Science – Policy workshop: Upscaling marine ecosystem models to implement EU plans and directives.

Ecopath 40 Years Conference

Date: Thursday 6 June 2024 (13.00-16.00)

Venue: InnovOcean Campus, Oostende, Belgium

13:00 – 13:05	Welcome & practical information by moderator. *Sheila Heymans, Executive Director, European Marine Board*
13:05 – 13:15	Brief introduction of Ecopath and Policy Landscape highlighting the outcomes from the EcoScope policy workshop and questionnaire *Sheila Heymans, Executive Director, European Marine Board*
13:15 – 13:30	Getting models ready to improve the implementation of MSFD (10 min) *Chiara Piroddi, Joint Research Centre of the European Commission (JRC)* Q&A for clarification (5 min)
13:30 – 13:45	Ecosystem-based fisheries management: Using EwE to keep human activities compatible with GES, for MSFD and CFP. *Jacob Bentley, Natural England, London UK.* Q&A for clarification (5 min)
13:45 – 14:00	FutureMARES: Using EwE for climate change scenarios and Nature Based Solutions to address Climate change, Nature Restoration Law, and Biodiversity Strategy. *Riikka Puntila-Dodd, Åbo Akademi University, and Finnish Environment Institute, Helsinki, Finland* Q&A for clarification (5 min)
14:00 – 14:15	Using the Ecopath approach for an end-to-end representation of marine ecosystems *Ekin Akoglu, Middle East Technical University, Institute of Marine Sciences, Turkey* Q&A for clarification (5 min)
14:15 – 14:45	*Group picture and Coffee break*
14:45 – 15:55	Discussion. Topics: - Outcomes from EwE models to address the CFP/WFD and MSFD GES/MSP - EwE mode outcomes to address the Action Plan for Fisheries, Nature Restoration Law and Biodiversity Strategy. - Linking with the EDITO. - What more is needed! Moderated by *Sheila Heymans, Executive Director, European Marine Board*
15:55 – 16:00	Wrap up and close of workshop. *Sheila Heymans, Executive Director, European Marine Board*

List of projects represented:

EC Initiative:

Blue2 Modelling Framework:

Short description: The Blue2 modelling framework is a comprehensive suite of modelling tools that has been built by the EC Joint Research Centre over the last 10 years with the involvement of the wider scientific community. During the setup of the different models and modules it has been tested and validated with the publication of numerous papers and technical reports. It incorporates models for freshwater quantity and quality, to recreate the conditions of EU rivers and lakes, as well as atmospheric forcing from either reanalysis or circulation models to capture atmospheric deposition of important chemical elements for marine ecosystems.

Main outcome: The Blue2MF was built to enable simulations of EU marine ecosystems under different management/policy scenarios to explore the consequences of various management and policy options in marine ecosystems, including the linkages between inland and marine waters. It has been designed to provide information on specific indicators set out in EU legislation (e.g., MSFD, WFD, CFP). It allows testing *what-if* scenarios regarding EU water policies (e.g., revision of directives) and help policy makers to evaluate the impacts on environmental variables. It is currently used for the Impact Assessment and potential Revision of the MSFD by analysing the probable future environmental conditions in EU marine regions under different policy scenarios (current MSFD vs. revised MSFD). It is also providing guidance for other policies: among all, the EU Algae Initiative, by identifying suitable regions for seaweed cultivation in the EU; the Zero Pollution Action Plan, by assessing the ecosystem benefits of reducing waste (nutrients, contaminants, litter) (50%) in EU seas; and the Biodiversity Strategy/Marine Action Plan by assessing the ecosystem benefits of fully protecting (10%) EU marine regions and/or banning the bottom trawling.

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EU projects:

ACTNOW: Advancing understanding of Cumulative Impacts on European marine biodiversity, ecosystem functions and services for human wellbeing.

Funding: EU Horizon Europe under grant agreement No 101060072

Short Description: ACTNOW advances the state-of-the-art in understanding and forecasting of the cumulative impacts of climate change and interacting drivers on marine systems and aims to deliver: 1) mechanistic understanding of the impacts of multiple interacting drivers on organisms, communities, habitats and ecosystems from individual-level performance to ecosystem-level stability, resistance, resilience and tipping points; 2) improved monitoring and new indicators of marine biodiversity based on

state-of-the-art biologging technology, molecular methods and advanced numerical modelling; and 3) enhanced forecasts of European marine biodiversity, ecosystem functioning and services using scenarios.

