delineated area.
3) The implementation of area-based bottom fishing closures to protect VMEs within the fishing footprint and the protection of all seamounts at fishable depths (located outside of the footprint).
4) The adoption of an ecosystem reference point, which aims to account for limitations in the ecosystem in terms of total fisheries production potential and inform the Commission's management decision-making to avoid ecosystem level overfishing.

One of NAFO's key vehicles for these successes is its joint working groups, which unite fisheries scientists and managers in less formal settings to work through challenging issues and make recommendations to the Commission. One of NAFO's three such joint bodies is the Working Group on the Ecosystem Approach Framework to Fisheries Management, or WG-EAFFM. Much of the progress NAFO has achieved in its incorporation of the ecosystem approach into its fisheries management would not have been possible had the organization relied on formal processes alone (i.e., the Scientific Council's provision of advice and the Commission's subsequent negotiations). In more challenging cases, even less structured approaches have been required, such as workshops and open dialogues. Practical simulation exercises enabled managers, as well as stakeholders, to contribute more openly and consider how novel approaches could be applied in the context of multilateral negotiations, and what limitations exist.

Biography

Kate Johnson is a senior policy advisor with Fisheries and Oceans Canada, based in Ottawa, Canada. She has worked in the international fisheries policy/management world since 2013. Prior to working on the Northwest Atlantic Fisheries Organization (NAFO) file for the last 5 years, she has also participated on Canada's delegation to other RFMOs including the Western and Central Pacific Fisheries Commission (WCPFC), the Inter-American Tropical Tunas Commission (IATTC), the North Pacific Anadromous Fish Commission (NPAFC) and the North Atlantic Salmon Conservation Organization (NASCO).

Session 2.2: Reconciling sustainable harvest with biodiversity conservation – science-management interface

The ecosystem approach to fisheries management in the Mediterranean and the Black Sea

Speaker 1: **Betula Morello**
Senior Fishery Officer, General Fisheries Commission for the Mediterranean (GFCM)

Authors: **Elisabetta B. Morello** and the **GFCM fisheries team**

The Mediterranean and Black Sea region has exceptional geographic, ecological, and cultural significance and peculiarities. It is home to rich biodiversity that supports a diverse range of marine multispecies fisheries. Fisheries are integral to the Mediterranean and Black Sea economic and social fabric, significantly supporting livelihoods and requiring sustainability be addressed in a holistic manner by considering the entire system – encompassing biological, environmental and socioeconomic aspects alike – towards ensuring a sustainable food production system. However, overfishing, habitat degradation, and the impacts of climate change, among others, have led to increasing pressures on all aspects of this system.

The General Fisheries Commission for the Mediterranean (GFCM) is a regional fisheries management organization (RFMO) that plays a critical role in fisheries governance in the region, having the authority to adopt binding recommendations for fisheries conservation and management and for aquaculture development. It therefore plays a pivotal role in advancing the ecosystem approach to fisheries management (EAFM) in the region and integrating it into fisheries governance.

Despite significant progress, challenges persist in the implementation of EAFM, including geopolitical issues, data gaps, economic pressures, and the impacts of climate change. Overcoming these obstacles requires robust scientific data, improved management frameworks, enhanced cross-border collaboration and a streamlined advisory process. GFCM's commitment to strengthening EAFM provides an implicit roadmap for achieving sustainable fisheries in the Mediterranean and the Black Sea, but further efforts are needed.

This presentation will explore how EAFM is applied in the Mediterranean and Black Sea through the advisory process of the GFCM, making use of examples, while also identifying and addressing the challenges ahead, including adaptation to climate change, enhanced regional cooperation, and the critical role of capacity development and high-quality science in fostering sustainable fisheries management.

Biography

Elisabetta Betulla Morello is a quantitative fisheries ecologist by training and Senior Fishery Officer at the General Fisheries Commission for the Mediterranean. She holds a PhD in marine biology from the University of London. In 2010, after ten years spent at the Italian National Research Council working on the impacts of fisheries and stock assessment, she moved to Australia where she worked for the Commonwealth Scientific and Industrial Research Organisation (CSIRO) on models of intermediate complexity for ecosystem assessments, as well as on the impacts of human activities on tropical and subtropical ecosystems. In 2015, she obtained a senior Marie Curie Fellowship looking at the application of models of different complexities to the same demersal fishery and management question. She joined the GFCM in 2017, where she now leads the GFCM Fisheries Team, supervising strategic planning and ensuring effective implementation of the GFCM workplan on fisheries, as well as liaison with government officials and experts from the region and beyond, and representation of the GFCM in strategic partnership and relevant global initiatives.

Trade-offs between fishing opportunities and VME fishery closures: Establishing practical and sustainable management measures

Speaker 2: **Andrew Kenny**
Principal Ecosystem Scientist, Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Lowestoft, Suffolk, UK

Fishing vessel tracking using satellite-based Vessel Monitoring Systems (VMS) is a routine undertaking by RFMOs and is mandated for all larger vessels which typically operate in the high-seas. In addition, VMS data is increasingly being linked to log-book daily catch records and in some instances to higher spatial resolution haul-by-haul data. At the same time, all bottom fishing RFMOs have Conversation and Enforcement Measures which require the recording of encounters with VMEs (above certain thresholds), and in some instances RFMOs also document all VME indicator species taken as bycatch irrespective of quantity caught. Sources of fishery independent survey data are also used to capture information on VME indicator taxa and VME element distribution (e.g. seamounts, ridges, steep slopes), especially when such data are used in combination with species and habitat distribution modelling techniques. Establishing effective VME conservation measures, through VME fishery closures, not only requires identifying the location and extent of VMEs, but also the need to consider the impacts of such measures on any actual or potential overlapping/ nearby fishing opportunities. Several additional factors, both in terms of the fishery and the sustainability of VME functions, must be taken into consideration when agreeing a final set of measures. For example, the history of the fishery, it's commercial value and any specific navigation or operational gear constraints in where or how fishing gears are deployed; the design and connectivity of proposed VME closures, the proportion of VME habitat protected versus VME habitat unprotected , and consideration of climate change effects on habitat suitability. Combined this information can lead to VME fishery closures which maximise the protection of biodiversity whilst sustaining existing and future fishing opportunities.

Biography
Dr Kenny is a Principal Ecosystem Scientist at CEFAS (Centre for Environment, Fisheries and Aquaculture Science). He is Chair of the International Council for the Exploration of the Sea (ICES) Steering Group on Human Activities, Pressures and Impacts (HAPISG). Dr Kenny is part of the UK Delegations to the Northwest Atlantic Fisheries Organisation (NAFO) and the North East Atlantic Fisheries Commission (NEAFC) advising on deep sea Vulnerable Marine Ecosystem (VME) management measures and Other Effective area-based Conservation Measures (OECMs). Dr Kenny is a marine benthic ecologist and ecosystem scientist with over 30 years of experience conducting research into the effects of various typse of human activities on the seabed environment. He has published over 60 scientific papers and articles on a wide range of subjects, including impacts of bottom trawling activities on deep sea Vulnerable Marine Ecosystems (VMEs), seabed habitat mapping, ecological risk assessment and modelling benthic ecosystem food-webs. Research publications: Google Scholar Contact Details: andrew.kenny@cefas.gov.uk

Vulnerable Marine Ecosystems: the ICES Experience in Controlling and Communicating Spatial Uncertainty in Advice

Speaker 3: **Neil Campbell**
ICES Secretariat, Copenhagen, Denmark

This presentation explores the International Council for the Exploration of the Sea (ICES) approach to managing and communicating spatial uncertainty in its advice on the identification and protection of Vulnerable Marine Ecosystems (VMEs). As deep-sea ecosystems face increasing anthropogenic pressures, effective protection requires robust methodologies that acknowledge and communicate varying levels of certainty in scientific advice.

The ICES framework incorporates multiple data streams—biological observations (including VME habitat classifications and VME index scores), physical oceanographic data, and human impact assessments through Vessel Monitoring System (VMS) data—to categorize areas where VMEs are known to occur (higher certainty) or likely to occur (lower certainty). This approach operates within established guidelines from the FAO and EU Deep Sea Access Regulation, focusing specifically on EU waters at 400-800m depths.

To address inherent uncertainties, ICES has developed a scenario-based assessment methodology that transparently communicates confidence levels in different data sources. Five distinct scenarios (A-E) with varying inclusion criteria allow policymakers to select protection approaches based on their risk tolerance and precautionary preferences. Buffer zones extend protection around known VME areas, with distances calibrated to fishing gear impact potential.

The presentation highlights known data quality challenges and outlines corrective measures implemented to maintain advisory integrity. Looking forward, ICES plans a 2027 benchmark to transition from the current VME index approach to predictive habitat modelling, incorporate static fishing gear considerations, and refine VMS effort measurements by depth.

This work exemplifies how scientific organizations can effectively bridge the gap between complex ecological uncertainty and actionable policy advice for marine conservation.

Afternoon

Dialogue and participatory processes at the science-management interface: Making ecosystem overfishing considerations operational within the NAFO Roadmap for an Ecosystem Approach to Fisheries

Keynote speaker: **Mariano Koen-Alonso**
Marine ecology and fisheries scientist, Fisheries and Oceans Canada (DFO), St. John's, Newfoundland and Labrador, Canada

The Northwest Atlantic Fisheries Organization (NAFO) is the Regional Fisheries Management Organization (RFMO) that manages deep-sea fisheries in the high seas of the Northwest Atlantic. Since 2007 NAFO has been working on developing and implementing an ecosystem approach framework for the organization. This framework is known as the NAFO Roadmap for an Ecosystem Approach to Fisheries (Roadmap). The architecture of the Roadmap integrates the scientific information and advice needed to deliver an ecosystem approach, with the structure and regular operations of NAFO. This means that translating the science within the Roadmap into operational management applications requires working at the science-management interface.

NAFO is organized around two main bodies, the Commission (COM) and the Scientific Council (SC), where the former is responsible for making management decisions and the latter is responsible for providing the scientific advice to inform those decisions. While this separation is important to maintain the integrity of the scientific work, making the different components of the Roadmap operational requires an enhanced dialogue and deeper collaborations between managers and scientists. Although the work of scientists and managers is guided by the general principles and goals in the NAFO Convention, the perspectives on how to approach them can be quite different. There are multiple and competing trade-offs at play, and how best to deal with those often depends on where we stand. The creation of joint COM-SC working groups provided a venue where some of these differences can be discussed, including the management implications of the science supporting the ecosystem approach, and the management mechanisms needed to put that science into practice.

