iAtlantic
INTEGRATED ASSESSMENT OF ATLANTIC MARINE ECOSYSTEMS IN SPACE AND TIME

iAtlantic Deliverable D6.2

Atlantic Ocean governance frameworks affecting Atlantic marine ecosystems under conditions of change

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Contents

List of Acronyms

Acronym	Full name
ABMT	Area Based Management Tool
ABNJ	Areas Beyond National Jurisdiction
AMOC	Atlantic Meridional Overturning Circulation
AORA	Atlantic Ocean Research Alliance
ASTRAL	Atlantic Ocean Sustainable, Profitable and Resilient Aquaculture
AtlantECO	Atlantic Ecosystem Assessment, Forecasting & Sustainability
AtlantOS	Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems
BBNJ	Marine Biodiversity in Areas Beyond National Jurisdiction
BCC	Benguela Current Commission
BCLME	Benguela Current Large Marine Ecosystem
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CDR	Carbon Dioxide Removal
CECAF	Fishery Committee for the Eastern Central Atlantic
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species
COP	Conference of the Parties
DoER	UN Decade of Ecosystem Restoration
DOSI	Deep Ocean Stewardship Initiative
DSCC	Deep Sea Conservation Coalition
DSI	Digital Sequence Information
DSM	Deep Seabed Mining
EbA	Ecosystem-based Adaptation
EBSA	Ecologically or Biologically Significant marine Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMOD	European Marine Observation and Data Network
FAIR	Findable, accessible, interoperable and reusable
FAO	Food and Agriculture Organisation of the United Nations
GBF	Global Biodiversity Framework
GES	Good Environmental Status
GMA	Global Marine Assessment
GOBI	Global Ocean Biodiversity Initiative
ICCAT	International Commission for the Conservation of Atlantic Tunas
IGC	Intergovernmental Conference
ILBI	International legally binding instrument
IMP	Integrated Maritime Policy
IOM	Integrated Ocean Management
IPCC	Intergovernmental Panel on Climate Change
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPOA	International Plans of Action
ISA	International Seabed Authority
IUU	Illegal, Unreported and Unregulated fishing
ICW	International Whaling Commission
LDAC	Long-Distance Advisory Council

Acronym	Full name
LTC	Legal and Technical Commission
MAR	Mid-Atlantic Ridge
MCS	Monitoring, control and surveillance
MGR	Marine Genetic Resources
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
NAFO	Northwest Atlantic Fisheries Organisation
NASCO	North Atlantic Salmon Conservation Organisation
NAUTILOS	New Approach to Underwater Technologies for Innovative, Low-Cost Ocean Observation
NDC	Nationally Determined Contributions
NEAFC	North East Atlantic Fisheries Commission
NET	Negative Emission Technologies
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PMS	Polymetallic Sulphide
REA	Regional Environmental Assessments
REMP	Regional Environmental Management Plans
RFMO	Regional Fisheries Management Organisation
RSC	Regional Seas Convention
RSP	Regional Seas Programme
SAI	Significant Adverse Impacts
SBSTA	Subsidiary Body for Scientific and Technological Advice
SDG	Sustainable Development Goal
SEAFO	South East Atlantic Fisheries Organisation
SO-CHIC	Southern Ocean Carbon and Heat Impact on Climate
TRIATLAS	Tropical and South Atlantic climate-based marine ecosystem prediction for sustainable management
UNCLOS	United Nations Convention on the Law of the Sea
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Convention on Climate Change
UNFSA	United Nations Fish Stocks Agreement
UNGA	United Nations General Assembly
VME	Vulnerable Marine Ecosystem
WEFAC	Western Central Atlantic Fishery Commission

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Executive Summary

This report discusses the complex and interconnected challenges and opportunities to effective ocean governance in the Atlantic Ocean. The report considers selected outcomes of iAtlantic research on the changing status of open and deep ocean ecosystems where relevant to ocean governance within the Atlantic region. The report concentrates on enhancing the current Atlantic Ocean governance structure to make it resilient and effective in light of the challenges that currently exist and lie ahead. By highlighting selected iAtlantic research on the changing state of the Atlantic Ocean, recommendations towards how these could influence current and future policy-making processes are made. The report is targeted towards researchers, policy makers, and other stakeholders looking to find a collection or 'one stop shop' report covering ocean governance processes relevant to the Atlantic Ocean.

The assessment of the current governance structure follows the approach of ecosystem-based integrated ocean management (IOM), which focusses on the strategic integration across five categories: (i) governance integration to overcome the fragmented governance structure, (ii) knowledge integration to bring together knowledge and information from multiple field of academia and beyond, (iii) stakeholder integration to capture and align the various needs of stakeholders and prevent negative impacts from actions from one stakeholder group on another, (iv) transboundary integration to coordinate across administrative and biophysical boundaries, and (v) the integration of system dynamics, such as temporal ecologic or social-economic dynamics. IOM is defined as an adaptive approach for governing human activities at sea, rooted in the ecosystem approach, guided by the SDGs, with a strong focus on improving the ecological status of the ocean and on strategic integration across governance, knowledge, and stakeholder silos.

The report provides a succinct overview of the existing governance framework (i.e., treaties, regulations, policies) in the Atlantic Ocean region and explores fisheries as a key example of the complexity of ocean governance. Key ocean issues (i.e., fisheries, deep sea mining, biodiversity, climate change) within ocean governance are then explored to provide a more detailed view into these selected policy fields. Reflecting on these governance processes under the framework of IOM the report touches upon possible responses and reflects on opportunities for improving ocean governance in the Atlantic region and beyond.

Research from the iAtlantic project has contributed significantly to advancing the understanding of the complex and interconnected system of the Atlantic Ocean and generated extensive knowledge that will inform policy and management decisions for the region. Through gathering and compiling data on various aspects of the ocean, such as ocean circulation, habitat-building corals, hydrothermal vent communities, and pelagic taxa, iAtlantic has helped to establish baseline information for the region and develop tools for predictive habitat mapping. These data can inform e.g., the development of guidelines for regional environmental management plans (REMPs) at the International Seabed Authority (ISA), the designation of marine protected areas (MPAs) in areas beyond national jurisdictions (ABNJ), and for forecasting the impacts of climate change on specific species. Furthermore, iAtlantic research has explored the impacts of multiple stressors on Atlantic ecosystems, including ocean warming, acidification, reduced oxygen, increased salinity, and lower food quality, as well as sediment plumes. The findings from this research can help to inform integrated management responses to emerging challenges such as acidification, deoxygenation, and deep seabed mining and highlight the potentially intensified impact of cumulative pressures.

