FISH FORUM ANTALYA 2024

Forum on fisheries science in the Mediterranean and the Black Sea

19–23 FEBRUARY 2024 • TÜRKİYE

Abstracts

FISH FORUM 2024 ABSTRACTS

CONTENTS

ABBREVIATIONS AND ACRONYMS

AASTMT	Arab Academy for Science, Technology and Maritime Transport (Egypt)
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea
AKD	Mediterranean Conservation Society
BESITO	Benthos Sensitivity Index to Trawling Operations
BRTA	Basque Research and Technology Alliance (Spain)
COB	Oceanographic Centre of the Balearic Islands (Spain)
CCMAR	Centre of Marine Sciences of the University of Algarve
CIBM	Consortium for the Interuniversity Centre for Marine Biology and Applied Ecology (Italy)
CNR	National Research Council (Italy)
CNRDPA	National Centre for Research and Development in Fisheries and Aquaculture (Algeria)
CNRS-France	National Centre for Scientific Research (France)
CNRS-Lebanon	National Council for Scientific Research (Lebanon)
DNA	deoxyribonucleic acid
DTU Aqua	National Institute of Aquatic Resources of the Technical University of Denmark (Denmark)
eDNA	environmental DNA
EMFAF	European Maritime, Fisheries and Aquaculture Fund
EMFF	European Maritime and Fisheries Fund
EUTECH	European Technology Chamber
EV-ILVO	Flanders Research Institute for Agriculture, Fisheries and Food (Belgium)
F	fishing mortality
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
GRSF	Global Record of Stocks and Fisheries
GSA	geographical subarea
HCMR	Hellenic Centre for Marine Research (Greece)
IAMC-CNR	Institute for Coastal Marine Environment of the National Research Council (Italy)
IAV-HASSAN II	Agronomic and Veterinary Institute Hassan II (Morocco)
IBER-BAS	Institute of Biodiversity of Ecosystem Research at the Bulgarian Academy of Sciences (Bulgaria)
ICATMAR	Catalan Institute for Ocean Governance Research
ICM-CSIC	Institute of Marine Sciences of the Spanish National Research Council (Spain)
ICMAN-CSIC	Institute of Marine Sciences of Andalusia of the Spanish National Research Council (Spain)
IEO-CSIC	Spanish Institute of Oceanography of the Spanish National Research Council (Spain)
IFREMER	French Research Institute for Exploitation of the Sea (France)
INAT	National Agronomic Institute of Tunisia (Tunisia)
INRH	National Institute of Fisheries Research (Morocco)
INP-ENSAT	National Institute of Agronomy of Tolouse (France)
INSTM	National Institute of Marine Sciences and Technology (Tunisia)
IMBRIW	Institute of Marine Biological Resources and Inland Waters (Greece)

IMEDEA	Mediterranean Institute for Advanced Studies (Spain)
IRBIM-CNR	Institute for Biological Resources and Marine Biotechnologies of the National Research Council (Italy)
IRPPS-CNR	Institute for Research on Population and Social Policies of the National Research Council (Italy)
ISMAR-CNR	Institute of Marine Sciences of the National Research Council (Italy)
ISPRA	Italian Institute for Environmental Protection and Research (Italy)
LEK	local ecological knowledge
LPUE	landing per unit effort
M	natural mortality
MCDA	multicriteria decision analysis
MCRS	minimum conservation reference size
MEDAC	Mediterranean Advisory Council
MEDFRI	Mediterranean Fisheries Research, Production and Training Institute
MedPAN	Mediterranean Protected Areas Network
MIO	Mediterranean Institute of Oceanography
MPA	marine protected areas
MSY	maximum sustainable yield
NBFC	National Biodiversity Future Centre
NEA	National Environmental Agency (Georgia)
NIMRD	National Institute for Marine Research and Development "Grigore Antipa" (Romania)
NIS	non-indigenous species
NIOF	National Institute of Oceanography and Fisheries (Egypt)
NORCE	Norwegian Research Centre (Norway)
OGS	National Institute of Oceanography and Applied Geophysics (Italy)
PAL	porpoise alerting device
PPA	partially protected areas
SPC	self-polishing co-polymer
SSF	small-scale fisheries
STECF	Scientific, Technical and Economic Committee for Fisheries
SUMAE	Central Fisheries Research Institute (Türkiye)
SZN	Stazione Zoologica Anton Dohrn Napoli (Italy)
UMR MARBEC	Joint Research Unit for Marine Biodiversity, Exploitation and Conservation (France)
UNEP/MAP-SPA/RAC	United Nations Environment Programme Mediterranean Action Plan Specially Protected Areas Regional Activity Centre
UNESCO	United Nations Education, Scientific and Cultural Organization
WMO	World Meteorological Organization
WMU	World Maritime University
WWF	World Wide Fund for Nature

INTRODUCTION

The General Fisheries Commission for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations (FAO) Forum on Fisheries Science in the Mediterranean and the Black Sea 2024 (Fish Forum 2024) is the second edition of this key regional initiative gathering scientists, researchers, engineers, academics, practitioners, managers and decision-makers. First organized in 2018 by the GFCM, Fish Forum aims to build a lasting scientific network in order to discuss existing and emerging challenges, identify research priorities and integrate scientific knowledge in decision-making with a view to better shaping the future of Mediterranean and Black Sea fisheries.

The event complements the GFCM 2030 Strategy for sustainable fisheries and aquaculture in the Mediterranean and the Black Sea, in particular Output 2 of Target 5, which highlights the importance of promoting technical cooperation and boosting scientific research and innovation by filling gaps in knowledge and capitalizing on existing research, and stresses the significance of scientific collaboration and best practices in fisheries and aquaculture.

Fish Forum has been recognized by the United Nations General Assembly as an example of efficient interface between science and policymaking and has joined the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) initiative. Similarly, it has gained recognition for contributing to the achievement of the United Nations Sustainable Development Goals (SDGs), in particular SDG 14 on the conservation and sustainable use of oceans, seas and marine resources, as well as SDG 5 on gender equality, SDG 8 on decent work and economic growth and SDG 13 on climate action. Similar events were then organized by FAO at the global level, such as the International Symposium on Fisheries Sustainability: Strengthening the Science–Policy Nexus, which was held in November 2019.

Similar to the 2018 edition, Fish Forum 2024 had an interdisciplinary focus, addressing three interrelated themes: i) Better science for better advice; ii) Healthy seas and sustainable fisheries; and iii) Economic and technological innovation for resilient fisheries; with a central view towards climate change and innovative technologies. Each thematic session was structured around keynote addresses to spotlight cross-cutting topics, as well as parallel sessions to highlight leading research in the field, expert roundtables to enable dynamic discussions on prominent issues, a poster session to provide insights on specific aspects in relation to each theme, and finally a wrap-up session to define the main outcomes and priorities for the coming decade. Side events held during Fish Forum enabled for focused discussions on topics complementary to the main themes of the event. Particular attention was paid to urgent research questions emanating from GFCM experts, as well as to global challenges, including those identified within newly adopted international agreements such as the Kunming-Montreal Global Biodiversity Framework and the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction. Throughout the event, emphasis was given to increasing inclusiveness, including through supporting the participation of youth and women, the organization of dedicated activities for the general public and the participation of organizations supporting and promoting the inclusion of persons with disabilities.

This document contains abstracts of all scientific contributions to Fish Forum 2024, including keynote presentations, oral contributions and posters.

PARTNERS

In order to strengthen regional dialogues and promote the sharing of scientific knowledge, Fish Forum 2024 was organized with the contribution of partners from a wide range of sectors and expertise. The following partners provided technical or financial support that was invaluable in the organization of the event:

- Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS)

- International Centre for Advanced Mediterranean Agronomic Studies of Bari (CIHEAM Bari)

- Commission on the Protection of the Black Sea Against Pollution

- Mediterranean Advisory Council (MEDAC)

- International Commission for the Conservation of Atlantic Tunas (ICCAT)

- International Council for the Exploration of the Sea (ICES)

- Oceancare

- United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP)

- World Maritime University (WMU)

- World Wide Fund for Nature (WWF)

INTERNATIONAL SCIENTIFIC COMMITTEE

An International Scientific Committee composed of well-known scientists from the GFCM region and beyond was established to support the scientific supervision of Fish Forum 2024. In particular, the Committee was tasked with selecting scientific abstracts based on the technical quality of the documents and their relevance to the topics of the three thematic sessions. Additionally, it supported the GFCM Secretariat and the technical partners with the overall programme, including selecting side events and workshops. During the event, the Committee oversaw the discussions, chaired all parallel sessions and compiled main messages and conclusions.

Tarûb Bahri
Food and Agriculture Organization of the United Nations

Tarûb Bahri is a fisheries biologist working with the Fisheries Division of FAO, where she coordinates work on climate change. Her portfolio has a strong focus on ecosystems, sustainable fisheries management and climate resilient fisheries management, including projects in the Caribbean, Africa and Asia. Ms Bahri represents FAO within the ocean community and is committed to raising awareness on the importance of fisheries and aquaculture in the global debate on climate change. She supports governments and national institutions from FAO Members in increasing knowledge on climate change impacts and in identifying solutions to the benefit of local communities and also lends her expertise to support policy formulation for effective adaptation measures to climate change.

Yessine Ben Arfa
National Institute of Marine Sciences and Technology, Tunisia

Yessine Ben Arfa is a researcher in fisheries economics at the Fisheries Sciences Laboratory of the National Institute of Marine Sciences and Technologies in Tunisia where he concentrates on the design of field survey models, data collection, development of indicators and estimation of economic performance. Since 2010, he has participated in several national and international projects, including Social Protection for Fisheries and Aquaculture (SocPro4Fish), Assessment and Monitoring of the Fishery Resources and the Ecosystems in the Straits of Sicily (MedSudMed) and Mediterranean Forum for Applied Ecosystem-Based Management (MED4EBM), and in several research actions as a project coordinator and focal point. In addition, he has collaborated with various national and international organizations, such as FAO, as well as with the GFCM and the MAVA Foundation, which has allowed him to strengthen his experience in terms of socioeconomic analyses of fisheries and to acquire expertise in policy and management measures.

Diego Alvarez-Berastegui

Spanish Institute of Oceanography of the Spanish National Research Council, Spain and International Commission for the Conservation of Atlantic Tuna Standing Committee on Research and Statistics

Diego Alvarez-Berastegui is a researcher at the Spanish Institute of Oceanography of the Spanish National Research Council, where he investigates the influence of environmental fluctuations on fish habitats. He is also the Coordinator for the Fisheries and Aquaculture Task Team of the Mediterranean Oceanographic Network for the Global Ocean Observing System and leads the Mediterranean Tuna Habitats Observatory. Since beginning his professional journey at the University of Cádiz, he has championed the integration of marine observation systems into the study of fish ecology and sustainability, helped coordinate various scientific initiatives and collaborated with organizations including the Climate Impacts on Oceanic Top Predators, ICES, the European Space Agency and ICCAT.

Giacomo Chato Osio

European Commission Directorate-General for Maritime Affairs and Fisheries

Giacomo Chato Osio is a Science and Policy Officer at the European Commission Directorate-General for Maritime Affairs and Fisheries within the unit in charge of the management of fisheries in the Mediterranean and the Black Sea. He holds a bachelor's degree in biology specializing in marine ecology and a doctorate in fisheries science and the environment and has extensive experience in stock assessment and in the provision of scientific advice for the GFCM and the European Commission Scientific, Technical and Economic Committee for Fisheries. He is extensively involved in the management of marine resources in the Mediterranean with a strong focus on management plans, testing with management strategy evaluation and implementation. Mr Chato Osio also follows the implementation of key European Union policies such as the European Green Deal and recent initiatives for the decarbonization of European Union fishing fleets.

Anne Marie Cooper

International Council for the Exploration of the Sea

Anne Cooper is the Professional Officer for Fisheries and Aquaculture Advice at ICES where she leads the work on the development, testing and use of methods to provide scientific advice on data-limited stocks of fish and shellfish in the northeast Atlantic and leads the development of the ICES advisory framework for sustainable aquaculture. She holds a PhD in conservation biology and development studies and social change theory and a MSc in fisheries science from the University of Minnesota. Prior to working at ICES, she held positions advising high-ranking government officials on national fisheries, aquaculture, climate and marine science policy in the United States of America Senate, House of Representatives, and the National Oceanic and Atmospheric Administration.

Kostiantyn Demianenko
Institute of Fisheries and Marine Ecology, Ukraine

Kostiantyn Demianenko is scientist and fisheries expert, serving as the Deputy Director on Science at the Institute of Fisheries and Marine Ecology of the State Agency of Melioration and Fisheries of Ukraine. He is also the Representative of Ukraine to the Scientific Committee of the Commission for the Conservation of Antarctic Marine Living Resources, Head of the Ukrainian delegation to the Commission for the Conservation of Antarctic Marine Living Resources and member of the Technical Advisory Committee of the Central Asian and Caucasus Regional Fisheries and Aquaculture Commission. Mr Demianenko holds an MSc in ichthyology and fish breeding and a PhD in biology. He has authored or co-authored over 60 scientific works, co-authored a research programme on Antarctic krill and toothfish, and drafted a law on traceability for fish and fish products in the Ukrainian market.

Reda Fahim
Arab Academy for Science, Technology and Maritime Transport, Egypt

Reda Fahim is an Egyptian fishery biologist with expertise in fish stock assessment and fisheries management. He is the Head of the Fisheries Department at the Arab Academy for Science, Technology and Maritime Transport, with duties of administering the department, teaching and developing curricula in the fisheries-related areas. As a fishery consultant for FAO, he performed tasks for the countries bordering the eastern Mediterranean in the implementation of fish stock unit identification project and worked as an instructor.

Emanuela Fanelli
Polytechnic University of Ancona, Italy

Emanuela Fanelli is a marine biologist and is working as Associate Professor of Ecology and Fishery Biology at the Polytechnic University of Ancona in Italy and the President of the Marine Biology MSc programme. She holds a PhD in Ecology and Management of Biological Resources. Her research spans different aspects of marine ecology, including biodiversity and ecosystem functioning with a focus on the impacts of human activities, especially fisheries, on marine ecosystems. She is also a member of the GFCM Working Group on Vulnerable Marine Ecosystems and Essential Fish Habitats.

Manuel Hidalgo

Spanish Institute of Oceanography of the Spanish National Research Council, Spain

Manuel Hidalgo is a fisheries ecologist and ecosystems oceanographer working with the Spanish Institute of Oceanography of the Spanish National Research Council, where he focuses on understanding the complexity of the impact of fishing activities and climate variability on the ecological mechanisms that regulate exploited populations, communities and ecosystems. He has been involved in scientific committees and working groups with FAO, the GFCM and ICES and has contributed to marine assessments and international processes, such as the most recent Intergovernmental Panel on Climate Change report and the Second World Ocean Assessment.

Nathalie Hilmi

Environmental Economics Section of the Scientific Centre of Monaco, Monaco

Nathalie Hilmi is a specialist in macroeconomics and international finance and is Head of the Environmental Economics Section of the Scientific Centre of Monaco and lead author for the Intergovernmental Panel on Climate Change special report on the ocean and cryosphere in a changing climate and for the Working Group II contribution to the sixth assessment report. She holds a PhD from the University of Nice Sophia Antipolis and as well as a post-doctoral diploma. Following her studies, she gained vast experience at numerous institutions including Allergan, the School of Advanced Commercial Studies of the North, the International University of Monaco, Hedge Funds Research Institute, Alpstar and the University of Nice Sophia Antipolis. Her experience also extends to the organization of international conferences and workshops, and the reviewing and editing of specialized publications.

Andrew Kenny

Centre for Environment, Fisheries and Aquaculture Science, United Kingdom of Great Britain and Northern Ireland

Andrew Kenny is a principal ecosystem scientist and marine benthic ecologist, serving as Chair of ICES Steering Group on Human Activities, Pressures and Impacts and working with the United Kingdom of Great Britain and Northern Ireland Delegations to the Northwest Atlantic Fisheries Organization and to the North East Atlantic Fisheries Commission where he advises on deep-sea vulnerable marine ecosystem management measures and other effective area-based conservation measures. He holds a PhD and has over 20 years of experience researching subjects including the impacts of bottom trawling activities on deep sea vulnerable marine ecosystems, seabed habitats, ecological risk and benthic ecosystem food webs, and is the principal chapter author of an academic handbook on methods for sampling marine benthos.

Mohamed Naji

Hassan II Institute of Agronomy and Veterinary Medicine, Morocco

Mohamed Naji is a fisheries economist specializing in fisheries management combined with value chain analysis, fisheries and aquaculture planning, the ecosystem approach to fisheries and fisheries ecolabelling and is the Head of the Fisheries and Aquaculture Department at the Hassan II Agronomy and Veterinary Medicine Institute in Rabat. He has supervised dozens of academic research studies on the Moroccan fisheries sector and has participated in numerous studies and sector development projects in Morocco, Africa and the Arab region.

Violin Raykov

Institute of Fish Resources and the Institute of Oceanology of the Bulgarian Academy of Sciences, Bulgaria

Violin Raykov is a fisheries biologist and works at the Institute of Fish Resources and the Institute of Oceanology of the Bulgarian Academy of Sciences where he focuses on the dynamics of exploited marine living resource populations. He also leads pelagic surveys and data collection programmes and has participated in over 30 projects related to fishing impacts and marine ecology in the Black Sea, multistressor impacts on the biota, and microplastic and macroplastic bioaccumulation, as well as in the programme for determination of particular measures to achieve good ecological status of the Black Sea. He has collaborated closely with the GFCM as former Vice-Coordinator of the Working Group on the Black Sea, former Coordinator of the Subregional Group on Stock Assessment for the Black Sea and initial phase Coordinator of the BlackSea4Fish project.

Olivier Thébaud

French Research Institute for Exploitation of the Sea, France

Olivier Thébaud is an economist and serves as a researcher with the French Research Institute for Exploitation of the Sea where he focuses on the use of economic analysis, in connection with marine science disciplines, to inform the management of marine and coastal resources. He obtained a PhD in economics from the School of Advanced Studies in the Social Sciences in France and participated in a European Marie Curie fellowship at the University of Portsmouth. After completing his studies, he led the French Research Institute for Exploitation of the Sea Economics Research Team and contributed to the foundation of the Centre for Law and Economics of the Sea (AMURE) Research Unit. He also spent several years with the Marine and Atmospheric Research Division of the Commonwealth Scientific and Industrial Research Organisation in Australia.

Eyüp Mümtaz Tirasin

Institute of Marine Sciences and Technology of Dokuz Eylul University, Türkiye

Eyüp Mümtaz Tirasin is a faculty member at the Institute of Marine Sciences and Technology of Dokuz Eylul University in Türkiye, where he instructs graduate courses in quantitative fisheries biology and conducts research on Turkish coastal fisheries. He holds a PhD and has over 30 years of experience in fisheries biology, with a special focus on population dynamics, stock assessment and fisheries management. He actively contributes to FAO and GFCM projects and served as the First Vice-Chairperson of the GFCM Scientific Advisory Committee on Fisheries from 2018 and 2023.

Anis Zarrouk

United Nations Environment Programme Mediterranean Action Plan Specially Protected Areas Regional Activity Centre, Tunisia

Anis Zarrouk is a marine ecologist and serves as Project Manager of the United Nations Environment Programme Mediterranean Action Plan Specially Protected Areas Regional Activity Centre (UNEP/MAP-SPA/RAC) and Project Officer of the European Union-funded ILIAD project. He holds a PhD in aquatic ecosystems, marine resources and environment from the National Agronomic Institute of Tunisia and has over 17 years of combined national and international experience, including 11 years spent managing Tunisia's four marine protected areas. Through his work, Mr Zarrouk leads and contributes to critical Mediterranean projects, with a focus on biodiversity conservation, sustainable fisheries and vulnerable species, while employing innovative ecosystem-based approaches and supporting UNEP/MAP-SPA/RAC marine conservation activities.

KEYNOTE SPEAKERS

Vera Agostini
Food and Agriculture Organization of the United Nations

Vera Agostini is the Deputy Director of the Fisheries and Aquaculture Division at the Food and Agriculture Organization of the United Nations where she provides oversight, strategic leadership and technical support. Dr Agostini is a fisheries scientist by training and has held positions in the non-governmental, governmental and academic sectors, providing technical and strategic leadership across a range of multidisciplinary efforts and working with coastal communities and artisanal fishers around the globe. From 2007–2017, prior to joining the Food and Agriculture Organization of the United Nations she worked with The Nature Conservancy, initially as Senior Scientist with the Global Oceans Team and then as Director of Conservation and Director of Climate Adaptation.

Olfa Ben Abdallah
National Institute of Marine Sciences and Technologies, Tunisia

Olfa Ben Abdallah is a researcher at the Tunisian National Institute of Marine Sciences and Technologies. She holds a PhD in fisheries sciences and focuses her research of numerous aspects of marine fisheries, including marine biology, population dynamics, stock assessment and fisheries management. Dr Ben Abdallah has extensive expertise working with non-indigenous species and is the Tunisian National Focal Point of the GFCM research programme on blue crabs. She has participated in several national, regional and international projects, and collaborates with international organizations such as FAO, the GFCM and UNEP/MAP-SPA/RAC.

Miguel Bernal
General Fisheries Commission for the Mediterranean of the Food and Agriculture Organization of the United Nations

Miguel Bernal is the Executive Secretary of the GFCM. He is the responsible for implementing policies agreed upon by GFCM countries towards ensuring the sustainability of fisheries and the sustainable development of aquaculture in the Mediterranean and the Black Sea. He has previously led the technical work of the GFCM Secretariat on fisheries-related issues, promoting modernization of work in support of decision-making, including through the publication of the biennial report on The State of Mediterranean and Black Sea fisheries. Prior to joining the GFCM, he worked in a number of top-level universities and fisheries research institutes across the world, publishing numerous scientific contributions in the fields of fisheries, ecosystem modelling and climate change.

Enrique Curchitser
Rutgers University, United States of America

Enrique Curchitser is Professor of Climate and Oceanography at Rutgers University. His research centres around understanding coastal physical–biological systems and how they are forced by, and contribute to, the climate system. He has worked in the North Pacific, Atlantic, Indonesian Throughflow, the Bering Sea and Arctic regions. At Rutgers University, he leads the Earth System Modeling Laboratory, which focuses on the development and use of high-resolution coupled bio-physical models. Professor Curchitser is the Editor-in-Chief for Progress in Oceanography and the Chair of the Intergovernmental North Pacific Marine Science Organization.

Alan Haynie
International Council for the Exploration of the Sea

Alan Haynie has served as General Secretary of ICES since 2022. He has broad, interdisciplinary experience with marine science and economics, fishery management and advice, stakeholder engagement, climate change research, policy analysis and organizational excellence. Prior to joining the International Council for the Exploration of the Sea, he spent 18 years with the National Oceanic and Atmospheric Administration Fisheries, working in the North Pacific as well as in diverse roles within the United States of America and internationally.

Simone Libralato
National Institute of Oceanography and Applied Geophysics, Italy

Simone Libralato is a Senior Scientist at the Italian National Institute of Oceanography and Applied Geophysics. He has a background in ecological modelling and quantitative analyses with special emphasis on bioenergetics of fish and shellfish, ecosystem modelling and ecological indicators. He has also gained experience in marine food web modelling and the application of integrated approaches to marine ecology (end-to-end models). His research is focused on the combined effects of different pressures on marine ecosystems, in particular fishing, aquaculture, climate and nutrient input. These studies are carried out with deterministic, statistical models and indicators that integrate resource dynamics and oceanographic variables at different scales and in different marine systems in the Mediterranean Sea and around the world.

Elisabetta Betulla Morello

General Fisheries Commission for the Mediterranean of the Food and Agriculture Organization of the United Nations

Elisabetta Betulla Morello is a quantitative fisheries ecologist by training and Fisheries Resources Officer in charge of the GFCM Fisheries Team ad interim. 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 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.

KEYNOTE PRESENTATIONS

Alan Haynie
International Council for the
Exploration of the Sea (ICES)

Challenges in connecting science to fisheries management: an International Council for the Exploration of the Sea perspective

The International Council for the Exploration of the Sea (ICES) is an intergovernmental marine science organization that advances and communicates scientific understanding of marine ecosystems and the services they provide. It harnesses this knowledge to produce unbiased advice towards meeting conservation, management and sustainability goals. Since its creation in 1902, ICES has been constantly challenged to adapt to evolving scientific and policy needs and priorities and a changing environment. In all regions, fishery managers must develop management measures in this dynamic context, with varying availability of information about harvested species and the effectiveness of potential measures. We discuss how the best available science can be utilized across all levels of scientific and management capacity, and identify challenges that remain to broaden the science needed to provide advice in the context of ecosystem-based management, to ensure trust and transparency in the usage of science in management, and to strengthen and better integrate the global marine science community.

Elisabetta Betulla Morello
General Fisheries Commission
for the Mediterranean (GFCM)
of the Food and Agriculture
Organization of the United
Nations (FAO)

Back to the future: better science for better advice in the Mediterranean and the Black Sea

Good (robust, unbiased and comprehensive) science is the key to quality advice that supports informed management, but how can adaptive management and decision-making be improved through better science? With the Mediterranean and the Black Sea as the starting and ending points, this presentation summarizes past scientific developments within the GFCM with the aim to promote a debate on what the future should look like, setting the stage for Fish Forum 2024. How has fisheries management evolved thus forth? What has been successful? What is missing for the future? Where should one seek knowledge, inspiration and ideas?

Camille Jean Pierre Manel
International Commission for the Conservation of Atlantic Tunas (ICCAT)

The experience of the International Commission for the Conservation of Atlantic Tunas on the implementation of an ecosystem approach to fisheries management

The mandate of the International Commission for the Conservation of Atlantic Tunas (ICCAT) has been evolving since its inception in 1966. Over the course of its history, ICCAT has been extending its single-species mandate to one with an increasing complexity of species and objectives. It now includes a much broader set of species, including non-target species and those that are affected by fishing for ICCAT species. In this presentation, we review aspects of ICCAT's experience with an ecosystem approach to fisheries management. In practice, it has been implementing the elements of this approach for over a decade through initiatives for the conservation of seabirds, turtles and sharks. In addition, under the new convention text, ICCAT has an explicit mandate for an ecosystem approach to fisheries management. Just as its mandate has widened, ICCAT has also expanded its collaborations to include the Convention on the International Trade of Endangered Species, non-governmental organizations, the Agreement on the Conservation of Albatrosses and Petrels, the Inter-American Convention for the Protection and Conservation of Sea Turtles, and the five other regional fisheries management organizations for tuna. In mandate and in practice, ICCAT is consistently applying the elements of an ecosystem approach to fisheries management.

Simone Libralato
National Institute of Oceanography and Applied Geophysics (OGS), Italy

Integrated fisheries management: running before we can walk?

Fisheries management at the global level needs to move rapidly from an approach that focuses on maximizing the catch of a single target species to a more comprehensive view that considers the well-being of the marine ecosystem as a whole, as well as the economic and social complexities of managing marine living resources. Comprehensive integrated ecosystem approaches to be used for marine resource management can include a variety of components linked by a detailed description of the biological processes involved, the physical and chemical factors that influence them and the socio-economic dynamics that depend on (and drive) ecosystem health and services. Despite being highly adaptive and enabling a balance between different societal goals, integrated approaches have been slow to gain acceptance and adoption in fisheries management. Lack of data, uncertainties, lack of precision and the complexity of results are some of the factors hindering the application of ecosystem approaches. We are still in the process of improving our stock assessments, can we afford this additional burden? What are the best ways to move quickly to the application of integrated approaches in fisheries management? A systematic discussion on data needs, trade-offs, reference indicators and available approaches to ensure a holistic view will help answer these questions.

Vera Agostini
Food and Agriculture
Organization of the United
Nations (FAO)

Mainstreaming biodiversity in the fisheries and aquaculture sectors: information needs, challenges and opportunities

Biodiversity for both fisheries and aquaculture is indispensable for food security, nutrition and the supply of many ecosystem services that support sustainable development. Biodiversity increases a social–ecological system's resilience to shocks and stresses, and helps production systems adapt to emerging challenges such as climate change, while underpinning fishers' and fish farmers' livelihoods and ability to produce food. The FAO Committee on Fisheries has recognized the key role that biodiversity plays for the fisheries and aquaculture sectors and noted, among other things, the important roles played by regional fisheries management organizations and regional initiatives. The Committee has also recognized the critical need for the sectors to be involved in intergovernmental processes in order to establish instruments related to biodiversity. In 2022 and 2023, biodiversity was at the forefront of international discussions as two important instruments were adopted: the Kunming-Montreal Global Biodiversity Framework (December 2022) and the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (June 2023). This presentation will outline the important links that these instruments have to the fisheries and aquaculture sectors as well as potential links to other treaties such as the United Nations Fish Stocks Agreement and will highlight the necessity to carefully examine the information needs and implications of each instrument.

Enrique Curchitser
Rutgers University, United
States of America

Enlisting climate science to advance fisheries management

There are numerous success stories in fisheries management that have led to sustainable harvests worldwide. Nevertheless, we see increasing examples of abrupt collapses of stocks that were once considered relatively stable. This presentation presents the case that a changing climate can be linked to some of these collapses and that resource management strategies can no longer ignore evolving environmental conditions. By drawing from examples of previously successful management efforts in North America, suggestions are made for tools that could be enlisted to better understand the science and potentially guide fisheries management strategies.