The Roadmap evaluates the sustainability of fisheries catches at different levels of ecological organization (ecosystem, multispecies, and stock levels). At the ecosystem level, this includes considering ecosystem overfishing (i.e. aggregated catches from an ecosystem should not exceed what the ecosystem can sustainably produce). In 2022 NAFO adopted the Total Catch Index (TCI) and its associated framework as the basis for an Ecosystem Reference Point (2*TCI). In the long process leading to this adoption, discussions at the COM-SC joint working group were critical to identify and address management concerns that permitted the articulation of the science into an acceptable management mechanism. Key steps in this process included the peer-review of the science itself, the maturation of the perception of the science by managers and stakeholders, and the refinement of the management mechanism to make the concept operational. This last step was implemented through a participatory exercise where scientists, managers, and stakeholders role-played a couple of alternative implementations in a simplified scenario that mimicked NAFO decision-making process. The outcomes of this exercise demonstrated that the Ecosystem Reference Point could be effectively integrated within the NAFO process. Since its adoption, the advice on ecosystem overfishing has been enhanced by including a scoping for upcoming years, and has been included within the standard request for stock advice from COM to SC.

Biography
Mariano Koen-Alonso is a marine ecology and fisheries scientist at Fisheries and Oceans Canada (DFO) based in St. John's, Newfoundland and Labrador. He took his first steps as a scientist in his native Argentina, moving to Canada in 2000 to further his education. Since the early 2000s he has been working at DFO on understanding the functioning of marine ecosystems in the Northwest Atlantic, and using the knowledge gained to develop tools and frameworks for the implementation of ecosystem approaches in Canada and the Northwest Atlantic Fisheries Organization (NAFO). Over the years he has been involved in many collaborations working towards getting ecosystem approaches off the ground around the world.

Session 2.3: EAFM and the tuna world

Progress and Challenges in Implementing the EAFM in tuna RFMOs

Speaker 1: **Hilario Murua**
Senior Scientist, International Seafood Sustainability Foundation (ISSF)

Authors: **Hilario Murua**, **María José Juan-Jorda**, **Ian Cartwright**, **Joseph Zelasney**, and **Alejandro Anganuzzi**

A major challenge in implementing the Ecosystem Approach to Fisheries Management (EAFM) in tuna Regional Fisheries Management Organizations (tuna RFMOs) is operationalizing it within the context of international tuna fisheries. While progress within tuna RFMOs may seem limited, numerous instances exist where elements of EAFM have been integrated into fisheries science and advisory practices. However, there remains a need to develop a formal EAFM operational plan tailored to the unique characteristics and specific needs of each tuna RFMO.

Since the 1990s, significant scientific advancements have been made regarding EAFM. During the first phase of the Common Oceans Tuna Project (2014–2019), two joint tuna RFMO meetings on the implementation of EAFM were organized. These meetings contributed to defining EAFM within the context of tuna RFMOs and determining actionable steps for operationalizing it. Key achievements included identifying essential elements for inclusion in an EAFM plan and establishing a structured process for its implementation.

This process involves initiating dialogue among managers, scientists, and other stakeholders at the outset, defining specific objectives and commitments, and establishing methods for monitoring progress and successes—critical aspects that must be effectively communicated to the public. The workshops identified four key steps for advancing EAFM implementation within tuna RFMOs: (i) Commission approval and establishment of an EAFM implementation process, including assigning necessary work to relevant subsidiary bodies; (ii) Preparation of an EAFM plan, with each tuna RFMO adapting its elements to meet specific needs; (iii) Implementation of the plan; and (iv) Monitoring and evaluation of EAFM implementation. These four steps were discussed further in a third workshop held on January 21–23 at FAO Headquarters in Rome. This workshop brought together a diverse group of managers, scientists, and other relevant stakeholders to advance EAFM implementation within tuna RFMOs. The outputs of these workshops, particularly the outcomes of the latest workshop, are presented here.

Biography

Hilario Murua (PhD) is a Senior Scientist at ISSF with more than 25 years of experience working on fish population dynamics, assessment and management. In recent years he has mainly focused his research on population dynamics of fish species and reproductive potential studies of fishes. Actually, he is working on population dynamics of tropical tunas and is member of the International Commission for the Conservation of Atlantic Tunas (ICCAT) and Indian Ocean Tuna Commission (IOTC) Scientific Committee, where was the chair of the Scientific Committee between 2015 and 2018. He was the chair of the Tropical Tunas Working Party of IOTC till 2014 and the Rapporteur for Bigeye of ICCAT until 2018, and regularly attends the Working Groups on Ecosystem and Bycatch. He has been involved in several EU funded projects related to biology, assessment and management of fish species being the Coordinator of the EU funded TXOTX project (Technical Experts Overseeing Third country Expertise- nº 212188), EU funded project Provision of scientific advice for the purpose of the implementation of the EUPOA sharks (MARE/2010/11) and the UE Framework Contract– EASME/EMFF/2016/008 - for the provision of scientific advice for fisheries beyond EU waters. He was also member of the Scientific, Technical and Economic Committee for Fisheries (STECF) from 2010-2018. He regularly supervises master and PhD students and has published more than 120 peer reviewed papers, coedited 5 special fishery journal volumes, and contributed over 250 working documents in various RFMOs. His h10-index is 128. Google Scholar: Hilario

Ongoing efforts to operationalize the Ecosystem Approach to Fisheries Management (EAFM) in tuna Regional Fisheries Management Organizations (RFMOs): practical tools and advisory products

Speaker 2: **Maria Jose Juan-Jorda**
Instituto Español de Oceanografía -CSIC, Spain

Authors: **Maria Jose Juan-Jorda**[1], **Valeria Allain**[2], **Diego Alvarez-Berastegui**[3], **Eider Andonegi**[4], **Dan Crear**[5], **Martin Cryer**[6], **David Die**[7], **Leanne Fuller**[5], **Shane Griffiths**[5], **Laurie Kell**[8], **Jon Lopez**[5], **Simon Nicol**[2], **Joe Scutt**[2], **Hilario Murua**[9]
[1]Instituto Español de Oceanografía (IEO, CSIC), Centro Oceanográfico IEO - Sede Central, Madrid, Spain; [2]Oceanic Fisheries Programme, Fisheries Aquaculture and Marine Ecosystems Division, Pacific Community,

Noumea, New Caledonia; [3]Instituto Español de Oceanografía (IEO, CSIC), Centro Oceanográfico de Baleares, Palma de Mallorca, Spain; [4]AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Sukarrieta, Bizkaia, Spain; [5]Inter-American Tropical Tuna Commission, La Jolla, CA, USA; [6]Consultant, CCSBT ERSWG Chair; [7]Highly Migratory Species Branch, Sustainable Fisheries Division, NOAA Southeast Fisheries Science Center; [8]Centre for Environmental Policy, Imperial College London, London, UK; [9]International Sustainable Seafood Foundation, Washington, DC, USA

This talk summarizes ongoing efforts to operationalize the Ecosystem Approach to Fisheries Management (EAFM) within tuna Regional Fisheries Management Organizations (RFMOs). Various tools and products have been developed or are under development as a proof of concept to integrate bycatch, ecosystem, and climate science into fisheries management advice. Key ecosystem-based tools include: 1. Spatial frameworks for identifying ecologically and operationally meaningful spatial units (ecoregions) for ecosystem-based planning and research (ICCAT, IOTC, under consideration in IATTC). 2. Ecological risk assessments (ERAs) for prioritizing species vulnerable to tuna fishing and climate change (produced in all the tuna RFMOs), and 3. Ecosystem models and indicators for evaluating past, present and future effects of tuna fishing and the environment on marine ecosystems that could elicit management action (IATTC and WCPFC, and under development in ICCAT and IOTC). Key ecosystem-based products include: 1. Ecosystem reports - Ecosystem Considerations Reports (IATTC), Overview and status Reports (WCPFC) and Ecosystem-Fishery Overviews (as pilot studies in ICCAT, IOTC) for documenting the scope of the fisheries, their dynamics within ecosystems, interactions with vulnerable taxa and other relevant background information to provide integrated research and scientific advice. 2. EcoCards and associated Ecosystem Status Assessments for providing an evidence-based description for commissioners and stakeholders of the state of the ecosystem, using trends and status of selected indicators (with associated thresholds linked to management objectives) that best represent effects of fishing and the environment on multiple ecosystem components (under development in all tuna RFMOs). These tools and products aim to support both strategic and tactical decision-making, enhancing ecosystem-based planning, research, and communication across tuna RFMOs. Examples from each tuna RFMO will illustrate progress, benefits and challenges in developing and using these tools and products to guide EAFM implementation.

Biography

Dr. Juan-Jordá is a Senior Researcher at the Spanish Institute of Oceanography (IEO-CSIC). As a marine ecologist and fisheries scientist, her research aims to identify and address the key drivers affecting fisheries sustainability, particularly for highly migratory species such as tunas, billfishes, and sharks, to ensure the long-term use and conservation of marine biodiversity. Through collaborative efforts, she develops ecosystem-based tools and products to support the implementation of the Ecosystem Approach to Fisheries Management (EAFM) in tuna Regional Fisheries Management Organizations (RFMOs). Her work directly supports scientific, advisory, and management organizations at European (DG MARE) and international levels (RFMOs, FAO, and IUCN), contributing to sustainable fisheries management.

Seapodym: Modelling physical-biological interaction between fish populations and the ocean pelagic ecosystem

Speaker 3: Inna Senina
Pacific Community, Noumea, New Caledonia

DAY 3

Day 3 - Implementation of EAFM

Morning

Ecosystem approach to fisheries management – FAO's work and its uptake by RFMOs

Keynote speakers: **Merete Tandstad and Marcelo Vasconcellos**
FAO, Rome, Italy

Session 3.1 Implementation

From theory to practice: Supporting decision-makers to lead the implementation of an ecosystem approach to fisheries management

Speaker 1: **Jean-Christophe Vandevelde**
Manager, Ecosystem Conservation, International Fisheries, The Pew Charitable Trusts

The evidence needed to support an ecosystem approach to fisheries management (EAFM) has advanced considerably since the concept was first defined in the 1990s. In regions with well-developed marine science institutions, many aspects of the functioning of marine ecosystems (food web dynamics, environmental and climatic drivers of exploited fish population status and distribution) and of the impacts of fisheries on these ecosystems (predator-prey interdependencies, benthic habitat resilience, vulnerable species sensitivity) are relatively well understood. Transposing this knowledge into concrete management measures remains the missing component of EAFM in many jurisdictions. Implementation of EAFM involves decision-makers including this evidence base in their management regimes. Such advances may be made through the development and use of roadmaps, fisheries ecosystem plans and other similar policy instruments that define specific ecological objectives to complement and enhance sustainable use-focussed fisheries objectives such as maximums sustainable yield.

In this talk, we present a series of EAFM-focused decision-support tools intended to help managers in building ecosystem considerations into their existing and future plans and policies. These include: a suite of case study examples on setting ecological objectives; a checklist for fisheries managers when requesting ecosystem-focussed science advice; and a guide to using harvest strategies as a vehicle for incorporating ecosystem considerations. While these tools are applicable for domestic and international fisheries managers, we specifically consider their use in multilateral contexts.

Biography

Dr Jean-Christophe Vandevelde is a manager for Pew's international fisheries project. He focuses on gearing the management of shared fish stocks toward an ecosystem-based approach, to support healthy, resilient marine ecosystems and fisheries over the long term. Vandevelde previously served as an officer with Pew's ending overfishing in northwestern Europe project.