Main outcomes: An ensemble of models including, but not limited to, Ecopath with Ecosim, will be used to understand the combined impacts of different types of pressures or perturbations on coastal and marine biodiversity and ecosystems condition and the biological mechanisms determining the response of organisms and ecosystems to environmental changes. ACTNOW will support awareness and understanding of links between marine biodiversity, ecosystem functioning and human health through capacity building, public outreach and by creating decision-support tools for regulators for the best context-dependent assessment and actions to achieve or restore good environmental status.

Website: https://www.actnow-project.eu

Main Contact: Ekin Akoglu (eakoglu@metu.edu.tr)

Bridge-BS: Advancing knowledge, delivering research, empowering citizens for sustainable and climate-neutral Black Sea.

Funding: EU Horizon 2020 grant agreement No. 101000240

Short Description: BRIDGE-BS aims to advance the Black Sea's marine research and innovation to co-develop Blue Growth pathways under multi-stressors for the sustainable utilization of the ecosystem services. To do so it will develop an ecosystem-based management framework to enable policy uptake and foster citizen engagement. BRIDGE-BS will develop predictive tools predict the impacts of climate-driven and anthropogenic multi-stressors on the services stemming from Black Sea ecosystems.

Main outcomes: BRIDGE-BS will develop the decision support tools necessary for the generation and implementation of holistic and adaptive management to identify the safe operating space. The EwE model of the Black Sea will be part of the Digital Twin of the Ocean being created by BRIDGE-BS.

Website: https://bridgeblacksea.org/

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Discardless: Strategies for the gradual elimination of discards in European fisheries

Funding: EU Horizon 2020 grant agreement No 633680.

Short Description: DiscardLess will provide the knowledge, tools and technologies as well as the involvement of the stakeholders to achieve the gradual elimination of discarding in European fisheries. These will be integrated into Discard Mitigation Strategies (DMS) proposing cost-effective solutions at all stages of the seafood supply chain. The first focus is on preventing the unwanted catches from ever being

caught. The second focus is on making best use of the unavoidable unwanted catch. DiscardLess will evaluate the impacts of discarding on the marine environment, on the economy, and across the wider society. These impacts will be evaluated before, during and after the implementation of the landing obligation, allowing comparison between intentions and outcomes.

Main outcomes: Discardless developed ecosystem models to study the impacts of discards and the Landing Obligation (LO). Ecosystem models predicted that discards contributed very little to the diet of scavengers at a regional scale. A reduction in discards through the Landing Obligation may therefore affect populations for a few species in some areas, but generally this is unlikely to be the case. The Azores EEZ ecosystem models recently developed, parameterised and fitted to time series data of abundance and catch were improved and used to assess the impact of the LO in particular species and in the whole ecosystem functioning, goods, and services. The ecosystem model was further used to test the whole ecosystem impact of different discard mitigation strategies scenarios and estimate the outcomes of selected scenarios. Due to low discard levels in Azores fisheries, the extensive size and great surrounding depths of the Azores EEZ, the ecosystem impacts of the LO are expected to be small.

Website: http://www.discardless.eu/

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EcoScope: Ecocentric management for sustainable fisheries and healthy marine ecosystems

Funding: EU Horizon 2020 Grant agreement No 101000302

Short description: EcoScope aims to promote an effective and efficient, ecosystem-based approach to fisheries management. The four-year (2021-2025) project addresses ecosystem degradation and anthropogenic impact that cause fisheries to be unsustainably exploited in several European Seas and promotes efficient, holistic, sustainable, ecocentric fisheries management that will aid towards restoring fisheries sustainability and ensuring balance between food security and healthy seas.

Main outcome: EcoScope will develop an interoperable platform, a robust decision-making toolbox, a series of online courses and a mobile application. These tools will be available through a single public portal, to promote an efficient, ecosystem-based approach to the management of fisheries and achieve maximum and continuous participation of stakeholders.