Olfa Ben Abdallah
National Institute of Marine Sciences and Technologies (INSTM), Tunisia

Empowering sustainable fisheries through stakeholder collaboration in Tunisia's blue crab industry

Fishing holds a paramount role in supporting livelihoods, ensuring food security and promoting global human health. Recognizing the need for comprehensive management, the fishing industry increasingly acknowledges the importance of aligning practices with the three pillars of sustainability: economic, social and environmental. In the specific context of blue crab fishing in Tunisia, the active engagement of fishers in adapting to ecosystem changes and embracing sustainable practices is a linchpin for ensuring long-term economic sustainability. The adoption of responsible fishing methods not only secures a robust economic future but also safeguards the newfound resource in a healthy manner. Simultaneously, involving fishers and other stakeholders in decision-making processes fosters community ownership, a vital element for sustainable practices. This collaborative approach guarantees the implementation of regulations that consider ecological impacts, with fishers assuming a central role in preserving the marine environment. Tunisia's blue crab fisheries serve as a compelling example of the transformative power of stakeholder participation. Through collaboration between fishers, government bodies and non-governmental organizations, what was once a potential catastrophe has been turned into an opportunity, seamlessly integrated into the fishing economy. This inclusive approach ensures good governance of fishing, practical and effective regulations, showcasing how fishers actively contribute to the resilience and sustainability of their livelihoods and marine ecosystems.

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Theme 1
Better science for better advice

KEYNOTE PRESENTATIONS

ORAL PRESENTATIONS

Parallel session 1.1: Good practice in data and resource limited assessments

Parallel session 1.2: Assessing fisheries under changing climate and productivity

Parallel session 1.3: Management strategy evaluation for fisheries advice

POSTER PRESENTATIONS

Better science for better advice

In the Mediterranean and Black Sea region, solutions backed by sound science are needed to solve growing technological, environmental and sustainability-related challenges. The objective of this theme is to explore best scientific practices and showcase research toward enhancing data-limited stock assessment approaches, developing adaptive management advice, and promoting the applicability of the management strategy evaluation framework.

Nawel Ainouche
Tahar Filali
Moussa Mennad

National Centre for Research and Development in Fisheries and Aquaculture (CNRDPA), Algeria

Improvement of biological knowledge for demersal priority species in geographical subarea 4

Key biological parameters are usually used in fisheries management to estimate exploitation levels and are still a determining factor in stock assessment accuracy from which scientific advice and management measures will be adopted. Therefore, in this perspective, this study aims to provide the most accurate data set for three priority species in geographical subarea 4 of the western Mediterranean area. Length-frequency data of red mullet (*Mullus barbatus*), European hake (*Merluccius merluccius*) and deep-water rose shrimp (*Parapenaeus longirostris*) collected from commercial landings and scientific surveys since 2015 to 2022 were used to estimate sex-ratio, growth parameters and length–weight relationships by sex, mortalities and selectivity by region according to the TRANSBORAN project results. Length-frequency data of small individuals collected during scientific surveys allowed a better fit of the three species' growth curves by refining the age t_0 calculation. Natural and fishing mortalities were estimated, as well as the exploitation rate for this species.

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Towards a multispecies maximum sustainable yield for the northwestern Mediterranean Sea

Worldwide fisheries are typically managed under a single-species perspective, despite often landing more than one or two species with certain levels of bycatch. Advancement towards a multi-species perspective requires consideration of the context of each specific area and definition of a starting point that can be comprehensible for modellers, managers and other stakeholders. For the northwestern Mediterranean Sea, we assess an assemblage of fish stocks from otter bottom trawl metiers to determine the current joint biomass, regarding the theoretical target biomass proportions related to their maximum sustainable yield. A modelling approach for data-poor fisheries based on analysis of length compositions of catches is used. Most of the selected commercial species are overexploited and therefore, current joint biomass is significantly lower than target joint biomasses of the assemblage. Statistical modelling of joint biomass proportions will allow glimpsing management scenarios to achieve maximum sustainable yield of the multispecies fishery. Variables such as predation, species competition and even environmental variables are to be considered in future analyses to improve current technical and strategic advice for management. This approach to ecosystem-based fisheries management is potentially applicable to any mixed or multispecies fishery with data of length composition of catches.

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Piked dogfish (*Squalus acanthias*) bycatch in the Turkish black sea demersal trawl fishery

Piked dogfish (*Squalus acanthias*) is a GFCM priority species that has been considered depleted. With a view to improving the status of this vulnerable species, in 2015 and 2021 the GFCM adopted two recommendations towards the implementation of management measures in the Black Sea. The most recent of these – Recommendation GFCM/44/2021/10 on management measures for sustainable piked dogfish fisheries in the Black Sea (geographical subarea 29) – also foresaw the establishment of a research programme to ensure the collection of information useful for the identification of potential future management measures. In this context, a combination of two different methodologies were evaluated to shed more light on piked dogfish bycatch in the Turkish bottom trawl fishery. First, a local ecological knowledge (LEK) study in which 156 fishers were interviewed between January and July 2023, and second, the GFCM discards monitoring programme where 1 200 trawl hauls were sampled between 2019 and 2022 in the Black Sea. The results of the LEK study showed that demersal trawls were the main fishing gear interacting with piked dogfish and winter was the prevailing season; the average depth (79-85 m) and the distance from the shore (8.6-15 km) where bycatch mostly occurs changed depending on the season. According to the discards monitoring programme, the predicted piked dogfish individuals were caught in fishing areas above latitude 42.1 where the depths ranged between 69 m and 96 m with a distinct seasonal variability. We suggest that assessing the LEK findings together with onboard observations can be a valuable approach for validating the credibility of data, thereby allowing fisheries managers to better understand the spatial and temporal patterns of bycatch.

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Spatial dynamics of bottom otter trawl fishery métiers in the northwestern Mediterranean: applications for management strategies

The multiannual plan for demersal fisheries in the northwestern Mediterranean Sea mainly considers reducing fishing effort and establishing spatial closures to achieve fishery sustainability. This study aims to provide decision-makers with the necessary information and tools to develop effective and sustainable management strategies, taking into account the bottom trawl fleet fishing strategies, or métiers, in the northwestern Mediterranean Sea. Multivariate analyses were applied to around 17 million daily bottom trawl trips reported by the Catalan Government since 2002 for 14 fishing ports along the Catalan coast. Six different métiers were identified based on the contribution of different species to the total catch: coastal shelf, coastal delta shelf, middle delta shelf, deeper shelf, upper slope and lower slope. To study the spatial impact of each métier, different zones were designated using vessel monitoring system data, revealing diverse species compositions within these zones. This indicates that each fishing fleet has a distinct spatially differentiated impact on different species in the study area. Our findings suggest that the management of the trawl fishery should consider not only the impact of each métier on target species but also the spatial variation of their impact.

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The Global Ocean Observing System: an essential partner for the Blue Economy

The ocean is vital to the economies and security of many nations, providing support to many economic sectors such as fisheries, aquaculture, transportation, energy and tourism. However, knowledge of the ocean is limited and there is a lack of observations. These observations are essential for accurate marine and meteorological forecasts and particularly beneficial for fisheries and aquaculture. They allow for the assessment of fish stocks, understanding of ecosystem dynamics and offer guidance to ensure the long-term sustainability of the blue economy. Addressing this challenge requires major ocean observation programs, supported by open data, information exchange and international collaboration. The Global Ocean Observing System, led by the Intergovernmental Oceanographic Commission of the United Nations Education, Scientific and Cultural Organization (IOC-UNESCO) and the World Meteorological Organization (WMO) plays a critical role in fulfilling this requirement. Today, it supports an extensive range of oceanographic observations conducted by roughly 9 000 instruments deployed by 84 countries and organized in 13 networks. The Global Ocean Observing System has recently launched various initiatives, including Dialogue with Industry and Odyssey, endorsed by the United Nations Ocean Decade. These efforts aim to expand the observing system and strengthen the link between observations and end-user products. One crucial aspect is engaging the private sector and new partners (e.g. fishers) throughout the value chain. Furthermore, there is a particular emphasis on the Mediterranean region, benefiting from the partnership between Monaco and OceanOPS. This collaboration aims to effectively address regional societal needs and foster the growth of the blue economy in the basin.

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Preliminary ecological risk assessment of megafauna for fishery effects in the Mediterranean using productivity–susceptibility analysis

Ecological risk assessment is frequently used in data-poor fisheries to identify potentially vulnerable species and set priorities for future study and management. We conducted an ecological risk assessment study to assess the relative vulnerability of four megafauna groups (seabirds, sea turtles, elasmobranchs and marine mammals) to Mediterranean fisheries by using a semi-quantitative productivity–susceptibility analysis. The analysis revealed that the four megafauna groups are differently vulnerable to fisheries in relation to the fishing gear used in different areas. This depended on the geographical distribution and the ethology of the species, and on the different use of fishing gear in different subregions of the Mediterranean. In most Mediterranean subregions, bottom trawling poses a risk to sea turtles and demersal elasmobranchs, while drifting longlines pose a risk to turtles and pelagic sharks. Gillnets pose a risk to many groups, especially to marine mammals, with a potential widespread risk. The study, though preliminary, highlighted the hot-spot areas and fishing gear that require priority management for the conservation of these groups.

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The Global Record of Stocks and Fisheries: unique identifiers in support to sustainable fisheries

In a growing data-dependent world, with communities seeking the best scientific evidence to apply effective management measures, the Global Record of Stocks and Fisheries (GRSF) is the digital answer offering key services in support of the state of fishery stock indicators and adding further transparency to the seafood value chain. The pilot release of the GRSF took place in 2019 during the FAO International Symposium on Fisheries Sustainability: Strengthening the Policy–Science Nexus. Since then, the GRSF has grown in sources, which today include records from the FAO Fisheries and Resources Monitoring System, FishSource, RAM legacy stock assessment database and the FAO Sustainable Development Goal 14.4.1 questionnaire. The number of records exceeds 3 500 stocks covering more than 1 100 species, contributing to global assessment of the status of stocks, and over 15 000 fisheries available for use in sustainable fisheries traceability schemes. The key innovation of the GRSF is that it assigns unique identifiers for stock and fishery identification, thus contributing to i) the inventory of fishery resources in support of stocks status evaluations and related indicators at national, regional and global level; and ii) the need for transparency in the seafood value chain supporting sustainable fisheries traceability schemes, including catch documentation, ecolabelling or food safety schemes. Alongside the unique identifiers, the GRSF collates data from the database sources as statistical time series, quantitative indicators or narrative content. The GRSF is also contributing to the new FAO methodology on stock status evaluation, which is in progress for the next FAO flagship publication: *The State of World Fisheries and Aquaculture 2024*.

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Remote estimation of fishing effort using Global Fish Watch automatic identification system data: a case study

This study presents a novel approach for efficiently estimating fishing effort in a given spatio-temporal area by integrating automatic identification system (AIS) data and fishing catch records. The method aims to remotely estimate total landings, overcoming the limitations of traditional spatial and temporal sampling techniques. Accurate estimation of fishing effort requires identifying the number of vessels engaged in fishing operations within the designated area, considering both temporal and numerical aspects of these activities, but they can be labour-intensive and costly, especially when applied to larger areas. To address these challenges, we leveraged AIS data obtained from fishing vessels to determine the count of bottom trawl vessels and their apparent fishing hours (as estimated from the Global Fishing Watch neural net) operating from mid-April to end of April 2023 in geographical subarea 24. Concurrently, we collected landed catch data from fishing vessel records within the same spatiotemporal confines. By integrating these datasets, we derived the total landed catch by multiplying the count of fishing vessels and their apparent fishing hours by the average daily landing volume of deep-water red shrimp. This integration of AIS data and fishing catch records provides a straightforward and cost-effective alternative for estimating fishing effort, making it valuable for fisheries researchers and managers. The proposed methodology offers a resource-efficient solution, enabling comprehensive estimations of fishing effort without the need for extensive labour or budget.

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Assessment of common octopus *(Octopus vulgaris)* in the Balearic Islands: comparing different data sources and methods

The common octopus (*Octopus vulgaris*) is a fisheries resource with a high socioeconomic importance around the world. In the Balearic Islands (western Mediterranean), it is mainly caught by bottom trawlers and, to a lesser extent, by the artisanal fleet. Despite its importance, this species is not routinely assessed in any area of the Mediterranean. The objective of this work is to perform an assessment of common octopus in the Balearic Islands using different methodologies, with two different data sources: historical catch data from official fishery statistics (1965–2022) and a shorter time data series from bottom trawl surveys (2001–2022). On the one hand, catch maximum sustainable yield and Bayesian state-space Schaefer production models were developed from official fishery statistics. On the other hand, some population indicators that could potentially be used to assess the conservation status of commercially exploited fish and shellfish stocks within the European Union Marine Strategy Framework Directive were estimated from bottom trawl survey indices and analysed over time. The indicators selected, which were computed using bottom trawl survey data, were size at first sexual maturity, proportion of individuals larger than size at first sexual maturity, mean maximum length, 95 percentile of the length distribution and somatic condition, among others. The results of this study will allow improvement of the knowledge about this resource in the Balearic Islands and could be used in the provision of advice in order to ensure its sustainable management.

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A multiannual and multifleet generalized depletion model for the stock assessment of common dolphinfish (*Coryphaena hippurus*)

The common dolphinfish (*Coryphaena hippurus*) is a key species for small-scale fisheries in the western and central Mediterranean, being one of most landed species annually from some of these areas. Countries like Italy, Malta, Spain and Tunisia target this species seasonally using fish aggregation devices and it also serves as bycatch for longline fisheries. The common dolphinfish constitutes a data-limited fishery and its management is a priority for the GFCM. Generalized depletion models have proven to be useful for providing management information for stocks of short-lived species with biomass fluctuations, high recruitment inputs followed by a fast depletion, which is the case of this stock. To address the challenges posed by varying fleet dimensions as well as different catch and effort dynamics among the fleets of the countries involved, a multiannual and multifleet generalized depletion model was applied to assess the common dolphinfish stock. This model enabled the first estimations of essential reference points for managing this stock. The main findings reveal a stable annual recruitment of approximately 10 million individuals in the last ten years, a high natural mortality rate of 0.25 per month and an exploitation rate only exceeding 40 percent during the peak month of catches. These results suggest sustainable exploitation of the common dolphinfish stock, but with precautionary advice to avoid increasing fishing effort during the months with the highest catches of the fishing season.

Parallel session 1.2 Assessing fisheries under changing climate and productivity

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Identifying the major biotic and abiotic factors of fish dynamics using multivariate time series analysis

The need for an ecosystem-based approach to fisheries management is widely recognized. Designing ecosystem models for management purposes requires the identification of key interactions and forces driving the dynamics of fish stocks, which can be a very challenging task given the large number of potential interactions existing in marine ecosystems. To overcome this difficulty, this study proposes a statistical approach based on multivariate time series analysis to identify the main biotic interactions and abiotic factors within a complex and exploited marine ecosystem, the Gulf of Lion in the Mediterranean Sea. To do so, pairwise Granger causality tests were first performed to detect and select the strongest interactions and drivers, then multivariate auto-regressive models were run to check the relevance of the selected causal relationships in a multivariate system. The results led us to identify three modules of moderated complexity, each one including a few biotic interactions and abiotic factors. These modules can serve as a basis to build models of intermediate complexities to describe the dynamics of the main fish stocks of the Gulf of Lion.

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How does the productivity of plankton available to fish vary?

The spatially and temporally varying oceanic productivity that is available for high trophic levels is assessed by monitoring the occurrence of productivity fronts (horizontal chlorophyll-a gradients). While most phytoplankton production is remineralized (80 percent to 90 percent), productivity fronts are active long enough (from a few weeks to a few months) to allow mesozooplankton populations to develop and ensure the flow of energy in the food chain. The ocean productivity available to fish (OPFish) indicator is an algorithm that accounts daily for the intensity of productivity fronts sensed by satellite ocean colour over the last two decades. Since the length of the day is also taken into account, the OPFish integrated over time represents secondary production whose relative levels are comparable in space and time. The OPFish index was calibrated using habitat studies for species ranging from mesozooplankton to tuna species and top predators such as whales and sharks. It was then validated using scientific and commercial data on spatial fisheries in European seas. While the occurrence of productivity fronts at global level shows multi-year oscillations over the last 20 years and a slightly positive trend, much stronger negative and positive trends are seen at regional level. This suggests that the natural capacity of regional oceans and seas to support fish production is diversely changing under the opposing effects of warming and vertical mixing. In addition to warming-induced changes in marine communities, such a trend in zooplankton productivity, as a bottleneck for energy transfer in food webs, is essential for the adaptation of the fisheries sector.

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Connectivity and unit stock of the Black Sea turbot (*Scophthalmus maximus*)

Turbot (*Scophthalmus maximu*s), a key Black Sea species, is traditionally thought to exist as a single stock across the entire sea due to the Black Sea's hydrography supporting widespread larval transport. In this study, we assessed this assumption using a larval drift model. Concurrently, assessments indicate a decline in spawning stock biomass, possibly due to overfishing. We also explored the impact of climatic shifts on the Black Sea's currents and turbot larval settlement. We designed a two-dimensional particle tracking model using Copernicus, a satellite-driven hydrodynamic model. Results revealed that hydrography, particularly the rim current, is crucial in maintaining connectivity across the Black Sea. However, isolation may exist between the eastern and western Black Sea due to steep eastern topography. This implies that the concept of a single unit stock for turbot requires re-evaluation. Moreover, our findings highlighted the significance of mesoscale eddies between the rim current and the coast for turbot settlement at the post-larval stage. As the meteorological conditions strongly influence the size and distribution of these eddies, the changes in climate patterns may have impacted recruitment success and worsened the decline of turbot stock. This urges the incorporation of climatic variability into turbot management plans, which currently focus solely on fishing impacts. In summary, our study questions the assumption of a single turbot stock in the Black Sea and emphasizes the importance of hydrography and climatic factors in understanding turbot population dynamics. Integrating these findings into the assessment models is crucial to better understanding and suggesting better management advice.

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Comparison of the space-time dynamics of clupeiformes habitats in Mediterranean and Atlantic French seas

A consistent decrease in the size of clupeiformes (anchovy, sardine and sprat) has been reported since the early 2000s in two contrasted French shelf seas: the Gulf of Lion in the Mediterranean and the Bay of Biscay in the Atlantic. We characterized the spatial distributions and temporal dynamics of the size-structured communities of clupeiformes in both regions to determine: i) if the decrease in size is associated with a spatial reshuffling of communities; ii) if it occurred in response to a local or a large-scale environmental change; and iii) which environmental factors shaped the fish spatial distributions. Acoustic survey data were gridded to derive long-term time series of spatially explicit data. Multivariate space-time ordination methodologies were then applied to characterize space-time patterns in biomass-at-length and hydrology. Fish habitats were spatially consistent in time in both regions but structured differently, depending on local environmental gradients. The decrease in fish body size was caused by local changes in species-to-size ratio compositions. Large anchovy and sardine were replaced by small sprat in coastal and mid-shelf habitats in the Gulf of Lion. In the Bay of Biscay, large sardine near the sea surface in northwestern areas progressively disappeared, while small clupeiforms increased near the seabed in southern and adjacent coastal areas. Though conditions structuring spatial distributions were different between regions, the two systems showed a replacement of large fishes by small fishes, not necessarily belonging to the same species.

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Stock boundaries and connectivity processes in a transition ecosystem: lessons learned from the TRANSBORAN project

The Alboran Sea lies in a complex transition zone between the Atlantic and Mediterranean Sea from ecological, oceanographic and socioeconomic perspectives. Fish stocks in this region have been considered as independent management units until now, due to knowledge gaps concerning the spatial structure and connectivity of fish populations. The Transboundary population structure of sardine, European hake and blackspot seabream in the Alboran Sea and adjacent waters: a multidisciplinary approach (TRANSBORAN) project was carried out under the framework of the FAO regional project, Copemed II, in collaboration with the GFCM to enhance understanding of the biological boundaries and connectivity processes of European hake (*Merluccius merluccius*), sardine (Sardina pilchardus) and blackspot seabream (P*agellus bogaraveo*) through a multidisciplinary approach including genetics, otolith microchemistry, otolith shape, parasite composition, body morphometry, meristic descriptors, hydrodynamic modelling, fisheries data and an ichthyoplankton survey. Results from the different disciplines were integratively compared and analysed. The project did not find scientific ground to conclude that European hake and sardine in the north and south Alboran Sea behave as a unique and homogenous population that could support joint stock assessment and management, with a differentiation between putative stocks in the north and south Alboran Sea stronger for European hake than for sardine. In the south Alboran Sea, samples in the east of geographical subarea (GSA) 4 (Algeria) were generally more similar to GSA 12 (Tunisia), while those west of GSA 4 were more similar to GSA 3 (Morocco). Blackspot seabream did not show evidence of population structure within the study area, while a potential migration pattern to spawn from the Alboran sea to the strait of Gibraltar was detected.

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Century-long impact assessment of climate change and fishing pressure on the Egyptian Mediterranean fishery

Spanning several millennia, fishing has been an integral part of Egypt's culture and economy. Several events have drastically reshaped the landscape of the Egyptian Mediterranean fishery, such as the opening of the Suez Canal and the Aswan High Dam. Our research delves into the historical evolution of this fishing industry within the shorter period of a century, from 1920, following World War I, to 2019, before the onset of the COVID-19 pandemic. Drawing from historical data and archives, we re-estimate the catch amounts yielded by the Egyptian Mediterranean fleet, including reported and formerly unreported, commercial and non-commercial, small- and large-scale catches and estimated discards. To further assess the health of the Egyptian Mediterranean fishery, the marine trophic index is applied to our 100-year dataset. Our findings suggest that "fishing down" has been occurring in the Mediterranean waters of Egypt since the early 1970s. This indicates a potential overfishing of higher trophic-level species. Finally, we examine the impacts of climate change on the fishery's overall productivity and species composition by applying the mean temperature of catch. Our analysis reveals an average annual mean temperature of catch increase of 0.07 degrees Celsius since 1987, primarily attributed to the exponential surge in lessepsian migration. By providing a comprehensive overview of one of the world's oldest fishing industries, our research can assist decision-makers in implementing measures to ensure the sustainable future of Mediterranean fisheries.

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A shared ecosystem approach to fisheries in the Adriatic Sea

Transboundary cooperation under the FAIRSEA project has contributed to an ecosystem approach to fisheries by implementing a quantitative, multidisciplinary and collaborative approach based on participation and co-creation at different levels. Scientific institutions, regional and national agencies, non-governmental organizations, institutional decision-makers and consultants have leveraged their wealth of knowledge, expertise and experience and worked together as a multidisciplinary network to lay the foundation for an applicable, collaborative, transboundary and integrated platform for an ecosystem approach to fisheries. The participatory approach focused on a decision support tool in the form of the integrated platform for an ecosystem approach to fisheries. The platform collects a variety of three-dimensional oceanographic variables, marine renewable resource distribution, fishing effort by fleet segment and other fisheries data in an easily accessible and transferable form. These data layers were used in a number of different complementary models (species distribution model, SMART, BEMTOOL and ECOSPACE) to test the scenarios considered in the participatory discussions. The developments have been used in capacity building and cross-boundary engagement programmes with different stakeholders and have enabled the development of innovative and targeted communication tools. The involvement of local and transnational stakeholders since the first steps of FAIRSEA can be considered a strength of the project, as it created the basis for the trust and acceptance of the results needed to deliver harmonized policy recommendations and best practices based on sound science coming from a range of marine disciplines integrated across the boundaries of the Adriatic basin.

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Climate change and seasonal dynamics of bottom-trawl fisheries landings in the western Mediterranean

The Mediterranean Sea stands out as one of the most vulnerable ecosystems on a global scale, facing an array of cumulative impacts, including high climate risks. Climate velocity drives species shifts and redistributions, which has led to changes at different ecosystem levels. However, it is necessary to examine how commercial marine species respond at regional and seasonal levels, which is often the optimal management scale. In this paper, we analysed time series data on bottom-trawl fisheries landings (2007 to 2021) and explored seasonal variations using climate velocity and relative climate exposure as metrics of potential range shifts (1987 to 2021) in the western Mediterranean Sea. Additionally, we examined the impact of climate connectivity, using climate velocity trajectories and temperature preferences, along with life-history traits of commercial species. The outcomes of our study showed fluctuations in climate velocity across diverse spatial and seasonal scales. We identified a relationship between the abundance of most captured commercial species and seasonal climate velocity. These variations were also influenced by the temperature preferences and the life-history traits of these species and play a key role in the climate connectivity between the network of marine protected areas. We conclude that climate velocity metrics are valuable to comprehend how economically important marine species respond in the western Mediterranean Sea at regional and seasonal levels. Using this knowledge, we can develop climate-smart management strategies, contributing to biodiversity conservation and the preservation of crucial ecosystem services, while mitigating the risks associated with future maladaptation.

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Assessing climate impacts on fish and fisheries spatial distribution in the Adriatic–Ionian region

Climate-related factors and ecological changes influence productivity and distribution of fisheries resources in marine ecosystems. Understanding how fish and fisheries spatial distributions adapt to these changes is pivotal for developing adaptive management strategies. This is particularly important in the Mediterranean Sea which is exposed to high climate risk. This study was developed within the project SEAwise and applies the International Council for the Exploration of the Sea Workshop 2 on Fish Distribution framework to predict the spatio-temporal distribution of important demersal species – European hake (*Merluccius merluccius*), deep-water rose shrimp (*Parapenaeus longirostris*) and red mullet (*Mullus barbatus*) – of the mixed fisheries in the Adriatic and Ionian Seas in geographical subareas 17, 18, 19 and 20. Fishing footprint was obtained from vessel monitoring system or automatic identification system data (Global Fishing Watch and fleet register) or by other methods such as multi-criteria decision analysis, where vessel monitoring system or automatic identification system data were not available. Climate change scenarios based on representative concentration pathway 4.5 and representative concentration pathway 8.5 up to 2099 were tested to project changes in fish stock distribution. In return, stock distributions were used as predictors in models describing fisheries responses to climate-related factors. The results show that the highest variations in species and fishing footprint distributions were forecasted by the representative concentration pathway 8.5 climate scenario in the long-term projection; slight distributional shifts and hotspot changes were identified, depending on the species, in all the analysed geographical subareas. Nevertheless, forecasts of species biomass resulted in small variations. The results of this work might contribute to support ecosystem-based fisheries management by considering the additional effects of climate drivers in shaping the future of fisheries in the subregion.

Parallel session 1.3 Management strategy evaluation for fisheries advice

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Improving the design of integrated assessment and management systems in octopus

Octopus fisheries are difficult to manage. The peculiarities of octopus' life history and population dynamics (short life, rapid growth, high natural mortality, high sensitivity to environmental conditions, etc.) make it particularly challenging to carry out quantitative assessments of their abundance and to define biological reference points consistent with maximum sustainable yield. These characteristics limit the options for developing harvest strategies and harvest control rules. To contribute to enabling a better design of assessment and management systems, this study compiled and analysed relevant information on five Iberian fisheries targeting common octopus (*Octopus vulgaris*). A workshop was subsequently carried out to analyse the information gathered, involving key scientists, management administrations, non-governmental organizations and other fishery experts. As a result, a tool was conceptualized to visualize and interconnect different assessment methods, data requirements and management objectives, aiming to guide the design of more integrated harvest strategies. The case studies analysed highlighted that while octopus abundance is generally estimated through catch (or landing) per unit effort, fisheries are managed through measures disengaged from those indicators. The tool developed seeks to facilitate a better planning of assessment and management elements to overcome these inconsistencies. Among the case studies analysed, the western Asturias fishery appeared as an example where biological reference points are defined to drive the management and establish catch limits. This was the first octopus fishery in the world to be certified as sustainable by the Marine Stewardship Council programme, reflecting the relevance of these management efforts to increase access to markets and consumer recognition.

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Ready and steady before going: lessons on advancing towards management strategy evaluation in Spanish fisheries

The use of management strategy evaluation (MSE) to support fisheries decision-making has increased worldwide over the last thirty years. Management strategy evaluation fits well within the advisory process, providing stability and consistency with long-term management objectives. If successfully implemented, it allows understanding and assessing of the consequences of management options, makes trade-offs explicit, identifies strategies that work reasonably well in favourable and challenging times, and balances competing objectives. The depth and breadth of a given MSE approach fit in a continuum between desk MSEs and full MSEs, based on the degree of stakeholder and analyst participation required. Evidence shows that for MSE to deliver in the real world, participatory processes are a critical component exhibiting opportunities for improvement. In 2022, the Spanish Institute of Oceanography launched a research project "New tools for mathematical modelling in the scientific advice of Spanish fisheries (Math4Fish)". While the main goal is improving stock assessment models, it includes MSE developments for three species – European hake (*Merluccius merluccius*), European anchovy (*Engraulis encrasicolus*) and common sole (*Solea solea*). During the implementation, it became evident that readiness for MSE influences outcomes. How ready managers, scientists and stakeholders are to use the MSE framework is somehow taken for granted. Readiness, however, goes beyond process design, technical expertise and models' fitness to encompass context-dependent attributes. This talk explores the critical features of the management system and the actors involved that need to be addressed. Building on the preliminary findings from the Math4Fish project, the notion of readiness assessment before developing MSE is introduced.

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Marine protected area effects on small-scale fisheries: a multi-area study from the Mediterranean

A large body of evidence exists about the effect of marine protected areas (MPAs) in recovering fish assemblages. However, the role of MPAs in enhancing small-scale fisheries (SSF) and supporting local communities is still largely debated. Here, we evaluated the effects of multiple Mediterranean MPAs (encompassing both multiple-use and strictly no-take protected areas) on SSF in six European Union countries. Potential benefits of conservation on SSF were assessed by comparing catch descriptors (i.e. catch per unit of effort and income per unit of effort) between SSF catches obtained within partially protected areas (PPAs) (or close to the no-take areas, for those MPAs without a PPA), and those obtained in surrounding unprotected areas. A photo-sampling method was used to collect data (size per each individual fished, converted into biomass) on the catches landed in each location. Data on catches were coupled with information on species prices to calculate revenue per unit effort and with information on the variable costs of each fishing operation (i.e. related to fuel cost) to calculate income per unit effort. More than 1 200 fishing operations spanning 12 months were used for the analyses. Despite a general positive trend (i.e. overall mean values were higher in PPAs than unprotected areas), no consistent patterns on catch per unit effort and income per unit effort were highlighted between MPAs. Our findings suggest that a stronger research effort is needed to understand the factors that shape fishery benefits of MPAs in order to make them socially meaningful for local communities' well-being.