1. Introduction

1.1 An ocean in need of protection – a fragmented governance regime

The ocean is essential to sustaining life on Earth. It provides critical resources and ecosystem services: regulating the global climate, offering a source of food, securing livelihoods, and providing a means to transport goods as well offering opportunities for culture, education, and recreation. However, the ocean is under threat. Human activities in ocean spaces are intensifying and pressures, including the cumulative impacts of such pressures, are undermining the health and resilience of the ocean.

Ocean governance – that is the laws, rules and processes established to manage the ocean, implemented through regional and global agreements with institutions mandated to manage resources and conserve ocean species, habitats, and ecosystems – provides the framework to address threats to ocean health. Effective ocean governance is necessary for the conservation and sustainable use of the ocean and its resources, to safeguard species, habitats, and ecosystems and to ensure the delivery of ecosystem services, including for future generations. However, the existing ocean governance structure is fragmented (Durussel et al., 2018; Gjerde et al., 2018) across sectors, legal jurisdictions, and spatial scales, rendering it insufficient to address the challenges currently facing the ocean – including the Atlantic (Unger et al., 2019).

This report aims to identify opportunities to enhance and improve the existing governance framework so that it is fit to address the complex and interconnected challenges threatening Atlantic Ocean health.

1.2 The current and future state of the Atlantic Ocean

Growth in human activities since the industrial revolution, both on land and at sea, have changed the planet and its ocean. The natural system and human development are deeply intertwined and interdependent.

Global trends show an increase in global biodiversity loss and degradation of marine and coastal ecosystems, further exacerbated by global climate change (IPCC, 2021; IPEBS, 2019) and resulting in extreme climate events, sea level rise, ocean acidification and deoxygenation, and changes in the physical-chemical properties of the marine environment. These pressures are the result of expanding human activities on land and at sea, including shipping and port activity, fishing, aquaculture, oil and gas extraction, tourism, agriculture, and waste management, as well as pressures such as pollution.

The Atlantic Ocean is no exception to these trends which impact primary production and distribution of marine species, thus affecting whole food webs and increasing conflict potential (Palacios-Abrantes et al., 2022; Pinsky et al., 2018). These threats risk human well-being by threatening food security and livelihoods, causing the loss of genetic resources, and hindering the ocean's capacity to help mitigate climate change. Climate change is manifesting in the ocean through warming, oxygen reduction, increasing acidification, and changes in food quality and provision. Moreover, these cumulative pressures within the Atlantic Ocean may create synergistic effects which exceed their individual impacts. These will likely be harmful to almost all marine life and with severe consequences to humans.

In the Atlantic, wind-driven surface currents and the Atlantic Meridional Overturning Circulation (AMOC), which distributes heat and energy and regulates climate, are major influencers of marine ecosystem habitats, species dispersal and ecosystem connectivity. Currently, the AMOC is experiencing what is probably its weakest state in the last 1,600 years, suggesting severe implications for ecosystem functions in the future and exposing marine ecosystems to changes in ocean circulation patterns and altering connectivity of species (Caesar et al., 2021).Rising temperatures are changing habitat distributions, both in the North and South Atlantic. In the South Atlantic, widespread declines in species with cold-water affinity, relevant for commercial fishing, have been recorded (Perez and Sant'Ana, 2022). Potential shifts in species abundance (e.g., shifts from fish to more squid) further up the water column will likely change

scavenger communities further down the water column and at the seafloor (Dunlop et al., 2021). iAtlantic has examined shifts in abyssal scavenger communities due to climate change induced changes in the water temperature. This research took place during the iMirabilis2 expedition in July/August 2021 (Orejas et al., 2022). Impacts are also possible for other poorly monitored deep-sea ecosystems and communities. For example, detailed data on vent communities of the Lucky Strike hydrothermal vent field on the Mid-Atlantic Ridge have indicated that while these communities have adapted over long timescales to stable conditions, they are expected to be highly vulnerable to disturbances, and prone to slow recolonisation and recovery (Van Audenhaege et al., 2022). The iAtlantic project developed a workstream dedicated to comprehending drivers of ecosystem change over the last 50 years. iAtlantic WP3 (Henry and Matabos, 2022) collected the analysis' of ocean warming related ecological processes of different marine fauna in the South-West and South-East-Atlantic, such as e.g. bacteria and primary producers, benthic invertebrates and whales.

1.3 Ecosystem-based integrated ocean management

This assessment focuses on ecosystem-based integrated ocean management (IOM) as an essential concept and approach needed for effective ocean governance in the Atlantic. According to (Lieberknecht, 2020) IOM is defined as '*an adaptive approach for governing human activities at sea, rooted in the ecosystem approach, guided by the SDGs, with a strong focus on improving the ecological status of the ocean and on strategic integration across governance, knowledge and stakeholder silos*'. For IOM to be successful, strategic integration is needed across five specific categories (see Figure 1). While presented separately, it should be noted that these categories are linked, and will need to be considered together. According to Lieberknecht (2020)[1]:

- ***Governance integration*** *focuses on enhancing communications, information exchange, as well as coordination and collaboration between organisations with a mandate or interest in managing marine spaces. Responsibilities for ocean governance are often divided across different organisations (i.e., regional, global) as well as national ministries focused on specific maritime sectors or goals (e.g., conservation). Considering both horizontal (e.g., sectoral) and vertical (e.g., multi-level) governance, mechanisms are therefore needed to collaborate across sectors as well as through governance levels.*

- ***Knowledge integration*** *focuses on the need to draw knowledge from multiple fields of academic expertise (through multidisciplinary, interdisciplinary, and transdisciplinary approaches) including relevant local and traditional knowledge. The overarching goal is to create a comprehensive understanding of the socio-ecological system of the region (e.g., the Atlantic Ocean) and establish a common information base and capacity level to ensure knowledge-based decision making across all actors.*

- ***Stakeholder integration*** *means establishing engagement processes to integrated stakeholder input into planning, decision-making, implementation, monitoring, and evaluation of management measures such as through a science-policy-society interface. Such integration should facilitate the inclusion of individuals or groups via consultative or participatory means to achieve accountability, transparency and active decision making (e.g., through information sharing, consultation, consensus building, decision making, and partnerships, while also ensuring shared information is easily accessible, consistent, and dependable.*

- ***Transboundary integration*** *is the coordination across administrative and biophysical boundaries through information exchange across international boundaries and across the land-sea boundary.*

[1] The descriptions of the five categories of ecosystem-based integrated ocean management have been adapted by the authors in an effort to provide clarity on the concept.