Website: https://ecoscopium.eu/

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FAIRSEA: Fisheries in the Adriatic Region – a Shared Ecosystem Approach

Short Description: Fisheries play central role in coastal communities of the Adriatic Sea and for their ecological, economic and social sustainability a quantitative integrated platform is co-developed and used in participatory approaches. The platform, integrating from physics to fish and fisheries, represents a multidisciplinary decision support tool and it is the cornerstone element of a broad approach for increasing technical capacities and consensus toward sustainable solutions for the Adriatic Sea fisheries.

Main outcomes: A decision support tool in the form of the integrated platform for an ecosystem approach to fisheries. The integrated tool gather together in a easily accessible and transferable way a large set of 3D oceanographic variables, distribution of renewable marine resources, fisheries effort at fleet segment level and other fisheries data. These layers of data were used in a set of different, complementary models (SDM, SMART, BEMTOOL, ECOSPACE) used to test scenarios.

Website: https://programming14-20.italy-croatia.eu/web/fairsea

Main Contact: Simone Libralato slibralato@ogs.it

FutureMARES: **Climate change and future marine ecosystem services and biodiversity**

Short Description: (100 words) FutureMARES examines the relations between climate change, biodiversity and ecosystem services. The activities are designed around two Nature-based Solutions (NBS)(Restoration and Conservation), and Nature inclusive Harvesting (NIH). Seven Ecospace models representing regional seas, and their sub-regions were used to model ecosystem change following regionally downscaled narratives based on the general scenarios. The models were used to run three contrasting scenarios including climate equivalent status quos. Implementations of management interventions under different Nature-Based Solutions (NBSs) and Nature-Inclusive Harvesting (NIH) options included protection, restoration and ecosystem-based management of fisheries, and considered regional contexts, current legislations and future developments of the legal frameworks.

Main outcomes: (100 words) The results show distinct ecological and fisheries socio-economic projections in the scenarios. The results are shaped by climate conditions as well as the pivotal influence of the management strategies, different in each scenario. They suggest that NBSs, together with NIH actions can play a vital role in mitigating the impacts of climate change. The results also show divergent trajectories for many species and indicators between the scenarios and their climate change analogues. In the future climate conditions, with expected increases in temperature and changes in primary production, effective

management interventions are crucial to maintain biodiversity and support productive, sustainable fisheries.

Website: https://www.futuremares.eu/

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iAtlantic, Integrated Assessment Of Atlantic Marine Ecosystems In Space And Time

Funding: EU Horizon 2020 grant agreement No 818123.

Short Description: iAtlantic aims to deliver knowledge that is critical for responsible and sustainable management of Atlantic Ocean resources in an era of unprecedented global change. This ambitious project will determine the resilience of deep-sea animals – and their habitats – to threats such as temperature rise, pollution and human activities. iAtlantic is undertaking an ocean-wide approach to understanding the factors that control the distribution, stability and vulnerability of deep-sea ecosystems. Central to the project's success is the international collaboration between scientists throughout the Atlantic region, with sharing of expertise, equipment, infrastructure, data and personnel placed at the forefront of iAtlantic's approach.

Main outcomes: iAtlantic demonstrated that improved deep-sea biodiversity assessments and regional management scenarios can inform the conservation and sustainable management of ecosystems in the Atlantic. In the Azores case study, iAtlantic developed a framework to systematically evaluate the performance of a spatially explicit ecosystem model (using Ecospace) for deep-sea and open-ocean environments assessments. The systematic approach aimed to determine the model's suitability as a tool to inform area-based management in the deep-sea. Overall, this approach proved useful in identifying key model sensitivities and sources of uncertainty that arise when considering spatial variability in trophodynamics in the ecosystem model. The systematic assessments presented in this study provide a framework for future model applications to predict the ecosystem-wide impacts of alternative spatial management measures in the deep-sea.

Website: https://www.iatlantic.eu/

Main Contact: Telmo Morato (t.morato@gmail.com; telmo.af.gomes@uac.pt)

MarinePlan, Improved transdisciplinary science for effective ecosystem-based maritime spatial planning and conservation in European Seas

Funding: EU Horizon Europe grant agreement No 101059407 and UKRI under the UK government's Horizon Europe funding guarantee grant numbers 10038951 & 10050537.

Short Description: The EU-funded project MarinePlan supports the implementation of ecosystem-based MSP through the development of a decision support system. It will offer guidance for an improved alignment of MSP, spatial conservation and restoration measures during the challenging times of ever-increasing pressures on marine ecosystems.