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Fishing impact assessment indicates an ecosystem approach to fisheries

The ecosystem approach to fisheries is a holistic strategy that recognizes the intricate connections between living organisms and their environment under fishing pressure. It emphasizes the need to consider the complex web of interactions within an ecosystem when making decisions about resource use, conservation and development. The Sea of Marmara, the northeastern most part of the Mediterranean Sea, is the most altered marine ecosystem by various human-induced pressures. It has a significant importance for fisheries in Türkiye by supporting a variety of commercially valuable fish species. The total catch dropped from a maximum amount of approximately 70 000 tonnes during the 2000s to 15 000 tonnes in 2020. The mean trophic level of catch decreased from 3.75 to 3.25, meaning that the withdrawal of predatory species such as European hake (*Merluccius merluccius*), turbot (*Scophthalmus maximus*) and Atlantic bonito (*Sarda sarda*) during the 2000s resulted to increases in European anchovy (*Engraulis encrasicolus*), Mediterranean horse mackerel (*Trachurus mediterraneus*) and deep-water rose shrimp (*Parapenaeus longirostris*). The continuous decline and overall negative values in the fishing in balance index are related to declines in both the catch and the mean trophic level which indicates that fisheries are no longer efficient in the Sea of Marmara. The capacity of its ecosystem has decreased significantly in the last decades and its ecosystem has become constantly vulnerable to human-induced pressures. Here, recommendations based on key ecosystem approach to fisheries principles such as precautionary approaches and adaptive management options are provided. Implementing those measures may enhance the resilience of the Sea of Marmara ecosystem, safeguard its biodiversity and ensure the sustainability of fisheries for future generations.

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The eastern Ionian demersal fishery: a first step towards an ecosystem approach to fisheries management

The eastern Ionian Sea demersal fishery is a typical Mediterranean mixed fishery. A large-scale fleet consisting of 26 trawl vessels and a small-scale coastal fleet utilizing longlines and nets (roughly 3 000 vessels) exploit a large number of stocks (around 80) with the bulk of the catch referring to European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and deep-water rose shrimp (*Parapenaeus longirostris*). Currently, only the large-scale fleet is managed through effort control, while the small-scale fleet is mostly unmanaged. For the first time, a mixed fishery bioeconomic model (FLBEIA) was applied to project the future of the fishery under different effort allocation scenarios to both fleets. The same scenarios are also projected within an ecosystem model built with Ecopath with Ecosim. The coupled bioeconomic and ecosystem models present a first step towards an ecosystem approach to fisheries management. A number of biological, economic and ecosystem indicators are estimated to obtain a comprehensive picture of the conflicts and trade-offs of potential management goals (e.g. fleet viability, stock sustainability and ecosystem health). As a second step, the effect of environmentally mediated recruitment of European hake and red mullet is projected and could inform future management measures in light of the ongoing climate change.

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Inadequacy of protected species bycatch monitoring in bottom set-net fisheries in the eastern Adriatic Seas

The small-scale fisheries (SSF) fleet in the Adriatic Sea consists of over 8.000 vessels, operating year-round in areas inhabited by protected and red-listed marine species. The Commission Delegated Decision 2019/910 obliges European Union member states to collect data on incidental catches (bycatch) of protected species for all types of fishing gear. With the present study, we compared bycatch of protected species in bottom set net SSF from official Croatian fisheries statistics to our independent bycatch quantification, with additional inclusion of red-listed species. Gillnets (GNS-DEF-16-0-0) and trammel nets (GTR-DEF-16-0-0) in the period from 2018 to 2021 were used for comparisons. We monitored five SSF vessels from the Umag and Savudrija fishing ports (Croatia) with onboard observers, with exception of 2020 when only sea turtle bycatch was reported by the fishers. Official Croatian fisheries statistics reports included 88 monitored fishing days, representing less than 0.03 percent of total effort, with one European shag (*Phalacrocorax aristotelis*) and one spotted ray (*Raja montagui*) reported. We monitored bycatch for 168 fishing days, while sea turtle bycatch was provided for an additional 131 fishing days. Concerning protected species, bycatch consisted of 59 loggerhead turtles (*Caretta caretta*), 23 common stingrays (*Dasyatis pastinaca*) and five common European shags among others. Additionally, 757 red-listed elasmobranchs were bycaught, including 15 critically endangered bull rays (*Aetomylaeus bovinus*). Our results suggest that the current extent of monitoring is inadequate to provide accurate bycatch estimates of protected species, which, combined with the lack of a requirement to monitor red-listed marine species, hinders evidence-based impact assessments of bottom set net SSF in the eastern Adriatic Sea.

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We want to manage non-indigenous fish species, but do we know everything about them?

The total number of non-indigenous fish species that have entered Türkiye›s seas through various means (Suez Canal, shipping activities, aquaculture, etc.) is 85, as of 2023, and the harmful effects of the presence of these species on the ecosystem, fisheries and even human health are a significant problem. The negative impacts of these species require management measures. Existing literature on non-indigenous fish species includes zoogeographic (first record, records of species expanding their distribution limits, etc.), bioecological (length–weight relationship, age, reproductive biology, nutrition, population size, etc.) and socioeconomic data. However, this information is usually only available for a limited number of species on a regional basis and is not sufficient to create an effective management plan. More research and data collection are needed to develop legislation. Identifying what information is available and conducting a gap analysis is an important step in developing legislation and taking more effective management measures for these species. Gap analysis is necessary for the systematic collection of literature information and the creation of appropriate infrastructure for better use and sharing of this information. In this study, a gap analysis was conducted on the non-indigenous fish species in our seas and a needs map was created for the species that should be prioritized for research. It is thought that the results will create a suitable infrastructure for a sustainable management plan for non-indigenous species, minimize the negative impacts of non-indigenous species in our seas and develop appropriate strategies for sustainable ecosystems and fisheries.

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A transdisciplinary approach to assess the connectivity of a highly exploited species: implications for management

Accurate identification of both stock boundaries and intrastock spatial structures is a prerequisite for implementing ecologically meaningful assessments. To date, although a variety of marine organisms are known to disperse actively and/or passively, the majority of harvested species are still managed in fixed spatial polygons, known as management units. Notably, these static management units have been equally used for the assessment of species with contrasting life histories and dispersal capabilities. Here, we combine a spatiotemporal model, oceanographic simulations and chemical markers to investigate the demographic connectivity and population spatial structure of one of the most important demersal species for Mediterranean fisheries, red mullet (*Mullus barbatus*), across multiple scales in the western Mediterranean Sea. We first detected persistent and dynamic spawning hotspots within two adjacent management units. Then, by integrating Lagrangian indices of dispersal, otolith and white-muscle microchemistry, we showed that some subpopulations are highly interconnected, whereas others show a high degree of spatial isolation, despite substantial interannual variability. As there is no clear evidence of migrations during the adult demersal phase for the red mullet, we conclude that all cases documenting spatial mismatch between birth sites and spawning grounds could be attributed to the oceanic dispersal of early-life stages. Our study reveals hotspots that are major demographic contributors to subpopulations inside and outside the management unit they belong to, and ultimately to the whole metapopulation system. Altogether, our results suggest interpreting with caution current stock assessment outputs and advocate for developing spatially explicit stock assessment in the Mediterranean Sea.

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Assessing the potential beam-trawling impact on Black Sea habitats aiming at sustainable fisheries management

The northwestern shelf of the Black Sea is highly vulnerable to disturbances of its habitats and ecosystems. In the past ten years, this area has become targeted by beam-trawl fisheries for the invasive gastropod rapa whelk (*Rapana venosa*), with a potential destructive impact of soft bottoms. Few studies have been carried out in the Black Sea and most investigations focused on gear selectivity and bycatch rates. In this context, our novel research aimed, on the one hand, to assess and quantify the actual impact of beam trawling, and propose effective spatial and temporal management measures for a sustainable zoning of the northwestern Black Sea shelf (marine zone of the Danube Delta Biosphere Reserve), on the other. The methodology used integrated beam-trawl catch dynamics information, vessel monitoring system data, geophysical investigations and macrozoobenthos sampling. Our findings show that beam-trawling activities can cause changes in the benthic habitat structure (lower number of taxa, lower values of ecological indicators and an overall lack of good environmental status). Further in-depth investigations are needed to underpin the ecosystem-based management of this marine protected area, aiming to allow the recovery of the affected benthic habitats.

POSTER PRESENTATIONS

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Fish environmental DNA detections in ports mirror fishing fleet activities in the Mediterranean Sea

Gathering comprehensive marine biodiversity data can be difficult, costly and time consuming, thus limiting knowledge of diversity patterns in many areas worldwide. We propose fishing ports as natural sinks of biodiversity information which can be collected by fishing vessels probing disparate habitats, depths and environments. By combining rapid environmental DNA metabarcoding surveys with data from public registers and automatic identification systems, we show significant positive relationships between fishing fleet activities (i.e. fishing effort and characteristics of the fishing grounds) and the taxonomic fish assemblage composition in eleven central Mediterranean fishing ports. Overall, we identified 160 fish and 134 invertebrate taxa, including twelve non-indigenous species, in some instances well beyond their known distribution areas. Our findings suggest that eDNA assessments of fishing harbour waters might offer a rapid way to monitor marine biodiversity in unknown or under-sampled areas, as well as to reconstruct fishing catches, often under-reported in several regions.

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The ichthyofauna of a large Algerian reservoir responding to changes in water quality

This study analyses the variations in the interactions between two compartments of the ecosystem (water quality and fish) through space and time at the Ghrib dam, located 150 km from Algiers in the province of Aïn Defla, Algeria. Monthly sampling was carried out over a period of four years at six selected stations around the lake. Water samples were taken at the same time as the fish catches. Thirteen physicochemical parameters were measured on the same sampling day using approved methods. The water quality of the lake was evaluated and was shown to have a transparency index of 90.30, chlorophyll index of 87.21, production index of 88.75, nutritional index of 114.69, winter total phosphorus of 113.18, winter total nitrogen index of 116.21, and oxygen consumption index of 26.11. Our results emphasize the observed seasonal variations in both the fish compartment and water quality. The b values revealed a significant difference between the seasons for the various fish species. Notably, fish growth was strong in spring and weak in winter. Throughout the four-year monitoring period, the organic pollution index fluctuated between low and moderate levels. Furthermore, the principal component analysis, analysis of variance results and correlation tests confirm the existence of a relationship between the different compartments.

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Demersal scientific bottom trawl survey-at-sea in Egypt from Alexandria to Al-Alameen

Scientific demersal surveys are widely acknowledged as the main source of fishery-independent information. In this regard, this work reports the results of a scientific demersal survey of the Egyptian Mediterranean coast in the area from Alexandria to Al-Alameen, according to standardized GFCM survey techniques and sampling plans for the efficient use of survey data from all Mediterranean regions. The results of the survey show that between 15 species and 55 species were caught per haul. These hauls can be divided into two categories: high catch weight hauls of around 16 kg to 21 kg and low catch weight hauls of around 5.5 kg. The abundance by number reveals that the number of fish caught ranged between 128 individuals and 2 110 individuals. In terms of weight, large-eye dentex (*Dentex macrophthalmus*) and common pandora (*Pagellus erythrinus*) were the dominant species, while in terms of number, Klunzinger's ponyfish (*Equulites klunzingeri*) and longspine snipefish (*Macroramphosus scolopax*) were dominant. The contribution of each faunistic category and the number of non-indegenous species in each haul were also reported. It is important to monitor these changes and adjust fishing practices accordingly to ensure their sustainability.

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Black Sea scientific database

The Black Sea scientific database has been part of the BlackSea4Fish project workplan and its need has been acknowledged during several meetings of the Working Group on the Black Sea and the Subregional Group on Stock Assessment for the Black Sea. As it was requested by Black Sea experts, the Black Sea scientific database was created by the BlackSea4Fish team and the GFCM Secretariat. With the initial aim to support the work of the Subregional Group on Stock Assessment for the Black Sea and the Working Group on the Black Sea by harbouring all data and parameters necessary for the assessment of stock status by species, the Black Sea scientific database holds three main categories of information focusing on the Black Sea subregion: information on experts who have publications on the Black Sea, a comprehensive publication reference database, and a species reference database reflecting biological indicators extracted from those publications. On 17 July 2023, the GFCM launched the Black Sea scientific database. With more than 100 researchers from six countries represented in the database, the platform is ready to provide access to publication reference lists and key information on priority species for Black Sea fisheries. By bringing together researchers from the sector, this one-of-a-kind platform is providing opportunities for networking, collaboration between researchers in Black Sea countries and afar, as well as access to publications that are issued in the field.

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Do morphological markers offer a reliable method for distinguishing between Mediterranean horse mackerel (*Trachurus mediterraneus*) stocks in the Marmara and Black Seas?

Despite some studies indicating multiple subpopulations of the Mediterranean horse mackerel (*Trachurus mediterraneus*) in the Black Sea and its neighbouring regions, others have challenged this notion. This has initiated ongoing discussions regarding its genetic makeup, emphasizing the need for further research to confirm its stock structure. This study used the morphological markers, in other words, body shape and otolith shape, to investigate the morphological structuring of the Mediterranean horse mackerel in the eastern Black Sea, central Black Sea and Marmara Sea. The body shape was analysed using geometric morphometrics while elliptical Fourier analysis was used for the otolith shape. The results revealed substantial differences in both body and otolith shapes among the sampled regions, suggesting the presence of three distinct stocks. Geometric morphometrics highlighted substantial variations in the snout length, caudal peduncle and body depth of the Mediterranean horse mackerel among the sampled regions. The elliptic Fourier analysis revealed significant directional bilateral asymmetry between the left- and right-sided otoliths, with a non-overlapping surface difference of 2.12 percent between the reconstructed left- and right-sided otolith outline shapes. However, no significant differences in otolith shape were observed between males and females. The elliptic Fourier analysis also supported the existence of three separate stocks of Mediterranean horse mackerel. This study provides evidence supporting the identification of multiple isolated stocks of Mediterranean horse mackerel.

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Assessing the impact of marine protected areas on non-indigenous species in the eastern Mediterranean

Marine protected areas (MPAs) constitute critical tools for marine conservation, serving as bastions of biodiversity and ecological resilience. While their potential to mitigate the spread of non-indigenous species (NIS) has been acknowledged, the designation of MPAs in degraded marine environments can inadvertently create conditions conducive to NIS proliferation. This study addresses the eastern Mediterranean›s susceptibility to such risks by undertaking a comprehensive assessment of changes in demersal fish populations within and outside a 12 by 16 nautical mile fisheries restricted area established in 1999 in response to severe fishing pressure. Data used in the study were collected over three distinct ecological phases – pristine, depleted and recovery – between 1983 and 2023. Non-indigenous species entry rates within and outside the FRA, and non-indigenous and indigenous species biomass trends were analysed using Bayesian population state-space modelling, considering the impact on depth. Key findings of the study underscore the complex interplay between MPAs and NIS. Nevertheless, in general terms, the results also suggest that MPAs exhibit a discernible slowing effect on the proliferation of NIS in the eastern Mediterranean, though they are not entirely impervious to invasion. A significant takeaway for fisheries management emerges from this study: the extension of the exclusion zone applied to bottom trawling to depths of 50 m or greater is proposed as a pivotal measure to curtail the further spread of NIS in the region. These insights emphasize the pivotal role of ongoing research and proactive management strategies in addressing the intricate challenges posed by NIS in local ecosystems.

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Relative growth in blotched picarel *(Spicara maena)*: comparison between marine protected areas and areas open to fishing

The blotched picarel (*Spicara maena*) is a commercial species that contributes to the fishing sector in Tunisia, specifically in the Bizerte region. However, there is limited information available regarding the population growth parameters of the species in Tunisia. To improve the understanding of this species and for comparative purposes, we investigated the length–weight relationship for two sample groups collected between May and June 2023. One sample group was obtained from the Galite Archipelago marine protected area (MPA) and the other from the open fishing area off the coast of Ghar El Melh. All length–weight regressions were significant, with correlation coefficients ranging from 0.819 to 0.971 for different sexes or areas. The findings revealed isometric growth patterns in males (growth coefficient, $b = 3.060$, $p = 0.71$), females ($b = 3.096$, $p = 0.76$) and both sexes combined ($b = 2.941$, $p = 0.51$) for samples captured from the open fishing area. However, positive allometry was observed in males ($b = 3.595$, $p < 0.001$) and in the total sample ($b = 3.588$, $p < 0.001$) obtained from the MPA. Females from the MPA exhibited isometric growth ($b = 3.102$, $p = 0.10$). The intercept parameter varied from 0.0000011 to 0.00013 with a mean of 0.0000195 ± 0.0000183. The allometry seemed to be unaffected by sex for both sample groups, but the geographical area demonstrated a strong effect on the length–weight relationship, as indicated by analysis of covariance tests.

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Modelling the distribution of blackspot seabream (*Pagellus bogaraveo*) in the Alboran Sea: management implications

Blackspot seabream (*Pagellus bogaraveo*) has been caught in the Strait of Gibraltar by Spanish and Moroccan fleets. According to the latest GFCM assessments, the current stock status is considered to be depleted with the spawning stock biomass below the biomass limit reference point. Despite this situation, there is limited information available on the stock structure and its distribution. Although tagging experiences indicate that juveniles show displacements from the Alboran Sea nursery areas towards the Strait of Gibraltar fishing grounds, better knowledge of the areas of aggregation of adults and juveniles might help support spatio-temporal management actions. In accordance with Recommendation GFCM/45/2022/3 on a multiannual management plan for the sustainable exploitation of blackspot seabream in the Alboran Sea (geographical subareas 1 to 3), repealing Recommendations GFCM/44/2021/4, GFCM/43/2019/2 and GFCM/41/2017/2, this paper intends to define nursery areas based on the available bottom trawl surveys carried out on both sides of the Strait of Gibraltar. Essential oceanographic variables might help to explain observations and improve capabilities for extrapolating knowledge other than sampling points. Therefore, the approach is based on linking two sources of data using species distribution models: blackspot seabream occurrence from trawl surveys and environmental datasets from the Copernicus Marine Environment Monitoring Service. Based on an already defined protocol, an ensemble of species distribution models is trained and tested for their capability to better represent observations for both juveniles and adults using an increasing number of essential oceanographic variables. The results could contribute to a better understanding of the spatial distribution of the species which could lead to better management.

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Data on European hake (*Merluccius merluccius*) in Lebanese waters, eastern Mediterranean Sea

The European hake (*Merluccius merluccius*) is a significant and lucrative deep-water fish. It is also regarded as a significant source of vital vitamins, minerals and nutrients for the diets of coastal communities in Lebanon. European hake is mainly targeted by trammel nets, gillnets and longlines of small-scale artisanal boats. European hake landing data between 2014 and 2021 was recorded by the Lebanese Ministry of Agriculture. A minimum catch of 11.5 tonnes in 2014 and a maximum catch of 32.7 tonnes in 2016 were recorded. The catch per unit effort fluctuated between 2014 and 2021 with a minimum and maximum reported in 2019 and 2021, respectively. The most abundant catches were observed between April and September. The CNRS-Lebanon collected the biological data from several national and international projects, as well as the GFCM experimental trawl surveys, which were conducted in 2021 and 2022. The length–frequency distributions were presented in 2019 and 2020 according to several gear. Mean length per sex revealed that in general female samples are larger than males. The minimum length and weight observed were 7.5 cm and 2 g, respectively. The maximum length was reported to be 61 cm and the maximum total weight was 2 100 g. The weight–length relationship displayed a positive allometry with a b value of 3.14. Furthermore, otoliths were collected from surveys and national landings and stored in the CNRS-Lebanon for future analysis.

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Age, growth and population dynamics of blackspot seabream (*Pagellus bogaraveo*) from the Strait of Gibraltar

Blackspot seabream (*Pagellus bogaraveo*) is a species of high economic importance for the Moroccan and Spanish demersal fishery sector in the Strait of Gibraltar. However, knowledge on several aspects of the population dynamics of this species, including age structure and growth, is very limited for this area. This study determines the age–growth and population dynamic parameters of blackspot seabream from the Moroccan waters of the Strait of Gibraltar. In all, 756 specimens were sampled monthly between July 2018 and June 2019 from commercial landings in the port of Tangier (35° 47' N, 5° 48' W). Using the sagittal otolith reading technique, age was determined for 478 individuals with a total length ranging from 265 mm to 556 mm. The length–weight relationship for all individuals was calculated as $W = 0.0174 \times L^{2.9093}$. Ages ranged from 2 years to 12 years. Growth parameters obtained using the FAO-ICLARM Stock Assessment Tools II (FiSAT II) software for the whole population were: $L\infty = 60$ cm, $K = 0.14$ year-1 and $t_0 = -1.011$ year; $\phi' = 2.190$. Blackspot seabream has a long lifespan of 21.5 years. The total (Z), natural (M) and fishing mortalities (F) were identified as $Z = 0.76$ year-1, $M = 0.24$ year-1 and $F = 0.52$ year-1, respectively. Blackspot seabream appears to be under high fishing pressure (E = 0.68) with no specific or joint management implemented yet. The results reported in this paper can serve as a component of stock assessment contributing to better management advice.

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Data on sand steenbras (*Lithognathus mormyrus*) in Lebanese waters, eastern Mediterranean Sea

Sand steenbras (*Lithognathus mormyrus*) is a common demersal stock inhabiting the Mediterranean Sea on rocky and sandy bottoms down to a depth of 80 m. It is an economically important species for coastal fisheries in Lebanon and the neighbouring regions, such as the Aegean Sea and the Mediterranean Sea off the coast of Türkiye. This species is exploited by Lebanese artisanal fishers and mainly targeted using gillnets, trammel nets and longlines. Through this study, we investigate aspects of the life history and biology of sand steenbras in Lebanese waters including its biological parameters (total weight, total length, sex) and spawning season. Moreover, age data was also estimated using otolith reading to contribute to the optimization of the management of the species.

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Analysis of discards in Egyptian Mediterranean trawl fisheries

The importance of discard and bycatch studies has been identified by several authors as these studies provide information on stock status, the effectiveness of certain fisheries management measures and the impacts of discards on marine ecosystems. In this context, a discard monitoring programme was carried out in Egyptian Mediterranean trawl fisheries from 2019 to 2022. Data were collected through onboard observations, questionnaires and self-sampling reports. The sampling design was applied for two fishing fleet segments: trawlers with 12–24 m length overall and trawlers with ≥ 24 m length overall, as well as six fish landing sites: Abu Qir, Rashid, Burullus, Damietta, Maadia and Port Said, along the Mediterranean coast of Egypt, covering about 66 percent of the total number of landing sites. Percentages of discards per fleet segment and landing site were estimated. The main results provide an overview of the composition and percentage of discards and bycatch of several key species in Egyptian Mediterranean trawl fisheries. In addition, they fill a gap in knowledge regarding catch composition (landing and discards) and length composition of some priority species as identified at the subregional level. In conclusion, information about discard rates, species composition and hot spot areas for discarding are vital for realistic stock assessments within data-limited situations, as well as effective management of trawl fisheries in the Egyptian Mediterranean.

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Warming and salinization effects on deep-water rose shrimp (*Parapenaeus longirostris*) distribution in geographical subarea 6

Deep-water rose shrimp (*Parapenaeus longirostris*), is one of the main target species for the bottom trawling fleet in geographical subarea (GSA) 6. In the last decade, the fishery has exhibited an unexpected increase in landings without a clear understanding of the underlying causes. This study aims to analyse the temporal trend in the spatial distribution of the species' landings over the past decade (2008–2020), which is potentially related to changes in environmental conditions. Results show an increase in landings and landing per unit effort (LPUE) of deep-water rose shrimp over the last decade, which spatially spread north along the continental margin of GSA 6. Generalized additive models show that location, time and fishing depths have a significant effect on the spreading distribution and LPUE of this species, as do temperature and salinity. Analysis of variance tests show a significant rise in water temperature and salinity, particularly since 2014. This trend correlates with the increasing LPUE of the species. This study highlights deep-water rose shrimp as an emerging fisheries resource along the GSA 6 continental margin. This pattern seems to be related to environmental changes rather than to changes in the fishing effort. Therefore, further research should be conducted to prevent the overexploitation of deep-water rose shrimp and to implement effective management plans to ensure its sustainable use.

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Turbot survivability, catches and gillnet Injuries: scientific support for the exemption from the landing obligation

The European Common Fisheries Policy aims to gradually eliminate discards in all European Union fisheries through the introduction of a landing obligation for all catches of species subject to catch limits, turbot included. In this context, the National Institute for Marine Research and Development "Grigore Antipa" (NIMRD) performed a pilot study aimed at obtaining sound scientific evidence regarding turbot survivability. Scientific fishing was performed in the Romanian marine area with specialized gear – turbot gillnets on board a NIMRD boat. The methodology consisted of launching the gillnets in established locations and recovering them after a soaking time depending on weather conditions. After each operation to recover the nets from the water, all turbot specimens caught were retained on board, parked in a fibre-reinforced polymer container filled with seawater and equipped with an aeration system. The specimens were kept in the tank for one hour, during which time they were monitored from the point of view of their condition (dead, alive, injuries, other negative effects produced by the fishing gear). Subsequently, all turbot specimens declared viable were released back into the sea. The results indicate high survivability rates of turbot caught in gillnets (81.67 percent). Some injuries were reported in the dead specimens, probably caused by the mechanical action of the gear. The results were reviewed by the Scientific, Technical and Economic Committee for Fisheries (STECF), who acknowledged that the data provided are valuable. Consequently, the exemption from the landing obligation of turbot was extended until 31 December 2024.

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Do climate changes have an impact on the ichthyoplankton communities in the south Adriatic Sea?

The Boka Kotorska Bay is the most indented bay the Adriatic Sea. It is situated in the southernmost part of the eastern Adriatic coast, in the contact zone between Montenegro and Croatia. Due to its morphological and geological structure, specific environmental conditions prevail within the bay. This semi-closed basin is characterized by the inflow of a large amount of water that reaches the sea through submarine outlets and the inflow of small rivers and streams. Based on the measurement of chemical and biological parameters, it is shown that in the spring and autumn, the area of the Boka Kotorska Bay becomes hypereutrophic. The investigation on ichthyoplankton composition and abundance in the Boka Kotorska Bay shows the presence of a significant number of pelagic species spawning within the bay. The total number of determinate species in the relatively small area of the Boka Kotorska Bay indicates significant species diversity. Given that the bay is a vulnerable and very sensitive zone in terms of the impact of climate change at the microregional level, it is to be expected that changes in the physical and chemical parameters of the environment have a significant impact on the diversity and abundance of ichthyoplankton.

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Stock assessment of common octopus (*Octopus vulgaris*) along the Tunisian coast using the Bayesian method

The common octopus (*Octopus vulgaris*) is an economically significant species in the Mediterranean Sea, particularly in the waters of Tunisia, where it supports a substantial artisanal and commercial fishery. The sustainability of this fishery relies heavily on accurate and up-to-date stock assessments to ensure responsible management practices. This research presents a comprehensive stock assessment of the studied species along the Tunisian coast using the Bayesian method. The catch maximum sustainable yield (CMSY) was fitted to landings and abundance indices (2005–2021). Results show that the common octopus' stock, as assessed by the CMSY model, is good. The F/F_{MSY} was less than one for the entire study period and B/B_{MSY} has been greater than one since 2010. The estimated maximum sustainable yield value ($3.35 \times 10^1 \times 13$ t, 95 percent confidence interval = 2.84–4.17) was not reached and not exceeded for the entire study period. In this study, there is a probability of 90.7 percent that the stock is in the green area. To conclude, the fishing effort could be increased in order to reach the equilibrium production maximum sustainable yield.

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Assessment of the common spiny lobster (*Palinurus elephas*) stock in Tunisian waters

The common spiny lobster (*Palinurus elephas*) belongs to the Palinuridae family and is a temperate crustacean restricted to small areas of the globe and found in the northeast Atlantic and Mediterranean. This species is the most abundant and accessible and has traditionally been the preferred target of lobster fisheries throughout its range. The market value of the common spiny lobster is very high and its meat is highly prized. In various Mediterranean countries, its exploitation is governed by fishing periods, a minimum catch size and a ban on fishing grained females. These regulations are the result of the over-exploitation of almost all stocks of the species. Despite the considerable number of studies carried out on the biology and ecology of the common spiny lobster, there are no reported studies on the assessment of its stock. This work is an updated overview of the available knowledge on stock assessment of this species in Tunisian waters using the catch maximum sustainable yield (CMSY) method (version CMSY_2019_9e.R) to estimate the maximum sustainable yield and associated indicators for common spiny lobster. Based on this method, the common spiny lobster stock is assessed as overexploited. The F/F_{MSY} ratio has been greater than one since 2013 and the B/B_{MSY} ratio was less than one throughout the study period and has a decreasing trend. The maximum sustainable yield set by the model (40.3×10^1 tonnes, 95 percent confidence interval = 32.4–52.9) was exceeded during the period 2014–2018.