Before joining Pew, Vandevelde was scientific secretary at the French Foundation for Research on Biodiversity, biodiversity officer for an infrastructure company, and campaigner for a coalition of French environmental nongovernmental organizations.

He holds an undergraduate degree in sociology and anthropology from Université libre de Bruxelles, a master's in international development from the University of Louvain, Belgium, and a doctorate in geography and environmental planning from the University of Orléans, France.

Implementing an Ecosystem Approach to Fisheries Management in the United States with Ecosystem and Socioeconomic Profiles

Speaker 2: **Abigail (Abby) Tyrell**
Research Fish Biologist, United States National Marine Fisheries Service, USA

Status quo fisheries management is challenged by changing environmental conditions as well as increasing and changing human uses. Ecosystem changes in particular may impact traditional fisheries assessment methods, which often assume stationarity or equilibrium of the system. Although fisheries management directives in the United States are increasingly emphasizing the importance of an Ecosystem Approach to Fisheries Management (EAFM), stock assessments and ecosystem and economic reports are both presented separately to regional Fisheries Management Councils, without a consistent mechanism for communication and collaboration between ecosystem, economic, and stock assessment scientists. To address this information gap, several regional Fisheries Science Centers have developed and implemented a new reporting framework called Ecosystem and Socioeconomic Profiles (ESPs). ESPs build on the long national history of fisheries and ecosystem research with a standardized framework that provides guidance around data curation, analysis, and reporting. There are four steps to the ESP process, which can be flexibly implemented according to the region's needs. In the first step, a list of priority stocks is developed by reviewing the available information for the managed stocks in conjunction with regional priorities. Then a literature evaluation is used to create an ecological and socioeconomic synthesis that summarizes processes driving stock dynamics and identifies mechanistic linkages and bottlenecks. A suite of indicators is created and trends and linkages are assessed using tests appropriate to the stock's data availability. The process is completed with a concise report that communicates the status of the leading indicators to fisheries managers within the stock assessment cycle.

Biography
Abigail (Abby) Tyrell is a Research Fish Biologist at the Northeast Fisheries Science Center of the United States National Marine Fisheries Service. She received her bachelor's degree in Biology from Tufts University and her Ph.D. in Marine Science from Stony Brook University. She is broadly interested in using data and technology to better understand the world around us, and she values collaborations and connections that bring in cross-disciplinary perspectives. Abby leads the Northeast Ecosystem and Socioeconomic Profile initiative to aggregate, analyze, and visualize ecosystem and socioeconomic data to provide scientific advice for fisheries management in the Northeast region of the United States.

Art of Balance: EAFM – Industry perspective

Speaker 3: **Hrefna Karlsdóttir**
Senior Advisor, Fisheries management and international affairs, Fisheries Iceland. Iceland

Biography
Fisheries Iceland, 2017-
Iceland Responsible Fisheries Certification Program, 2014-2016.
Directorate of Fisheries, 2013-2014.
Ministry of Fisheries and Agriculture 2007-2013. Iceland´s HOD in NEAFC, NAFO and Coastal States Negotiations.
Rhodes Academy of Oceans Law and Policy, 2007.
PhD. in Economic History, Gothenburg University 2005. Dissertation: Fishing on Common Grounds. The Consequences of Unregulated Fisheries of North Sea Herring in the Postwar Period.

Session 3.2 Spatial resource management and biodiversity conservation

Challenges and opportunities in applying ecosystem-based approaches for deep-water fisheries

Speaker 1: **Rui Vieira**
CEFAS, Lowestoft Laboratory, UK

Technological advances since the 1980s have increased access to deep-sea fisheries, but the introduction of management measures and economic factors, including low viability of sustained activities, have reduced fishing pressure on deep-water species. While much of the deep-sea fisheries in the North Atlantic occur at the same water depths as known Vulnerable Marine Ecosystems (VMEs), such as cold-water corals and sponge aggregations, many aspects of ecology, including spatial distribution of deep-sea species and their connectivity, are not well understood. Predicting responses to climate change and understanding of cumulative pressures from human activities also remains constrained by limited long-term monitoring. Developing approaches to inform stock status of important data-limited species/stocks, as well as to supplement the data for other components of the ecosystem, would allow a better understanding of direct and indirect effects of bottom trawling on the wider ecosystem and fisheries effects on food webs and ultimately on fish stocks.

Fisheries and the Global Biodiversity Framework: Key challenges and opportunities

Speaker 2: **Joe Appiott**
Marine, coastal and island biodiversity, Secretariat, Convention on Biological Diversity (CBD), Montreal, Canada

The Kunming-Montreal Global Biodiversity Framework, adopted by the CBD Conference of the Parties in 2022, contains the most ambitious set of global targets for nature ever adopted by an intergovernmental process. Many of the 23 targets of the framework require bold action by the fisheries sector and the goals of the Framework cannot be achieved without fisheries. Likewise, various areas of work under the Convention, including on OECMs, EBSAs, mainstreaming and monitoring, provide key opportunities to recognize and better support the fisheries sector in fulfilling its key role in the conservation and sustainable use of biodiversity.

Biography
Joe Appiott coordinates the work on marine, coastal and island biodiversity at the Secretariat of the Convention on Biological Diversity (CBD). At the CBD Secretariat, Joe works with governments, international organizations and other stakeholders to support the implementation of the Convention. This work includes facilitating the description and mapping of ecologically or biologically significant marine areas (EBSAs), coordinating capacity building activities, and synthesizing policy advice related to pressures on marine biodiversity. Joe work also includes coordination with, and input to, other UN agencies and multilateral processes with regards to issues related to marine, coastal and island biodiversity.

Spatial measures in RFMO management – a summary

Speaker 3: **Tony Thompson**
Deep-sea Fisheries Project, FAO, Rome, Italy

This presentation examines the EAFM elements of the ecological pillar and how they are currently implemented by dsRFMOs. It opens with two well know and powerful maps showing the global distribution of ecological or biological sensitive areas (EBSA) map and the marine protected areas (MPA) map. It then contrasts these with

FAO's vulnerable marine ecosystem "Measures" map. The EAFM elements: retained species, non-retained species (trash/discards and protected/threatened species) and general ecosystems (direct, indirect, and climate effects). It also shows some maps associated with each element to help visualise the extent of the RFMO's work. Further elaboration is presented in Fletcher (2020) and Thompson and Reid (2024). Conclusions are presented, which will be developed into the symposium's two concluding panel sessions.

Fletcher, W.J. 2020. A review of the application of the FAO ecosystem approach to fisheries (EAF) management within the areas beyond national jurisdiction (ABNJ). Rome, FAO. https://www.fao.org/3/cb1509en/CB1509EN.pdf

Thompson, A.B. and Reid, K. 2024. Review of the implementation of the International Guidelines for the Management of Deep-sea Fisheries in the High Seas. FAO Fisheries and Aquaculture Technical Paper, No. 703. Rome, FAO. https://doi.org/10.4060/ca7692en

Afternoon

The role and development of ecoregions to implement EAFM in dsRFMOs

Keynote speaker: **Mark Dickey-Collas**
DickeyCollas Marine, UK

Determining boundaries for monitoring, measures and tracking progress is an element of EAFM. Ecoregions are a key tool in our portfolio for this in the spatial dimension. Ecoregions are technical devices, as the ecosystem does not conform to any super-imposed human boundaries but they must be developed with an understanding of the physical, ecological, social and governance context of EAFM. I will review a number of initiatives to develop and implement ecoregions in regional fisheries bodies. I will look at the challenges and opportunities. I will then suggest key elements for guidance on the rationale, development and implementation.

Panel 3.3 EAFM Science and management responsibilities for implementation

Panel session 1

Session chair	Stefán Ásmundsson, *Iceland*
Panel member 1	Mark Dickey-Collas, *UK*
Panel member 2	Paul Regular, *Canada*
Panel member 3	Ellen Kenchington, *Canada*
Panel member 4	Ashley Rowden, *NZ*
Panel member 5	Merete Tandstad, *FAO*

Panel 3.4 Organisational/process considerations for implementation of EAFM by dsRFMOs

Panel session 2

Session chair	Deirdre Warner-Kramer, *NAFO Commission Chair*
Panel member 1	Darius Campbell, *NEAFC*
Panel member 2	Joe Appiott, *CBD*
Panel member 3	Hilario Murua, *ISSF*
Panel member 4	Betula Morello, *GFCM*
Panel member 5	Vera Agostini, *FAO*

Facilitators and Chairs

Facilitators

Day 1: **Steve Parker**

Dr Parker took up the post of Science Manager at CCAMLR in 2021. He manages a science team that supports and advises the CCAMLR Scientific Committee on topics such as data collection systems for vessels, scientific observers and ecosystem monitoring programmes, stock assessments, development of marine protected areas, monitoring the effects of climate change, monitoring the ecosystem effects of fishing, and policy development to meet the objective of the CCAMLR Convention.

Dr Parker is originally from the USA where he worked on supporting stock assessment and improving sustainability of commercial and recreational fisheries on the west coast and Alaska. He came to CCAMLR from New Zealand where he worked for 14 years as an Antarctic fisheries scientist advising the New Zealand government on marine ecosystem and fisheries management issues. He is a veteran of eight Antarctic expeditions in the Ross Sea region, working from vessels and from research camps on the sea ice, and has spent many months at sea on research vessels. His Antarctic research focuses on toothfish ecology, ecosystem effects of fishing, survey design, fish tagging and telemetry, and biological inputs into stock assessment.

Day 2: **Stefán Ásmundsson**

Stefán Ásmundsson is Special Advisor on Ocean Affairs and Fisheries at the Icelandic Ministry for Foreign Affairs. He is well known in international circles regarding fisheries, ocean affairs and law of the sea after being a prominent participant in many different international fora for twenty-five years. He holds an LLM in International Law and International Relations, where he specialised in the international legal regime for fisheries.

An important part of Mr Ásmundsson's work has been in relation to Regional Fisheries Management Organisations (RFMOs). His role has been most prominent in NEAFC, where he has represented Iceland, is currently President (having also previously served as President of NEAFC 2007-2009) and was Executive Secretary 2011-2017. Mr Ásmundsson has also been an active participant in organisations including NAFO and ICCAT and in coastal State consultations. During 2009-2011 he worked for the European Commission on the reform of the Common Fisheries Policy.

At the global level, Mr Ásmundsson is the Chair of the recently established FAO Sub-Committee on Fisheries Management. He is Iceland's Head of Delegation at FAO COFI and has been an active participant in several FAO Technical Consultations and expert workshops, including as Chair, and was Chair of the FAO-organised Regional Fisheries Bodies' Secretariat Network. Mr Ásmundsson has also worked with a number of other global bodies, including UNEP, DOALOS and CBD. He has been Co-Chair of the CBD-organised Sustainable Ocean Initiative – Global Dialogue since its inception.