Main outcomes: The Azores Ecospace model has been demonstrated useful to project the ecosystem and fisheries impacts of the implementation of the UE Biodiversity targets (30% / 10%). The overarching conclusion of the forecasted ecosystem outcomes is that networks of MPAs in the Azores can have strong positive effects in the biomass of top-predators and lead to spatial trophic cascade effects through the food-web. Our model also projected that the implementation of "no-take areas" should be accompanied by other fisheries management measures. We noted that the implementation of a MPA strategy projected potential detrimental effects in some shallow-water and coastal commercially important fisheries stocks. This may result from the displacement of fishing effort to coastal and shallower fishing grounds, with potentially negative effects on some fish stocks. Notwithstanding, following the MPA implementation with additional fisheries tools (i.e., effort reductions) might be crucial to avoid local depletion of stocks in response to the displacement of fishing activities to non-protected grounds.

Website: https://www.marineplan.eu/

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MISTIC SEAS III Developing a coordinated approach for assessing Descriptor 4 via its linkages with D1 and other relevant descriptors in the Macaronesian sub-region

Funding: 80% funded by European Commission DG ENV/MSFD: GA 110661/2018/794676/SUB/ENV.C2.

Short Description: The main objective of MISTIC SEAS III project was to address the assessment of the environmental status of the marine environment, based on Descriptor 4 (D4, food webs) of the Marine Strategy Framework Directive (MSFD) in Macaronesia sub-region (Azores, Madeira and Canary Islands), following the criteria set by the European Commission. Through coordinated action and a common approach, the assessment of the environmental status of the marine environment in the Macaronesia sub-region was carried out, defining and testing methodologies that enable to identify trophic guilds.

Main outcomes: MISTIC SEAS III demonstrated that ecosystem models can be a powerful tool to obtain information of ecosystem changes. Indicators describing the cumulative biomass curve of marine ecosystems were revealed to be robust model-derived indicators of the food-web state. We identified threshold values that inform a critical condition of the system and suggest a weak ability of the system to return to a baseline state of the food web. Fishing impacts combined with environmental conditions that limit the transfer of energy up the food-web were predicted to promote outstanding ecosystem-wide effects. We suggested that the structuring role of low trophic level groups, for example zooplankton,

should be better understood to ultimately investigate if they can be used as indicator-species of food-web status.

Website: https://misticseas3.com/en/the-project

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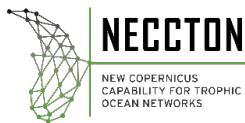
**NECCTON: New Copernicus capability for trophic ocean networks**

Funding: EU Horizon Europe RIA Grant Agreement No 101081273 and the UK Research and Innovation

Short description: NECCTON is transforming the European Copernicus Marine capability to predict marine ecosystems operationally. The ultimate goal is to support EU capacity in protecting marine biodiversity and managing fisheries sustainably. The project (2023-2026; 23 partners, 10M €) is engaging many stakeholders to co-create models, data-products and case studies. NECCTON has been endorsed by the UN Ocean Decade as project of the Marine Life 2030 Programme.

Main outcomes: NECCTON will couple and ensemble of seventeen fish models, including Ecopath, as well as benthic models and pollution models (e.g., plastic, metals and oil) with the operational models of the Copernicus Marine Service. These coupled models will produce twenty-seven new products, including fish biomass and climate change stressors. These products will be tested in thirteen-case studies, co-created with stakeholders, to confirm their technological/operational readiness levels for fisheries management and biodiversity protection.

Website: www.neccton.eu

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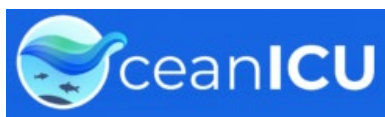
Ocean ICU: Improved Carbon Understanding

Funding: EU Horizon Europe grant agreement no. 101083922 and UK UKRI under the UK government's Horizon Europe funding guarantee [grant number 10054454, 10063673, 10064020, 10059241, 10079684, 10059012, 10048179].

Short Description: The Horizon EU OceanICU is a five-year project that seeks to gain a new understanding of the biological carbon pump and its processes to provide fundamental knowledge and tools to help policy makers, regulators and Ocean industry (fishing and mining, along with the wider blue economy) manage and understand the impact of their actions on Ocean carbon. This will ultimately lead to a better approach for addressing climate change in alignment with the EU Green Deal to reduce the net emissions of greenhouse gases to Zero by 2050.