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Mediterranean horse mackerel (*Trachurus mediterraneus*) stock exploitation in Georgian coastal waters in 2022–2018

Mediterranean horse mackerel (*Trachurus mediterraneus*) is one of the major commercial fish species for the Georgian Black Sea fishery. Most of the landings (mainly bycatch) occur on the wintering grounds using purse seines and midwater trawls. According to official statistics and expert assessments, its mean annual catch (including bycatch) was equal to 290 tonnes. The majority of the landings (47–70 percent of the total amount) consisted of the more than one age group. The overall Mediterranean horse mackerel size range was between 6.0 cm and 19.5 cm but most individuals were from 8.0 cm to 13.0 cm. The parameters of the von Bertalanffy equation were estimated as: $L\infty$ = 14.86–18.4, K = 0.42–0.87, t_0 = -0.16 – -0.97, a = 0.0021–0.0095, b = 2.94–3.51. According to the length-based Bayesian biomass method, the fishing mortality (F) to natural mortality (M) ratio was higher (2.2–3.8) than the optimal level. The biomass (B) was quite low at B/B_0 = 0.21 and B/B_{MSY} = 0.57. The estimated length ratios L_{mean}/L_{opt} = 1.1 (L_{opt} = 11.02 cm) and L_c/L_{c_opt} = 1.1 (L_{c_opt} = 9.7 cm) were both higher than one. The ratio M/K = 1.66 and $L\infty$ = 16.9, given by the length-based Bayesian method were used in the length-based spawning potential ratio method. The length-based spawning potential ratio result showed that the estimated spawning potential ratio was only 16 percent. According to the catch maximum sustainable yield stock assessment method, F was estimated as 0.329, B as near 800–850 tonnes, B/B_{MSY} as 0.269, F/F_{MSY} as 2.29, maximum sustainable yield (including bycatch) as approximately 830 tonnes with 95 percent confidence limits at 653 tonnes and 1040 tonnes. Taking into account the precautionary approach, the maximum sustainable yield should not exceed 650 tonnes.

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Shaping ecosystem-based fisheries management

The European H2020 project "Shaping ecosystem-based fisheries management" (SEAwise) started in 2021 with a network of scientists, stakeholders and advisory bodies working to co-design key priorities and approaches for an open knowledge base on European social–ecological fisheries systems. The SEAwise project works through four case studies, from the Baltic Sea to the Mediterranean, each centred on the link between social, economic and ecological objectives, target stocks and management at regional scale. The project develops predictive models and ready-for-uptake advice, to address the issues linked to the need of increasing fisheries benefits, while reducing ecosystem impacts under environmental change and increasing competition for space; ultimately to deliver a fully operational tool for fishers, managers and policy makers to easily apply ecosystem-based fisheries management in their own fisheries. Scoping workshops with stakeholders provided insights on objectives and issues at different geographical scales. Progress in the Mediterranean so far includes modelling of the effects of the environment on recruitment and life history processes, estimates of fish distribution, impacts of management and climate change on fisheries, and effects of fishing on sensitive species, benthic habitats, food webs, biodiversity and fishery-related litter. Enhanced multispecies–multifleet bioeconomic modelling provide forecasts of the effect of fisheries management measures under a changing environment and accounting for new socio-economic (e.g. fishers' behaviour, fishing family income) and environmental impact (e.g. carbon emission estimates) indicators. The project's networking facilitates direct use of these methods at regional sea-basin scale, while main outputs are shared through web-apps tailored to different users.

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Early-life dispersal traits of coastal fishes: long-term database combining observations and growth models

Early-life stages play a key role in the dynamics of bipartite life cycle marine fish populations. Difficult to monitor, observations are scarce and disparate. While Mediterranean coastlines have been highly surveyed, no effort has been made to assemble historical observations. In this paper, we build an exhaustive compilation of dispersal traits for coastal fish species, considering in situ observations and growth models. Our database contains over 110 000 entries collected from 1993 to 2021 in various subregions. All observations are harmonized to provide dates and geolocations of both spawning and settlement, along with pelagic larval durations. When applicable, missing dates and associated confidence intervals are reconstructed from dynamic energy budget theory. Statistical analyses allow revisiting traits' variability and revealing sampling biases across taxa, space and time, hence providing recommendations for future studies and sampling. Comparison of observed and modelled entries gives hints to improve the input of observations into models. Overall, this long-term database is a crucial step to investigate how marine fish populations respond to global changes across environmental gradients.

Tatiana Sitchinava

Black Sea Young Ambassadors Programme, Republic of Moldova

Climate change and the Black Sea: a focus on Georgia's fisheries and conservation efforts

The Black Sea, renowned for its distinctive ecological features, is among the world's most vulnerable regional seas due to its limited connection to open oceans and the significant inflow of effluent waters from continental Europe, alongside a complex network of rivers within its basin. Emerging challenges like climate change, novel pollutants and disruptions to the Black Sea's ecological equilibrium have extensive repercussions for its delicate environment, yet our understanding of the ecosystem's reactions remains limited. Georgia, with finite resources, faces obstacles in independently conducting comprehensive research in the expansive Black Sea. With substantial fishing activity, Georgia ranks second only to Türkiye in the region, accentuating its responsibility for resource management and restoration. This study highlights the urgent need for active conservation measures, underscoring Georgia's obligation, along with other Black Sea basin nations, to safeguard aquatic resources. Focusing on Georgia's waters, this study explores the alarming decline of fish populations exacerbated by uncontrolled fishing practices and the impacts of climate change. All six sturgeon species, integral to the Black Sea's biodiversity, are under imminent threat within Georgia's waters. The research assesses Georgia's regulatory efforts to address these challenges, providing insights into mitigation measures. Through a comprehensive analysis of climate change's implications for aquatic life and an evaluation of the state's initiatives, this study contributes to a nuanced understanding of multifaceted issues in the Black Sea ecosystem and the need for sustainable resource management.

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A holistic approach for bilateral sustainable exploitation of garfishes in Turkish and Bulgarian coastal water: BeloneHUB

This is a bilateral research project, supported by the Scientific and Technological Research Council of Türkiye (TUBITAK-121N777) and the Bulgarian Academy of Sciences (BAS-IC-TR/1/2022-2023), that aims to incorporate genetic, morphologic and bio-ecologic stock analysis methods and data-limited stock assessments as a holistic approach to understand bilateral sustainable exploitation of garfishes on Turkish and Bulgarian coasts. During the project, the genetic and morphologic structure of garfish stocks in Turkish and Bulgarian marine waters will be analysed, as well as the number of garfish species existing in these waters and how many of them are shared between the two countries. Additionally, a preliminary assessment of stock size and status of garfish via virtual population analysis and yield-prediction analysis will be performed as a holistic ecosystem-based approach for the bilateral sustainable exploitation of garfish in Turkish and Bulgarian coastal waters.

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Understanding the life-cycle characteristics of small-spotted catshark (*Scyliorhinus canicula*) and nursehound (*Scyliorhinus stellaris*)

Before implementing effective fisheries management for any species, it is essential to understand the life-cycle characteristics of the species under investigation, including growth and reproductive biology, and to incorporate them into the management strategy. To apply sustainable management strategies to fish stocks, it is necessary to study these species-specific biological features in detail. Based on this approach, some biological and reproductive traits of two species of the family Scyliorhinidae, small-spotted catshark (*Scyliorhinus canicula*) and nursehound (*Scyliorhinus stellaris*) from Gökçeada Island in the northern Aegean Sea, were studied. Life-history parameters were determined for 1 267 individuals (1 157 small-spotted catsharks and 110 nursehounds) collected by commercial bottom trawl vessels between February 2019 and February 2020. The length at 50 percent maturity was 35.5 cm in males and 42.4 cm in females for the small-spotted catshark and 37.7 cm in males and 40.8 cm in females for nursehounds. The largest male and female small-spotted catsharks were 55.7 cm and 74.3 cm in total length and weighed 509.1 g and 2 375 g, respectively. The largest male and female nursehounds were 91 cm and 88.5 cm in total length and weighed 3 115 g and 3 031.5 g, respectively. Vitollegenic activity and production of egg cases permanently occurred throughout the year for the small-spotted catshark. Females nursehounds carrying egg cases were found in February and April. Some measurements were taken on egg cases for small-spotted catsharks and nursehounds: mean lengths of 5.1 cm and 5.4 cm; mean widths of 1.6 cm and 1.6 cm; and mean weights of 3.08 g and 3.17 g, respectively.

Theme 2
Healthy seas and sustainable fisheries

KEYNOTE PRESENTATIONS

ORAL PRESENTATIONS

Parallel session 2.1 Advancing fisheries management through marine spatial planning

Parallel session 2.2 Innovation and adaptation in building resilience to climate change impacts

Parallel session 2.3 Effective measures for protecting vulnerable species

POSTER PRESENTATIONS

Healthy seas and sustainable fisheries

The Mediterranean and the Black Sea hold significant socioeconomic importance, as they are home to a great variety of species, providers of ecosystem services and host to fisheries that secure livelihoods for thousands. However, the acceleration of climate change and degradation of coastal ecosystems present risks to these seas and their fisheries. The objective of this theme is to highlight paths toward effectively managed fisheries in the region with a particular emphasis on climate change resilience and vulnerable species protection.

ORAL PRESENTATIONS

Parallel session 2.1 Advancing fisheries management through marine spatial planning

Rosa Caggiano

Mediterranean Advisory Council (MEDAC)

Mediterranean Advisory Council contribution to marine spatial planning

The Mediterranean Advisory Council (MEDAC) is co-financed by the European Union and is made up of national organizations representing the European Union Mediterranean fisheries sector (industrial fleet, small-scale fishery, women in fisheries organizations, the processing sector and trade unions) and other interest groups (environmental organizations, consumer groups and sports/recreational fishery associations) for the preparation of advice on fisheries management and socioeconomic aspects in support of the fisheries sector. The MEDAC highlighted the fundamental steps of spatial management, ensuring efficiency and the best collaboration of the fishery sector. The analysis takes into consideration the bottom-up approach from the local to the regional level. The MEDAC considers that the main difficulties could be avoided with greater and more structured engagement of stakeholders as early as possible in the proposal of new spatial restrictions, at least before their submission and evaluation. In addition, there is a need to ensure greater transparency, because this would also guarantee the highest possible level of effectiveness in the localization and the subsequent management of the areas. Moreover, professional fishing must be seen in the wider context of the use of maritime space, where fishing is combined with other uses and environmental policies. In this sense, MEDAC emphasizes that a clear definition of a marine protected area has to be provided to understand the overall picture of the Mediterranean in terms of areas already protected, fishery restricted areas, zones dedicated/planned to be devoted to energy production, and so on.

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Mapping benthic biocenosis of Bou Ismail Bay with a focus on sensitive habitats, essential fish habitats and vulnerable marine ecosystems

Mapping and characterizing marine habitats, in particular areas of fisheries and ecological interest, are essential for rational management and sustainable exploitation of their resources. The results constitute part of the basic data of an ecosystem approach used for analysing and carrying out a relevant diagnosis to develop different management plans and measures for fisheries, for example habitat monitoring, marine protected area implementation and artificial reefs. This work aims to map sensitive habitats, essential fish habitats and vulnerable marine ecosystems in the Bou Ismail Bay through the compilation and analysis of geological, ecological and fisheries data collected through bibliography, remote sensing (optical and acoustic), in situ observations and field surveys.

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Mediterranean Protected
Areas Network (MedPAN)

Status and way forward for sustainable small-scale fisheries in Mediterranean marine protected areasa

Every four years since 2010, the Mediterranean Protected Areas Network and the United Nations Environment Programme Regional Activity Centre for Specially Protected Areas support Mediterranean countries, non-governmental organizations, marine protected area (MPA) management bodies and other regional organizations to take stock of progress toward Mediterranean MPA goals in international and regional commitments. In 2020, 8.33 percent of the Mediterranean Sea was under protection status. However, 97.33 percent of the total Mediterranean surface under protection status is located in European Union member countries' waters and the cumulative surface of no-go, no-take or no-fishing areas represents only 0.04 percent of the Mediterranean. Managers from 152 nationally designated Mediterranean MPAs shared their experience via an online survey in 2019. Those data show that currently only 0.71 percent of the Mediterranean is covered by MPAs with a fishery management plan whilst this is a key target of the Regional Plan of Action for Small-Scale Fisheries in the Mediterranean and the Black Sea. The Mediterranean Protected Areas Network, is developing and supporting activities, bringing together MPA managers and involving non-governmental organizations, actors and researchers working towards supporting sustainable small-scale fisheries (SSF) in the Mediterranean. In particular, a recurrent training programme and a dedicated guide on sustainable SSF has been developed for MPA managers and fishers and policy recommendations have been developed. This presentation will share success stories of sustainable SSF in Mediterranean MPAs: how MPAs designed, managed or co-managed by fishers provide benefits to the environment while ensuring their livelihood.

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Pioneering marine spatial planning in Morocco: an opportunity to articulate conservation and development

Morocco has a high potential for developing its Blue Economy. However the growth of Morocco's Blue Economy has historically been hindered by limited intersectoral cooperation, fragmented policies and lack of integrated budget-planning across blue sectors. Marine spatial planning (MSP), with its multistakeholder focus, could support Morocco's New Development Model, the Halieutis Strategy and post-pandemic job-creation targets by boosting Morocco's Blue Economy in an inclusive manner while helping to reverse the trend toward ecosystem degradation. Between April 2021 and December 2022, the World Bank provided technical assistance to Morocco's Department of Maritime Fisheries to incubate MSP as a tool to conserve fishery resources while supporting artisanal fisheries The MSP process does not only bring benefits for the short and medium term. Using a robust MSP approach to pursue the creation of marine protected areas is a strategic choice for Morocco. Marine spatial planning is a powerful tool for developing marine protected areas because it involves stakeholders in a transparent way throughout the planning process. The stakeholders who attended engaged in deep dialogue, which has allowed for meaningful responses and the thoughtful integration of concerns relating to the creation, management and fishing regulations of a future marine protected area. The Department of Maritime Fisheries' leadership and commitment towards a multisector approach has been key for the success of the MSP process to date.

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Effects of marine protected areas on fishing activities: the case of the European Union Mediterranean and Black Sea

Marine protected areas (MPAs) represent one of the principal management tools needed to address the cumulative impacts on the marine environment, fisheries collapse and the ongoing loss of marine biodiversity. The European Commission, through a comprehensive set of policy tools, such as the Common Fisheries Policy, the Maritime Spatial Planning Directive and the Marine Strategy Framework Directive, acknowledged the potential role of MPAs and aims to support MPAs in reconciling biodiversity conservation and the sustainable use of marine resources, therefore taking into account an ecosystem-based approach. In this framework, MPAs can represent a key component of the fisheries management toolbox to achieve ecological and social sustainability of marine ecosystems. However, very little quantitative information exists about the effect of MPAs on fisheries catches and these are generally limited to single case studies. Here, we compiled data about fishing operations within and around a very large number of MPAs in the European Union Mediterranean and Black Sea and we compared fisheries descriptors (e.g. catches, catch per unit of effort), between different types of MPAs in ten European Union countries. Specifically, we considered nationally designated MPAs and MPAs established within the framework of Natura 2000. Results suggest variability in fisheries descriptors between MPAs and countries, and support the role of MPAs as effective management tools under some conditions.

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Conservation of vulnerable marine ecosystems and sustainability of deep-water fisheries in the Mediterranean Sea

Deep-sea corals are key components of marine ecosystems and act as biodiversity hotspots. Because of their high vulnerability to fisheries, their conservation is an urgent task. The critically endangered bamboo coral (*Isidella elongata*) has been listed as an indicator of vulnerable marine ecosystems; however, effective measures for its conservation in the Mediterranean are lacking. The current research on bamboo coral has focused on mapping its probability of distribution including the impact of climate change and fisheries. A further step forward is now being undertaken by investigating the genetic diversity and the interpopulation connectivity at Mediterranean scale. A DNA-based approach was used to assess the genetic diversity and the phylogeography of 32 bamboo coral samples collected in six different areas based on the analysis of partial sequences of the mitochondrial (mtDNA) MutS and the nuclear (nuDNA) ITS2 genes. Furthermore, a Lagrangian model (forward-in-time simulations) was implemented to investigate the species larval behaviour and connectivity at Mediterranean scale using different modelling scenarios. The preliminary results of the genetic analysis confirmed that all the investigated Mediterranean populations belong to the bamboo coral, suggesting a higher genetic structuring, with all the detected haplotypes connected by heterozygous individuals. The outputs of connectivity scenarios suggest the presence of persistent pathways, supporting the self-sustaining nature of the populations. All the results obtained from the habitat suitability models, climate change and fisheries scenarios, genetic and larval dispersal approaches are discussed in light of the implementation of management measures for the conservation of vulnerable species and the sustainability of deep-water fisheries.

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Mapping fisheries distribution in data limited cases: a spacetime tool applied in the Adriatic–Ionian region

Small-scale fisheries (SSF) vessels generally have an overall length less than 12 m and are not equipped with monitoring devices. Thus, their spatiotemporal distribution remains mostly unknown. By means of a method that combines geospatial techniques and multicriteria decision analysis (MCDA) SSF pressure can be spatially derived. The MCDA analyses the most influential anthropogenic and environmental components affecting the distribution and intensity of SSF, while it considers and incorporates experts' knowledge into the analytical process in a transparent and flexible way. Recently, this method has been expanded to include weather/climate data, species distribution and other fishing effort estimations (performed in coarser spatial scales, such as at geographical subarea level). In this work, we present the recent advancements regarding the MCDA method, through some examples applied for SSF in selected areas of the central Mediterranean (Adriatic Sea, western and eastern Ionian Sea). The merit of including the above information to the MCDA, is that maps of fishing effort can be now elaborated in several temporal scales and expressed in commonly used indicators (e.g. days at sea, fishing hours). Meanwhile, fishing grounds can be now delineated by species. An R-package is also developed and expanded to support and automate the above procedures. Overall, the MCDA provides an innovative and cost-effective way aiming for better understanding of the SSF spatial distribution and potential interactions and impacts. The contribution of this tool on the marine spatial planning process and for managing fishing activities is also discussed.

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Assessing spatial reallocation of fishing activities in response to marine protected area implementation

Marine protected areas (MPAs) are acknowledged as an effective tool for biodiversity conservation; however until relatively recently, their potential role as a fisheries management tool remained neglected and is still highly debated. The implementation of MPAs can determine some degree of displacement of fishing activities and with it, a potential set of related implications (e.g. selection of alternative fishing grounds, fishing methods, target species and economic performance of the fleet segments); however very few empirical studies have been carried out to investigate this displacement, especially in the Mediterranean and the Black Sea. To fill this knowledge gap, information about large-scale and small-scale fisheries operations within and around five MPAs: Banyuls MPA (western Mediterranean), Torre Guaceto MPA and Egadi Islands MPA (central Mediterranean), Gyaros Island MPA (eastern Mediterranean), and the special area of conservation Ropotamo (Black Sea) was collated. Automatic identification system (AIS) and vessel monitoring system (VMS) data for the fleet segments equipped with tracking devices were gathered and complemented with a participatory mapping exercise to cover the smallest fleet segment (small scale fisheries) as this segment is not often covered by AIS and VMS. Analysis of the AIS data indicates that they are adequate for estimating fishing effort trends in the different study areas. The results show that, in some cases, the establishment of MPAs determined an adaptation of the fishing segments in terms of fishing strategy, including the fishing footprint and all the related consequences (i.e. exploitation pattern, composition of the catches, economic performance), but these effects vary largely among different case studies. These results support the need for a careful preliminary assessment, also based on modelling approaches, of the potential effects of MPAs.

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Identifying other effective area-based conservation measures in the Mediterranean and the Black Sea

Since 2019, the GFCM has been addressing the concept of other effective area-based conservation measures (OECMs) towards their application in the Mediterranean and in the Black Sea. To start the process, FAO and the GFCM co-organized an expert meeting in February 2022. This meeting sought to establish a way forward for identifying fisheries-related OECMs in the Mediterranean region and to provide technical inputs to prepare and test FAO's practical guidelines. Indeed, GFCM fisheries restricted areas have proved to be good candidates as fisheries related OECMs and a comprehensive roadmap towards their potential recognition was made available to relevant GFCM contracting parties and cooperating non-contracting parties. By describing the process followed to date, this contribution seeks to outline the challenges encountered towards addressing, discussing and clarifying emerging doubts and procedural issues encountered on the way. This will serve to outline future steps towards assessing the implications, opportunities and potential difficulties in identifying and recognizing fisheries-related OECMs in the Mediterranean and the Black Sea.

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Strategic infrastructure for improved animal tracking in European seas

Scientific-based methods, integrated research platforms and international collaborations are necessary if we are to protect and manage marine organisms and the habitats they rely upon. Acoustic telemetry is a monitoring method that works via the detection of signals from acoustic transmitters by acoustic receivers and is widely used to determine the behavioural patterns of living animals. The Strategic Infrastructure for Improved Animal Tracking in European Seas (STRAITS) project is a four-year project funded by the Horizon Europe Framework Program under "Developing the European research infrastructures landscape, sustaining global leadership". We will deploy acoustic telemetry arrays to the Danish Straits, North Channel, Strait of Gibraltar and Turkish Straits System. Flagship species will be tracked by tagging them with acoustic transmitters to follow them as they migrate across all corners of Europe. The project will also leverage ongoing acoustic tracking projects, expand efforts to connect tracking initiatives across Europe, develop data management plans and networking to promote synergy and deliver data to national and international governing bodies. Moreover, STRAITS will listen to cetaceans and the broader soundscapes via passive acoustic monitoring at all four locations. The project is a major win for monitoring aquatic life in Europe seas and provides important opportunities to identify migration routes, estimate survival, locate spawning grounds, determine the timing of major life stage transitions and assess threats. The STRAITS project consists of ten world-leading organizations in the study of animal movement. Together, they will advance our understanding of aquatic animal movements in Europe and abroad, and change the way biodiversity is monitored in European waters, thereby contributing to conservation and policy initiatives.

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Vulnerable marine ecosystems conservation and spatial planning in the Mediterranean

The conservation of vulnerable marine ecosystems (VME) in areas beyond national jurisdiction became of important concern in 2006 when the United Nations called States and regional fisheries management organizations to prevent VMEs from significant adverse impacts. However, the regional implementation of conservation measures to protect VMEs in the Mediterranean remains complex. Currently, VMEs are intensely impacted by bottom trawling activities, although some spatial management measures, such as fisheries restricted areas have been implemented. A fragmented geopolitical context, conflicts between uses and poor scientific knowledge of the spatial distribution of VMEs complicate the management of these ecosystems in the Mediterranean. In order to design a spatial planning exercise at the Mediterranean scale with the main objective of balancing fisheries activities, economic development and VME conservation, three steps are proposed: 1) develop species distribution modelling to map the potential distribution of VME indicator species in relation to current environmental conditions and under future climate change; 2) describe spatial patterns of the different benthic invertebrate communities, first at a regional scale and then at a larger scale in unobserved areas by using several environmental predictors to support the development of benthic invertebrate bioregionalization; and 3) design a marine spatial planning approach for the Mediterranean sea focusing on VME protection but accounting for existing human uses and future environmental conditions.

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Assessing benthic state in the Adriatic–Ionian region for spatial fishery management

Fishing activities involving mobile bottom-contacting gear can impact the seafloor and associated ecosystems by disrupting the composition and abundance of species, causing potential loss of biodiversity. Benthic habitats can take a long time to recover according to habitat sensitivity, the fishing gear used and the intensity and frequency of fishing. In this work, we present the assessment of the benthic state conducted in different areas of the central Mediterranean Sea (Adriatic Sea, western and eastern Ionian Sea; geographical subareas 17, 18, 19 and 20) in the context of the SEAWise project. The data used were from trawl and grab surveys. Methods applied included the approach for assessing physical disturbance from bottom-contacting fishing gear and their environmental impacts on seabed habitats, following the developments and standards of the International Council for the Exploration of the Sea Working Group on Fisheries Benthic Impact and Trade-offs. The relative benthic state estimates were obtained from modelling information of fishing pressure and habitat sensitivity, the latter evaluated from longevity of epibenthic and macrofauna species. The results highlighted the presence of more impacted areas in the Adriatic Sea in comparison with the Ionian Sea, due to the more intense fishing activities mainly concentrated on the muddy habitats of the continental shelf, while coarse habitats were less impacted globally. In geographical subareas 19 and 20, fishing activities narrowed to deep-water areas may have resulted in assessing a better benthic state. These model-based results can support the evaluation of spatial fisheries management measures aimed at minimizing ecological and socioeconomic trade-offs.

Parallel session 2.2 Innovation and adaptation in building resilience to climate change impacts

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Fuel use and carbon footprint of the Turkish Atlantic bluefin tuna (*Thunnus thynnus*) fleet

The effects of climate change on nature have become increasingly visible in recent years particularly in the Mediterranean zone. Determining anthropogenic greenhouse gas emissions on a sectoral basis and subsequently carrying out decarbonization studies is of critical importance to achieving the United Nations Sustainable Development Goals and the climate change commitments of the Paris Agreement. This study aimed to determine the fuel use and carbon footprint of the Turkish Atlantic bluefin tuna (Thunnus thynnus) fleet in the Mediterranean Sea for the first time. The data were obtained through full sampling and survey interviews (face-to-face, online and telephone) with the owners of vessels that had fishing permits during the 2023 Atlantic bluefin tuna fishing season (15 May–30 June). The fleet consists of a total of 74 vessels, including 29 fishing (purse seine), 29 transport and 16 support vessels, operating under five commercial groups. The number of days at sea were 33.0 ± 12.92. The fleet's fuel use efficiency, fuel use intensity, total CO_2 emissions and fuel footprint of CO_2 per kg of fish landed were 2 362 L/day, 1 762 L/kg, 16 347 722 kg and 4 998 kg, respectively. The share of fishing, transport and support vessels in total emissions is 40.8 percent, 41.1 percent and 18.1 percent, respectively. Fuel footprint of commercial groups ranged from 3 163 kg CO_2/kg to 6 539 kg CO_2/kg. This study is the first snapshot of Turkish Atlantic bluefin tuna fleet fuel inputs and CO_2 emissions to date, providing a baseline against which future performance can be measured.

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Blue crab in Tunisia: from a crisis to an opportunity

The invasive blue swimming crab (*Portunus segnis*), recorded in Tunisia since 2014, has long been a menacing predator wreaking havoc on delicate marine ecosystems, damaging small-scale fishers' nets and decimating their catches. However, Tunisia has taken a proactive stance, turning this problem into a promising opportunity through targeted investment and dedicated projects. Blue crab has become a beacon of hope, providing a new source of income for affected local fishers, particularly in the Gulf of Gabès. The region has witnessed the creation of processing and marketing plants aimed specifically at Asian, European and American markets. This strategic decision has fuelled impressive economic growth and progress in the region. Despite the positive results, it is imperative to implement measures to control the exploitation of this precious resource. Indeed, the stock assessment study revealed a worrying decline in blue crab biomass, requiring urgent action.

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Fuzzy cognitive mapping of downscaled shared socioeconomic pathway and representative concentration pathway scenarios for fisheries social–ecological systems

Policymakers and industries face the challenge of developing adaptation and mitigation strategies in front of the increasing impacts of global change on human societies and natural ecosystems. To this end, they need to be able to anticipate these impacts. We present a novel approach to construct projections for fisheries social–ecological systems. Our approach consisted of a regional downscaling of global scenarios combining Intergovernmental Panel on Climate Change representative concentration pathways and shared socioeconomic pathways at the 2050–2100 horizon. We developed our methodology in the North Sea and the Mediterranean, where we co-constructed downscaled scenarios by engaging with French fisheries managers, policy makers, scientists and non-governmental organizations through a series of homogeneous focus groups and a participatory workshop. We then integrated the scenarios into a fuzzy cognitive map of fisheries social–ecological systems and assessed the expected impacts of climate change and socioeconomic transformations on marine ecosystems and fishing communities. We were able to identify some of the key factors regulating these fisheries in a context of global change, as well as some interdependencies and feedback loops between their key components. The development of this method represents a promising approach to provide projections of marine social–ecological systems. It underscores the importance of engaging diverse stakeholders in the construction of projections, fostering knowledge exchange to support informed decision-making and sustainable management of fisheries in a rapidly changing world.

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Assessment of socioeconomic impacts of non-indigenous species in the Mediterranean Sea

Marine ecosystems around the world are changing more rapidly due to multiple stressors including anthropogenic activities with increased global marine trade and climate changes, allowing the introduction and establishment of non-indigenous species (NIS) to reshape the neighbouring ecosystems, and increase the challenges for resource managers and decision-makers. The Mediterranean basin is threatened by an intensification of human activities and various additional pressures, such as pollution, overfishing, habitat loss and climate change. The present article utilized a stakeholder's questionnaire, observations and published literature, to present an essential outline of a consistent, transparent process for the evaluation of the socioeconomic impacts of NIS in the region. The marine fishery is an important segment of the fishery industry in the region with great economic and cultural influences. Most of the NIS that were introduced are very successful, have established large populations mainly in the eastern Mediterranean and have become common in local fish landings, constituting a significant share of commercial catches. The reported negative impacts of NIS are based on assumptions, while the benefits for coastal communities from NIS are verified. In some areas, a market-based approach has been endorsed as a measure to limit the spread and reduce the negative impact of these species, if any, and to provide economic revenues for fishers. Managing the NIS would create jobs and enhance ecosystem services for the benefit of the coastal society such as food provisioning and recreational activities.

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Assessing natural capital and ecosystem services in the Strait of Sicily: a multimethodological approach

The Strait of Sicily is identified as a Mediterranean biodiversity hotspot able to provide multiple ecosystem services, supporting human life at different scales. Nevertheless, the Strait of Sicily is one of the most threatened areas in the Mediterranean basin. Stressors and anthropogenic pressures are degrading its natural capital and ability to provide ecosystem services, negatively affecting human well-being. In this context, the study and conservation of the Strait of Sicily marine ecosystem represents an urgent need. Although several studies on the Strait of Sicily have been conducted over time, there is a gap in studies adopting a multimethodological approach to comprehensively assess natural capital stocks and ecosystem service flows. The present study aims to implement a multimethodological assessment framework combining environmental accounting methods and conventional ecological indicators. In particular, the ecoexergy method is proposed to account for the complexity and organizational level of the Strait of Sicily marine ecosystem, coupled with a biomass-based Shannon diversity index. In addition, an ecosystem accounting framework is applied to assess a set of ecosystem services provided by the Strait of Sicily, in both biophysical and monetary terms. The results of this study will be useful to policymakers in charge of developing strategies to achieve impelling conservation actions and sustainability goals.