Day 3: **Darius Campbell**

Dr. Darius Campbell is the Secretary of the North-East Atlantic Fisheries Commission, taking up this role in 2017. Before this, Darius was the Executive Secretary for the OSPAR Commission, a Regional Seas Convention aiming to protect and conserve the North-East Atlantic and its resources. Previously Darius worked for the UK's Department for Environment Food and Rural Affairs as a Deputy Director responsible for issues including IUU fisheries, developing the National Climate Change Adaptation Programme, UK policy on marine environment, and international oceans governance issues.Before joining the UK Civil Service, Darius worked in international rural development in Jordan, Nigeria and India. His first degree was in zoology, followed by an MSc in Livestock production and a PhD in nomadic livestock systems in Nigeria.

Session Chairs

Session 1.1 Retained species
Diana González-Troncoso, *NAFO SC Chair*

Session 1.2 Discarded and vulnerable species
Rui Vieira, *UK*

Session 1.3 Ecosystem effects and spatial management
Ashley Rowden, *NZ*

Session 2.1 Ecosystem Approach to Fisheries Management – managers' perspectives
Eszter Hidas, *DSF Project, GFCM*

Session 2.2 Reconciling sustainable harvest with biodiversity conservation – science-management interface
Deirdre Warner-Kramer, *NAFO Commission Chair*

Session 2.3 EAFM and the tuna world
Joe Zelasney, *Tuna Project, FAO*

Session 3.1 Implementation
Andy Kenny, *UK*

Session 3.2 Spatial resource management and biodiversity conservation
Chris Rooper, *Canada*

Panel Chairs

Panel 3.3 EAFM Science and management responsibilities for implementation – Panel style
Stefán Ásmundsson, *Iceland*

Panel 3.4 Organisational/process considerations for implementation of EAFM by dsRFMOs – Panel style
Deirdre Warner-Kramer, *NAFO Commission Chair*

POSTERS

Journal of Northwest Atlantic Fishery Science

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How Do Grand Challenges Travel Between Organizations? A Case Study On The Protection Of Vulnerable Marine Ecosystems

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How Do Grand Challenges Travel Between Organizations? A Case Study On The Protection Of Vulnerable Marine Ecosystems

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Contextualization and Background

- Following the UN Sustainable Development Goals, **Organization Studies** has been researching the role of organizations in **tackling "grand challenges"** (GCs), i.e., evaluative, complex and uncertain societal issues that need to be addressed across organizations (Ferraro et al., 2015; Gümüsay et al., 2022).
- However, relatively little is known about how GCs emerge and evolve as they **travel between organizations** and what translation processes they undergo (Howard-Grenville & Spengler, 2022; Schwoon et al., 2022).
- To study such 'idea travelling' , I look at the case of the protection of **Vulnerable Marine Ecosystems.**

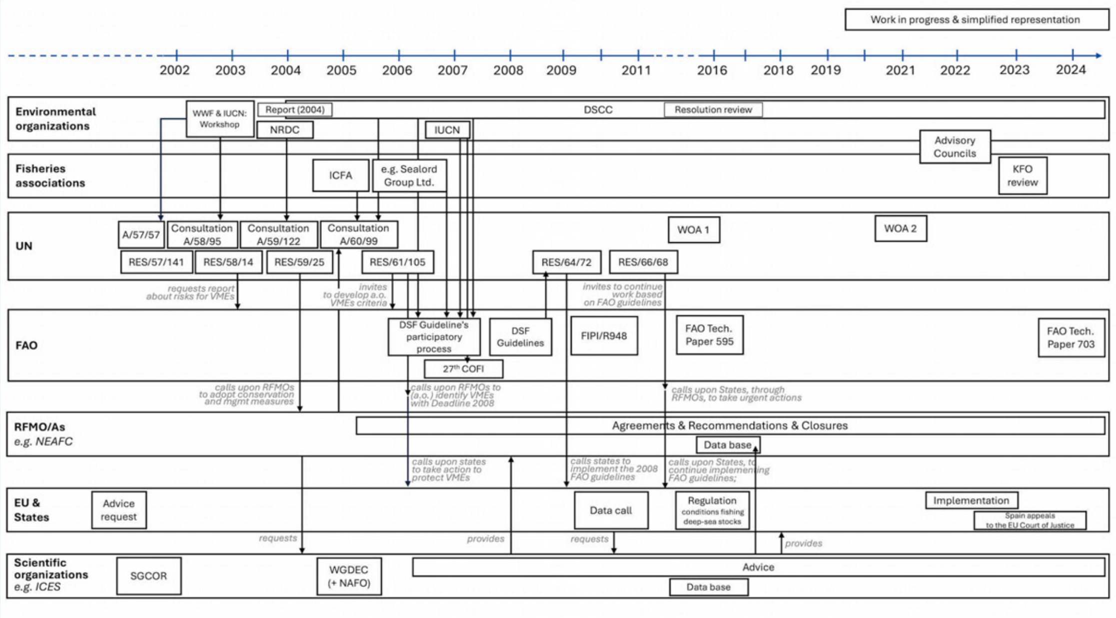
Theoretical Framing

- Issue-based organizational field (Hoffman 1999)
- Translation (Czarniawska & Joerges 1996)
- Multidirectional idea travelling (Nielsen et al. 2022)

Methodological Framing

- Longitudinal case study (Yin 2014)
- Thematic analysis (Silverman 2011)
- Data: interviews, observations, documents

The Traveling of the GC of Vulnerable Marine Ecosystem Protection: Timeline

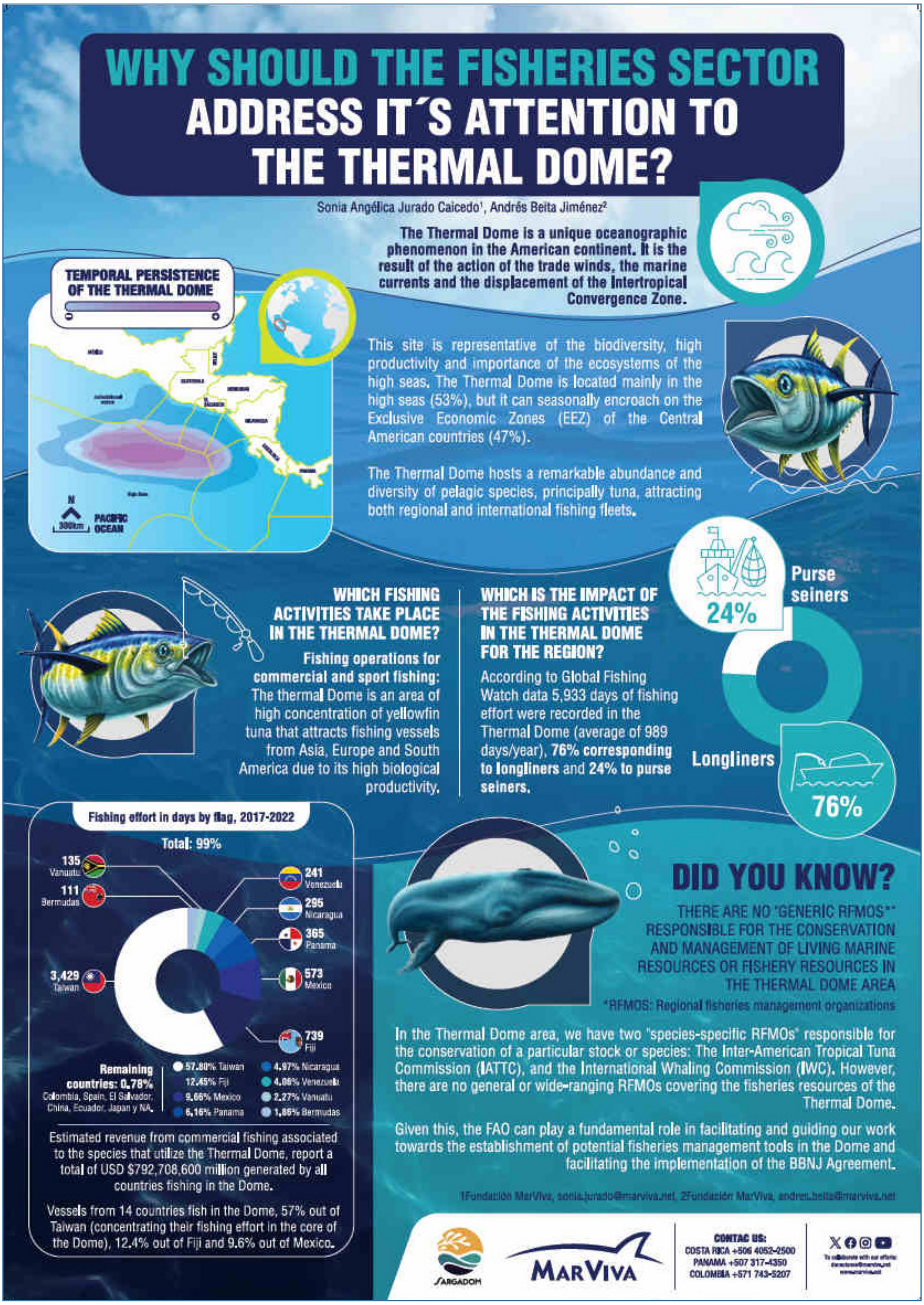


Forms of idea travelling (lit.)	Forms of idea travelling / translation processes (VME-case)
Reinforcing	Identifying, standardizing and embedding the challenge
	Raising awareness and encouraging others to take up the challenge
Complementing	Creating infrastructure and knowledge to monitor the challenge
	Deciding on how to tackle the challenge
Polarizing	Calling decisions made in connection with the challenge into question

Next Steps: Refinement of findings based on further interviews, document analysis