Main outcomes: Ecopath with Ecosim (EwE) has been used to develop a pipeline which is able to estimate the carbon sequestered from fish as part of the biological carbon cycle, and how this sequestration might be impacted by fisheries. This pipeline will be coupled with biogeochemical models to deliver decision support tools. This work was also supported by activities at ICES WKFishCarbon (Workshop on Assessing the Impact of Fishing on Oceanic Carbon).

Website: https://ocean-icu.eu/

Main Contact: Jacob Bentley (jacob.bentley@naturalengland.org.uk)

Other projects:

Name: *UK Ecosystem-based Fisheries Management*

Funding: UK Government - Statutory duty

Short Description: The UK Fisheries Act 2020 includes an ecosystem objective which aims to ensure that the collective pressure of human activities is kept within levels compatible with the achievement of Good Environmental Status. The UK government is looking to marine ecosystem modelling (using Ecopath with Ecosim among other tools) to deliver strategic ecosystem information to support the maturation of an ecosystem approach for fisheries management.

Main outcomes: Ecopath with Ecosim (EwE) has been used to deliver evidence on the ecosystem role of important forage fish in UK waters. Important species for ecosystem function and commercial fisheries include sandeels, Norway pout, sprat, herring, mackerel, horse mackerel, and blue whiting among others. EwE has been used to identify key predators and the likely impacts to the wider ecosystem if forage fish biomass was to change. In 2023, EwE was used to deliver evidence to accompany the UK's consultation on the closure of its North Sea waters to industrial fishing for sandeels.

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Name: *ICES WKFoodWeb (Workshop on the operational use of Food Web indicators and information)*

Short Description: Understanding the structure of marine food webs and how they, as well as the services they support, respond when perturbed is a fundamental prerequisite of Ecosystem-based Management. This understanding can help to identify social, economic, and ecological trade-offs and assess the risks of ocean uses as well as the risks of failing to respond to pressures such as climate change. ICES is seeing growing requests for ecosystem-based advice. WKFoodWeb was designed to review the latest advances in food web research, explore needs and pragmatic solutions for integration into ICES advice, and consider how complex food web models can be more systematically applied across ICES ecoregions.

Main outcomes: WKFoodWeb focused on delivering against four terms of reference to enhance the delivery of ecosystem informed advice from ICES. These included 1) reviewing the availability and usefulness of food web indicators for advice, 2) identifying priority routes for the integration of ecosystem information into advice, 3) developing systematic ways for EwE and other ecosystem models to be used within ICES, and 4) developing new food web products for the ICES ecosystem overviews. It is anticipated that this Workshop will transform into a new Working Group to streamline the transformation of ecosystem information into advice for ICES requesters.

Website: https://www.ices.dk/community/groups/Pages/WKFoodWeb.aspx

Main Contact: Jacob Bentley (jacob.bentley@naturalengland.org.uk)

Name: *Ecological Reference Points for internationally shared forage fish*

Funding: Pew

Short Description: Internationally shared forage fish play a crucial role in Northeast Atlantic marine ecosystems, serving as a conduit for energy transfer from plankton to higher trophic levels and supporting valuable commercial fisheries. Current management strategies, primarily focused on achieving Maximum Sustainable Yield (MSY) while meeting the Precautionary Approach (PA), infrequently consider broader ecosystem objectives and predator needs. Progress to integrate ecosystem information into management practice has been limited by structural inertia within management systems, regulatory constraints, and the challenge of deriving specific actions from an esoteric concept. In this project, we reviewed how existing tools and approaches can be used to deliver an ecosystem approach now.

Main outcomes: The project has explored how existing Management strategy Evaluation (MSE) and ecosystem modelling tools (EwE) can be used to explore the trade-offs associated with forage fish fisheries. By incorporating ecosystem complexity and Ecological Reference Points (ERPs) into fishing strategies, we show how MSE offers a quantitative approach to advance Ecosystem-Based Fisheries Management (EBFM) within existing regulatory frameworks. The feasibility of using ecosystem models to support the development of MSE and ERPs for forage fish stocks in the Northeast Atlantic was reviewed, focusing particularly on the utility of Ecopath with Ecosim (EwE).

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