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Impact of invasive edible species on Mediterranean small-scale fisheries

The biodiversity of the Mediterranean Sea is undergoing rapid changes due to anthropogenic movements, resulting in the introduction of invasive species. This semi-enclosed ecosystem is renowned for its rich diversity of endemic and endangered taxa, making it a vital biodiversity hotspot, but also faces significant challenges as one of the primary global hotspots for marine bio-invasions. Consequently, monitoring and managing the spread of non-indigenous organisms have become critical nature conservation priorities. This study focuses on small-scale fisheries and aims to determine the catch amounts of non-indigenous and invasive species using specific fishing gear and estimation of density maps of edible invasive species, catch per unit effort according to fishing gear, and evaluates the diversity. Data were collected from April 2022 to July 2023, involving nine small-scale fishers utilizing 12 different fishing gear specifications. During the study period, a total of 390 fishing operations yielded 67 species, with 13 categorized as non-indigenous species, including eight identified as delicious invasives. The proportion of delicious invasives in the total catch exhibited an increase, closely correlating with rising seawater temperatures in the Mediterranean. This study sheds light on the profound impact of anthropogenic movements and invasive species on small-scale fisheries in the Mediterranean Sea. The findings underscore the urgent need for implementing effective conservation measures and sustainable management strategies to safeguard both indigenous species and the livelihoods of small-scale fishers in the region.

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Subsidies from the European Maritime, Fisheries and Aquaculture Fund: prefinancing facility for small-scale Mediterranean fishers

This abstract provides an overview of a prefinancing facility co-designed by BlueSeeds and the World Wide Fund for Nature (WWF) to bridge the gap between small-scale fishers in the Mediterranean region and European subsidies. Only 3 percent of the European Maritime and Fisheries Fund dedicated to the fleet has been assigned to small-scale fishers. Although the European Maritime and Fisheries Fund is a key source of financial assistance for the development and sustainability of the fishing sector, small-scale fishers often encounter difficulties in accessing it. This is mainly due to the complexity of application processes and the lack of upfront capital. BlueMove, a prefinancing facility developed by BlueSeeds and WWF, aims to address the financial challenges faced by small-scale fishers in accessing the necessary resources to transform their activities and develop sustainable practices. It provides upfront funds to eligible fishers, enabling them to meet immediate financial requirements while awaiting the disbursement of the European Maritime, Fisheries and Aquaculture Fund grants. The prefinancing facility operates through a partnership between relevant local stakeholders such as financial ethical institutions, non-governmental organizations, fisheries associations and governmental agencies. It offers low-interest loans or cash advances based on the anticipated amount of the European Maritime, Fisheries and Aquaculture Fund subsidies. The pre-financing facility also provides technical assistance and capacity-building programs to enhance the financial management skills of the beneficiaries. By addressing the technical and financial constraints faced by small-scale fishers, this facility contributes to the sustainability of Mediterranean small-scale fisheries. Additionally, it helps strengthen the economic resilience of coastal communities by supporting livelihoods and income generation opportunities.

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The way from invasion to commercialization of illegal, unreported and unregulated rayed pearl oyster (*Pinctada radiata*) fisheries in Greece

The commercial harvesting of the rayed pearl oyster (*Pinctada radiata*) a well-established non-indigenous species (more than 50 years old) in the eastern Mediterranean, is still unregulated. Because of how the non-indigenous species legislation treats it, the bivalve is mislabelled in order to be transported through supply chain channels and the current local exploitation of shellfish by fishers is considered as illegal, unreported and unregulated fishing. An all-encompassing scientific approach to problem-solving begins with the evaluation of the bivalve stock and provides the seasonal pattern of harvesting. Through market research, including both consumers and the supply chain, the product biochemical profile was identified and marketed. A techno-economic study on processing aiming to add value by raising the revenue of fishers has been also conducted. By submitting fishing regulations for the season and size of the harvest to the government for approval, the legalization of the fishery is promoted.

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From pest to luxe: turning invasive pufferfish into exotic fish leather

The silver-cheeked toadfish (*Lagocephalus sceleratus*) is an invasive fish of high concern in Türkiye. It is invasive due to its high toxicity, its predation effects on native biodiversity and the harm they inflict on small-scale fishers by eating their catches and tearing up their fishing nets. One of the best ways to control invasive species is to commercialize them. A new project is doing just that by fishing them and turning their skin into exotic fish leather and leather products. This will offset their predation on native species, help to improve fisheries, improve livelihoods of small-scale fishers and offer new jobs stimulating a new small industry that may be upscaled. A general overview will be presented of the science behind why this species is so invasive followed by an overview of the project's development. It is a top predator with a trophic level of 4.4, can grow up to 10 kg and can be fatal to humans if ingested. Also, there have been some minor lacerations between humans in the marine environment. This new industry offers more targeted control of this species and also provides a highly eco-positive option to the exotic and luxury leather markets, which are in need of more sustainable choices.

Parallel session 2.3 Effective measures for protecting vulnerable species

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Conservation genetics and restoration strategies for endangered sturgeon species in the Black Sea

The sturgeon species in the Black Sea face numerous threats, such as overfishing, habitat degradation and pollution. This review highlights the significance of conservation genetics in formulating effective restoration strategies for these iconic species. Through the use of molecular techniques, recent studies have provided insights into population structure, genetic diversity and evolutionary lineages within populations. Conservation genetics facilitates monitoring, allowing for the identification of population declines, estimation of effective population size and detection of genetic bottlenecks. To ensure the resilience and adaptive potential of populations, it is essential to focus on preserving genetic diversity within and among populations. This can be achieved through the implementation of management plans, including breeding programs, artificial insemination techniques and gene banks. Habitat restoration emerges as a key priority, particularly for protecting and restoring spawning grounds and critical feeding areas. Complementing habitat restoration efforts, the controlled release of hatchery-reared individuals, guided by genetic data, can enhance the population recovery of sturgeon species. Collaboration among Black Sea countries is crucial due to the transboundary nature of sturgeon populations. International cooperation and regional partnerships are necessary to implement effective conservation measures. Public engagement initiatives and conservation awareness campaigns play a vital role in raising awareness about the ecological significance of sturgeon species and promoting sustainable fishing practices. By integrating the knowledge derived from conservation genetics into comprehensive restoration strategies encompassing genetic management, habitat restoration and international cooperation, the long-term survival and recovery of endangered sturgeon species in their native Black Sea range can be ensured.

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The MedBycatch project: mitigation of vulnerable species bycatch in geographical subareas 12 and 13 (central Mediterranean)

Within the framework of the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project), mitigation trials of vulnerable species bycatch were carried out in geographical subareas 12 and 13 for bottom trawls, trammel nets, bottom gillnets and longlines. The use of a rectangular grid fixed at an angle of 45° in conjunction with an escaping window placed upstream from the bottom trawl codend allowed for a considerable reduction of elasmobranch bycatch. The escape of the targeted demersal species was low and did not exceed 17 percent of the total catch. For bottom longlines, experimentation of several types of bait showed a decrease in elasmobranch bycatch (62 percent) with the use of cuttlefish and octopus as bait instead of elasmobranch pieces or sardines. The survival rates of sharks caught by circle hooks were slightly higher compared to J-hooks and curved hooks. The increase of the gillnet hanging ratio from 50 percent to 70 percent and total buoyancy minimized the accidental capture of elasmobranchs, in particular rays, to 80 percent with a 21.5 percent decrease in captures of target species no matter the twine thickness. For red mullet (*Mullus barbatus*) and cuttlefish trammel nets, the reduction of vertical slackness, the external net mesh size and the increase in buoyancy were considerably in favour of a 61 percent reduction of ray bycatch. The reduction in the soak time for monofilament trammel nets targeting common Pandora (*Pagellus erythrinus*) and multifilament trammel nets targeting lobster to 12 hours, coupled with an increase in buoyancy of 20 percent and a reduction in vertical slackness by 30 percent, decreased the elasmobranch bycatch by 37 percent.

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Evaluation of bycatch mitigation strategies for vulnerable marine megafauna in the Gulf of Gabès

Marine megafauna such as elasmobranchs and sea turtles are particularly vulnerable to fisheries bycatch due to their life history characteristics. To reduce the incidence of catch and/or reduce at-haulback mortalities of these species, a wide variety of mitigation measures have been proposed. This study aims to evaluate the effect of certain mitigation measures on elasmobranch species and sea turtle bycatch rates in trawlers, demersal longlines and gillnets targeting elasmobranchs to provide effective management alternatives that could reduce their bycatch. The experiments were done in the framework of the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project) which aims to reduce the impact of bycatch in targeted fleet segments on vulnerable marine species in the Mediterranean. Results showed that the bycatch rates of sea turtles and elasmobranch species decrease significantly with depth for all fishing gear. However, it appears that soak time in gillnets does not influence the bycatch rates of most elasmobranch species and sea turtles. Data analyses show that attractive bait in longlines affects the catch rates of sharks. Low at-haulback mortalities of elasmobranch species and sea turtles were registered in trawlers and demersal longlines. However, direct mortality of loggerhead sea turtles (Caretta caretta) in gillnets is significantly higher in the case of control soak time (more than 24 hours) than experimental soak time (12 hours). Results suggest that excluding fishery activities from coastal waters would eliminate most of the sea turtle and elasmobranch species bycatch. Furthermore, the release of specimens caught alive should be recommended.

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Bycatch monitoring and mitigation strategies for pelagic longlines in the southern Adriatic Sea

Shark and batoid capture represent around 10–15 percent in biomass of the total catch from the Mediterranean pelagic longline fishery with the highest bycatch rates found in the Alboran and Adriatic Seas. The blue shark (*Prionace glauca*) is currently listed as critically endangered by the International Union for Conservation of Nature in the Mediterranean and it represents the most important bycaught species for the pelagic longline fishery. This study aimed to monitor the bycatch from pelagic longlines targeting swordfish in the southern Adriatic Sea, in particular during the summer to early autumn period. In this study, 32 blue sharks were tagged using pop-up satellite tags to assess their post-release survival. In addition, MaxEnt modelling was used for predicting the spatial distribution of blue sharks using environmental co-variates (e.g. temperature and currents) and the model performance was evaluated by cross-validation with pop-up data from tagging. Moreover, two types of bycatch mitigation trials were tested: hook type (circular hook, C-type vs. normal, J-type) and fishing strategy (fishing mostly during the night vs. fishing mostly during the day). The results showed that there was no significant difference in terms of numbers of caught individuals per fishing effort between the two types of hooks. However, individuals caught with the C-type hook showed a significantly better condition than the J-type, suggesting possible increased survival rates after release. Using the second fishing strategy, no shark was caught, but a significant reduction of the targeted swordfish catch (about 30 percent) was observed. The overall post-release survival was about 80 percent.

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Working with fishers: an essential collaboration to collect data on angelshark (*Squatina squatina)* in Corsica

The ecology of the critically endangered angelshark (*Squatina squatina*) remains poorly understood due to its disappearance from much of its original range in Northeast Atlantic and Mediterranean, mainly because of overfishing. Corsica (northwestern Mediterranean) stands as one of the last significant areas where angelsharks thrive, owing to low fishing pressure. Collaborating with local fishers emerges as the most effective means to gather data on this species. The project aims to achieve three main objectives: 1) acquire fishers' knowledge through a local-ecological knowledge study; 2) identify functional areas through a mark and recapture study; and 3) utilize acoustic telemetry to understand the sharks' habitat use and migration throughout the year. The predictable occurrence of angelsharks in the fishers' nets helped identify new areas for the presence of the sharks and gave new insights on the seasonality of the species. Trained fishers tagged over 150 sharks enabling the estimation of crucial indicators for the Corsican population, such as sex ratio and population size. Finally, the first results of the ten-month acoustic tracking indicate a seasonality for their habitat use: most sharks are detected during summer and more than half of them seem to be leaving the area in autumn and winter. The remaining sharks displayed a preference for coastal and estuary areas, which could be linked to reproduction or pupping season. Working with fishers grants scientists access to a rare species and fosters communication, raising awareness about its vulnerability. Sharing best practices for bycatch situations in fishers' nets enhances conservation efforts.

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Top predators of the Mediterranean Sea as indices of functional and phylogenetic diversity

Marine protected areas (MPAs) are known to be effective tools of conservation and beneficial to fisheries as they restore the productivity of the entire area stretching further than their actual borders; this is referred to as the spillover effect. It is also known from land ecosystems that top predators act as biodiversity indices and are frequently considered as umbrella species in management efforts. The same does not apply to marine ecosystems management as we spotted a gap in published literature regarding marine top predators and their biodiversity index potential. We gathered georeferenced data of marine top predators in the Mediterranean basin and checked the correlation between their presence and the functional and phylogenetic diversity of fish species in Mediterranean communities. The results highlighted a strong, positive correlation between the number of top predators and the functional and phylogenetic diversity of the communities. Moreover, we used the presence/absence data of the two predators with the highest trophic level, smooth hammerhead (Sphyrna zygaena) and killer whale (*Orcinus orca*) and showcased that even one apex predator can act as a proxy for marine biodiversity hotspots. Finally, we demonstrated that both the top predator's richness and the presence of the two most notorious apex predators correlate strongly and positively with the species richness of species considered threatened in the International Union for Conservation of Nature Red List. In light of these findings, we propose the distribution of the Mediterranean Sea's top predators be considered in the establishment or expansion of existing MPAs.

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Providing a standard turtle excluder device for Mediterranean bottom trawl fisheries

Bottom trawl fisheries in the Mediterranean are among the major threats for the survival of the loggerhead sea turtle (Caretta caretta), being the main fishing gear that accidentally catches this species. The turtle excluder device (TED) consists of an inclined grid inserted before the codend of a trawl net, which allows sea turtles eventually caught to escape. Turtle excluder devices have been extensively tested in the Mediterranean, with promising results in bycatch reduction without significantly penalizing the commercial catch. However, even small modifications in the TED rigging (e.g. TED material and dimension, TED angle, mesh size and material of the grid section, funnel or flapper specifications) can alter its functioning and thus lead to a loss of catch of commercial species. The present work takes advantages of years of experience in TED trials in Italian seas (mainly from TartaLife project) to provide a manual for TED rigging aimed to ensure its efficiency in Mediterranean fisheries. A step-by-step procedure is illustrated to rig a particular type of TED called "Flexgrid", a very light grid made of an alloy of high-strength plastic material that ensures a remarkable elasticity and ability to maintain a stiff configuration during trawling and withstand considerable bends during mechanical stress, such as its winding around the net winch, and consequently resume its natural shape. This application manual, by allowing the production of standards, can be easily consulted by fisheries scientists, industries and/or fishers, to make them independent in the TED rigging and thus stimulate a wider dissemination of TEDs.

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Monitoring bycatch and implementing mitigation measures in a French Mediterranean Atlantic bluefin tuna (*Thunnus thynnus*) longline fishery

The producers' organization SATHOAN's Atlantic bluefin tuna (*Thunnus thynnus*) line fishery is double ecocertified with the "Pêche Durable" label and the Marine Stewardship Council certification. The organization is implementing an action plan to meet the objectives of sustainable management of the stock, protection of biodiversity and reduction of bycatch and accidental catches. In this regard, a smartphone application (ECHOSEA app) was developed. It allows fishers to record their catches of non-targeted species and to better understand the sensitive species of the Mediterranean and their interactions with fisheries. In parallel, the REPAST and SELPAL projects, and more recently the POBLEU project – in collaboration with the World Wide Fund for Nature and the French Research Institute for Exploitation of the Sea (IFREMER) – were led to strengthen observation data at sea, obtain relevant information on bycatch rates and train fishers on good practices of handling and releasing sensitive species. In addition, the RAYVIVAL project, with IFREMER, the French National Centre for Scientific Research and the League for the Protection of Birds, aims to deploy survival tags on pelagic stingrays (*Pteroplatytrygon violacea*) in order to estimate their survival rate after the release operations. Moreover, the innovative SHARKGUARD device (created by FISHTEK), which emits a short-range low-intensity electric field was tested in 2019 and 2021 (SHARKGUARD and SAVESHARK project). Bycatch of skates and sharks – in particular, blue shark (*Prionace glauca*) – were reduced, but so was the target species. The device is still in the prototype stage and is not yet used by fishers. Data collection at sea, tests of new mitigation measures and fisher sensitization, will continue with the project PROTECT-MED in partnership with IFREMER, the Research Institute for Development, the National Plan of Action in favour of Balearic puffins and the World Wide Fund for Nature, awaiting European Maritime, Fisheries and Aquaculture Fund funding approval.

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Sustainable fishery management strategies for demersal elasmobranchs in the Mediterranean: insights from Italian case studies

The alarming decline of elasmobranchs in the Mediterranean Sea urgently calls for effective management strategies. Within the Italian programmes of the Marine Strategy Framework Directive (Directive 2008/56/EC), we investigated the effectiveness of releasing juveniles of commercial elasmobranchs after capture (i.e. through establishing a minimum conservation reference size) as a potential fishery management strategy. We monitored 142 commercial fishing operations from gill and trammel nets, benthic and pelagic trawlers in the Strait of Sicily, Adriatic and Ligurian Sea (2020–2023), and evaluated at-vessel mortality (after sorting), short-term post-release mortality (two hours post-capture) and long-term post-release mortality (72 hours post-capture). Overall, at-vessel mortality was 21.3 percent, but varied significantly among species, fishing gear, season and area (N = 4 950; 22 species). Short-term (N = 1 161; 17) and long-term post-release mortality (N = 132; 4) were generally below 16 percent and 20 percent, respectively. Population dynamics models for the most fished species were constructed to assess the expected population recoveries, adjusting for different minimum conservation reference sizes and survival rates. Furthermore, within the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project), we deployed conventional (n = 1 813; 16 species) and acoustic (n = 61; 3 species) tags in the Adriatic Sea to monitor post-release mortality *in situ*, and to investigate species' spatial use within highly fished areas. Preliminary results for three highly commercialized species, smooth-hound (Mustelus mustelus), blackspotted smooth-hound (*Mustelus punctulatus*) and piked dogfish (*Squalus acanthias*), highlighted different uses of space, site fidelity and residency. Our results will be fundamental to inform future management and demonstrate that an integrated approach towards understanding key biological and ecological traits is essential to developing sustainable and feasible management measures for commercial as well as protected elasmobranchs.

POSTER PRESENTATIONS

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Guardians of biodiversity: coral reef fish communities' resilience across the years

Reef fish are vital for reef health as their feeding types disturb the benthic environment. Studies on reef fishes have been supported to conserve and manage both reef fishes and the reef environment. But studies on reef fish are rarely conducted in Sri Lanka. The present study was conducted at the Paraiwella, Polhena and Hikkaduwa coral reefs at the Southern Province in Sri Lanka with the objective of studying the major reef fish families, their feeding habits and size variations. The stationary point count method with a 5 m radius water column was used for surveying the reefs. Data were collected between September 2018 to February 2019 and February 2022 to November 2022. Reef fish families, their feeding habits (herbivorous, carnivorous and omnivorous) and their size classes (small, medium and large) were observed. Twenty-six fish families were recorded and among them four families (Acanthuridae, Pomacentridae, Labridae and Monodactylidae) showed dominance throughout the reefs. Partially conserved Paraiwella had the highest diversity of reef fish followed by Polhena and Hikkaduwa reefs. But the highest abundance of fish was recorded in the Hikkaduwa reef which is a major tourist destination. Omnivore was the feeding type of more than 50 percent of the fish followed by herbivores and carnivores. Medium-sized fish were the most abundant. As there were some breeding grounds among the reefs, small-sized fish were the second most abundant. There was no significant difference of the reef fish diversity and abundance with time.

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Recent additional record of the oceanic puffer (*Lagocephalus lagocephalus*) in Tunisian waters (central Mediterranean)

In the Mediterranean, nine species represent the Tetraodontidae family. Among these species, oceanic puffer (*Lagocephalus lagocephalus*) inhabits the Atlantic Ocean and is known from the British islands to South Africa. This fish is also known from both the western and eastern basins of the Mediterranean. Oceanic puffer was first reported in Tunisian waters in 2000, then in 2004. In 2023, six specimens were caught at various locations along the Tunisian coast, the first capture in over 15 years. Information on the records as well as the biological characteristics of these specimens are reported in this work.

Mustafa Altug Atalay
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General Directorate of Fisheries and Aquaculture of the Ministry of Agriculture and Forestry, Türkiye

Four years of experience for pufferfish catching incentives in Türkiye

Pufferfish have been known as invasive non-indigenous fish species in the Mediterranean since the 2000s. Because of rapid spread and harmful impacts on indigenous species and fishing gear, the Ministry of Agriculture and Forestry of Türkiye has given financial incentives to fishers based on the delivery of the tails of fish caught since 2020. According to our data, 46 192 tails in 2020, 9 886 tails in 2021, 48 193 tails in 2022 and 37 073 tails until end of the August 2023 were delivered by the fishers to the local directorate of the Ministry to benefit from the incentive. Results of the online survey done with the fishers who live in the incentive coverage area located on the Mediterranean and Aegean Sea coasts show that almost 90 percent of the fishers think that the pufferfish incentive model is beneficial and 92 percent of them want the incentive to be continued by the Ministry. One of the most important outputs of the survey is that it reveals the change in the population of invasive pufferfish species year by year. Apart from these findings, participants expressed their demand to change the practice of paying different prices according to the species type and to pay the same amount for all species and increase the incentive fees. As a result, we think that all Mediterranean countries should take an action together for pufferfish control. In addition, financial incentives are a tool for pufferfish control, but not enough alone.

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DNA barcoding to characterize fish biodiversity in the Mediterranean Sea

The Mediterranean Sea is a hotspot for marine biodiversity. DNA barcoding is the best-suited technology for fish species identification and biodiversity assessment. Several studies have employed DNA barcoding to study the Mediterranean Sea's biodiversity. The current investigation aimed to assemble the DNA barcoded fish species inhabiting the Mediterranean Sea, where 111 cytochrome c oxidase I (COI) species' barcodes were considered, whether indigenous or non-indigenous. Out of the 111 barcodes, 26 were obtained from the current study collected from Mediterranean Sea species in Egypt. In addition to 20 published COI barcodes for other Mediterranean Sea fish species in Egypt, retrieved from the Genbank database, 65 published COI barcodes (recorded in other Mediterranean Sea countries) were also retrieved from the Genbank database. Overall, these 111 species belonged to 54 families and 79 genera. The Mediterranean Sea indigenous species were nearly half of the gathered species. The phylogenetic tree indicated presence of 11 clades and one singleton representing pearly razorfish (*Xyrichtys novacula*). The genetic distance among species using the kimura two-parameter method was moderate and ranged between 0.225, annular seabream (*Diplodus annularis*) and Randall's threadfin bream (*Nemipterus randalli*), and 0.483, striped eel catfish (*Plotosus lineatus*) and spotted seabass (*Dicentrarchus punctatus*). The results ensure the discriminatory power of COI barcodes and their efficiency in cases requiring species level resolution. Despite the point of view that considers non-indigenous species as a threat for the biodiversity in Mediterranean Sea, we believe that the biodiversity in the Mediterranean Sea is greatly enriched by the presence of these non-indigenous species.

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Results of 30 months of monitoring of vulnerable species bycatch in geographical subarea 13 (eastern Tunisia)

Within the framework of the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch Project), the monitoring of vulnerable species bycatch was carried out in three geographic subareas (12, 13 and 14) in Tunisian waters. This monitoring took place during two phases (15 March 2019 to 14 June 2020 and 1 November 2020 to 31 January 2022) via three sampling methods: 1) onboard observations; 2) questionnaires at fishing harbours; and 3) auto-sampling. Incidental catches of vulnerable species were recorded following the standard data collection protocol. The results in geographical subarea 13 show that elasmobranchs are the most impacted. They represent about 98.2 percent of the total bycaught vulnerable species. Although the various fishing gear incidentally captured them, the bottom trawl is widely the most impacting one. Sea turtle bycatch represents 1.26 percent while cetaceans and seabirds present respectively only 0.03 percent and 0.51 percent of the total bycaught vulnerable species. About 30 vulnerable species were recorded: rough ray (*Raja radula*) was the species most caught by bottom trawlers (45.25 percent), followed by Dasyatidae sp. (33.87 percent). Catches by small-scale vessels were dominated by Rajidae sp. (51.5 percent) and Dasyatidae sp. (23.87 percent).

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Spatio-temporal risk assessment for longnose spurdog (*Squalus blainville*) in the Adriatic–Ionian region: a semi-quantitative approach

Unintended catch of non-target species remains a challenge in multispecies fisheries, in particular for elasmobranchs that may represent a considerable portion of bycatch. As those species also exhibit a carrying capacity (K)-selected life-history strategy, they are considered particularly sensitive to fishing impacts. The longnose spurdog (*Squalus blainville*) is a demersal small-sized shark, constituting an important bycatch of bottom trawling in the Mediterranean, collected also by small-scale fishery gear. In an effort to contribute to more effective ecosystem-based fisheries management in the Adriatic–Ionian region, we used experimental trawl survey data from the International Bottom Trawl Survey in the Mediterranean (MEDITS) project, supplemented with information collected by observers onboard commercial vessels and European Union multiannual programme for data collection (EU-MAP) fishing effort data (e.g. based on vessel monitoring system analysis) to conduct a productivity–susceptibility analysis. This approach identifies the risk that fishing poses to a species, assuming that fishing vulnerability is determined by two properties: its productivity, defined by life-history characteristics, and its susceptibility, based on the likelihood of interactions between the population and fishing. Moreover, a spatio-temporal analysis of the population's potential exposure to fishing activity was also provided. Results indicate that the longnose spurdog shows the highest exposure risk in the eastern part of the southern Adriatic, in particular either in the second and third quarters or in the first and second quarters, depending on fishing gear used. For the eastern Ionian, the central part presented high exposure scores. In both areas, the overall risk for the longnose spurdog is ranked as medium-level for the gear considered, while exposure hotspots have been identified. Although this effort is rather preliminary, the approach may provide useful information towards implementing ecosystem-based fisheries management.

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Three-year bycatch monitoring in the Gulf of Gabès (Tunisia): impact on sea turtles

Fisheries bycatch is one of the main serious threats to long-living marine megafauna such as sea turtles. Monitoring bycatch is the first step to understand the impact of fisheries on the species affected. The objective of this work is to assess the multi-gear fisheries impacts on sea turtles in the Gulf of Gabès (geographical subarea 14, Tunisia) based on data collected during 2019, 2020 and 2021 via 1 678 at-port questionnaires to fishers and via 1 248 on-board observations of fishing vessels including bottom trawlers, small-scale fisheries (bottom longlines and set nets) and purse seines. Data were collected in the framework of the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project) which aims to reduce the impact of bycatch in targeted fleet segments on vulnerable marine species in the Mediterranean. Loggerhead sea turtle (*Caretta caretta*) was the most captured species (n = 306 turtles), while three specimens of the leatherback turtle (*Dermochelys coriacea*) were also captured. The number of loggerhead sea turtles caught per year was estimated at 1 130 for trawlers (0.05 loggerhead sea turtles per fishing day). For the small-scale vessels, the estimation was about 63 000 specimens (0.07 loggerhead sea turtles per fishing day) and for purse seines, the estimation was about 6 700 individuals (0.06 loggerhead sea turtles per fishing day). Bycatch per unit of effort and mortality of loggerhead sea turtles varied depending on the season, depth and fishing gear. Data shows a low mortality of bycaught loggerhead sea turtles, mainly in trawlers and purse seines leading to the release all live specimens caught accidentally.

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Elasmobranch bycatch in longline fisheries in the Gulf of Hammamet (geographical subarea 13) (northeast Tunisia)

Bycatch has a negative ecological impact and involves loss in biological resources. Developing and implementing solutions to prevent bycatch remains extremely important, but primarily it is crucial to evaluate the rate of bycatch by species, gear, area, and so on. This study aims primarily to assess the interaction between elasmobranchs and longline fishing in the Gulf of Hammamet (geographical subarea 13) and to evaluate the catch per unit of effort. To achieve this, monitoring of landings from benthic and pelagic longline fisheries targeting grouper and swordfish (*Xiphias gladius*), based in the port of Kélibia and operating in the Gulf of Hammamet, was conducted during the summer season in 2020. Elasmobranchs represent respectively 31 percent and 20 percent of the total catches of the benthic and the pelagic longline fishery in the Gulf of Hammamet. The sandbar shark (*Carcharhinus plumbeus*) and smooth-hound sharks (*Mustelus spp.*), and the devil fish (*Mobula mobular*) and thornback ray (*Raja clavata*) being the main species bycaught in these fisheries. The assessment of catch rates per unit of fishing effort in terms of number of individuals per 1 000 hooks showed that the sandbar shark (1.17 individuals per 1 000 hooks) and thornback ray (1.25 individuals per 1 000 hooks) were the sharks and rays with the highest catch per unit effort in the benthic longline fishery. In the pelagic longline fishery, shortfin mako (*Isurus oxyrinchus*) (0.37 individuals per 1 000 hooks) and devil fish (0.1 individuals per 1 000 hooks) were the sharks and rays with the highest catch per unit effort.