Why should the fisheries sector address it's attention to the Thermal Dome

Sonia Angélica Jurado Caicedo and Andrés Beita Jiménez

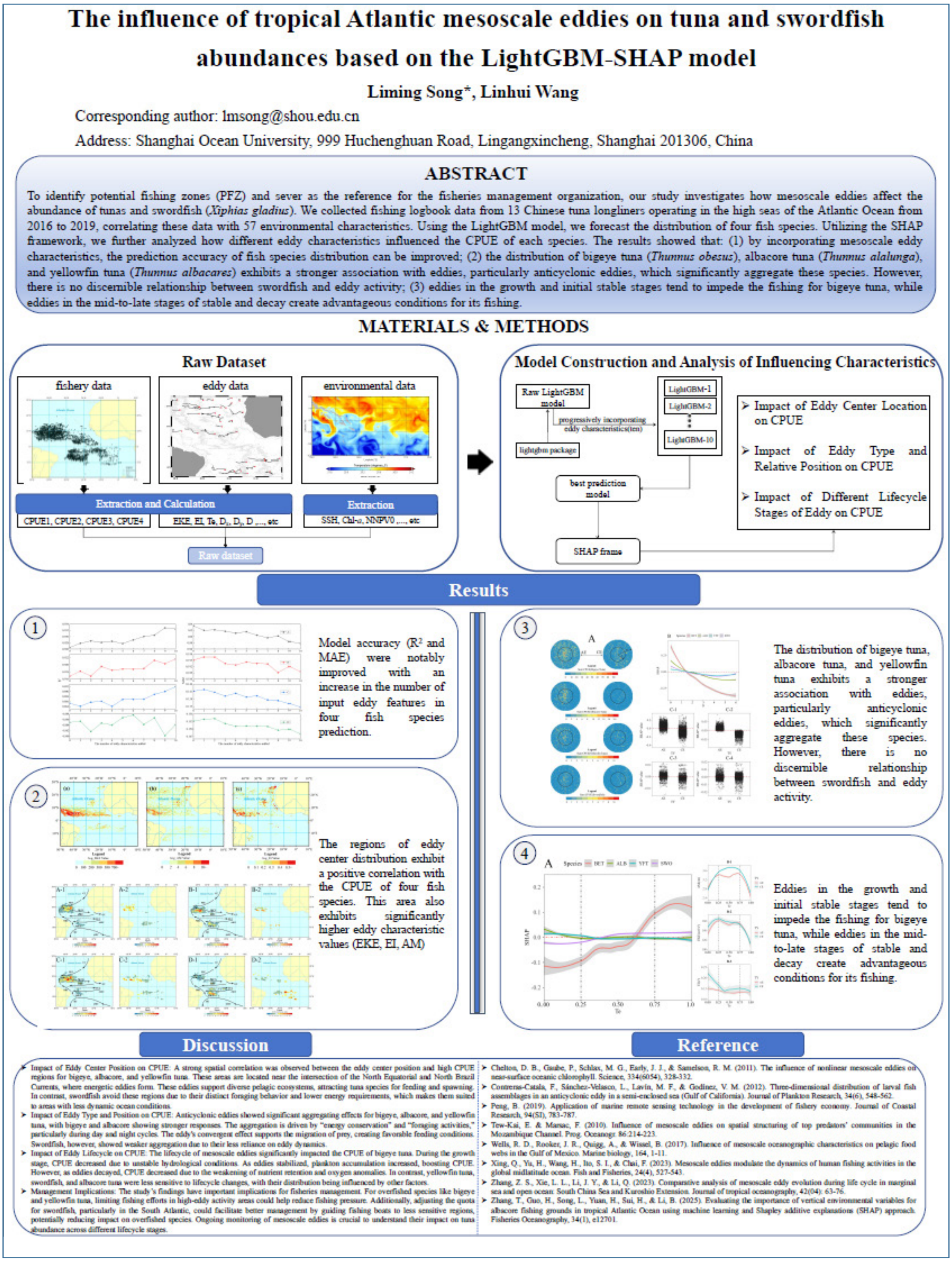


Development of standards for ecosystem-based management of deep-water fisheries in the South Pacific Ocean

Jordi Tablada, Shane Geange, Alexander Arkhipkin and Trent Timmiss

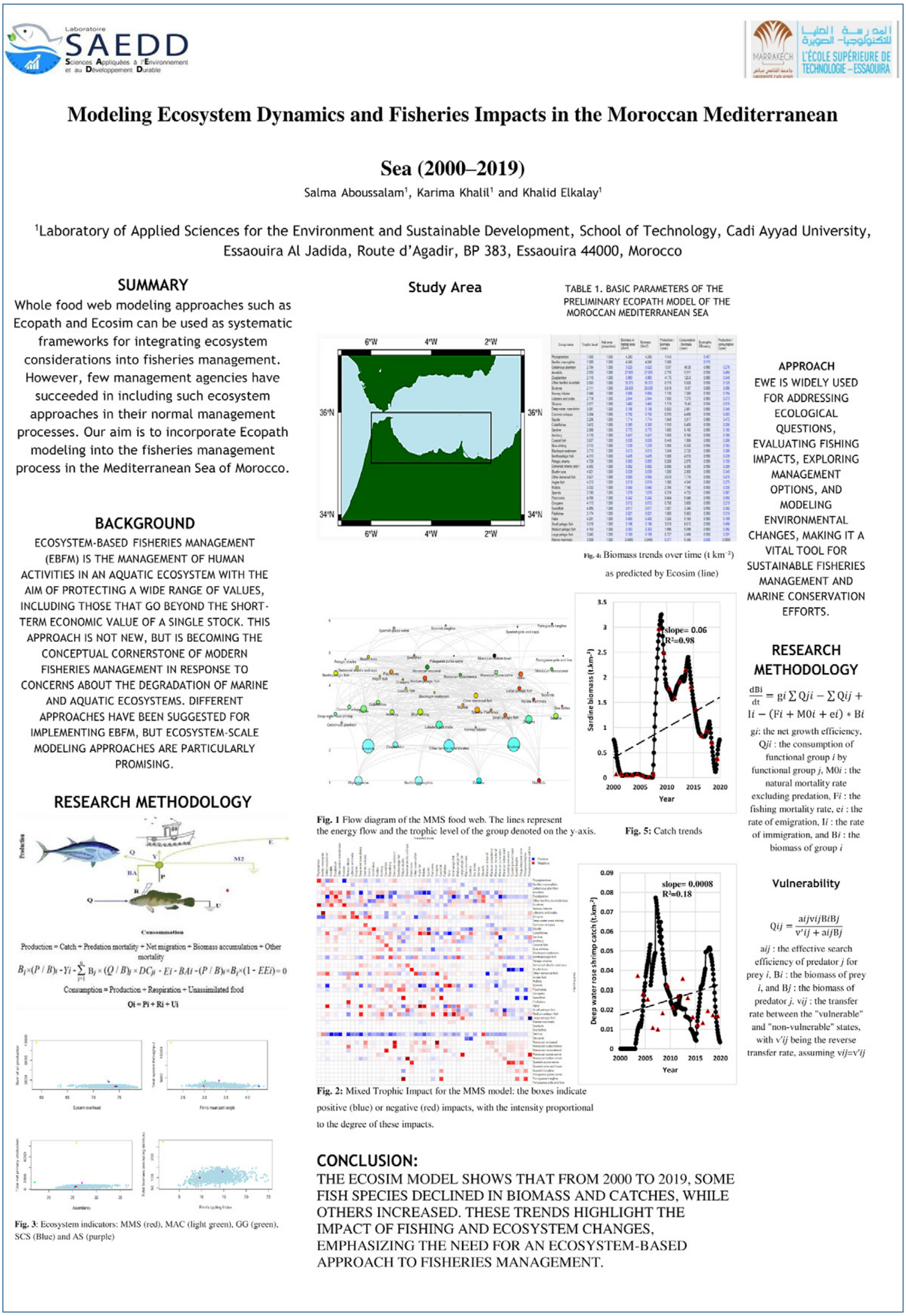
The influence of tropical Atlantic mesoscale eddies on tuna and swordfish abundances based on the LightGBHM-SHAP model

Liming Song and Linhui Wang



Modeling ecosystem dynamics and fisheries impacts in the Moroccan Mediterranean

Salma Aboussalam, Karima Khalil and Khalid Elkalay



Multifactor ecosystem approach to stock assessment and management of fish stocks: initial results

Vladmir Khlivnoy

Multifactor ecosystem approach to status assessment and management of fish stocks: initial results

Khlivnoy V.N.

Polar Branch of the Federal State Budgetary Scientific Institution "Russian Federal Research Institute of Fisheries and Oceanography" (Polar Branch of FSBSI "VNIRO" ("PINRO" named after N.M. Knipovich))

Introduction

An ecosystem is a system formed by organisms in interaction with their environment (Chapin, F. Stuart III, 2011). The biotic and abiotic components are linked together through nutrient cycles and energy flows. Taking into account the interrelations between ecosystem components, the 1992 UN Convention on Biological Diversity (CBD) introduced the concept of ecosystem approach. The Reykjavik FAO Expert Consultation agreed on the purpose of an ecosystem approach to fisheries, "..an ecosystem approach to fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries" (FAO, 2003). In view of the objectives identified by FAO we attempted to evaluate ecosystem dynamics and fisheries management tools taking into consideration the biotic and abiotic factors impacting those ecosystems.

Material and methods

This study applies the multifactor ecosystem approach to estimate the status of individual aquatic species and the ecosystem in general, taking into account the impact of biotic and abiotic factors on the stocks. The abiotic factors were habitat temperature and atmospheric effects (wind velocity), while the biotic factors included the biomass of aquatic species and zooplankton abundance dynamics or primary production of the ocean.

Ecosystem status was evaluated using the energy transformation models in ecosystems. Energy flow in the ecosystem was estimated based on the data on the abundance of zooplankton, major external food source. Reduction in the energy flow was estimated based on energy consumption of ecosystem objects and withdrawal of species from the ecosystem as a result of fisheries and natural mortality. Energy accumulated by the ecosystem was calculated using data on species biomass and caloricity.

Energy intake by the ecosystem was estimated as a sum of energy intake by each species. Equation for assessed energy requirements of fish has been derived on base of relationship (1) for calculating the energy required to account for maintenance, growth and reproduction (Winberg, 1956; Mann, 1965; Backiel, 1971; Jones, 1978).

$$F=1.25(M+G)+S, \quad (1)$$

where G is the growth rate,

F is the food consumed per unit time,

M is the energy required for metabolism.

S is the energy cost of gonad production for mature fish during the spawning season.

Based on this dependence, the following energy intake equations were derived in experiments for immature (2) and mature (3) individuals (Jones, 1978):

$$F=3.285*W^{0.8}*exp(0.081*t)+1.27*G*W^{0.15} \quad (2)$$

$$F=3.285*W^{0.8}*exp(0.081*t)+1.27*G*W^{0.15}+0.28*G*W^{1.15} \quad (3)$$

where F is the rate of food consumption in kcal/yr,

W is the body weight in g,

G is the growth rate in g/year,

T is the temperature in °C.

Energy value of the studied species was expressed in calories and identified based on the caloricity studies (Kulka, Corey, 1982; Davis. 2003; Gorbatenko at al., 2007). Data on zooplankton abundance were applied (SAHFOS fund data (DOI, 10.7487/2017.51.1.1035)). Data on biomass of species in the ecosystem were derived by the estimates of fish stock status (ICES, 2019) and literature data. Fish maturity information was taken from literature (Filina, Khlinoy, Vinnichenko, 2009; ICES, 2019). Basides, data on ocean surface temperature were used.

The stock-recruitment dependence was derived based on the ecosystem approach, using spawning stock biomass of the studied species, zooplankton abundance, temperatures at spawning and the development of recruits, and wind velocity. The stock-recruitment dependence was calculated according to the method suggested by the author (4) (Khlivnoy, 2018) based on the modified Ricker equation (Ricker, 1954).

$$R=d*k1*SSB*exp(-SSB/(k2*d)), \quad (4)$$

where R is the stock recruitment;

SSB is the spawning stock biomass;

k1 and k2 are coefficients;

d is the coefficient describing the impact of food sources and wind velocity on the recruitment, calculated using the formula (5):

$$d=c*k3*P*exp(-P/(k4*c)), \quad (5)$$

where P is the abundance of Euphasiidae and Calanus finmarchicus divided by wind velocity;

k3 and k4 are coefficients;

c is the coefficient describing the impact of habitat temperature on the recruitment, calculated using the formula (6):

$$c=k5*T*exp(-T/k6)), \quad (6)$$

where T is ocean surface temperature;

k5 and k6 are coefficients.