- ***Systems integration*** *is the integration of system dynamics (e.g., temporal ecological, economic and/or socio-ecological) to create an information base to inform governance and IOM.*

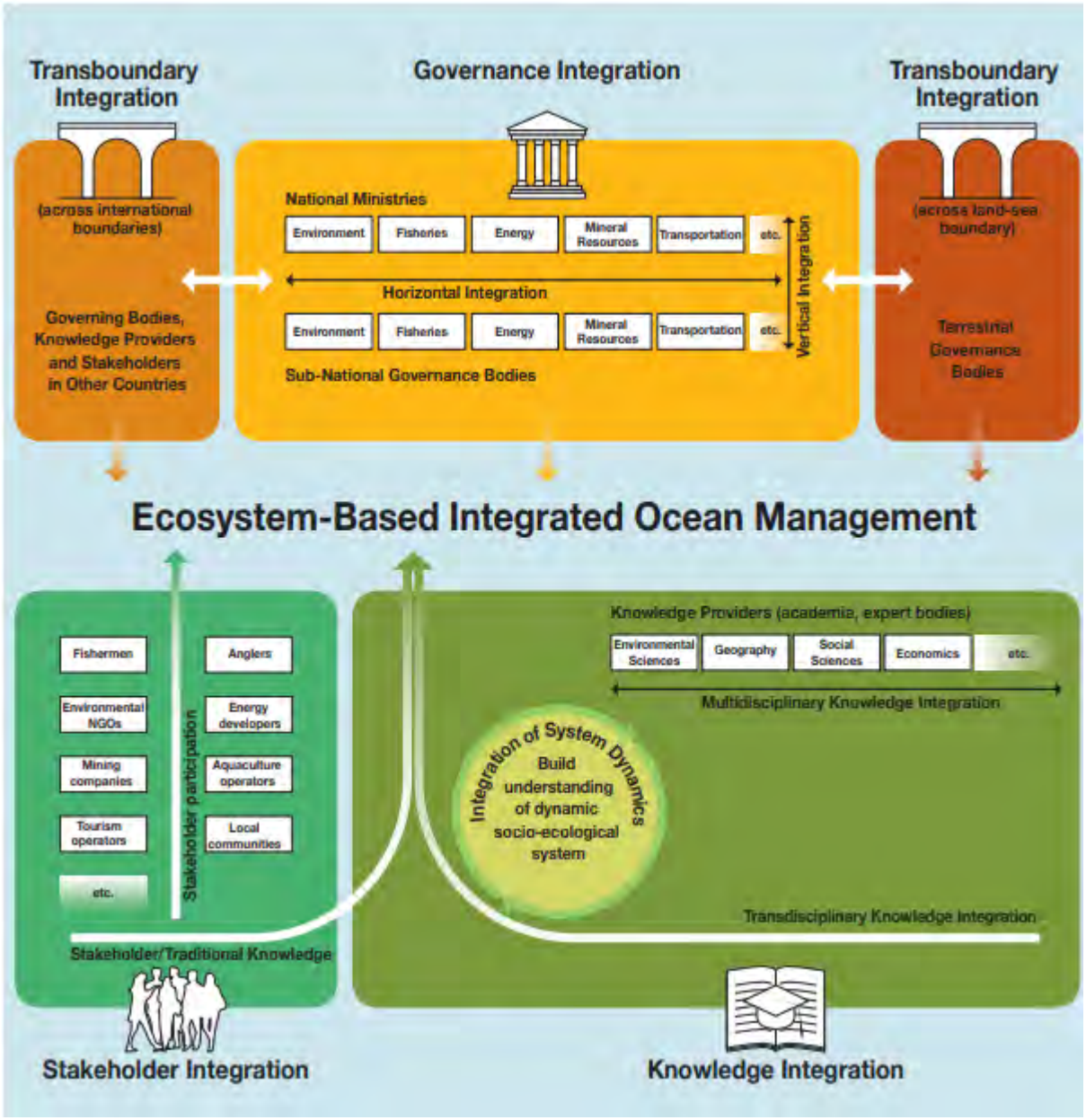


Figure 1: Ecosystem-Based Integrated Ocean Management

Source: Lieberknecht (2020)

1.4 About this report

This report aims to provide an overview of ocean governance challenges and opportunities for the Atlantic region, considering the results produced by iAtlantic research into the changing status of ecosystems in the deep and open ocean in response to environmental pressures. In particular, the report focuses on building upon the existing ocean governance framework tasked with ensuring ocean health to create a governance approach that is fit to address the challenges which it faces. The report refers to selected iAtlantic research to highlight key scientific findings relevant to a changing Atlantic Ocean, considering climate change scenarios, and noting their relevance to ongoing and emerging policy processes.

This report was prepared as part of the EU-funded iAtlantic project. Its findings are based on the scientific work done by iAtlantic, as well as a literature review of publications and policy documents as well the authors' own expert opinions developed over many years of engaging in, studying, and advising ongoing policy processes in the field of ocean governance.

It should be noted that at the time of developing this report, many expected and planned research results from the iAtlantic project are still underway and therefore not reflected in this report. Moreover, it is not the aim of this report to summarise all outputs from iAtlantic, as this is taken up elsewhere within the project, but instead highlight where specific results are especially relevant for the governance processes discussed here.