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Evidence of a blue shark (*Prionace glauca*) nursery area in the southeastern Adriatic Sea (Montenegro)

The blue shark (*Prionace glauca*) is an epipelagic species and one of the most widespread sharks in the seas of the world. It represents one of the most common bycatch species in pelagic fisheries, in which target species' populations are highly affected by overfishing. Although this species is assessed as near threatened according to the latest International Union for Conservation of Nature global assessment, its Mediterranean population has suffered a severe decline and is therefore assessed as critically endangered. The existence of a nursery area along the Montenegrin coast (geographical subarea 18) was proposed in 2017, and since then, more than 20 newborns and older young-of-the-years (< 100 cm of total length) have been recorded in this area. In addition, social media data mining provided earlier records of newborns and confirmed that this coastal area has been a nursery area for a long time. Newborns and young-of-the-years were recorded during the late spring and summer months, most often between May and July. They were captured by both commercial (43.48 percent) and recreational fisheries (47.83 percent), while stranding events made 8.70 percent of records. These observations are supported by sporadic occurrences of gravid females in the same period, as reported by the local fishing community. Due to the vulnerability of the species in the Mediterranean Sea, efforts are needed to better investigate the use of this area by young blue sharks.

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The bycatch rate of threatened marine species in fishing gear on the Mediterranean coast of Morocco

This study shows a descriptive analysis of bycatch of vulnerable species in the Moroccan Mediterranean area by analysing a database produced by the observer's programme during three years of field activities (2019–2022) under the GFCM data collection protocol. The region hosts important populations of threatened marine mega vertebrates including sea turtles, sharks and rays, marine mammals and seabirds. All of these taxa can be affected by bycatch and this study is a pioneer assessment of the interaction between those species and fisheries towards understanding the biodiversity and functioning ecosystem effects of these fisheries. The key figures of the monitoring programme of the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project) are 16 observers, 2 799 day-at-sea observations (920 on board trawlers, 464 on board long liners and 783 on board purse seiners) and 5 792 questionnaires. Sharks and rays had the highest percentage with an estimated 93 percent of the total number of bycaught individuals. Approximately, 725 elasmobranch individuals were bycaught in the monitored gear, most of them being deep-water sharks (Triakidae, Oxynotidae). Twenty-three common dolphins (*Delphinus delphis*) were bycaught in purse seiners. Moreover, 12 loggerhead sea turtles (*Caretta caretta*) and one leatherback sea turtle (*Dermochelys coriacea*) were also bycaught. For seabirds, eight Audouin's gulls (*Larus audouinii*) and three Balearic sheerwater's (*Puffinus mauretanicus*) were reported. Some mitigation measures have been developed and will be monitored. Efforts to further complete the illustration of bycatch issues and reduce bycatch are ongoing. Finally, additional research will be required for accurate knowledge of bycatch quantities, full understanding of fisheries practices and achievement of the target for bycatch reduction.

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Perspective for sustainable fisheries through better use of marine spatial planning tools in Bulgaria

Common interests and potential conflicts can be found in the Black Sea region within nature protection and restoration efforts, fisheries, regional industrial activities and accompanying pollution impacts, including oil development and production, and development of transport infrastructure. Minor pressures exist from tourism, sand mining and fisheries. It is important to balance the different economic, social and ecological interests in the area. However, cooperation efforts are often hindered by a number of factors such as uneven economic and political development within countries. Each of these activities is greatly influenced by activities within and beyond the coastal zone. It is for this reason that the resolution of conflicts in the use of coastal and marine resources analysed in the study required a broad perspective on the environmental process and interaction among human activities. For the study, the author prepared groups of indicators for nature protection and human uses and future development needs. The indicators of socioeconomic impact of the fisheries sector are a direct result of human influence on the environment. As a result of this inventory, three different kinds of areas could be identified:

· unrestricted use areas with priority for economic development (ports, shipping, industry);
· restricted use areas with priority for nature protection (marine protected areas, Natura 2000 network); and
· coexisting use areas with spatially or seasonally differentiated uses (tourism, fishing, aquaculture).

The proposed classification and system of indicators, with an emphasis on the impact of climate change on the fisheries in Bulgaria, are an addition to the tools of marine spatial planning.

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Measuring the sensitivity of benthic communities in the Aegean Sea

Bottom trawl fisheries seem to impose an ever-present danger to benthic ecosystems. With the focus on the Aegean Sea, we used the BEnthos Sensitivity Index to Trawling Operations (BESITO index) to reveal the level of sensitivity of these benthic communities both at present and throughout time. This index utilizes biological traits to classify individual species into five categories of tiered sensitivity to bottom trawling, ranging from categories one and two, characterizing opportunistic and tolerant species, respectively, to categories three, four and five, assigned to species of graduated sensitivity. Using bottom trawl survey data, we constructed a list of 148 species and calculated the BESITO index for each of them by collecting trait data mainly from FishBase, the World Register of Marine Species and from other databases and literature. We produced the weighted average of the BESITO index for the years 1997–2021, using catch per unit effort data. The results showed that most species in the Aegean benthic communities are either tolerant towards trawling activities or slightly sensitive to them – categories two and three – while the time series analysis highlighted a somewhat declining sensitivity with a BESITO index score of around 2.55. It appears that the years of bottom trawling in the area might have shifted the benthic communities towards more tolerant species as revealed by the time series analysis. Spatial analysis and longer time series of data are required to assess the effect of bottom trawling and these indices should be used in designating marine protected areas.

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Bycatch monitoring in the Gulf of Gabès: impact of trawling on some vulnerable taxa

The incidental capture of vulnerable species in fishing gear is a key threat for several taxonomic groups, including sea turtles, elasmobranchs, marine mammals as well as birds. In order to evaluate the bycatch of marine vulnerable species in the Mediterranean Sea, we performed the Understanding Mediterranean multi-taxa bycatch of vulnerable species and testing mitigation – a collaborative approach project (MedBycatch project) (2019–2022) together with four countries, adopting a standardized data collection protocol. The present work concerns the impact of benthic trawlers on vulnerable species in the Gulf of Gabès (geographical subarea 14 –Tunisia). For this, we performed 515 fishing operations by benthic trawl using direct observation methodology. Results show that sea turtles and sharks are caught in 13 percent of fishing operations. However, batoids are caught in more than 75 percent of trawl tows. Incidental catches of seabirds and dolphins have not been recorded, despite their presence in the fishing areas. All sea turtle individuals caught by trawls were removed alive and released while 12 percent of elasmobranchs specimens were removed dead.

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Minimum conservation reference size of red mullet (*Mullus barbatus*) in the Black Sea

Red mullet (*Mullus barbatus*) is one of the most important fish species fished and consumed in Black Sea countries. The Working Group on the Black Sea (eighth and ninth sessions) acknowledged the fact that red mullet in the Black Sea was considered to be in overexploitation. In light of this, it proposed the formulation of a roadmap towards achieving conservation and sustainability goals. Such roadmap includes conservation measures with the possibility of a minimum conservation reference size (MCRS) applicable to the entire Black Sea. The objective of this survey is to analyse the length and age structure of the red mullet catches in the Black Sea followed by a proposition of MCRS for this species for the entire basin. Length frequency distribution and age composition of red mullet catches used in this research are based on published data provided for the Subregional Group on Stock Assessment for the Black Sea; the Scientific, Technical and Economic Committee for Fisheries; and pooled literature data. The Tsikliras and Stergiou approach was implemented, according to which the proposed MCRS of red mullet was estimated as the median of length at first maturity. The red mullet reaches sexual maturity around 11–12 cm total length. The length frequency distribution of the Black Sea catches (2015–2022) evidenced that a significant part of the fish in the catches (50 percent for Türkiye and Bulgaria, 87 percent for Romania, 45 percent for Georgia) are under this critical length of 12 cm. In this regard, for the Black Sea the red mullet MCRS is proposed to equal 12 cm total length.

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The importance of the climatic and fishery parameter combination in stock management

The use of surplus-production models was and remains a relevant tool for stock assessment. Nevertheless, the introduction of climatic parameters improves the output quality of these models. In fisheries, maximum sustainable yield refers to the largest average catch that can be captured from a stock under existing environmental conditions and is considered as the reference point used in population dynamic models. Furthermore, the introduction of climatic parameters can improve the stock assessment of fishery resources and therefore improve the accuracy of results towards making the recommendation of management measures more reliable. Studies have been carried out based on a database including production, fishing effort and landing per unit effort for several species, both demersal: common octopus (*Octopus vulgaris*); and pelagic: round sardinella (*Sardinella aurita*), sardine (*Sardina pilchardus*) and Atlantic mackerel (*Scomber scombrus*). The climatic parameter used was the sea surface temperature. The analyses were carried out, essentially, in the central southern zone of the Mediterranean using CLIMPROD as an assessment tool. Global models were chosen based on a non-parametric test, presenting models combining the relationship between landing per unit effort, fishing effort and sea surface temperature. This model is supposed to influence the catchability and/or the abundance of the resource. As part of the stock assessment, several management scenarios taking into account the variation of the fishing effort and the climatic parameters appear as an approach to better understand and assess the state and the evolution of the fisheries resources.

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Environmental and fisheries dynamics in the eastern Mediterranean (Aegean Sea)

Mediterranean marine ecosystems are currently under threat from a diverse array of stressors. In response to the growing imperative to address these multifaceted challenges, ecosystem-based fisheries management has emerged as the most suitable strategy. The Ecopath with Ecosim software offers well-suited capabilities for the pursuit of ecosystem-based fisheries management objectives. The Aegean Sea is an oligotrophic area in the eastern Mediterranean, with the status of most stocks deemed to be overexploited and affected by climate change. An Ecopath model for the entire Aegean Sea was developed, looking into food web interactions and fisheries. The Ecosim model developed in this study was calibrated using historical time series of biomass, catches and environmental parameters, along with fishing effort estimates from 2006 to 2021, and simulated until 2050 to forecast the dynamic changes in the ecosystem (business-as-usual). Virtual scenarios of fishing effort reduction by 10 percent, 30 percent and 50 percent, aligned with the Common Fisheries Policy directives of achieving maximum sustainable yields, were performed. Moreover, climate scenarios of increasing sea surface temperature and net primary production in accordance with the emissions scenarios outlined by the Intergovernmental Panel on Climate Change, were explored. In the business-as-usual scenario, total biomass decreased by 16 percent at the end of the simulation period, while total catch decreased by 29 percent. Overall, fisheries reduction scenarios forecasted an increase in biomass and decrease in catches according to the corresponding reduction, while the climate change scenarios affected mostly the biomass and catches of the pelagic functional groups.

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Effects of climate change on the Marmara Sea

It is an issue of both regional and global importance; climate change affects the physical, chemical, and biological properties of the Marmara Sea, and therefore its ecosystem and human activities. To understand what these impacts are and how they can be reduced, it is necessary to evaluate the sensitivity and adaptation capacity of the Marmara Sea to climate change. The mucilage formation seen in the Marmara Sea between 2007 and 2009 dealt a serious blow to regional fisheries. The mucilage, which gradually reappeared in the Marmara Sea in the autumn months of 2019, reached its highest level in the spring of 2021, starting from the autumn months of 2020. This formation, which has regressed in the Marmara Sea due to its obstruction of aquaculture and its physical structure, leaves serious and negative effects that are very difficult to repair. To this end, this study used various data sources and methods to analyse the response of the Marmara Sea to climate change. First of all, indicators showing how the Marmara Sea is affected by climate change have been determined. These indicators include seasonal temperature, salinity, oxygen, pH, chlorophyll-a and planktonic samples. Then, the historical changes in these indicators and satellite data were examined. The results of this study revealed that climate change has serious and negative effects on the Marmara Sea. It changes the temperature and salinity regime of the Marmara Sea, reduces the oxygen level, causes acidification and affects the ecosystem..

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Essential habitats for sandbar shark *(Carcharhinus plumbeus)* in the Gulf of Gabès (Tunisia)

The sandbar shark (*Carcharhinus plumbeus*) is a coastal, highly migratory species. The migratory nature of this species makes it vulnerable to several threats – mainly fisheries. The identification of essential fish habitats used to survive and reproduce is key for the development of spatial conservation and management. The aim of this study was to determine suitable habitats for the sandbar shark along the Gulf of Gabès using species occurrence records collected onboard commercial fisheries during 2020 and 2022. Besides, life-stage distribution and catch sizes were investigated. The investigation shows that all life stages of the sandbar shark were captured on the continental shelf of the Gulf of Gabès. A distribution map indicates that adult sandbar sharks appear around the Kerkennah and Zarzis coasts during spring. However, during summer, this abundance was noticed on the coasts of Mahres and Gabès. These observations suggest a movement of adult individuals towards the coasts to reproduce. Furthermore, data show the presence of pregnant females along the coasts of Mahres, Zarat, Djerba and El-Ketf followed by the appearance of neonates which suggests that these areas could constitute parturition sites. The results suggest that particular attention should be paid to the protection of these areas, which are essential for the management and conservation of sandbar sharks.

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Contaminants in fish from the eastern Mediterranean and human health risks due to their consumption

Assessing contaminants in seafood is important due to their biomagnification in the food chain, and consequently their adverse effects on human health. Levels of aluminium, arsenic, cadmium, chromium, copper, iron, mercury, lithium, manganese, nickel, lead, vanadium and zinc were assessed in commercially valuable fish species, namely little tunny (*Euthynnus alletteratus*), white seabream (*Diplodus sargus*) and red mullet (*Mullus barbatus*), and mollusc species, namely the rustic limpet (*Patella rustica*) complex, collected from three regions along the Lebanese coast (eastern Mediterranean). Concentrations of regulated heavy metals cadmium, mercury and lead were below the maximum levels set by the European Commission. The human health risks for cadmium, mercury and lead were assessed using the target hazard quotient and estimated weekly intake. All calculated target hazard quotients were below one and estimate weekly intakes were lower than the correspondent provisional tolerable weekly intake for all elements. The results indicate that the analysed fish products in this study are safe for consumption and unlikely to cause adverse effects on human health.

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Elasmobranchs in the Kerkennah islands (geographical subarea 14): diversity and interactions with artisanal fisheries

The Kerkennah archipelago is located on the eastern coast of Tunisia, north of the Gulf of Gabès, about 18 km east of the city of Sfax. It has outstanding environmental potential, which in 2012 helped the islands to earn the status of natural reserve. The northeastern part of the archipelago, considered an area with a fragile ecosystem, is classified at national scale as a sensitive coastal zone, according to a 1998 decree. Around the archipelago, large gaps remain in our understanding of elasmobranch resources. The limited information on their diversity as well as their interactions with the artisanal fisheries from this region are of concern. Thus, the aim of this work is to inventory elasmobranch species occurring in the Kerkennah islands as well as their interactions with the artisanal fisheries in the region. In fact, many artisanal fishing gear are used in the archipelago. Elasmobranchs were captured by about five of those gear, mainly using gillnets and longlines. We identified 17 elasmobranch species belonging to eight families including five sharks belonging to three families and 12 batoids belonging to five families. Elasmobranch bycatch was dominated by sharks. Further research should focus on the incidents of bycatch and evaluate the potential solutions to allow artisanal fisheries to co-exist alongside the elasmobranch species.

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Effects of fishing gear on stress in elasmobranch species from the Gulf of Gabès

Elasmobranch species are incidentally caught by fishing gear operating along the coast of the Gulf of Gabès. The captures are done with two types of gear: active (trawlers) and passive (gillnets and bottom longlines). Each fishing gear can cause external and internal physical trauma. Additionally, the capture results in physiological stress for elasmobranch species. This study aims to assess this stress at the cellular level in a various elasmobranch species through the analysis of the following parameters: blood glucose level, superoxide dismutase activity, malondialdehyde content, reduced glutathione activity and advanced oxidation protein products. Furthermore, the effect of each fishing gear on the variation in mortality rates among the captured species was evaluated. Results show that fish caught by active gear experience higher stress levels compared to those captured by passive gear, as the analysed parameters are higher in the former group. Overall, capture induces a significant increase in protein levels, activity and advanced oxidation protein products, thiobarbituric acid reactive substance and superoxide dismutase, and a decrease in glutathione levels in all species. These physiological responses to capture stress appear significantly more pronounced in species captured by active gear (trawlers). Moreover, a high mortality rate among the species captured by active gear was noted. These results confirmed the vulnerability of elasmobranchs to non-selective fishing gear.

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Commercial tests of porpoise alerting devices in the Black Sea turbot (*Scophthalmus maximus*) gillnet fishery

The primary cause of cetacean mortality in the Black Sea fishery is often attributed to incidental capture. The sustainability of fishing activities that adversely interact with marine mammals is specifically highlighted in the GFCM 2030 Strategy for sustainable fisheries and aquaculture in the Mediterranean and the Black Sea, and in a pilot project (CetaByM) which assesses cetacean bycatch in Black Sea turbot (*Scophthalmus maximus*) gillnet fisheries and tests measures to mitigate the incidental catch of cetaceans, endorsed by the GFCM in 2021. One of the work packages of the project aims to test the efficiency of porpoise alerting devices (PALs) to mitigate incidental catch of Black Sea harbour porpoise (*Phocoena phocoena relicta*) in turbot gillnet fisheries. Porpoise alerting devices imitate harbour porpoise alarm signals at a frequency of 10–130 kHz, causing them to increase their echolocation activity and improving their ability to detect the nets. Forty fishing operations, with a total soak time of 502 days, were observed under commercial conditions at five different locations in Bulgaria, Romania and Türkiye (western, central and eastern) between January and August 2023. Half-lengths of the gillnets in each operation were rigged with PALs and operated in nearby areas with a minimum distance of 500 m from each other. The weight of targeted turbot and number of bycaught Black Sea harbour porpoises were recorded. The combined results show that the gear rigged with PALs have less Black Sea harbour porpoise bycatch than the control gear, six individuals and 22 individuals, respectively. Obtained results are highly promising. However, one more year of testing is proposed to draw statistically robust conclusions to lead any recommendations to fisheries management authorities.

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Impacts of biofouling on the industrial fishing vessels operating in the General Fisheries Commission for the Mediterranean area of application

The study assessed the impact of biofouling on industrial purse seiners and trawlers in the Mediterranean and Black Sea during a fishing season. Initially, interviews with fishers identified five commonly used self-polishing co-polymer (SPC) coatings. These coatings, along with an uncoated reference panel, were tested in the Black Sea's natural seawater for fouling accumulation (SPC immersion tests). Additionally, foul release coatings were included in the tests for comparison. The SPC coatings were also applied to a fishing vessel and compared after a year of operation (ship tests). The ship test results were compared to the static immersion test outcomes. Case studies were conducted on three fishing vessels operating in two locations, using either trawls or purse seines. The results revealed that applying SPC coatings to industrial fishing vessels could lead to fuel savings of between 6 percent and 10.26 percent, while choosing basic antifouling coatings could save up to 3.11 percent in total fuel consumption in the GFCM area of application during a fishing season. Furthermore, regardless of fishing gear or location, this decision could reduce or increase fuel consumption by up to 146.1 million litres, fuel costs by GBP 112.5 million and CO_2 emissions by 0.42 million tonnes for the regional fleet. For the global fleet, the choice of antifouling coatings could result in a decrease or increase in fuel consumption by up to 660.37 million litres, fuel costs by GBP 508.48 million and CO_2 emissions by 1.9 million tonnes.

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Raising awareness of stakeholders on the conservation status of sturgeon, cetaceans and piked dogfish (*Squalus acanthias*)

Major steps were undertaken by the GFCM towards future sustainable management of piked dogfish (*Squalus acanthias*), protection of sturgeons and reduction of incidental catches of cetaceans in the Black Sea. A recommendation was adopted by the GFCM in 2021 which establishes a research programme on piked dogfish and in response to it, a concept note was endorsed to further explore the interactions between this species and other Black Sea fisheries. Another GFCM recommendation on the establishment of minimum standards for bottom-set gillnet fisheries for turbot and conservation of cetaceans served as a basis for the CetaByM pilot project to assess cetacean bycatch in turbot gillnet fisheries. In 2021, again a GFCM resolution on the mitigation of fisheries impacts for the conservation of sturgeons was endorsed. One of the aims of those decisions is to increase the awareness of the stakeholders and the general public on the conservation status of these species. The CetaByM and sturgeon pilot projects and the piked dogfish research programme have turned into main participatory activities of the BlackSea4Fish project. In 2023, to raise awareness about the sector in Bulgaria, Georgia, Romania and Türkiye, most of the main fishing ports were visited, hundreds of fishers were informed about the status of those stocks and asked for their active involvement in all conservation activities. Leaflets and posters were created in the local languages and distributed to the stakeholders together with other branded materials. The work on the awareness-raising campaigns was combined with other activities under these initiatives.

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Small-scale fisheries and bio-invasions in the Bizerte Lagoon (northern Tunisia)

Small-scale fisheries strongly contribute to national fisheries production in Tunisia. However, this activity is facing several difficulties, such as trawling in shallow waters, irregularity of the activity due to climatic hazards and an ever-growing influence of bio-invasions. The Bizerte Lagoon is the largest lagoon in northern Tunisia and has been recently considered a hotspot of bio-invasions, with more than 20 non-indigenous species. In the region, small-scale fisheries activities are handed down through generations and the number of artisanal fishers varies from 300 up to 500, during species-specific fishing seasons. As the first victims of invasive non-indigenous species adversities, fishers are not only information providers but can also collaborate with scientists and policy-makers in decision management. This work assessed the impacts of nine invasive non-indigenous species of different zoological groups, in the Bizerte Lagoon, using local ecological knowledge and field observations. Information related to first record dates, abundance in specific seasons and areas, and potential uses were collected. Observations and questionnaires demonstrated significant threats, namely negative socioeconomic impacts (e.g. waste of time in unravelling and mending of nets, loss of nets, and decrease in the efficiency of fishing gear) and health impacts (injuries, burns and allergic reactions), but also goods and services (species with commercial interest). Faced with these "new" non-indigenous, and sometimes highly invasive species, fishers discover, monitor and finally, adapt.

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Multiple pressures and their combined effects in the Strait of Sicily

The assessment of the cumulative effects of all anthropogenic pressures at sea is a requirement of the European Union's Marine Strategy Framework Directive and is essential for managing human activities in the marine environment and achieving the Directive's "good environmental status" goal. This knowledge is also needed by decision-makers and governing bodies to enact effective spatial planning of human uses at sea within the framework of the European Union's Marine Spatial Planning Directive. In this study, we used a cumulative effects assessment approach to assess the combined effects of multiple human pressures on the Strait of Sicily (central Mediterranean Sea). We integrated spatially explicit data on key human activities, primarily fishing, and recently updated information regarding environmental components, particularly essential fish habitats and fish distributions, into the Tools4MSP Geoplatform. This allowed us to model and map the interactions between human activities and their cumulative impacts on marine ecosystems. These findings will inform the development of management strategies and spatial plans to mitigate cumulative impacts and balance conservation needs with the sustainable use of marine resources in the Strait of Sicily.

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Climate risk exposure of biodiversity in marine reserves of the Balearic Islands, western Mediterranean Sea

The Mediterranean Sea is considered a biodiversity hotspot where climate change shows a faster rate in comparison with other regions due to its enclosed shape. Here, marine species are responding through alterations in their abundance and significant changes in growth, survival and/or reproduction, ultimately leading to redistributions of biodiversity as a consequence of a changing sea. In the realm of marine protected areas, marine reserves with fisheries restricted conditions are known as powerful tools to manage current and future threats to biodiversity. However, these marine reserves were established based on the current presence of vulnerable species, habitats and ecosystems and conservation plans disregard changes in climate conditions over time. The analysis of the exposure and vulnerability of fish communities to climate change is crucial for adaptive conservation and developing resilience. In this study, we integrate biomass data from visual censuses of fish species targeted by small-scale fisheries (2000 to 2022) in marine reserves of the Balearic Islands (western Mediterranean Sea). We analyse the climate risk exposure of marine reserves, the long-term changes of fish biomass and the conservation measurements of fisheries restrictions. The most abundant species exhibit dominant changes both in depth, latitude and longitude importantly related to high climate risk exposure. Some of the population shifts were also related to the species' thermal and depth preferences. Our study helps to identify unknown local climate-driven changes in biodiversity and advance towards climate-smart management of marine protected areas.

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Modelling discards in Mediterranean bottom trawl fisheries in relation to environmental and fisheries-related variables

The effects of environmental, operational, temporal and catch-related variables on the discard quantities of four species subject to the European Union landing obligation and widely caught in Italian and Greek bottom trawl fisheries – European hake (*Merluccius merluccius*), deep-water rose shrimp (*Parapenaeus longirostris*), red mullet. (*Mullus barbatus*), Atlantic horse mackerel (*Trachurus trachurus*) – were explored by applying generalized additive models. The catch data derived from the Data Collection Framework in seven geographical subareas of the Mediterranean Sea distributed in all major sub-basins (western, central, eastern Mediterranean and Adriatic Sea). Overall, the generalized additive models were able to explain 21–96 percent of the deviance. Geographic coordinates and depth were included as significant co-variates in most models showing that species bathymetric preferences, local patterns in productivity and/or possible existence of nursery grounds affect discards. Positive relationships between discards and volume of catches and negative ones between discards and the species' mean length (especially for European hake) were identified, highlighting the effect of catch composition as well as fishers' discarding behaviour. Interannual patterns seemed to be affected by trends in species abundance and recruitment success, while seasonal effects were usually linked to the recruitment period and/or seasonal fishing intensity. Operational variables (length of the vessel, vessel age and haul duration) were significant in few cases, but there were no common patterns across all regions/species. The current study shows that discarding in Mediterranean bottom trawl fisheries is affected by a large number of variables that should be considered for more effective management of unwanted catches.

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Mesopelagic fish species composition in open seas and deep enclosed basins of Greek seas
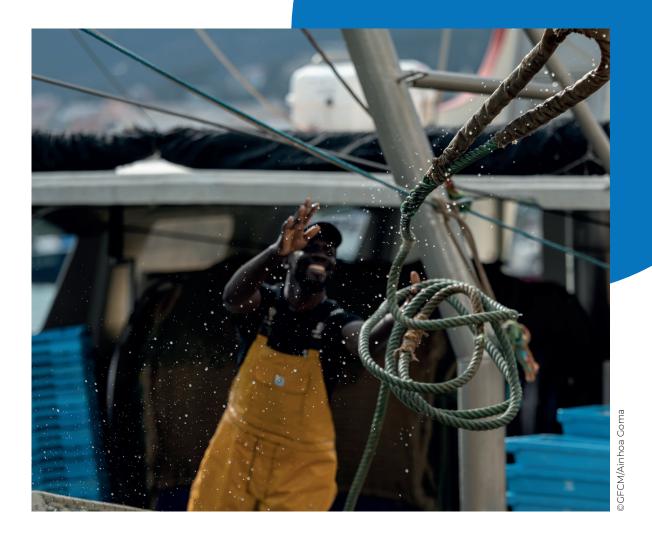
Recent estimates of the mesopelagic fish biomass in the world's oceans have increased the interest on the ecological role and the potential for exploitation of this poorly studied group of species. Here we analyse the catch composition of 43 hauls performed with a mid-water trawl during surveys dedicated to the study of the twilight zone or sampled opportunistically during other acoustic surveys in Greek seas. The hauls targeted the deep scattering layers formed by mesopelagic fish, either during daytime or during their diel vertical migration at night. In total, 30 taxa (most identified to the species level) were recorded, mostly belonging to the families Myctophidae, Sternoptychidae, Stomiidae, Paralepididae, Gonostomatidae and Phosichthyidae. Species composition varied locally with the highest species richness recorded in the open seas (North Aegean Trough: 18 species; Cretan Sea: 23 species; eastern Ionian Sea: 21 species) in contrast to three deep (> 400 m) gulfs where members of the Gonostomatidae and Phosichthyidae families were totally absent and only 2–15 species were sampled. These biogeographical features are affected by the complex topography, local bathymetry and the geological history of the area but also by current abiotic factors (e.g. hypoxic conditions) prevailing in each subregion. Our findings provide baseline information for the study of mesopelagic fish communities in the eastern Mediterranean and highlight the need to focus on the local scale.

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Effect of bottom trawl fishing protection on key vital traits of striped red mullet *(Mullus surmuletus)*

We test the hypothesis that bottom trawl fishing protection, and subsequent recovery of benthic ecosystems and trophic webs, could positively affect production of demersal fishing resources. We compared key vital traits of striped red mullet (*Mullus surmuletus*), such as population structure, condition and diet, together with prey availability, in three different areas of the Menorca Channel (Balearic Islands, western Mediterranean): i) an area within the Natura 2000 Network site of community interest since 2014, including maërl beds, where trawling was forbidden in 2016 (ZPP), and two trawled areas; ii) one within the site of community interest (LIC); and iii) an area adjacent to the site of community interest (ADJ). Size distributions showed that larger individuals, with predominating females above 20 cm total length, are clearly more abundant in LIC and ZPP. Mature females from these two areas also showed mean values of gonadosomatic index higher than in ADJ, suggesting larger egg production capacity compared to females from ADJ. Stomach content analysis showed that peracarids were predominant preys in ADJ, while more balanced contribution of multiple taxa was observed in LIC and ZPP. Besides, higher stomach fullness and overall benthos abundance were observed in SCI compared to ADJ, reflecting higher feeding intensity and food resource availability in the former. Striped red mullet displayed similar trophic position across areas, although different isotopic niches were observed, highlighting resource use pattern variations. Our results reveal some important beneficial effects of effective sensitive habitats protection for striped red mullet which could help in reversing the long term fishing resources overexploitation.

Theme 3 ···

Economic and technological innovation for resilient fisheries

KEYNOTE PRESENTATIONS

ORAL PRESENTATIONS

Parallel session 3.1 Using economic data and engaging stakeholders to support fisheries livelihoods

Parallel session 3.2 Envisaging the future of fisheries value chains

Parallel session 3.3 Innovative technologies for sustainable fisheries

POSTER PRESENTATIONS

Economic and technological innovation for resilient fisheries

Mediterranean and the Black Sea fisheries have profound impacts on livelihoods in the region; as such it is necessary to bolster their resilience to possible threats, including climate change and illegal, unreported and unregulated fishing. The objective of this theme is to delve into economic and technological innovations toward supporting fisheries livelihoods, strengthening value chains, enhancing social protection and tackling emerging challenges in the sector.