This dependence was applied to estimate stock recruitment defining future dynamics of the stocks.

Selected for experimental calculations were the ecosystems of the Rockall Bank and the North Sea with adjacent waters.

Results

The analysis has shown absence of significant correlations between the recruitment to the haddock stock and the spawning stock biomass, both on the Rockall Bank and in the North Sea. However, a statistically reliable dependence was revealed between haddock yearclass abundance, food supply and habitat conditions at early development stages (Figs. 1a, 1b). The use of the ecosystem approach as suggested by the author (equation 4) increased the significance of the dependence describing the formation of haddock yearclass abundance (Figs. 2a, 2b). This equation demonstrates the impact of diet, habitat temperature and spawning stock biomass on yearclass strength (Fig. 3).

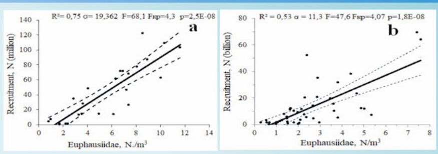


Fig.1. Dependence of haddock recruitment abundance on the abundance of Euphausiidae on the Rockall Bank (a) and in the North Sea (b)

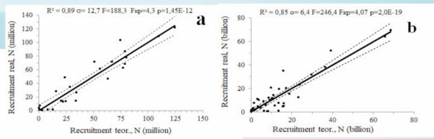


Fig. 2. Comparison of recruitment abundance by stock assessment results (real.) and calculated by the ecosystem method (teor.), which takes into account the abundance of Euphausiidae u Calanus finmarchicus, sea surface temperature and wind velocity for haddock on the Rockall Bank in 1991-2016 (a) and in the North Sea in 1972-2016 (b)

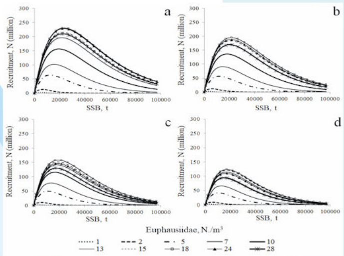


Fig. 3. Recruitment dynimics of the Rockall haddock stock estimated by the suggested method in relation to the abundance of Euphausiidae at 10° C (a), 11 °C (b), 12 °C (c), and 13 °C (d) sea surface temperature

Exploratory runs of ecosystem model

The suggested methodology was used for ecosystem simulations based on energy transformation. Energy flow and the increase in the accumulated energy in the ecosystem (energy of the ecosystem biomass) due to stock recruitment were calculated. Trial runs of the model have shown that yearclass abundance and energy of the ecosystem biomass are limited by environmental conditions and by the energy inflowing the ecosystem with zooplankton as a food item. Periods of increase alternate with periods of decline in energy accumulated by the ecosystem, demonstrating a certain cyclicity, which was found to be most prominent for the scenarios with the stable zooplankton abundance and habitat temperature (Fig. 4a).

An increase in biomass of the stock leads to a considerable increase in the energy consumed by the stock. When the biomass of the stocks is high, their energy intake may exceed the available level of energy inflow to the ecosystem due to food zooplankton. This will trigger the cycle of low ecosystem energy and biomass resulting from reduced recruitment and food shortage mortality (Fig. 4a).

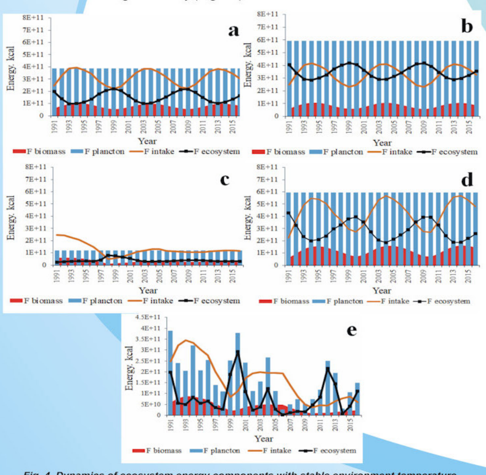


Fig. 4. Dynamics of ecosystem energy components with stable environment temperature (11.6°C) and constant optimal (a), high (b) and low (c) levels of energy flowing in the ecosystem with food zooplankton, and low temperature (9.5°C) (d) and under environmental conditions actually observed on the Rockall Bank in 1991-2016 (e). Exploratory runs of model.

Fbiomass is the ecosystem biomass energy (excluding food zooplankton), **Fplankton** is the energy flowing in the ecosystem with food zooplankton, **Fintake** is the energy required for vital functions of the ecosystem, **Fecosystem** is the total ecosystem energy, including F biomass and

When the food energy flow in the ecosystem is high, stock growth is limited by temperature of the environment (Figs. 4b, 4d, 3), while when it is low, this limit is set by the level of energy flow (Fig. 4c). Warming of the sea leads to an increased consumption of energy by haddock caused not only by accelerated metabolism, but also by body weight increase observed under such conditions (Figs. 5). The simulations have shown that, water temperature and food zooplankton abundance actually observed on the Rockall Bank in 1991-2016 were associated with large year-to-year variations in the ecosystem energy (Fig. 4e).

As the first step towards the implementation of the suggested methodology, energy intake by the stocks and stock biomass energy was estimated for the Rockall haddock and for cod and haddock of the North Sea ecosystem (Fig. 6, 7).

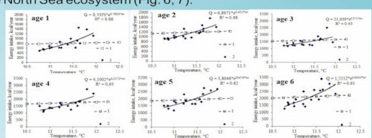


Fig. 5. The dependence of energy intake by one Rockall haddock individual (age 1-6 years) on water temperature under constant body weight (1) and the observed body weight increase under water temperature warming (2) in 1991-2016

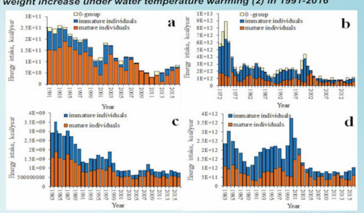


Fig. 6. Annual energy intake by Rockall haddock (a), haddock in 1972-2016 (b) and cod 1983-2016 (c) in the North Sea and overall energy intake by the haddock and cod stocks in the North Sea (d) in 1983-2016

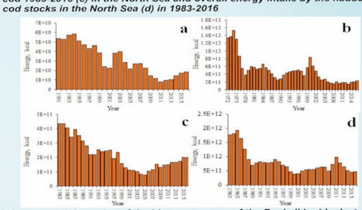


Fig.7. Interannual dynamics of the biomass energy of the Rockall haddock stock (a), haddock in 1972-2016 (b) and cod in 1983-2016 (c) in the North Sea and total biomass energy of haddock and cod in the North Sea (d) in 1983-2016

Impact of environmental factors on the yield

The analysis of the impact of environmental factors on the stock exploitation level has shown time-related variations in the maximum sustainable yield and MSY-based fishing mortality (FMSY) depending on yearclass strength, which is impacted by environmental conditions and food availability. In high recruitment periods and increase in FMSY is observed, while in the periods when recruitment is poor, FMSY tend to decline (Fig.8).

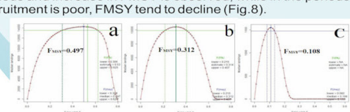


Fig. 8. The dynamics of maximum sustainable yield (MSY) and MSY-related fishing mortality in relation to Rockall haddock yearclass strength:
a period with strong yearclasses (1991-2002):
b entire study period (1991-2013);
c period with weak yearclasses (2003-2013)

Conclusions

- food supply at early development stages and environmental conditions have a considerable effect on stock recruitment, which is often greater than the impact of spawning biomass;
- estimation of energy balance is a universal tool to estimate species interaction at different trophic levels, to evaluate ecosystem status and develop management measures in the context of ecosystem biodiversity;
- stock biomass increase is associated with a considerable growth in the amount of the energy consumed by the stock. When biomass of the stocks is high, their energy intake may exceed the available amount of energy flowing into the ecosystem with food zooplankton. This leads to reduction in recruitment and ecosystem biomass due to mortality induced by poor food supply;
- calculations have shown that there are periods with excessive biomass of one or several stocks, when energy flow in the ecosystem with food cannot support their vital activities. Thus, the withdrawal of such excessive stock biomass in these periods can be considered;
- for specific stocks, food energy supply is impacted by its consumption by the entire ecosystem, therefore single-stock management needs to take into account energy dynamics in the ecosystem in general;
- the analysis has shown time-related variations in the maximum sustainable yield and MSY-based fishing mortality (FMSY) depending on yearclass strength, which is impacted by environmental conditions and food availability. With that in view, it can be viable to revisit stock exploitation levels under changing ecosystem conditions.

Size-spectra of unexploited deep-sea community in the Colombian Caribbean Sea

Jorge Paramo and Daniel Perez

Symposium:
Applying the Ecosystem Approach to Fisheries Management in the Areas Beyond National Juristiction (ABNJ)

Size-spectra of unexploited deep-sea community in the Colombian Caribbean Sea

11-13 March 2025, Rome, Italy

Jorge Paramo[1]*, Daniel Pérez[1]

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1 INTRODUCTION

The deep-sea ecosystem of the Colombian Caribbean is unexploited because no fishing activity has ever registered there. However, some species of crustaceans are potential resources for new fisheries, such as the giant red shrimp, *Aristaeomorpha foliacea*, the royal red shrimp, *Pleoticus robustus* (Paramo & Saint-Paul, 2012a), the pink speckled shrimp, *Penaeopsis serrata* (Paramo & Saint-Paul, 2012b) and the deep-water Caribbean lobster, *Metanephrops binghami* (Paramo & Saint-Paul, 2012c).

Herein, we quantified the marine community current state using body size distribution (size-spectra) and Shannon-Wiener diversity (H') to generate a baseline of potential ecological indicators that contribute to management and conservation of the bento-demersal community of deep-sea marine ecosystem.

2 METHODS

Study area. Sampling was in the Colombian Caribbean Sea from the north of Uraba Gulf to Punta Gallinas (Figure 1). The northern area of the Colombian Caribbean is influenced by the northeast trade wind system that causes Ekman transport away from the coast and upwelling of subsurface waters rich in nutrients (Paramo et al., 2011; Correa-Ramírez et al., 2020).

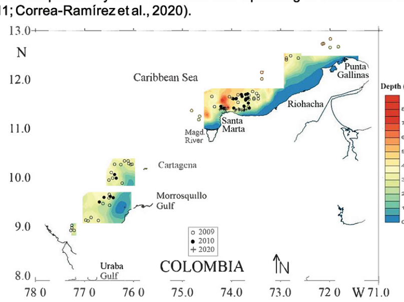

FIGURE 1 Study area showing sampling locations and bathymetry in the Colombian Caribbean Sea in 2009 (empty circles), 2010 (filled circles), and 2020 (crosses).