A draft version of this report was reviewed and commented on by additional experts in an effort to validate and check its findings. The target audience is a broad audience of researchers, policy makers, and other stakeholders looking to find a collection or 'one stop shop' report covering ocean governance processes relevant to the Atlantic Ocean. While this report focuses particularly on the Atlantic, many global and regional ocean governance processes and structures are considered where relevant.

Following this introduction, Chapter 2 provides a short overview of the existing governance structures (i.e., policy processes) in the Atlantic region and explores fisheries as a key example of the complexity of ocean governance. Chapter 3 highlights key ocean governance processes and identifies challenges and relevant for management, while Chapter 4 highlights possible responses to the challenges and reflects on opportunities for improving ocean governance in the Atlantic. Recent research results from the iAtlantic project are highlighted in Chapter 4 as well as included throughout the report to highlight specific findings relevant to ocean governance for the Atlantic Ocean and beyond.

2. Atlantic Ocean governance

This Chapter aims to provide a general background on current international, regional, and European ocean governance processes that are relevant for the Atlantic region. The collection of policies and management bodies relevant to the Atlantic Ocean demonstrates the complex and intertwined nature of ocean governance for the region and beyond. The governance of activities with an impact on the Atlantic Ocean is multi-layered and comprises legal obligations, political commitments and implementing mechanisms at different governance levels and geographic scales. Much of the governance structure is geared toward regulating sectoral activities such as fishing, shipping, and mining, but there are also international and regional commitments, treaties and soft-law instruments that apply to multiple sectoral activities or more generally to the conservation and sustainable use of the marine environment.

The United Nations Convention on the Law of the Sea (UNCLOS) sets out general rules and the legal basis for governing the ocean. However, concluded over 40 years ago, many issues related to the conservation and sustainable use of the marine environment remain poorly addressed or missing. To date, 168 States Parties, including the European Union, have ratified UNCLOS (see Figure 2) (UNTC, 2023).

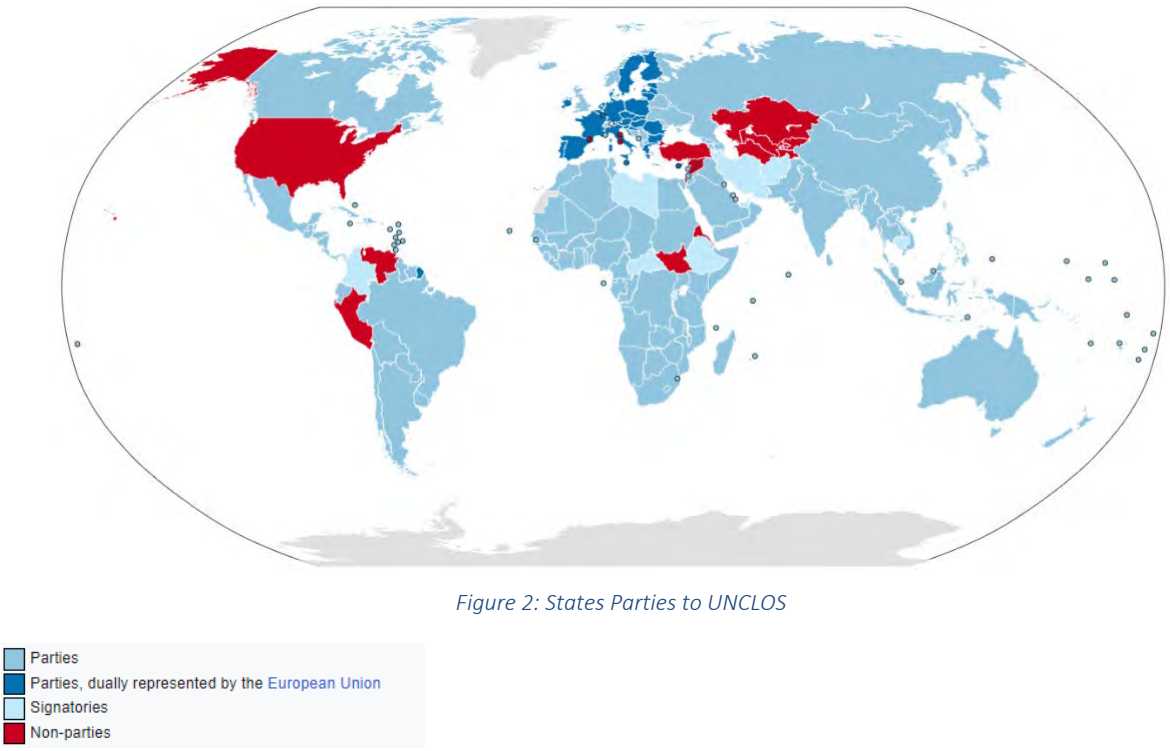


Figure 2: States Parties to UNCLOS

Source: (Wikipedia, 2023)

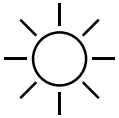
Other specific conventions have been established to focus on single sectors or uses of marine resources, and often include formal organisations or entities tasked with coordinating the commitments included in their conventions. These include the International Maritime Organisation (IMO) covering international shipping, the International Seabed Authority (ISA), for activities regarding deep-sea mining, and regional fisheries management organisations (RFMOs) and regional FAO regional fisheries bodies which are forums by which States coordinate to manage commercial fish stocks.

In addition to these, other conventions and agreements have been established at the global and regional levels with a primary focus on protecting or conserving marine ecosystems or safeguarding against key pressures (e.g., climate change). These include the Convention on Biological Diversity (CBD) aimed at safeguarding and protecting global biodiversity, the future global agreement on marine biodiversity in areas beyond national jurisdiction (commonly referred to as the 'BBNJ Agreement') (negotiations concluded in March, 2023), the United Nations Framework Convention on Climate Change (UNFCCC), as well as Regional Seas Conventions (RSCs) and Regional Seas Programmes (RSPs) which provide a forum for States to cooperate and coordinate for the protection of the marine and coastal environment in specific regions of the ocean.