ORAL PRESENTATIONS
Parallel session 3.1 Using economic data and engaging stakeholders to support fisheries livelihoods

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Economic valuation of the coastal and marine ecosystem services provided by Tunis Lagoon's fishery

The northern Tunis Lagoon's fishery is characterized by a very unique ecosystem; it is a coastal and urban lagoon and classified as a wetland. The Lagoon holds small-scale fisheries, mainly artisanal eel fishing (fences and fyke nets) and artisanal lagoon fishing (gill nets and trammel nets). The fishery's ecosystem provides a significant number of ecosystem services which have direct and indirect contributions to human well-being and have an impact on our survival and quality of life. We identified 25 ecosystem services, which we have classified into four types following the Millennium Ecosystem Assessment classification: eight providing services, eight regulation services, six cultural services and three supporting services. The economic valuation of ecosystem services is a complex and interdisciplinary field that seeks to assign economic values to the benefits that ecosystems provide to human well-being. We used several methods and approaches to value the identified services, such as market-based valuation, cost-based valuation, benefit transfer, stated preference methods and revealed preference methods. The economic assessment of ecosystem services plays an important role in exploring the interplay between ecological and socioeconomic systems by enhancing fishers' awareness and comprehension of ecosystem services, investigating lagoon fisheries' co-management and ensuring the sustainability of the small-scale fishery in the lagoon (also contributing to the United Nations Sustainable Development Goal 14). Additionally, it contributes to the identification of scenarios for the future specially facing climate change, also towards Sustainable Development Goal 13.

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Diversity, competition and collaboration in coastal fisheries

The coastal fishing sector is constituted by a great diversity of fishing practices with different ecological, social and economic characteristics. These practices have common and opposing interests, leading to competitive and collaborative behaviours. In this paper, through a case study in the Mediterranean Sea, we explore the diversity of fleet characteristics from a United Nations Sustainable Development Goal perspective and we evaluate the economic implications of fleet interdependences associated with the capture of shared stocks and their collective action in attracting governmental financial support. Our results show the trade-offs between fishing fleet preferences according to the prioritized societal objectives and track the uneven interrelations between fleet segments in terms of ecosystem captures, with the bottom trawling fleet interacting the most, particularly with small-scale fleets and deep-sea long-liners. Finally, we investigate the collective success in attracting governmental support, which, in turn, leads to greater dependence on public funding and tax exemptions, resulting in an uneven distribution of public resources between fleet segments. The fleet diversity analysis and the integrated quantification of economic interdependencies contribute to the general discussion on socioecological and economic transitions taking place worldwide.

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Bioeconomic integrated modelling to explore the sustainability of management alternatives in the Adriatic–Ionian region

Bioeconomic modelling can provide useful support to fishery management, allowing for the testing of a range of alternatives with different viability profiles. This is achieved by integrating biological and socioeconomic datasets and nested models, while leveraging a range of management scenarios tailored to the specific system. In this study, the BEMTOOL bio-economic model is applied to the demersal mixed fisheries of the Adriatic–Ionian region to simulate the impacts of a suite of management measures on the target stocks included in the multiannual management plan and on the relevant fleets (trawlers, longliners and small-scale fisheries). Process error and model uncertainty are included in the simulations, incorporating climate change and carbon footprint. To this aim, the recent fuel price increase and compensation mechanisms on fish prices were modelled, ensuing from better product quality as a result of improvements in the exploitation pattern. Effects of a suite of measures combining effort reduction, spatio-temporal closures to protect nursery areas and fishery selectivity were simulated. The results showed that the exploitation pattern modifications can ease the achievement of the FMSY impacting less severely on the economic performance of the fleet, especially in the short term. A communication process with stakeholders was also undertaken starting from the GFCM Subregional Committee for the Adriatic Sea in 2023.

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Socioeconomic studies on rapa whelk *(Rapana venosa)* and piked dogfish *(Squalus acanthias)* fisheries in the Black Sea

Two socioeconomic studies were included within the rapa whelk (*Rapana venosa*) and piked dogfish (*Squalus acanthias*) research programmes of the BlackSea4Fish Project, in view of establishing a benchmark for assessing the socioeconomic impact of these fisheries in the Black Sea. Recognizing the lack of an explicit regional methodology to capture the socioeconomic status of species-specific fisheries in the region, a survey was designed, drawing from the harmonized regional methodology used for national socioeconomic surveys in the GFCM area of application. In this way, the rapa whelk and piked dogfish survey results could be comparable with national socioeconomic data. The ensuing questionnaire consisted of 78 questions encompassing a wide range of socioeconomic indicators, including revenue, costs, employment and economic performance. Between February and May 2023, in-person surveys were conducted with fishers representing a combined fleet of 280 vessels (53 in Bulgaria, 23 in Romania and 204 in Türkiye), of which 98 percent, 100 percent and 89 percent, respectively, actively targeted rapa whelk. The results showed that, in 2022, these vessels were generally more economically efficient when fishing for rapa whelk as opposed to when fishing for other species. For the piked dogfish survey, results showed that a significant proportion of the overall catch was exported from Romania, while none of the vessels in Bulgaria exported their landings. Species-specific socioeconomic data are vital for considering socioeconomic impacts within decision-making for fisheries management. The methodology applied in these two studies is expected to serve as a model for future species-specific socioeconomic studies in the Mediterranean and Black Sea.

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Illuminating hidden harvests: the contributions of small-scale fisheries to sustainable development

The study "Illuminating hidden harvests: the contributions of small-scale fisheries to sustainable development" by FAO, Duke University, and WorldFish was published in March 2023 to generate and disseminate new evidence about the benefits, interactions and impacts of small-scale fisheries to inform policy and practice. The initiative helps to inform all levels of policy-making processes and contributes to empowering fishing communities, their organizations and advocates to make a strong case for productive, sustainable and equitable small-scale fisheries. In this way, the initiative supports the implementation of the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication and progress towards the United Nations Sustainable Development Goals. The report is grounded in data and information from diverse data sources, including 58 country case studies and 104 government questionnaires, representing a novel, multidisciplinary approach to assess and understand small-scale fisheries, in particular in relation to production, livelihoods (including subsistence), nutrition, gender and governance dimensions. Country case study authors included a varied of partners, in particular researchers, non-governmental organizations and government institutions who engaged with stakeholders in each country to compile the information. This presentation will introduce the illuminating hidden harvests study and provide insights from the specific country case studies from Morocco, Egypt and Spain, delving into the approach and methodology applied to compile these studies (on which a handbook and e-learning is forthcoming), and present related results and opportunities for follow-up and uptake across the GFCM region, and beyond.

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Fishing: challenges and opportunities for ocean sustainability

Although fishing to feed the rapidly growing human population and ecosystem protection to maintain an efficient carbon pump and enable important quantities of carbon storage might seem to be antagonists, they are, actually, quite interlinked. Addressing the food security challenge implies the sustainable use of marine living resources, preventing overfishing and having a positive impact on carbon pump functioning. Conversely, climate change is causing shifts in marine species distribution, abundance and habitat fragmentation, and scarcity of species of interest, thus disrupting fishers and fishing communities. However, considering the knowledge gap on the exact contribution of each biological compartment within the carbon pump, further discussions and research are expected to rise to properly adapt the transition toward sustainable fishing activities. Therefore, fish carbon and food security should definitely be crucial components and the subject of in-depth analysis for fishery management to stimulate blue growth and reach United Nations Sustainable Development Goals 2 and 14. Promising options to regulate human activities while keeping these essential ecosystem processes safe include the development of adequate economic instruments, such as taxes and user-pay charges. In order to improve the sustainability of this sector, market-based incentives that have monetary value might be more efficient than regulatory measures, also known as command and control approaches, which have dominated marine living resource management. Regardless of the efficiency of each method, the synergy potential of these two kinds of methods is not to be ruled out.

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Revisiting the tragedy of the commons: lessons from past and the way forward

The concept of the tragedy of the commons, first introduced by Garrett Hardin in 1968, remains a prescient framework for understanding the complex challenges posed by the overexploitation of shared resources and other contributing factors. Today, particularly in the Mediterranean basin, this tragedy manifests most prominently in the context of fisheries, exacerbated by other factors such as climate change, pollution, invasive species and the shared use of resources. To address the tragedy of the commons, several solutions have been proposed in previous studies, some of which still hold their validity today. In this paper, after making a general reference to the concept of the tragedy of the commons, the problems experienced in fisheries and the way these problems affect the stakeholders were discussed. Within the scope of our common future, sustainability targets were examined specifically for fisheries and socioeconomic determinations were made for the future. Some suggestions that provide hope for addressing these pressing issues to prevent any potential tragedy were presented. It becomes evident that a more holistic approach is needed, as the fisheries system is no longer a closed entity within the basin; it is interconnected with various external pressures. Empowering fishing communities with emerging technologies could serve as a promising starting point, making use of the resources and support provided by United Nations, FAO and GFCM instruments. Additionally, there is a growing need for enhanced cooperation and coordination among sectors benefiting from the basin to prevent a potential tragedy.

Mustafa Zengin

Central Fisheries Research Institute (SUMAE), Türkiye

An unrecognized workforce potential in the Turkish Coasts of the Black Sea: female fishers

Along the Black Sea coast of Türkiye, fishing was traditionally a male-dominated occupation. Compared to terrestrial farming communities, women had fewer opportunities to directly participate in the maritime workforce. However, these demographics began to shift at the beginning of the twenty-first century. Changing living conditions, especially the radical decline of fish stocks, have led to a decline in living standards and increased costs of many inputs, mostly in traditional small-scale fishing communities. In field studies carried out between 2019 and 2021 along the Turkish Black Sea coast, the social, economic, cultural and demographic characteristics of female fishers who are potentially engaged in fishing activities were examined according to the full count method by surveys face-to-face with women who directly/individually or indirectly participated in the fishing sector (chief, crew). This is the first time that the situation has been regionally demonstrated.

Parallel session 3.2 Envisaging the future of fisheries value chains

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Luca Mulazzani
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Balancing environmental concerns and efficiency: an economic approach for enhanced resilience in overexploited fisheries

In the pursuit of sustainable and resilient fisheries, there is a growing imperative to reduce the negative externalities of the fishing sector on ecosystems and biodiversity. To this end, the European Commission has recently recalled the importance of minimizing the impact of fishing activities on the seabed. This implies that Member States are expected to adopt measures prohibiting mobile bottom fishing in marine protected areas that are Natura 2000 sites and ensure that by 2030, mobile bottom fishing is phased out in all marine protected areas. Being one of the most impacting fisheries in terms of carbon footprint, seabed damages and unwanted catches in the Mediterranean, we take the Italian beam trawl fishery in the Adriatic Sea as a relevant case study to investigate the interplay between management regulations and economic efficiency in those contexts characterized by multispecificity and overexploited stocks. The methodology involves the categorization of fishing trips into homogeneous groups characterized by similar target species using cluster analysis, followed by the estimation of efficiency through stochastic frontier analysis. The predefined catch profile groups are then employed to assess the performance of different fishing strategies with regard to economic profitability and CO_2 emission intensity. The results reveal that significant heterogeneity exists in terms of strategies and efficiency among vessels belonging to the same fleet, challenging the assumption of homogeneity implicit in input-based (i.e. effort-regulated) fisheries management. Our findings advocate for a more adaptable and multifaceted management framework considering local specificities (areas, periods, fishing strategies) and market trends of relevant species.

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Linking food web models and value chains: a portrait of the Ebro Delta

The fish value chain describes the full range of activities required to bring fish from the harbour to final consumers. It is important because it offers a more holistic perspective on the implications of fish activities and fish policies than the usual analysis focused on specific actors in the chain. In this paper, through the integration of a food web model with a value chain model, we study the tendencies and current status of the main elements of the fish value chain in the Spanish Ebro Delta, a key area in terms of both biological and fisheries activities, as well as increasingly in terms of export and import activities. A complex picture emerges from the study of the tendencies: while fleets and captures decrease, ecological characteristics show worrying trends; at the same time, imports and exports increase, and transformation activities are increasingly provided mostly from non-Mediterranean species. Furthermore, the distribution is becoming more concentrated in supermarkets, but there is still a relevant role for retailers. Consumption is focused on a limited number of species and is mostly covered by non-Mediterranean captures. The current structure of the fish value chain conditions fisheries management strategies and fisheries transition strategies towards an environmentally sustainable and socially just space in the region.

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Envisaging territorial catch valorization as a political instrument of advocacy and self-affirmation

The regional fisheries committee of the French Occitanie region developed, in 2023, a sectoral strategy to collectively define actions for the future of fisheries. Seven strategic areas have been defined, notably one regarding the dialogue within the value chain, the marketing and the valorization of catch. Indeed, while unsuccessful attempts have been made in past years, the regional fisheries committee wishes to give impetus to a new dynamic in order to extend the offer of local fisheries and products to buyers in urban centres, to encourage local transformation to meet the sharp rise in demand for processed seafood products, as well as to boost the image and visibility of regional fisheries. This initiative has led to the formulation of a research question focusing on valorization and regional markets for local seafood products, aimed at gaining a better understanding of the perceptions and expectations of the sectoral stakeholders (fishers, wholesalers, fishmongers, professional organisations, fish auctions and public institutions). This presentation draws on document analysis, observations and about 40 semi-structured interviews performed during fieldwork with students. We find that the catch valorization directly questions the capacity for collective actions within the fishers' professional group, as well as within the regional value chain. The analysis of the unsuccessful attempts reveals, at different levels, several barriers to the development of the consumption of local products. As a whole, catch valorization represents, and is used as, a political instrument for advocacy and better recognition, notably by small-scale fishers.

Deme Elhadj Bara

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Reinventing fishery value chains in West Africa: food security, climate adaptation and sustainability

The West African region generates an average annual fishery production of three million tonnes, which is insufficient to meet the needs of a growing population estimated to reach 500 million by 2030. To maintain a per capita consumption of 11 kg per year, production must reach five million tonnes by 2030 and eight million tonnes by 2050, creating a deficit of three to five million tonnes. Up to 40 percent of fish stocks are overfished, exacerbated by climate changes that could reduce catches by 26 percent. Existing policies, focused on maximizing yields, compromise resource sustainability. There is an urgent need to shift paradigms towards optimization rather than maximization. Strategies include strengthening ecosystem resilience, improving capture techniques, minimizing post-capture losses and modernizing value chains.

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The wild-caught shrimp value chain in the Mediterranean

Capture fisheries in the Mediterranean are important contributors to the economic development of the region in terms of food security, poverty eradication and international trade. This presentation focuses on the wild shrimp value chain originating from Tunisia with end-markets in Spain and Italy. Tunisia is one of the main suppliers of wild shrimp in the region, particularly with regard to deep-water rose shrimp (*Parapenaeus longirostris*) and caramote prawn (*Penaeus kerathurus*), and Spain and Italy are its main markets for these species. However, the value chain is facing both socioeconomic and environmental challenges which need to be addressed through appropriate policies for sustainable development. The analysis of the Tunisian wild shrimp value chain was conducted as part of the FAO Sustainable Fisheries and Aquaculture Value Chains for the Mediterranean project, following a standard methodological approach. Secondary and primary data have been collected and analysed to assess the socioeconomic and environmental sustainability performance of the activities. The analysis quantifies the flow of raw material along the value chain and examines each actor type, identifying areas for improvement. Among others, it reveals that, while the activity remains profitable, there are concerns about bargaining power along the value chain which may lead to unequal distribution of benefits and risks, and there are signs of overexploitation of the stocks undermining the long-term environmental sustainability of activities. The proposed upgrading strategies include improving resource management, such as through ecolabelling; strengthening cooperative action; and increasing product innovation and market diversification.

Badr Laamiri

National Water and Forest Agency, Morocco

Are inland fisheries and aquaculture value chains resilient against climate change? The case of Morocco

Morocco contains a rich and diversified hydrographic network and climate, which have enabled it to acclimatize some thirty freshwater animal species. In the past, continental aquaculture focused mainly on the production of cold-water fish, such as rainbow trout (Oncorhynchus mykiss) and pike, for restocking natural environments. Under the impact of climate change, marked by more recurrent droughts and floods, the habitats of salmonid waters have suffered degradation. As a result, the new development approach has focused on promoting and structuring value chains that are sensitive to climate change. This has involved: i) selecting more resilient warm-water species such as carp and tilapia; and ii) promoting smart aquaculture practices such as integrated aquaculture, water recirculation systems and multi-trophic aquaculture. In 2022, a continental aquaculture value chain survey was carried out involving the main stakeholders. This survey made it possible to assess the economic weight of this value chain, as well as the bottlenecks hindering its development and resilience. The study then identified the key levers for stimulating all links in the chain, namely: i) improving consumer perception of freshwater aquaculture products; ii) marketing the positioning of freshwater products (particularly in terms of price) in relation to marine water fish; and iii) innovation to generate better value-added products.

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Strengths, weaknesses and upgrading strategies of the deep-water rose shrimp (*Parapenaeus longirostris*) fishery value chain in the southern Adriatic

The study is part of the Sustainable Fisheries and Aquaculture Value Chains for the Mediterranean project, aiming to contribute to the Blue Transformation of aquatic food systems by enhancing the competitiveness and the sustainability of the Mediterranean fisheries value chains. The study is focused on the sustainability analysis of the value chain of deep-water rose shrimp (*Parapenaeus longirostris*) in the southern Adriatic, a fishery of particular interest when considered in the light of the current multiannual management plan for demersal fisheries in the Adriatic and of the on-going process aimed at improving the sustainability attributes of the fishery, under the Marine Stewardship Council fisheries standard. The analysis of primary and secondary data was accompanied by the consultation of interested parties for the development of the sustainability assessment, allowing the identification of hotspots, from the environmental, economic and social pillars and the identification of potential upgrading strategies. The analysis disclosed a value chain controlled by brokers who act as price-makers and regulate the trade, especially in scenarios of discrepancy between supply and demand. Potential upgrading strategies of the deep-water rose shrimp value chain include aggregation of supply to allow producers to acquire more market power or develop vertical integration. Preliminary practices of upstream (e.g. exclusive supply) or downstream (fish processing) vertical integration have been already detected and can be replicated. Consultations also emphasized the possibility of transforming the value chain by introducing new production methods or new products, based on a circular economy perspective, also achieving waste reduction.

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Upgrading the wild shrimp value chain in Türkiye

An analysis of the wild shrimp value chain in Türkiye was conducted on as part of the FAO Sustainable Fisheries and Aquaculture Value Chains for the Mediterranean project, to assess its sustainability performance and identify strategies for improvement. The analysis was performed according to a standard methodology. The findings reveal that the domestic supply of shrimp species has stabilized at around 4 500 to 5 500 tonnes in the last five years. Bottom trawlers operating in the Mediterranean, Aegean and Marmara Sea account for the largest share of catches. After landing, the vast majority is sold to commissioners/wholesalers, who deliver the quantities to processors or the retail market. Most of the quantities are consumed on the domestic market, through the hotel, restaurant and catering sector, and retailers. All nodes of the value chain had positive revenues and profit margins. However, there are concerns about the unequal distribution of bargaining power, particularly between the fishers and the commissioners/wholesalers. Social sustainability concerns include the employment of fishers without contract and insufficient safety measures on board, as well as lack of interest by young people in the activity. The long-term environmental sustainability is compromised by depleting stocks. Some of the main recommendations for improvement include to formalize work relations between fishers and employers, and promote apprentice training on fisheries to attract young generations to the fisheries profession; strengthen the role of fisheries cooperatives in distribution and sales through upgrading the legislative aspects; increase the number of value-added shrimp products; and enhance scientific studies on biology of shrimp species and introduce effective management measures.

Parallel session 3.3 Innovative technologies for sustainable fisheries

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Using innovative technologies and artificial intelligence for sustainability

Innovative technologies and artificial intelligence can be used to achieve sustainability in order to preserve fish stocks and to protect endangered species by tracking them. Some techniques can be used to retrieve ghost fishing nets. Artificial intelligence can also be used to identify certain biological and physiological variables for some species such as sardine (*Sardina pilchardus*).

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Linking strategies of the Mediterranean Oceanographic Network for the Global Ocean Observing System and Mediterranean fisheries

Monitoring climate change, managing the associated impacts and developing adaptation strategies are key components of the GFCM 2030 Strategy for sustainable fisheries and aquaculture in the Mediterranean and the Black Sea. For the Mediterranean, an essential step in this effort is the establishment of a robust network of ocean observing systems, incorporating fit-for-purpose technologies and managed by scientists with expertise in developing effective strategies for monitoring, ocean modelling and knowledge transfer. These are the main pillars of the Mediterranean Oceanographic Network for Global Ocean Observing System (MonGOOS), which we present here and which includes a working group dedicated to knowledge and data transfer for the benefit of fisheries, aquaculture and conservation. The MonGOOS has made significant progress in promoting oceanographic research and its practical application in the Mediterranean. The results include the implementation of state-of-the-art technologies for data collection and marine monitoring. Collaboration with scientists, experts and organizations has ensured an efficient exchange of information and created the basis for an integrated approach to marine management. Future efforts will focus on improving the transfer for the conservation of Mediterranean ecosystems. We aim to intensify the dissemination of knowledge and cooperation with organizations responsible for fisheries and the protection of the Mediterranean Sea in order to promote synergistic strategies for the long-term health of this unique marine environment. In summary, MonGOOS is committed to the continuous improvement of marine observation systems, data sharing and collaboration to address the challenges of climate change in the Mediterranean.

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Smartfishing: the hardware and software solution for remote monitoring of fishing vessels and predictive maintenance

Federpesca is committed to the goal of energy transition and decarbonization of the fishing fleet, through its support, as a partner, together with European Space Agency and RINA Consulting, to the Smartfishing project. Smartfishing is a hardware–software platform developed by G-nous that enables remote-monitoring of fishing vessels; optimization of fishing activities; reduction of fuel consumption; and predictive maintenance of critical vessels components. The idea behind the project takes inspiration from shipowners' needs and port authority activities, improving the productivity of fishing activities by carrying out cost- and time-saving practices, and solving the lack of efficiency and maintenance of the fishing vessel systems. Having a decision support system for fishers, fishing companies, shipowners and port authorities is the needed solution. The innovative element is based on the combination of a wide range of technical solutions, integrating space assets and artificial intelligence techniques to provide a comprehensive decision support system for shipowners and fishers. Smartfishing may prevent failures and inefficiencies, thus optimizing fishing operations, meaning supporting fishing activities, checking the fleet status (e.g. failure detection and management) and giving a real-time benchmark of fuel consumption and efficiency of fleet. The analysis of a wide variety of data in conjunction with inputs given by on-board sensors and satellite assets can guarantee safety of vessel crew, as well monitoring and reducing vessels' environmental impact. The analysed parameters are mainly related to the vessels' status, weather and sea conditions. Smartfishing is the way towards technological improvement of fishing vessels and the optimization of fishing activities.

Maia Chkhobadze

Ministry of Environment Protection and Agriculture, Georgia

Innovative technology for sustainable fisheries in Georgia

The obligations taken at the international level, future perspectives, the effective mechanisms and existing practices of fishing management in the Black Sea waters of Georgia are very important. How does the country provide mechanisms for managing and regulating fish resources? Are existing innovative technologies sufficient in terms of maintaining the sustainability of the Black Sea ecosystem? The policy, law enforcement and management bodies in the fishery sector in Georgia are sharply determined. Every year in the Black Sea of Georgia, an assessment of fish stocks is carried out and the amount of industrial resources to be extracted (quota) is determined based on scientific research, and fishing laws and procedures are also defined. Veterinary control mechanisms for fish products have been introduced. Control of industrial fishing in the Black Sea, in order to control the obtained fish resource in real time, is in accordance with the obligation under the association agreement. Industrial fishing in the Black Sea waters of Georgia has been carried out in accordance with an electronic monitoring program since 2017 and long-distance fishing vessels sailing under the Georgian flag have been controlled using an electronic satellite monitoring program since 2020. But a lot of steps are still needed to fully harmonize the obligations under the Association Agreement with the national legislation in order to bring the innovative technologies and mechanisms of fishing management and law enforcement into full compliance with European standards.

Giacomo Chato Osio
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Directorate General for Maritime Affairs and Fisheries (DG MARE), European Commission

A step towards the decarbonization of the Mediterranean and Black Sea fleets

The European Union adopted its Green Deal which established decarbonization goals for different industrial sectors with the aim of reducing European Union CO2 emissions. These goals apply to the maritime domain, including fisheries, where certain types of gear are more dependent on fossil fuels and their profitability can be impacted by price volatility. The European Union Commission is in the process of launching a research project in the Mediterranean and Black Sea to develop and test key technical improvements in fishing gear that would lead to a decrease in fuel consumption, a lower carbon footprint and savings on fuel expenditure. The study will focus on towed fishing gear, starting with the review of latest gear technology advancements and a compilation of best practices. On this basis, the study will focus on testing, through pilot sea trials, a set of gear modifications that will allow reaching fuel consumption targets as well as an economic analysis of the costs/benefits of adopting more fuel-efficient fishing gear. Finally, the project will ensure full engagement with the fishing sector, fishing gear manufacturers and stakeholders to guarantee the maximum dissemination of the sea trials and results. As this is an ongoing project, the presentation will address the main scope of the project, the rationale and a review of the attainable improvements in gear technology currently in the literature.

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MEDigital: a digital observatory of public attention and recreational fishing of Mediterranean marine fishes

The Mediterranean Sea is facing a biodiversity crisis that requires efficient and effective solutions, backed by ecological and socioeconomic information to guide decision-makers. To fill this gap, we developed a digital observatory with two main objectives – public attention towards, and recreational fishing of, Mediterranean fishes. First, understanding public attention is key to mobilizing political interest and consequently increasing conservation efforts, investments and success. Second, social and ecological aspects of recreational fishing are not well understood due to difficulty in obtaining reliable and comprehensive data. However, catches of recreational fishers have a huge, underexplored potential to monitor marine ecosystems. The MEDigital observatory integrates two emerging research approaches (conservation culturomics and iecology) to provide an unprecedented volume of data for Mediterranean fishes. First, we quantified Google search volumes (i.e. a proxy of public attention) in each Mediterranean country for 770 fishes from 2013 to 2022. Second, we assembled a machine learning workflow to automatically extract information about recreational fishing from YouTube. In this context, we present a case study to showcase the functionalities and potentialities of such automatic mining of ecological and social data for monitoring recreational fisheries. Finally, we built an easy-to-use interface to facilitate exploration of these results by the general public. The MEDigital observatory will contribute to characterizing social–ecological aspects of the Mediterranean biodiversity crisis in near real-time, with special focus on societal attention to species and recreational fishing, potentially unveiling impacts of climate change and biological invasions.rine water fish; and iii) innovation to generate better value-added products.

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Combining satellite and landings data to investigate fisheries impacts on sharks and rays in Tunisia

The Gulf of Gabès is regionally important for fisheries and biodiversity. This area of shallow coastal habitat supports a highly productive fishery that contributes significantly to the artisanal and industrial fishing sector; 40 percent of total landings in Tunisia come from these waters. Scientific studies showed the Gulf of Gabès to be an important nursery ground. In the absence of traditional vessel tracking data typically used to assess, manage and control fishing effort, we combine remotely observed estimates of fishing vessel detections with official port landings data to better understand the interaction and impact of fishing on the elasmobranchs in the Gulf of Gabès. Synthetic aperture radar and optical satellite imagery are processed and an algorithm is applied to detect vessels, creating a dataset of potential fishing vessel detections. During the same period, we construct monthly port landings of elasmobranchs in the Gulf of Gabès. The landing data are provided by the Tunisia General Directorate of Fisheries and are collected by the statistics collection agents directly in ports. Finally, we combine these two outputs and model fishing vessel detections with monthly landings per port to explore the relationship between the Gulf of Gabès fisheries and elasmobranch species. We report the output of these analyses for the period 2017–2020, aimed at providing the first spatially explicit description of fishing effort in the area. We hope this approach could enable fisheries and conservation objectives in the region, which from a fisheries management perspective has until now been relatively data poor.

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Underwater cameras to monitor individuals escaping from juvenile selection grids in Mediterranean bottom trawl fisheries

The use of selection grids to exclude from the catch the juveniles of species targeted by Mediterranean bottom trawl fisheries is seen as one promising solution to reduce discards. Recent studies conducted on a two-section juvenile selection grid showed a general catch reduction of undersized individuals of targeted species, although a commercial loss at different degrees depending on the species was observed. However, no information on vitality of individuals escaping from the juvenile selection grid was provided. Therefore, the present study aimed at implementing easy-to-handle underwater camera equipment to monitor, during the haul, the individuals escaping from a 20 mm bar spacing of the upper grid section. We first described the optimal setup (camera, housing, lights specifications and position) to obtain useful underwater data in deep (100–200 m), dark and turbid environments. Data on instant vitality at escape were then collected. Results from seven successfully monitored hauls showed that, regardless of the species, the probability for individuals to be alive was significantly more than 65 percent, on average. Red mullet (*Mullus barbatus*) had a 99 percent probability of being alive after escape, which was significantly higher than the 82 percent probability estimated for deep-water rose shrimp (*Parapenaeus longirostris*), 76 percent for European hake (*Merluccius merluccius*) and 67 percent for Norway lobster (*Nephrops norvegicus*). Additional results on grid catch performances compared to a standard trawl were provided in terms of differences in catch composition for all the species caught and in catch efficiency for the most important commercial species. The trials and methodologies here described can be replicated in other Mediterranean trawl fisheries.