Survey data. Sampling at 124 stations included 58 stations in August (south) and December (north) of 2009, 21 stations in March (south) and May (north) of 2010, and 45 stations in the northern zone between August and December of 2020. The swept area method was used at depths between 200 and 550 m.

Catch composition. Biological samples were taken to the laboratory and each individual was identified at the lowest possible taxonomic level (Cervigón et al., 1992; Diaz & Pullana, 1994; Carpenter, 2002). Total length of each individual was measured to the nearest 0.01 mm, and total weight to the nearest 0.1 mg. Total length of fish and chondrichthyes were measured from the tip of the snout to the tip of the caudal fin, and crustaceans from the posterior margin of the ocular margin indent to the telson.

Size-spectra. The body size distribution of fish, chondrichthyes, crustaceans, and total community was evaluated using a Pareto or power-law function probability distribution. Using total weight (g) of each individual, a bounded power-law distribution with probability density function was fitted (Eq.1):

$$f(x) = \frac{(b+1)x^b}{x_{max}^{b+1} - x_{min}^{b+1}} \quad b \neq -1$$

where x = the body mass of each individual, b = the scale exponent, xmin and xmax = the lowest and highest body weight measured (Edwards et al., 2017). Maximum likelihood estimation was used to fit the distribution (Edwards et al. 2017) using the log-likelihood of a power-law distribution (Eq.2):

$$log[L(b|data)] = n \log \frac{b+1}{x_{max}^{b+1} - x_{min}^{b+1}} + b\sum_{j=1}^{n} \log x_j$$

Diversity indexes. The Shannon-Wiener diversity index (H') (Eq.3) was estimated for all sampling stations (Clarke & Gorley, 2001).

$$H' = -\sum_{i=1}^{S} p_i \ln p_i$$

Where S = the number of species, pi = the proportion of individuals of species belonging to the ith species, and ln = the natural logarithm.

3 RESULTS

Catch composition. The total catch composition was mainly Teleosteans (> 50%), followed by Chondrichthyes (> 26 %) and Crustaceans (> 9%). Cephalopods were less than 5% (Figure 2) of the catch composition.

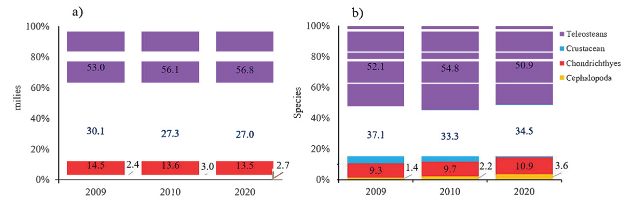

FIGURE 2 Catch composition (%) of families (a) and species (b) of Teleosteans, Crustacean, Chondrichthyes, and Cephalapoda of the deep-sea marine community of the Colombian Caribbean Sea in 2009, 2010, 2020.

Size-based indicators. Weight of Chondrichthyans ranged 2.30–1136.44 g (mean = 88.20 + 144.76 g) in 2009, 2.80–3750.00 g (mean = 120.08 ± 432.13 g) in 2010, and 11.40–3985.00 g (mean = 230.20 ± 778.97 g) in 2020. Weight of Crustaceans ranged 0.40–233.30 g (mean = 11.87 + 15.79 g) in 2009, 0.80–180.60 g (mean = 17.47 + 17.20 g) in 2010, and 0.39–120.43 g (mean = 11.51 + 14.66 g) in 2020 (Figure 3).

Size-spectra. Size spectra for teleostei (b = −2.02 to −2.30), crustacean (b = −2.09 to −2.34) and the whole community (b = −2.08 to −2.26) indicated unexploited communities (b = −2), but not Chondrichthyes (b = −1.58 to −1.83), in 2009, 2010, and 2020 (Figure 3).

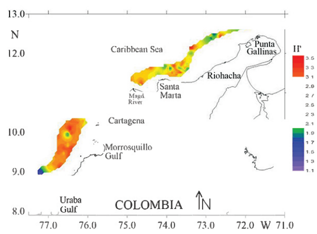

FIGURE 4 Spatial distribution of Shannon-Weiner diversity (H') indices of the deep-sea community in the Colombian Caribbean Sea in 2009, 2010, and 2020 (pooled years).

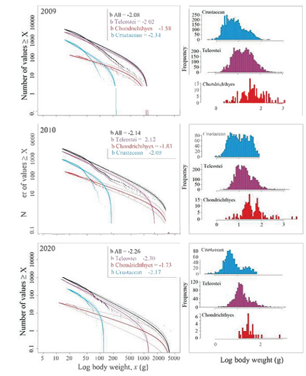

FIGURE 3 Biomass spectra and weight-frequency distributions (log[body weight], g) of Crustaceans (light blue line and bars), Teleostei (purple line and bars), Chondrichthyes (red line and bars), and the deep-sea community (black line) in the Colombian Caribbean in 2009, 2010 and 2020.

Diversity indexes. Shannon-Weiner diversity (H') (Figure 4) of the deep-sea community was higher to the north, near the Magdalena River, Santa Marta, Riohacha, and the west, near Cartagena and the Morrosquillo Gulf, which are associated with submarine canyons (Figure 1).

4 DISCUSSION

In many tropical countries, collection of biological and ecosystem information is scarce and expensive, and is insufficient to produce quantitative stock assessment or to determine biological reference points for fisheries management (Edwards, 2015). Size-spectrum models quantify relative abundance of organisms based on body size (weight) regardless of biological species identity (Blanchard et al., 2009) and represent energy flow in a food web, by describing community structure based on individual size (Xu et al., 2021) and ecosystem productivity (Saiz-Salinas & Ramos, 1999).

Our length-based indices provide a baseline reference point for fishes, Chondrichthyes, and crustaceans in an unexploited ecosystem to monitor effects of future fishing in new waters deep in the Colombian Caribbean. The spatial distribution of diversity was higher in locations related to highly productive waters resulting from upwelling in the northern area of the Colombian Caribbean (Paramo et al., 2011; Correa-Ramírez et al., 2020) and around submarine canyons (Paramo et al., 2012).

To the best of our knowledge, ours is the first size-spectra analysis of deep-sea communities in an unexploited ecosystem that has the potential to provide new fishing resources, so our findings can serve as a reference point for future ecosystem-based management. The future potential of deep-water fishing resources in the Colombian Caribbean Sea exhibited characteristics of tropical multispecies fish (Paramo et al., 2012) and crustaceans (Pérez et al., 2019), so implementation of ecosystem models is crucial for multispecies fisheries management (Wo et al., 2020).

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ICES contribution to an Ecosystem Approach to Fisheries Management, EAFM

Lara Salvany and Iñigo Martinez

ICES contribution to an Ecosystem Approach to Fisheries Management, EAFM

ICES CIEM
Lara Salvany and Iñigo Martinez,
International Council for the Exploration of the Seas (ICES)

Abstract

The **International Council for the Exploration of the Sea (ICES)** is committed to developing the evidence base for EAFM and providing ecosystem-informed science and advice scientific advice to inform decision-making.
Here, we outline the role of ICES in supplying the scientific foundation necessary for EAFM implementation:

First, the **ICES Ecosystem Overviews**, a risk based regional analyses of key pressures and human activities, trends, and ecosystem status. As an example, the Offshore Northeast Atlantic waters ecosystem overview, enhancing our capacity to deliver integrated ecosystem advice in ABNJ.

Second, a recent **advice to NEAFC describing a suite of approaches on EAFM,** and methods to support implementation, understanding of stakeholder and management priorities, and strength of links to management actions**.**

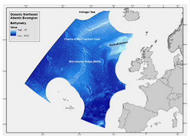
Third, ICES has recently launched the **Framework for Ecosystem Informed Science and Advice (FEISA),** which enhances the integration of ecosystem considerations into scientific advice. **FEISA** can accommodate a wide spectrum of information and addresses the multiple dimensions of ecosystem-based management (EBM) by combining risk assessments with quantitative and qualitative indicators.

ICES products to support EAFM

Oceanic Northeast Atlantic ecosystem Overview

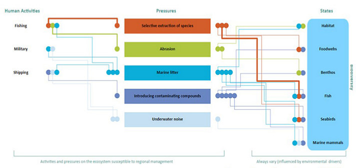
ABNJ ecoregion

The Oceanic Northeast Atlantic ecoregion consists of the portion of the ICES Area that is ABNJ of the EU Member States, the Faroe Islands, Iceland, and Greenland.



Risk based assessment

A risk scoping tool to rank and prioritize the main pressures and human activities in an ecoregion. The Ecosystem Overviews provide information on trends in the ecosystem in recent years and identify the main human activities and pressures, explaining how these affect key ecosystem components.



Ecosystem Overviews (2019)

This ABNJ region, has fewer human activities than other ICES ecoregions. Last assessment (2019) highlighted fishing, military activities and shipping as the main activities contributing to the top five pressures in the area. Diffuse global sources contributed also to background contamination.

WKONEA (Feb 2025)

- New assessment for Oceanic Northeast Atlantic
- Based on Mission Atlantic project results
- New Overview to be published in December 2025

More on Overviews: https://www.ices.dk/advice/ESD/Pages/Ecosystem-overviews.aspx

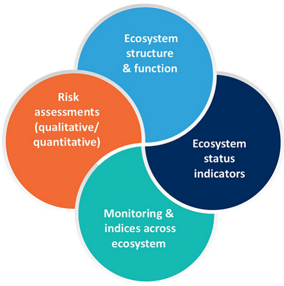
Interested to participate on a future ICES ABNJ group? Submit a note of interest at: ecosystem.overviews@ices.dk

NEAFC request on Ecosystem Approaches to Fisheries Management

Request

"For given higher-level biodiversity and ecosystem objectives describe the available approaches to define related operational objectives, and to monitor and assess progress towards meeting these operational objectives"

Approach



?

- Range and scope of operational objectives
- Targets, limits and other reference points
- Monitoring and assessment requirements
- Timelines (development and implementation)
- Maturity of science underpinning
- Application status.
- Contribution to an EAF
- Assumptions, gaps, caveats, uncertainty

Conclusions

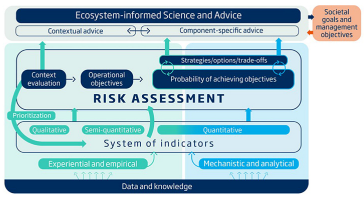
EBFM implementation:

- requires clearly defined & functioning links between operational objectives, targets, management actions and ability to respond to evidence & monitor progress
- Requires a link to decision-making framework & action
- Is incremental

ICES Framework for Ecosystem - Informed Science and Advice (FEISA)

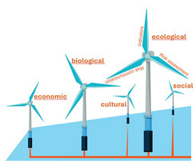
- A framework to guide knowledge development in support of EBM and its practical implementation into ICES advice
- A framework to evaluate and prioritize incremental progress towards ecosystem-informed science and advice

Architecture



Goal

Generate **relevant** and **actionable** ecosystem-informed science and advice in **support** of **EBM decision making**



FEISA principles can be used to evaluate progress and identify priorities moving forward.
For example, the ICES Ecosystem Overviews.