Table 1 below provides an overview of the global and regional treaties and commitments as well as EU policies relevant for the conservation and sustainable use of marine resources and ecosystems for the Atlantic region. The table provides an overview of the policy, the parties involved, the type of membership, whether it is legally binding, and its focus. The primary aim of the table is to demonstrate the numerous governance processes underway with the Atlantic that are relevant to the management of human activities and to address ocean health. Moreover, the policies range significantly in their focus (e.g., sectoral vs cross-cutting) as well as their members, type of membership and legal implications, highlighting the complexity and challenges of taking an integrated approach to ocean management in the Atlantic. The table is based on a summary of previous work conducted with the iAtlantic project namely an iAtlantic internal working document '*An overview of sustainable management and conservation objectives reflected in political commitments, declarations and legal obligations related to the Atlantic marine environment*' shared within the project in 2020 (Turner et al., 2020). Selected policy processes are discussed in further detail in Chapter 3.

Table 1 Overview of ocean governance processes relevant to the Atlantic region

Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
1982 United Nations Convention on the Law of the Sea (UNCLOS)	UNCLOS is the overarching global treaty for the use of the world's oceans and seas often referred to as the 'constitution' for the world's oceans. It also establishes a framework for the further development of international instruments for the use of the seas, including the two 'implementing' agreements of UNCLOS adopted thus far and a third currently under negotiation (see below).	168	Open to all States, international organisations, and other entities referred to in Article 305	Yes	CC
The 1994 Part XI Agreement and the International Seabed Authority (ISA) (see also section 3.2.2)	Part XI of the 1982 United Nations Convention on the Law of the Sea (UNCLOS) and the 1994 Implementation Agreement relating to Part XI of UNCLOS (UNGA, 1994) establish the legal regime for the management of mining in the international seabed (i.e., the 'Area'), including obligations to protect the marine environment. The International Seabed Authority was established to implement these provisions of UNCLOS.	151 to Part XI and 168 to ISA	Open to all States	Yes	
The 1995 UN Fish Stocks Agreement (see also section 3.2.1)	The United Nations Fish Stocks Agreement (FSA), the second implementing agreement of UNCLOS, establishes general obligations for the sustainable management of fisheries for straddling fish stocks and highly migratory fish stocks and managing their impacts on the marine environment, including deep-sea fisheries in international waters. The implementation of the UNFSA is largely through regional fisheries management organisations (RFMOs) in combination with coastal States, flag States (e.g., of distant water fishing fleets) and port States.	92	Open to all States and other entities referred to in Article 305	Provides a compulsory and binding dispute settlement mechanism to resolve conflicts in a peaceful manner	
UN 2030 Agenda for Sustainable Development (Agenda2030)	The United Nations 2030 Agenda for Sustainable Development, adopted in 2015, commits States to a series of 17 Sustainable Development Goals (SDGs) that aim to achieve a better and more sustainable future, including SDG 14 – Life Below Water.	193	Open to all States	No	CC
Convention on Biological Diversity (CBD) (see also section 3.2.4)	The CBD provides a legally binding commitment for: i) the conservation of biological diversity, ii) the sustainable use of the components of biodiversity and iii) the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by	196	Open to all States and any regional organisation	Yes	

Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
	appropriate transfer of relevant technologies.				
UN Decade on Ecosystem Restoration (DoER)	The UN Decade on Ecosystem Restoration (2021-2030) was established by UN General Assembly resolution 73/284. Its aim is to prevent, halt and reverse the loss of nature. The lead implementing organisations are the UN FAO and UNEP. Activities under the DoER to date include marine restoration projects.	n.a.	Voluntary	No	
Global Marine Assessment	The Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects is conducted under the auspices of the UN General Assembly. It involves a science-based review the state of the world's oceans and seas to inform policy-makers and other stakeholders. The GMA has produced two reports to date: The World Ocean Assessment I (2015) and the World Ocean assessments II (2021).	n.a.	Brings together experts from around the world	No	
UN General Assembly resolutions: deep-sea fisheries in ABNJ (see also section 3.2.1)	A series of United Nations General Assembly (UNGA) resolutions have been adopted that commit States and regional fisheries management organisations (RFMOs) to sustainably manage deep-sea fisheries and to protect marine biodiversity from the impacts of such fisheries in ABNJ.	Various	Open to all States	Yes	
International Maritime Organisation (IMO): London Convention and Protocol	The International Maritime Organisation is the UN agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. It also administers the London Convention and Protocol, which is the international legislation to enforce marine pollution prevention.	87 to Convention and 53 to Protocol	Open to all States	Yes	
UN Framework Convention on Climate Change (UNFCCC) (see also section 3.2.5)	The UN Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and entered into force in 1994 with the aim to prevent dangerous human interference with the climate system.	197	Open to all States and regional economic integration organisations	No	
UNESCO World Heritage Convention	The United Nations Educational, Scientific and Cultural Organisation (UNESCO) Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention for short) was adopted in November 1972.	71	Open to all States	Yes	CC
Convention on the Conservation of Migratory Species of	The Convention on Migratory Species (CMS) entered into force on 1 November 1983. As of 1 March 2022, the Convention on Migratory Species has 133 Parties. One country signed the original Convention but has yet to ratify it so is not a Party	133	States Parties	No, but supports the developmen	

Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
Wild Animals	(Jamaica)			t of agreements	
Biodiversity Beyond National Jurisdiction (BBNJ) Agreement (under negotiation) (see also section 3.2.3)	In December 2017, the United Nations General Assembly adopted a resolution to embark on discussions and negotiations via an Intergovernmental Conference (UNGA resolution 72/249) to establish an international legally binding instrument (ILBI) under the United Nations Convention on the Law of Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (commonly called the BBNJ Agreement). State parties agreed to treaty text in March 2023, which will require further modalities (translation and legal scrubbing) and then for sixty States to ratify the Agreement before it can enter into force, after a four-month period.	Not yet entered into force	State parties and regional economic organisations	Yes	
UN FAO Port State Measures Agreement	The Agreement on Port State Measures is the first binding international agreement to specifically target illegal, unreported, and unregulated (IUU) fishing. Its objective is to prevent, deter and eliminate IUU fishing by preventing vessels engaged in IUU fishing from using ports and landing their catches.	74	Open to all States and regional economic integration organisations	Yes	
UN Ocean Decade	The United Nations Decade of Ocean Science for Sustainable Development (2021-2030) aims to spark a 'revolution in the generation and use of ocean science'. The Decade will generate the qualitative and quantitative knowledge needed for more robust science-informed policies at global, regional, national, and local levels, leading to the development of a sustainable ocean economy and contributing to the 2030 Agenda for Sustainable Development.	n.a.	Voluntary	No	
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	CITES is an international agreement aimed at ensuring that international trade wild animals and plants does not threaten the survival of the species.	183	Open to all States and regional economic integration organisations	Yes (through national legislation)	
International Whaling Commission	The International Whaling Commission (IWC) was established in 1946 as the global body responsible for management of whaling and conservation of whales.	88	States Parties	Yes	

Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
Regional treaties and agreements	Overview	Number of Parties	Membership	Legally binding	Primary focus
OSPAR Convention	The 1992 OSPAR Convention unified, updated and extended two previous conventions to protect the marine environment of the NE Atlantic. These two conventions were the 1972 Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (the Oslo Convention, which entered into force in 1974), and the 1974 Convention for the Prevention of Marine Pollution from Land-Based Sources (the Paris Convention, which entered into force in 1978)	16	States Parties based on geographic location, including catchment areas	Yes	CC
Regional Fisheries Management Organisations	Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	27 Members and 10 Acceding States	Open to State parties or regional economic organisations	No	
	Fishery Committee for the Eastern Central Atlantic (CECAF)	34	Member Nations and Associate Members are selected FAO	No	
	International Commission for the Conservation of Atlantic Tunas (ICCAT)	52	States Parties, specialised UN agencies, and regional economic organisations	Yes	
	North Atlantic Salmon Conservation Organisation (NASCO)	7	States Parties	Yes	
	North East Atlantic Fisheries Commission (NEAFC)	6	States Parties	Yes	
	Northwest Atlantic Fisheries Organisation (NAFO)	13	States Parties	Yes	
	South East Atlantic Fisheries Organisation (SEAFO)	7	States Parties	Yes	
	Western Central Atlantic Fishery Commission (WEFAC)	34	States Parties	No	
Sargasso Sea Commission	The Sargasso Sea Commission aims to encourage and facilitate voluntary collaboration towards the conservation of the Sargasso Sea.	17	Voluntary collaborating partners	No	

Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
Abidjan Convention	The Convention for Cooperation in the Protection, Management and Development of the Marine and Coastal Environment of the Atlantic Coast of the West, Central and Southern Africa Region (the Abidjan Convention) provides a legal framework for all marine-related programmes in western, central and southern Africa, covering a coastline of ~14,000 km from Mauritania to South Africa.	19 and 2 State observers	State parties, based on geographic location	Yes	CC
Benguela Current Commission (BCC)	The Benguela Current Commission (BCC) is a multi-sectoral inter-governmental initiative between Angola, Namibia and South Africa, established in January 2007 with the Benguela Current Convention being signed on 18 March 2013. The BCC 'promotes the vision of the Benguela Current Large Marine Ecosystem (BCLME) sustaining human and ecosystem wellbeing for generation after generation'.	3	Angola, Namibia and South Africa	yes	
The Cartagena Convention	The Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Area (the Cartagena Convention) aims to promote regional cooperation for the protection and sustainable development of the Wider Caribbean Region, which includes 28 countries that border the Gulf of Mexico, the Straits of Florida and the Caribbean Sea out to a distance of 200 nautical miles from shore.	26	States Parties, based on geographic location	yes	CC
EU policies	Overview	Number of Parties	Membership	Legally binding	Primary focus
EU deep-sea fisheries regulation	Regulation (EU) 2016/2336 establishes regulations for bottom fishing below 400 meters in EU waters in the northeast Atlantic and the international waters in portions of the central east Atlantic. The regulation prohibits significant adverse impacts of bottom fisheries on vulnerable deep-sea ecosystems below 400 m depth and establishes a ban on bottom trawling below 800 m depth.	27	Member States of the EU	Yes	
Integrated Maritime Policy and the Marine Strategy Framework Directive	The European Union's Integrated Maritime Policy (IMP) aims to coordinate European policies related to the sea and to enable sustainable blue growth; the IMP encompasses a broad range of fields, including maritime and coastal industries (e.g., offshore energy, shipping, fisheries, aquaculture, tourism) as well as policies relating to the marine environment and marine research. The Marine Strategy Framework Directive (MSFD) forms the environmental pillar of the IMP providing a framework for protection of the marine environment and challenging Member States to achieve Good Environmental Status (GES) within European Seas	27	Member States of the EU	IMP (No); MSFD (Yes)	CC

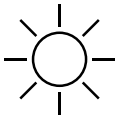
Global treaties and agreements	*Overview*	Number of Parties	Membership	Legally binding	Primary focus
	by 2020.				
EU Integrated Maritime Policy, EMODnet and the Marine Spatial Planning Directive	The 2007 EU Integrated Maritime Policy aims to provide a coherent approach to maritime issues that are not sector specific. To help support sustainable blue growth, the IMP focuses on the need for i) improved knowledge and access to marine data, ii) integrated maritime surveillance, iii) cooperation between countries and iv) Maritime Spatial Planning.	27	Member States of the EU	IMP (No); MSPD (Yes)	CC
European Green Deal, including the Climate Target Plan and the Biodiversity Strategy for 2030	The European Green Deal was first presented in December 2019 and provides an action plan to help boost the efficient use of resources by moving to a circular economy, as well as to restore biodiversity and cut pollution.	27	Member States of the EU	Legally binding targets through European Climate Law	
Belém Statement on Atlantic Research and Innovation Cooperation	The Belém Statement on Atlantic Research and Innovation Cooperation aims to strengthen scientific collaboration in the Atlantic Ocean between Brazil, South Africa, and the European Union, and was signed on 13 July 2017.	3	European Union, Brazil, South Africa	No	
Galway Statement	The Galway Statement on Atlantic Ocean Cooperation aims to strengthen scientific collaboration in the Atlantic Ocean between Canada, the United States of America, and the European Union, and was signed on 24 May 2013.	3	EU, USA, and Canada	No	

Table legend

CC	Cross-Cutting		Conservation of marine species and ecosystems		Climate change		Commercial fishing
	Deep-sea mining		Science and research		Shipping		

Fisheries as an example of the complexity of ocean governance in the Atlantic region

Marine sectors are often subject to multiple obligations, regulatory bodies and implementing mechanisms, both directly and indirectly – creating a complex governance system. A good example of this is the governance of fisheries in the Atlantic.