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Automated detection of threatened fish species in bottom trawl surveys using computer vision

Incidental catches of protected, endangered and threatened species by fishing gear constitute a high risk for their sustainability, despite the implementation of existing management regulations. Remote electronic monitoring has been proposed as a cost-efficient and reliable way to improve bycatch monitoring, given that current sampling from on-board observers does not provide sufficient data for bycatch estimates. In this study, we automate fisheries monitoring using artificial intelligence, with a special focus on automatically detecting protected, endangered and threatened species of elasmobranch fish. Our initial dataset is composed of around 200 images acquired during the International bottom trawl survey in the Mediterranean (MEDITS) bottom trawl surveys between 2016 and 2023 in the eastern Ionian Sea (geographical subarea 20). The images present piles of fish from each haul, involving both commercial species and protected, endangered and threatened species. Fish detection was accomplished using rotated object detection architectures (e.g. NVIDIA Object Detection Toolkit, YOLOv8-obb), designed to better fit the objects within images as bounding boxes represented on an angle rather than as horizontal or vertical rectangles. The automated system enabled the detection and classification of the three most frequently caught elasmobranchs (sharks, skates and rays). The detector's robustness was improved with image augmentation techniques during the training of the algorithms. The trained algorithms were evaluated with manual, human-based annotated images, achieving promising results. Overall, the present approach aims to process on-board images in real time to accelerate fish recognition and can be equally implemented in commercial fisheries. The limitations and future challenges related to data collection and processing, and implementing object detection algorithms on such imagery are also discussed.

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Relative performance of sorting grid and turned mesh in reducing juvenile fish and shrimp catch

It is well-known that improving selectivity in bottom trawling and avoiding catches of juveniles and vulnerable species, are crucial for contributing to fisheries sustainability and ocean conservation. In this context and in agreement with Resolution GFCM/43/2019/7 on information on access agreements in the GFCM area of application, a pilot project was promoted by the GFCM to enhance the selectivity of bottom trawl fisheries in the Strait of Sicily. During the investigation, three commercial vessels took part in a paired gear sampling design with two of them rigged with a sorting grid in front of the codend and a 90-degree turned mesh (T90) codend while the other one was the control. During the six-day survey, vessels targeted deep-water rose shrimp (*Parapenaeus longirostris*) for the first three days and European hake (*Merluccius merluccius*) for the last three days. The sorting grid has been the most efficient device for reducing the number of undersized specimens in the catches although a loss of marketable fractions was recorded compared to the control. By using the investigated gear, it is possible to reduce the catches of juveniles of deep-water rose shrimp and European hake contributing to mitigating the impact of bottom trawl fisheries on the demersal resources.

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The Fish-X Project: supporting European Union small-scale fisheries going digital

European Union policies and practices in the fishing industry show that digitalization is crucial for effective management of sustainable fisheries. The most impactful benefits are improved data management, multistakeholder cooperation, and enhanced monitoring, control and traceability. Focusing on small-scale fisheries, the European Union co-funded project Fish-X proposes to present its work for an open, secure and interoperable digital platform. The Fish-X dataspace will facilitate effective access to fisheries data from vessels. Fishers, control/monitoring authorities, and so on, will be enabled to share and receive data, thus eliminating data silos and deciding on data accessibility for third-party consumers. The goal is to prioritize fishers in the seafood supply chain, promote transparency and foster data exchange. The Insight Platform will serve as user interface of the Fish-X dataspace while complementing national monitoring systems for fisheries administration plus research projects. A portal with free data and maps related to fishing activities, such as fish stock status and exploitation, and responsible practices, will be made public. The Traceability Platform will enable transparent mapping of a seafood product from harvest to sale. Utilizing blockchain technology, documented data will remain accurate, safe and unalterable. With the traceability app, consumers can scan a product to access documented information enabling informed purchasing decisions and improved economic returns for responsible fishers. To invite collaborations, the presentation provides practical insights into three use cases for digital tracking, logbook and fishing effort analysis (Atlantic, Mediterranean, Baltic) and its roadmap for the digital transition of European Union fisheries.

POSTER PRESENTATIONS

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Economic weight and opportunities for the development of the fisheries and aquaculture sector in Algeria

To strengthen Algeria's ongoing economic development and diversification efforts, a transformative approach is paramount. This approach is geared towards not only igniting economic growth but also fostering job creation and enabling the introduction of innovative, exportable goods and services to the market. The maritime sector emerges as a highly promising arena, offering fertile ground for reshaping the economic landscape through aligned public policies. Consequently, Algeria strategically embraces the blue economy to diversify its economic prospects. Of particular significance is the fisheries and aquaculture sector, which gained official recognition as a strategic sector under the 2022 investment law. This sector has consistently demonstrated robust economic performance since 2018. Beyond its pivotal role in the maritime economy, it acts as a linchpin, harmonizing with various other sectors. Importantly, it plays a substantial role in preserving the environment and sustaining aquatic ecosystems. This study has two primary objectives: firstly, to meticulously evaluate the economic impact of Algeria's fisheries and aquaculture sector, and secondly, to pinpoint avenues for growth within the broader canvas of the blue economy. The fisheries and aquaculture sector, recognized as strategic in 2022, accounts for 5 percent of the entire agriculture sector, contributes 0.2 percent to the gross domestic product, and sustains over 145 000 jobs. Coastal fishing propels the blue economy, while aquaculture exhibits remarkable growth. With approximately DZD 10 billion invested in this sector, its potential is unequivocal. Aquaculture also serves as a catalyst for other sectors, including industry, the digital economy and knowledge-based industries. Algeria's remarkable 67 percent growth in aquaculture in 2022 underscores its distinctive position, offering substantial investment and export prospects. The upward trend in global trade of aquatic products offers immense potential for industry players keen on diversifying their markets. Aquaculture, a cornerstone of this sector, has witnessed remarkable expansion, achieving a notable 67 percent growth in 2022. Algeria's ambitious roadmap includes a tenfold increase in aquaculture production by 2035, underpinned by substantial investment prospects. This flourishing aquaculture sector positions Algeria as an emerging global contender, ensuring not only domestic food security but also unlocking vast international export potential. The thriving global trade in aquatic products underscores considerable room for export growth, encouraging industry players to explore these promising opportunities, broaden their market horizons and embark on an international trajectory.

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Algerian attapulgite clay-supported titanium dioxide for photocatalytic oxidation of aqueous ammonia in aquaculture recirculation systems

Recirculating aquaculture systems (RAS) are one of the future platforms for intensively rearing marine and freshwater fish. The interest in RAS stems from inherent benefits such as reduced land and water requirements, a high degree of environmental control allowing year-round growth at optimal rates, and the ability to produce close to markets. Water treatment in the RAS process generally consists of filtration to remove suspended solids, biofiltration via a bacterial route to reduce ammonia and nitrite concentrations, and a degassing, oxygenation and disinfection system. The goal of this research is to create new hybrid materials that can replace biofilters in order to eliminate aquaculture nitrogen pollution. The materials are made from calcite-rich natural Algerian attapulgite clay modified with titanium dioxide (TiO_2). First, the catalysts were prepared using the sol-gel method with CAL (calcite/palygorskite) and titanium isopropoxide as a precursor and then calcined at 480°C for 2 hours. The TiO2 particles were successfully immobilized on the surface and within the pores of the obtained catalytic materials. The following composite materials were successfully developed: CAL5, CAL10, CAL15, CAL20, CAL30 and pure TiO_2. The photocatalytic activity of pure TiO_2 and CAL-Ti% materials on eliminating ammonium ions (NH4+) revealed a significant decrease in the initial concentration of NH4+ ions during the reaction time. In addition, after pure TiO_2, the best purification yield of the studied materials is CAL20, with an NH4+ elimination rate exceeding 93 percent. The results suggest that photocatalytic oxidation using a local clay available in Algeria could be used to treat ammonia-rich water.

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The problem of depredation and experimentation of the reinforced seine in the Moroccan Mediterranean

Bottlenose dolphins (*Tursiops trunactus*) are causing the depredation problem in the Moroccan Mediterranean, especially in the two ports of M'diq and Al-Hoceima. These dolphins interact with seiners and attack purse seines when the shoal of small pelagic fish is encircled and cause significant economic damage to fishers. To this end, the National Institute for Fisheries Research shall carefully monitor the phenomenon of depreciation caused by dolphins. In order to find a sustainable solution, the National Institute for Fisheries Research has tested a new reinforced seine (in three different prototype dimensions: large, medium and small) which has been evaluated according to two criteria: fishing efficiency and resistance to attacks by the bottlenose dolphin. These two parameters are calculated for the reinforced seine and are subsequently compared with the data collected for seiners operating with ordinary seines during the same period from July 2018 to December 2020. The reinforced seine (three dimensions) sustained on average fewer tears than the purse seine. The large, reinforced seine suffered six tears compared to 33 tears per tide attacked for the purse seine. For medium sized reinforced seine 18 tears, against 91 for purse seine. And finally seven on the small seine reinforced against 19 on the purse seine. The results of the tested enhanced seine experiment indicate that the enhanced seine has better fishing efficiency, better resistance to attacks by the bottlenose dolphin and lower repair costs than the purse seine.

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Can purse seine strengthening be a mitigation measure to dolphin depredation?

When bottlenose dolphins (*Tursiops truncatus*) come into physical contact with fishing gear, they can remove and/or damage fish captured in nets, resulting in damage to fishing gear, loss of capture and consequently lower catch values and fisher revenues. In order to mitigate dolphin depredation in the Tunisian northeastern purse seine, the National Institute of Marine Sciences and Technology in collaboration with experts from the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) have set up a programme to reinforce the most fragile parts of purse seines constantly depredated by dolphins. The trial was conducted during the period from November 2020 to November 2022. Just one purse seine was reinforced by changing the yarn thickness. During this experiment, we quantified the depredation rate, the hole typology, the associated mending costs, and the landing per unit effort and we compared it with a normal purse seine net through onboard observations and questionnaires at port. Depredation is evidenced by a partial or total escape of the school of fish aggregated under the light deployed by purse-seiners or damage to the seines during the encircling and brailing operation. In general, the results of experiments with strengthened purse seine have shown that the purse seines experimented present better fishing efficiency and improved resistance to bottlenose dolphin interactions and thus incur much lower repair costs than ordinary purse seines. Over the longer term, the National Institute of Marine Sciences and Technology continue trails with reinforced seine as well as test potential additional acoustic devices that could limit bottlenose dolphin encounters.

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Is the Licado system the most efficient dolphin depredation mitigation measure for purse seines in northeastern Tunisia?

Dolphin depredation induces damage to fishing gear, costs associated with mending operations, purchase of new gear and immobilization days due to mending of nets or changing of fishing grounds in order to avoid possible depredation events. The purposes of our study were to test a new acoustic mitigation device, the Licado system, and to detect any potential adaptation cases. During November 2020 to November 2022, two Licado systems were tested on two vessels targeting small pelagic fish. We assessed the depredation rate, the mending costs, the landing per unit effort and the dolphin presence rate. The deterrents tested showed that the depredation rate (5.50 percent with Licado; 34.76 percent with the control) and associated mending costs (USD 320 with Licado; USD 624 with the control) dropped notably with a net increase in the landing per unit effort compared to control purse-seiners (1 145 75 ± 426.6 kg per day with Licado; 851.10 ± 120.36 kg per day with the control). The efficiency of this type of device remains above 75 percent even after two years of trials. The Licado systems continue to disperse bottlenose dolphins (Tursiops truncates). Dolphins reappeared after four months of using this acoustic device. In fact, even if bottlenose dolphins are present in the operation area, and even if they interact with purse seines, the severity of the depredation event remains moderate to low (0.14 ± 0.11 with Licado; 49.28 ± 25.13 with the control where $p < 0.01$). However, the experimentation should be continued in order to specify the period of adaptation.

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Bio-economic scenario simulations and stakeholder involvement for viable demersal fisheries in the Adriatic Sea

Different aspects of the system need to be considered in bioeconomic predictive models for the evaluation of fisheries management strategies in an ecosystem context. In particular, the integration of accurate socioeconomic data is of paramount importance to ensure that management strategy remains consistent in terms of key economic and society objectives. In this study, the BEMTOOL bioeconomic model is applied to the demersal mixed fisheries in the Adriatic Sea to explore several management scenarios. European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water rose shrimp (*Parapenaeus longirostris*), Norway lobster (N*ephrops norvegicus*) and common sole (*Solea solea*) are set as target species; trawlers, longlines and small-scale fisheries are considered as fleet segments. The consequences of the scenarios are simulated to determine how robust management strategies are to process error and model uncertainty, incorporating climate change. The results showed that the exploitation pattern modification, through spatiotemporal closures, can ease the achievement of the FMSY impacting less severely on the fleet in the short term. The action plan developed under the BluFish project, aimed to enhance the ecological and economic sustainability of the deep-water rose shrimp fishery in the Molfetta seafaring (southern Adriatic Sea), adopts a participatory approach involving stakeholders representing different types of interests (environmental, commercial, research, management and control). The results of the explored scenarios run with the BEMTOOL model were presented and discussed with stakeholders of various Adriatic countries, emphasizing the crucial role of fisher engagement in achieving a more sustainable fishery. This study highlights the potential of bioeconomic models in the communication process with stakeholders in a bottom-up approach to fishery management.

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Producer Organization SATHOAN, France

HALIOP: a technological innovation for resilient fisheries

The transition to sustainable and resilient fisheries requires innovative approaches, particularly in the areas of economic and technological tools. At the heart of this revolution is HALIOP, a fisheries information system developed by the Producer Organization SATHOAN. Distinguishing SATHOAN in the Mediterranean, HALIOP allows real-time georeferencing of all activities of affiliated vessels, thus providing unprecedented transparency and traceability. However, HALIOP's capabilities don't stop there. It is closely integrated with applications capable of georeferencing bycatch of sensitive species via the ECHOSEA application, thus facilitating decision-making in terms of fisheries management and the preservation of marine ecosystems. Constantly improving, this tool illustrates SATHOAN's commitment to economic and technological innovation, in the service of a resilient and sustainable fishery.

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An affordable system for passive acoustic monitoring applications

Passive acoustic monitoring is widely used to detect the presence of, and the fisheries interactions with, marine mammals, particularly dolphins. However, passive acoustic monitoring activities are hampered by the high costs associated with the required equipment, limiting its use mainly to research purposes. To make it more accessible, a completely functional low-cost system was developed and validated. The two main components are an underwater microphone (i.e. a hydrophone) and a signal preamplifier, both assembled employing accessible and easy-to-obtain components. The hydrophone was assembled using piezo disks and its performance was evaluated using acoustic signals acquired in two different environments: a round-shaped pool with signals emitted by two controlled artificial sound sources and a dolphin pool containing seven bottlenose dolphins (*Tursiops truncatus*). Results were compared with commercially available hydrophones. The preamplifier was designed to work with piezo disks and employed a modern operational amplifier integrated circuit, comparatively tested against a commercial grade fet preamplifier. Acquired data can be easily stored and/or processed using single-board computers (e.g. Raspberry pi), while real-time spectrogram up to 48 kHz can be visualized on a common smartphone via free-to-use apps, without the need for additional hardware. The global cost of the hydrophone and preamplifier could be estimated, making it extremely competitive when compared to more expensive commercial solutions. The significant cost savings associated with non-expensive technology minimally impacted the device recording performance (resulting in a valid sensitivity of the system within the frequency range of 0–35 kHz), opening opportunities for broader acoustic monitoring in yet unexplored contexts (e.g. fishers, citizen science, developing countries).

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Involvement of fishers in the process of monitoring and collecting primary data in Bulgaria

Observing and studying the seas and oceans provides predictions of trends and changes. Stakeholders benefiting from systematic observations include various members of the blue network whose work and life are related to the ocean. The inclusion of new entrants in the network for monitoring and collecting primary data can significantly improve the modelling and prediction process. The participation of people involved in various maritime professions can contribute to expanding the possibilities for predicting the oceans. For the last 10 years, the Balkan and Black Sea Business Institute has been actively working to involve small-scale fishers in the process of monitoring and collecting primary data in Black Sea coastal waters. Given the frequency of boats going to sea (two to three times per day), the collection of samples of sea water and data on air and water temperature, water quality, wind, as well as samples of different marine flora and fauna allows for improvement of the monitoring and modelling of the processes in the respective region. In 2014–2015, a project proposal was developed for the construction of a market facility for fish storage and first point of sale in Byala, which received funding under the Operational Program for Development of the Fisheries Sector. The second phase took place in 2015–2016 and included training and equipping small-scale fishers in the process of monitoring and collecting primary data in coastal waters. Unfortunately, due to the COVID-19 pandemic, the second project has been delayed, but the final phase of training fishers is under way.

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Fishers' local knowledge and geographic information systems supporting blackspot seabream (*Pagellus bogaraveo*) fishery management in the Strait of Gibraltar

The blackspot seabream (*Pagellus bogaraveo*) is a main targeted species for Moroccan and Spanish longliners operating in the Strait of Gibraltar. This fishery of high economic interest is dealing with overexploitation issues and adopting a joint recovery plan is becoming imperative. Suitable management implies a better knowledge on technical aspects of the Moroccan fishery, fishing areas and fishing gear characteristics. In this study, we integrated the local knowledge of fishers and geographic information systems to establish, for the first time, a spatial distribution of the blackspot seabream fishing grounds in Moroccan waters of the Strait of Gibraltar. A total of 123 surveys were conducted between June and August 2023 with the coastal and artisanal community of fishers in Tangier port. The results identified 23 main fishing grounds for Moroccan longliners and artisanal boats with medium depths ranging between 13 m and 266 m. The identified fishing grounds showed four habitat types: rocky, rocky-muddy, sandy-muddy and sandy. Longliners targeting the blackspot seabream use a bottom longline known in the area as Harita while artisanal boats use a specific longline called Harssya and a hand line called Chambil. Despite the high selectivity of fishing gear, incidental species may occur and consisted of various species of significant commercial value: slender rockfish (*Scorpaena elongata*), red scorpionfish (*Scorpaena scrofa*), forkbeard (*Phycis phycis*) and European conger (*Conger conger*). The present study allowed the elaboration of a baseline resource map based on fishers' knowledge to help adopt future spatial management measures for sustainable exploitation of this fishery.

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High added value products from bycatch and waste from processing industries

Fishery by-products represent an important economic issue. About 50 percent of what is caught is directly consumed as food. The remaining 50 percent are subject to waste recovery to generate high value-added products. The valorization of by-products can bring additional income to fishing activities, an additional source of proteins of animal origin, and molecules with high added value with interesting properties to the agro-food, pharmaceutical or cosmetics market. In this context, we are working on the recovery of fishing and aquaculture by-products from bycatches not marketed on board as well as from waste products of the fishing product processing industries. This work is done in four steps. The first is the collection of information on bycatch at the port level and on waste products generated from processing industries; this task is carried out through surveys whose main objective is to quantify the available resources and the uses of the by-products produced in the two fishing and processing sectors in Algeria. Next is the identification of species that may present a biotechnological interest, and the extraction and characterization of the derived products, before finally arriving to the food and pharmaceutical application trials in collaboration with specialized partners. The expected direct impacts of this project consist of improving the profitability of fishing activities, maximizing the profit of the processing industries, creating jobs, contributing to sustainable development through the transformation of waste into substances of interest and finally the protection of the environment through the recycling of waste.

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Big data transforming small-scale fisheries: a low-cost tracking architecture

Today, a massive amount of data is available to tape routes and analyse behaviours of vessels belonging to industrial fisheries. This has been made possible thanks to the development of various remote sensing systems and ship-reporting technologies. Across the latter, tracking devices, such as vessel monitoring systems and automatic identification systems, can record the activity of fishing vessels in space and time, mapping fishing grounds and estimating fishing effort at high spatial resolution. Nonetheless, while plenty of information is available concerning commercial fisheries, small-scale fisheries are characterized by a paucity of quantitative or spatial data, remaining untracked and largely unregulated even though they play an important socioeconomic and cultural role in European waters and coastal communities. Indeed, space, power and technological capacity are limited on these vessels and the costs of ordinary vessel tracking systems are often prohibitive for fishers. In this context, an efficient low-cost and low-burden architecture was drafted to collect and process real-time positional data sent over long-range wide area network or 2G/3G/4G connections by small-scale vessels. Coupled with artificial intelligence, such cost-effective and open-source technology could help estimate the small-scale fisheries' fishing effort, turning transparent data into actionable information. Therefore, spatial data collection, processing and analysis enable a new monitoring strategy that could effectively include small-scale fleets and support the design of new sustainable policies oriented to inform coastal resource and fisheries management., developing countries).

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Blue Ports Initiative

The Blue Ports Initiative is an innovative effort that reimagines the role of fishing ports in fostering the socioeconomic development of coastal areas while adhering to sustainability standards. Conceptualized and executed with a focus on sustainability, the Initiative transforms fishing ports into strategic platforms for growth and value creation at local, national and regional levels. Under the Blue Ports Initiative, we encouraged and assisted fishing ports to undertake a Blue Transformation. This included making strategic and operational processes more environmentally friendly, which resulted in not just the conservation and restoration of natural resources, but also led to more efficient and competitive operations and social welfare. Ports adopting this approach are termed blue ports. The Initiative's strategy included the setup of an active network; the implementation of capacity-building programs such as workshops and seminars; the introduction of innovative tools for knowledge management such as guidance documents; and the formulation of projects and actions under the Blue Transformation approach. The strategy also stressed measuring the real impact of ports within their spheres of influence. In sum, the Blue Ports Initiative is more than a strategy; it is a vision for the future where ports are not just gateways for goods but also catalysts for sustainable growth and development. The Initiative's commitment to fostering sustainable practices, strengthening partnerships and promoting innovation has set a new course for the fishing industry, one where prosperity and sustainability sail together.

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Sustainability of value chains as fisheries resilience basis

Approximately 10 percent of catch is being discarded in marine capture fisheries. According to a report from FAO, a total of 11 207 761 tonnes of bycatch is estimated globally and of this, 84.86 percent is discarded. The landing obligation has been in force since January 2019 in the European Union. But World Wide Fund for Nature research reveals that 92 percent of recorded fishery discards in the European Union come from bottom trawl fisheries. Bottom trawling is to be banned in all marine protected areas by 2030. But despite this, the problem of the circular model of bycatch processing and its climate neutrality remains relevant. In response to these challenges, we have developed a technology to valorize bycatch and fish processing waste. The technology constitutes methods of enzymatic hydrolysis, preparative chromatography of proteins and differential fractionation. At various stages of the cyclical waste-free process, the protein molecules can be obtained: collagen, proteases of various specificities, a fraction of bio-active peptides. All these molecules make it possible to create biotechnological products, which, due to their properties, can be used in medicine for prevention of metabolic syndrome, treatment of wounds and correction of pathologies; they can also be used in the feed, food and leather industry. Based on the obtained peptides, a biostimulator for plants was developed. Its properties are analysed within the framework of the European Union ECOTWINS project, funded by Horizon Europe. Thus, developed innovative technological solutions may reduce waste disposal costs, and contribute to value addition of fish bycatch and reduction of greenhouse gas emissions.

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Beyond diesel consumption reduction: life-cycle assessment for the sumwing in beam trawling

A quarter of global greenhouse emissions is attributed to food production, which includes fisheries. Consequently, it is important to find more sustainable fishing techniques. In Belgium, fishing vessels are mainly represented by beam trawlers for the large-fleet segment and eurocutters for the small-fleet segment. However, these techniques are associated with high fuel consumption. The sumwing, a wing-shaped structure that flies over the seabed, could replace the traditional beam and create a lighter gear alternative. The sumwing can be designed for 4 m and 12 m beams. Besides the weight component, the penetration depth decreases with this replacement. The use of the sumwing could be a suitable option in order to obtain decreases in fuel consumption. Evidence of multiple trials with the sumwing were available and different fuel consumption decreases were observed, ranging from 11 percent to 42 percent for Belgian, Dutch and English trawlers. In this study, we are using life-cycle assessment to determine the environmental impact of a classical beam trawl and its alternative with the sumwing. As a case study, we assess the environmental impact by covering the life cycle from ship building until the arrival of 1 kg of plaice sold at the auction in Zeebruges, Belgium. The outcomes of the different impact categories, for example the improvements in climate change and eutrophication impacts, could create an incentive in the use of the sumwing on other beam trawlers, for example on the Italian rapido trawl in the Adriatic Sea.

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Valorization of by-products through feed formulation for tilapia species: zootechnical performance study

The present work was oriented towards development of new fish feed formulations, incorporating tomato and fish biowaste. The quality and feed performance of the manufactured feed, based on the least cost linear formulation, was compared with an extruded feed, imported as a control. For the estimation of the quality of the developed feed, a comparative evaluation of the zootechnical performance in aquariums of the formulated feed was compared with the imported extruded feed as a control. In all experiments, alvine phase red tilapia fish with a initial mean weight of 7.36 g (manufactured feed) and 5.50 g (imported feed) were used. Developed and manufactured feed met the requirements of red tilapia fish at the chosen stage, in terms of crude protein (40.76 percent), fat (8.82 percent), total sugars (0.49 percent), starch (3.26 percent), moisture (7.57 percent), fibre (6.79 percent), calcium (5.6 percent), phosphorus (0.99 percent) and carbohydrates (5.9 percent), with an energy value of 279.6 Kcal per 100 g. Optimized feed was compared to commercially available reference feed in respect to feed intake, feed efficiency, specific growth rate of fingerlings of tilapia species and, most importantly, zootechnical parameters. With a fish survival rate of 100 percent, calculated feed conversion index for the formulated feed was 2.7.

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Measurement of trawl gear tension to regulate catchability

The blue and red shrimp (*Aristeus antennatus*) fishery is of great commercial importance in the Palamós fishing harbour, in the northwestern Mediterranean. This resource represents 20 percent in landed biomass and more than 50 percent in first sale value over the total trawl fleet. Since 2013, a number of management measures have been implemented to improve gear selectivity and reduce fishing effort in the framework of the management plan that regulates the fishery locally. The implementation of pelagic trawl doors has reduced the impact on the seabed, as there is no friction on the bottom during trawling. This reduces the gear stress generated while towing and therefore, less fuel is consumed. However, this may lead to a possible oversizing of the fishing gear and, consequently, an increase in fishing capacity. Under this framework, the TipoArt project analysed the tension during trawling by fishing gear size, measured with tensiometers installed on board. This was compared with the maximum tension that a vessel can exert (tug test) according to its power characteristics. The results showed that the tension of a trawl increased with larger gear opening and, exponentially, when the engine power exceeds 1 000 horsepower. This experiment shows the potential of tension as a management measure to regulate fishing capacity by establishing a limit value favouring a sustainable use of smaller gear with similar characteristics in the fleet. For compliance, it has the advantage of being able to monitor and control tension in real time.

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Boosting narrow-clawed crayfish (*Pontastacus leptodactylus*) production: a factorial model for dietary nutrient demands

Narrow-clawed crayfish (*Pontastacus leptodactylus*) is a valuable freshwater crustacean facing challenges, including disease, overfishing, pollution and invasive species. Narrow-clawed crayfish aquaculture can reduce fishing pressure and increase production. Determination of the nutrient requirements of crayfish is the most important priority. The factorial approach was used to estimate dietary protein and energy requirements up to harvest size (around 50 g). Juvenile crayfish (0.70 g) were fed four feeding levels for 29 days to estimate maintenance and utilization efficiencies. Maintenance requirements based on metabolic body weight (MBW) were 1.67 mg/MBW0.7/day protein and 44.77 kJ/MBW0.8/day energy, with utilization efficiencies of 0.41 and 0.28. Whole-body nutrient concentrations did not change significantly with size. Growth potential was estimated from experimental and literature data, with live weight gain estimated by weight gain (mg/crayfish) equalling 25.006 (body weight)0.7512. The dietary protein/energy ratio decreased from 30.5 g/MJ for 0.5 g crayfish to 24.7 g/MJ for 50 g crayfish. Iterative diet specifications should be changed when crayfish reach 4 g and 20 g weights, allowing lower protein and slightly higher energy diets. The study provides practical species-specific diet specifications for narrow-clawed crayfish across growing stages, supporting aquaculture expansion to increase production in natural resources and farming conditions.

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Trackwell, Iceland

The new era of fisheries management coming into the Mediterranean Sea

Trackwell´s lecture summarizes the valuable insights gained from the implementation of a fully fledged fisheries management system for a European Union country. The system is a complex information system designed to support and streamline a nation's fisheries management activity and support decision-making and compliance. The fisheries management system solution, called Trackwell FiMS, comprises a suite of interconnected components, including a vessel monitoring system, all European Union required modules for the Fisheries Language for Universal eXchange (FLUX) Business Layer, and in addition, an electronic logbook, workflow manager, business rules engine, content management system and risk analysis tools, to name a few. Implementing such a multifaceted system brought forth numerous challenges and lessons that have far-reaching implications for the effective management of fisheries that can be analysed and researched. Trackwell´s key takeaways from this experience encompass technological, operational and strategic aspects that can benefit other nations who want to move forward with modernizing their fisheries management in the years to come.

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Ecological and socioeconomic potential of the artificial reefs of Martil (Morocco, Mediterranean Sea)

Faced with the constant pressure exerted by human activities on the coast and the loss of biomass and marine biodiversity, artificial reefs represent one of the biomanagement tools available, enabling integrated management of the coastal strip and its resources. This management can cover protecting coastal habitats and conserving biodiversity, but most importantly, it can improve fisheries catches for an eventual socioeconomic impact on the locals. In this context, a pioneering artificial reef project was set up in Martil, northern Morocco (Mediterranean Sea). The results of scientific monitoring carried out over more than six years have demonstrated the effectiveness of artificial reefs as a means of biodevelopment of coastal areas, in particular by the establishment of suitable habitats for fish and other aquatic organisms and improving their specific richness. In addition, the positive impact on artisanal fishing can already be observed despite the fact that the project is being monitored and that fishing activity inside the reefs is not yet permitted.