	Current Advice	Future Directions
Indicators	✓ **Empirical biological, ecological, climate, human activity** and in some cases **economic** and **social indicators**	Expand to include social, economic, cultural, governance and ecosystem services indicators
Operational objectives	×	Investigate and identify achievable **biological and ecological objectives**
Risk Assessment	✓ **Contextual risk assessment** for **biological and ecological** components	Evaluate risks relative to objectives, evaluate/rank social and economic risks
Risk-based scenarios	×	Identify management strategies and trade-offs relative to objectives
Risk Communication	✓ Explicit in some regions but only for **biological and ecological** components	Communicate priority risks and potential trade-offs

Conclusions

- ICES is well positioned to support the implementation of EAFM and provide advice on EAFM.
- The ICES Ecosystem overviews provide contextual advice and prioritize the narratives that scientist and managers should focus on when applying the ecosystem approach.
- The EAFM depends on identifying operational objectives informed by indicators to be actionable.

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NAFO: https://www.nafo.int/Portals/0/PDFs/rb/2023/redbook2023_final.pdf
MSFD: https://research-and-innovation.ec.europa.eu/research-area/environment/oceans-and-seas/eu-marine-strategy-framework-directive_en

Summing the parts: Improving population estimates using a state-space multispecies production model

Paul M. Regular, Mariano Koen-Alonso, M. Joanne Morgan, Pierre Pepin, Rick M. Rideout

Fisheries and Oceans Canada | Pêches et Océans Canada

Summing the parts

Improving population estimates using a state-space multispecies production model

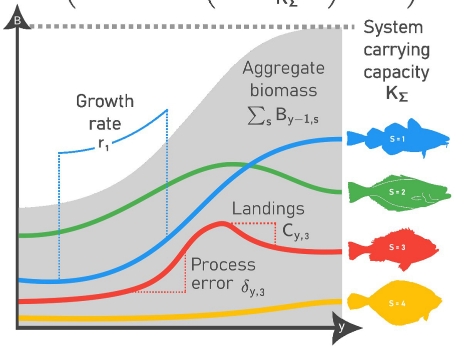
Paul M. Regular*, Mariano Koen-Alonso, M. Joanne Morgan, Pierre Pepin†, Rick M. Rideout
Fisheries and Oceans Canada, Northwest Atlantic Fisheries Centre, St. John's, NL, Canada

Background

- Single-species assessments often fail to capture important interactions in an ecosystem
- Ecosystem models capture interactions but are often data-intensive and difficult to implement
- We present a state-space multispecies production model to serve as a middle ground to support an Ecosystem Approach to Fisheries Management (EAFM)
- **Model:** Extends surplus production models to account for species interactions.
- **Data Requirements:** Fisheries landings & survey indices.

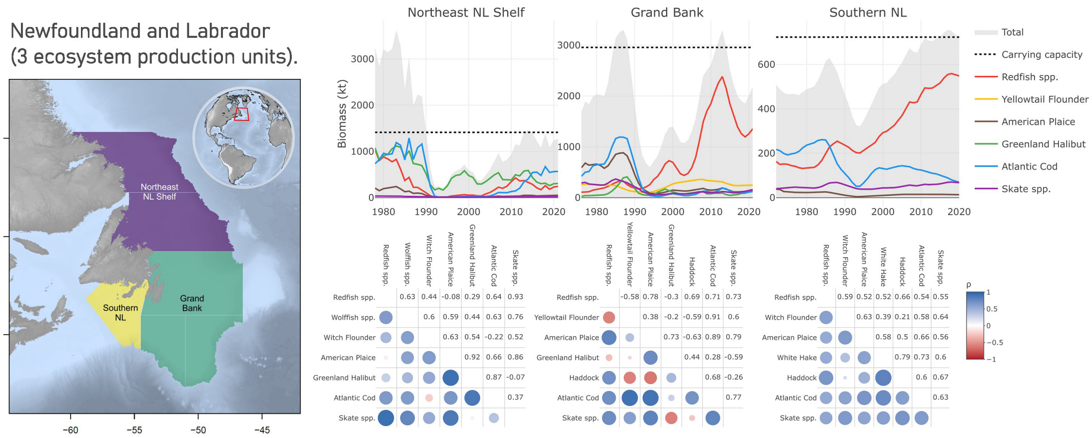
Model schematic

$$B_{y,s} = \left(B_{y-1,s} + r_s B_{y-1,s}\left(1 - \frac{\sum_s B_{y-1,s}}{K_\Sigma}\right) - C_{y-1,s}\right) e^{\delta_{y,s}}$$



Case Study

Newfoundland and Labrador (3 ecosystem production units).



- Cross-validation shows multispecies models yield more accurate biomass estimates than single-species models.
- Process errors highly correlated across species, implying shared ecosystem drivers.
- Environmental factors, not just fishing, played an important role in the stock collapses of the early 1990s.

Conclusion

- Our model provides a practical, intermediate solution between simplistic single-species and complex ecosystem models.
- Also suitable for data-limited fisheries, making ecosystem-based insights more attainable.
- This approach may serve as a stepping stone towards multispecies assessment and EAFM.

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ARE OUR FISHERIES IN HOT WATER? Integrating Climate Risk as Part of an Ecosystem Approach to Fisheries Management

Katie Schleit (Oceans North / Wild Ocean Research)

ARE OUR FISHERIES IN HOT WATER?

Integrating Climate Risk as Part of an Ecosystem Approach to Fisheries Management

Climate change poses a growing threat to marine life, creating an urgent need for climate-informed management strategies across spatial areas. In recent years there have been increasing calls by United Nations bodies for Regional Fisheries Management Organizations (RFMOs) to address climate change impacts on fisheries and ecosystems and fully consider it in conservation and management measures. While many deep-sea (ds) and tuna RFMOs have moved forward in incorporating climate change into their work, either through commitments in resolutions and/or scientific undertakings, practical examples remain sparse.

Using the Northwest Atlantic Fisheries Organization (NAFO) as a case study and drawing on the work of Boyce (2024), we present how climate change science and management decisions can be advanced within dsRFMOs as part of an Ecosystem Approach to Fisheries Management (EAFM) by:

- Integrating climate change science and climate-adaptive management into existing or new EAFM plans and roadmaps.
- Applying a climate risk index to identify and prioritize at-risk species.

NAFO CASE STUDY

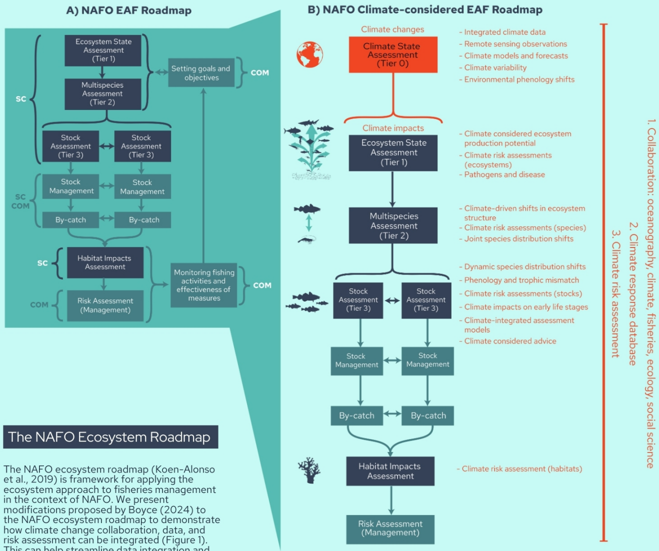

Figure 1. Climate considerations included in the NAFO roadmap. A) Current NAFO roadmap. B) steps to enhance climate readiness (Boyce, 2024).

The NAFO Ecosystem Roadmap

The NAFO ecosystem roadmap (Koen-Alonso et al., 2019) is framework for applying the ecosystem approach to fisheries management in the context of NAFO. We present modifications proposed by Boyce (2024) to the NAFO ecosystem roadmap to demonstrate how climate change collaboration, data, and risk assessment can be integrated (Figure 1). This can help streamline data integration and facilitate management action, both in terms of EAFM, but also overall scientific and commission work.

Climate Risk Assessment of 14 NAFO stocks

The Climate Risk Index for Biodiversity (CRIB) (Boyce et al., 2022) assesses the risk of over 20,000 marine species to climate change under two different emissions scenarios: one that assumes high emissions going forward and another that assumes high mitigation.

The CRIB generates detailed data about when, where, and how marine species will be impacted across three dimensions of vulnerability: sensitivity, adaptivity, and exposure (Figure 2). It was used in conjunction with a review of a scientific literature database to assess the climate risk for 14 NAFO-managed stocks (Boyce, 2024).

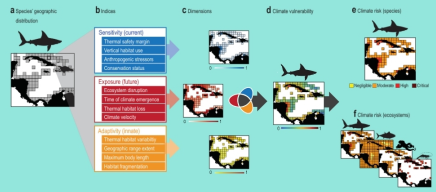

Figure 2. Climate Risk Index for Biodiversity (CRIB): spatially explicit climate risk for species and ecosystems across 12 indices (Boyce et al., 2022).

The analysis revealed that half of the assessed NAFO stocks were at high risk due to climate change under either scenario (Figure 3). It also projected the magnitude (the proportion of thermally suitable habitat loss) and timing (the year when temperature is expected to exceed the species' upper thermal limit) of climate impacts on these species across both scenarios (Boyce, 2024) (Figure 4). This information can help identify and prioritize species and areas for future data collection, scientific studies and integration, or management action.

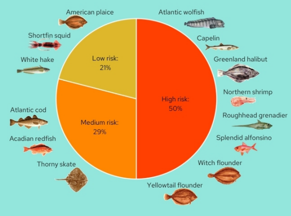

Figure 3. Assessed climate risk of NAFO-managed species categorized as high, moderate and low. (Boyce et al., 2024).

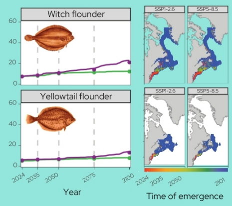

Figure 4. Example of projected magnitude and timing of climate impacts for two NAFO species classified as at high climate risk. (Left) Magnitude: Projected loss of thermally suitable habitat across the NAFO area under high emissions (purple) and high mitigation (green) scenarios. Dotted vertical lines show years 2035, 2050, and 2075. (Right) Timing: The projected year when the temperature could exceed the species' upper thermal limit across the NAFO study area. Red shows earlier, and blue later. (Boyce, 2024).

RECOMMENDATIONS

Deep-sea RFMOs should:

- Integrate climate data and management strategies that account for climate change directly into new and existing EAFM plans.
- Use climate risk tools to identify the species and locations that are most urgently in need of management adaptation and take the steps necessary to help them, such as integrating climate change considerations into stock assessment, harvest advice, and decision-making.
- Share and align data, tools and approaches across RFMOs for better planning of EAFM and climate change across ocean basins.

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Climate Risk Index for Biodiversity

OCEANS NORTH

Wild Ocean Research