The 1995 UN Fish Stocks Agreement is the second of the implementing agreements of UNCLOS and adds to the obligations of UNCLOS related to fisheries for to e.g., establish common approaches (e.g., precautionary and ecosystem based), clarify flag-state responsibilities, minimise environmental impacts on target and non-target species, and strengthening obligations for States to establish and participate in regional fisheries management organisations (RFMOs).

Six RFMOs (see Table 1) operate within the Atlantic region, and all have the legal competence to establish binding regulations for fisheries on the high seas and, to some extent, fisheries within Exclusive Economic Zones (EEZs). Each has its own set of established obligations. While often similar, there are important differences amongst them. For example, regarding procedures for decision making, and generating scientific advice, as well as differences in mix of membership of fishing nations. One challenge with this system is the differences in the obligations established under the UN Fish Stocks Agreement and those established by RFMOs. For example, following the UN General Assembly resolutions for the management of deep-sea fisheries some RFMOS have closed seamounts within their convention areas to bottom fishing, while others have allowed the activity to continue. In addition, a major gap within the Atlantic occurs in the southwest Atlantic where intensive fishing by distant water fleets on the high seas for non-highly migratory species takes place but where no RFMO exists. There are also two regional fisheries bodies covering the central Atlantic Ocean (see Table 1) which have a purely advisory role (i.e., cannot establish legally binding measures for managing fisheries).

In addition to treaty obligations there are many soft-law instruments applicable to the management of fisheries in the Atlantic. These include multilateral instruments negotiated under the auspices of the UN FAO such as the Code of Conduct for Responsible Fisheries; International Plans of Action (IPOAs); and various FAO Guidelines such as the Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries, the International Guidelines for the Management of Deep-sea Fisheries in the high seas and the Voluntary Guidelines for Flag State Performance. Since 2003 the UN General Assembly (UNGA) has adopted annual Sustainable Fisheries resolutions which contain numerous political commitments – amongst the most impactful and relevant for the iAtlantic Project are those related to the management of bottom fisheries on the high seas. These commit States to ensure conservation of deep-sea fish stocks and the protection of vulnerable deep-sea marine ecosystems and biodiversity.

Other soft-law instruments and political commitments related to fisheries and the conservation and protection of the marine environment and biodiversity include outcomes from major UN Conferences such as Agenda 21 of the UN Conference on Environment and Development (1992), the Johannesburg Plan of Action adopted by the World Summit on Sustainable Development (2002), and the United Nations Conference on Sustainable Development (2012). This last conference resulted in a high-level document titled 'The future we want'. It commits States to '*protect and restore the health, productivity and resilience of ocean and marine ecosystems, to maintain their biodiversity and enable their conservation and sustainable use for present and future generations' and called for 'urgent actions that effectively reduce the rate of, halt and reverse the loss of biodiversity*'. The 2030 UN Sustainable Development Goals (SDGs) also contain relevant goals and targets as do those negotiated through the Convention on Biological Diversity (CBD) such as the Aichi targets adopted in 2010 and more recently the 2030 Global Biodiversity Framework adopted in December 2022 (see Chapter 3).

Other treaties that are not specific to fisheries *per se* but create obligations relevant to conservation and sustainable use of marine species and the marine environment are also important to mention. For example, the Convention on the International Trade in Endangered species (CITES) includes several species targeted or taken as bycatch in commercial fisheries – most recently through November 2022 decision to include all 54 species of requiem sharks (family *Carcharhinidae*) and six species of

hammerhead sharks. Other agreements include the UN Framework Convention on Climate Change; the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) and its various protocols; and the Stockholm Convention on Persistent Organic Pollutants. The potential future legal instrument on plastic pollution as agreed by the United Nations Environment Assembly in March of 2022 should also play a role. Another important agreement is the 'BBNJ Agreement' for which negotiations through the Intergovernmental Conference (IGC) convened by UNGA concluded in March 2023 and once entered into force could enhance cooperation and coordination amongst sectoral and regional bodies, including RFMOs (see Chapter 3). In addition, the International Seabed Authority (ISA) could potentially address adverse impacts on fisheries from deep-sea, most notably the European Union's Long Distance (fishing fleets) Advisory Council (LDAC, 2021) (see Chapter 3). Finally, Regional Seas Conventions (RSCs) and Regional Seas Programmes (RSPs) in the Atlantic also play an important role in implementing commitments and obligations to protect marine species and the environment (see Table 1).

Ocean governance of Atlantic fisheries is a dynamic process and continuously evolving. Growing societal awareness and concern over ocean health is prompting efforts to both understand and improve governance of fisheries and more broadly. This governance system is impacted by e.g., changes in technology, shifting political and economic interests, ongoing efforts to improve compliance with legal obligations, as well as new scientific information and knowledge. At the same time, there remain both overlaps as well as gaps in the various obligations and governance structures tasked with managing fisheries (see Chapter 3).

3. Exploring ocean governance – challenges and key policy processes

This chapter aims to provide a brief snapshot of overarching ocean governance challenges (3.1) structured along the elements of the IOM approach as well as a more in-depth look into specific selected policy processes (3.2) relevant to the Atlantic region.

3.1 Overarching ocean governance challenges

3.1.1 Governance challenges

Incoherent and competing governance objectives

There is a growing intensity and diversity of activities in the ocean at a global level (Spalding and de Ycaza, 2020), including in the Atlantic. These activities focus on, *inter alia*, ensuring access to food sources, maintaining livelihoods, harvesting resources for medicines or other products, and conserving and protecting ocean ecosystems and species. Ocean governance also consists of numerous actors and stakeholders across sectors and between governance levels and which often have different, and sometimes competing, goals as well as varying degrees of power within the governance system (Blythe et al., 2021). Their objectives are negotiated through governance arrangements which include institutions, processes, rules, and norms that provide the 'rules of the game' for how actors make decisions, share power, distribute responsibility, and create accountability for the ocean (Kooiman, 2003). The result is a complex array of often incoherent and competing governance objectives (e.g., economic, social, environmental) that create inconsistent obligations amongst and between regulatory processes.

Fragmented governance structures

The existing ocean governance structure to sustainably manage human uses on and in the ocean is fragmented, both in terms of spatial and sectoral coverage. This means that the existing institutional and legal arrangements to govern the Atlantic ocean do not adequately allow for integrated responses (i.e. across jurisdictions and sectoral mandates) to address pressing ocean challenges (Durussel et al., 2018;

Gjerde et al., 2018). The 1982 United Nations Convention on the Law of the Sea (UNCLOS) provides for rules governing uses of the ocean and its resources, including in ABNJ, and is considered the umbrella convention for the protection of the marine environment and sustainable use of ocean resources (UNGA, 1992). However, over 40 years ago when UNCLOS was developed, many pressures on the ocean were not well understood or only emerging within global governance discussions. In this regard, UNCLOS does not comprehensively address the conservation and sustainable use challenges of marine spaces, leaving many spatial, institutional, and sectoral gaps in governing these areas. Regional governance structures have been established where cooperation between littoral States, on resource allocation and transboundary impacts, is advantageous. The fragmented nature of ocean governance poses serious challenges to creating the integrated approach across legal jurisdictions and sectoral responsibilities needed to address the conservation and sustainable use challenges outlined below.

3.1.2 Transboundary challenges

An ocean connected across jurisdictional boundaries

The ocean is divided into legally distinct maritime zones, including national waters i.e., Territorial Sea, Exclusive Economic Zones, continental shelves, and Area Beyond National Jurisdiction, which includes: the water column (high seas) and the seabed (the Area). However, the ocean spans jurisdictional boundaries and is connected through both oceanographic and ecological connectivity across all ocean layers and spaces (Gary et al., 2020; Ortuño Crespo et al., 2020; Popova et al., 2019). Human activities and their pressures on the ocean can therefore result in impacts well beyond their source or from the location of the activity (Popova et al., 2019). This widespread impact from human activities on the ocean requires that human activities on land, as well as climate change are also considered in ocean management.

3.1.3 Stakeholder challenges

The need for collaboration and coordination to address ocean challenges

The preamble to the UNCLOS acknowledges that 'the problems of ocean space are closely interrelated and need to be considered as a whole'. Yet coordination and integration across the large array of global and regional treaties, and other arrangements for governance of major ocean issues such as biodiversity, fisheries, pollution, and climate often remain weak. Efforts to improve coordination and integration should build on existing frameworks and good practice examples. At the same time, governance of the ocean involves much more than global and regional conventions. States, including the sub-national local level, as well as the private sector and civil society need to play active roles (Mahon et al., 2015). However, there is no one size fits all solution. Holistic perspectives at the Atlantic-basin scale will be important to implement ocean governance (Ferreira et al., 2022) in an integrated and coordinated approach, but such a perspective also means that there are numerous tailor-made possibilities for governance arrangements, including on how they operate and possible formal agreements. Organisational and geographical factors as well as the horizontal and vertical interactions of institutions and actors (e.g., States) will influence the design and eventual implementation of governance arrangements (Young, 2002). Supporting frameworks for collaborative ocean governance in marine regions need to respond to and help to leverage this diversity of approaches.

3.1.4 Knowledge challenges

Gaps in data, information, knowledge, and capacity

Adequate data, information and knowledge are essential for effective ocean governance and management. While ocean research and knowledge are increasing, with two World Ocean Assessments to date and currently bolstered by the UN Decade for Ocean Science, much of the ocean remains poorly understood. This includes areas of deep and cold water, as well as the role of biodiversity to support and maintain ocean health. Uncertainties also exist regarding the interactions and processes within the ocean which are often studied in isolation (Fissel et al., 2012). Recent studies on the state of ocean knowledge reveal that significant challenges exist with potential impacts on understanding and decision making.

Focusing on climate-driven ocean change, Hauser et al. (2016) highlighted significant differences in spatial and temporal scales of investigation among disciplines and in particular that biological studies are rarely conducted on scales that match those of physical and chemical studies. Similarly, Amon et al. (2022a) showed that informed decision making regarding deep-sea mining remains greatly hampered by the low-levels of available knowledge and information, despite increases in relevant deep-sea research. The complex nature of the ocean means that not only do information and knowledge gaps need to be filled, but that scientific approaches and methods must evolve and adapt to improve critical understandings – such as interdisciplinary and international collaborations which bring together diverse groups of researchers from across different fields (Roberts et al., 2023). It will also be important for researchers to look for new and effective ways to ensure that their findings are disseminated into governance processes, fostering the science-policy interface. It is also worth highlighting that a shift in the way data and information is approached within governance processes towards greater collaboration, sharing, and contribution across different actor groups, especially industry, as well as how scientific approaches and methodologies are jointly applied, such as linking machine learning and modelling techniques. At the same time, challenges in capacity exacerbates these challenges, especially in the Global South.

iAtlantic research highlight: Addressing knowledge gaps by monitoring changes in the deep sea
Authors: Marjolaine Matabos, Jozee Sarrazin (IFREMER) and Didier Jollivet (SU)

Many knowledge gaps remain in our understanding of deep-sea ecosystem biodiversity, functioning and dynamics. At mid-ocean ridges, deep-sea observatories collect the data and information urgently needed for sound environmental monitoring, supporting the characterisation of biological and environmental baseline states, discriminating natural variations from changes resulting from anthropogenic activities, and assessing ecosystem degradation, resilience, and recovery after disturbance. They provide long-term, multidisciplinary time-series data comprising repeated observations and sampling at temporal resolutions from seconds to decades, through a combination of cabled, wireless, remotely controlled, and autonomous measurement systems. The three existing vent observatories are located on the Juan de Fuca and Mid-Atlantic Ridges (Ocean Observing Initiative, Ocean Networks Canada and the European Multidisciplinary Seafloor and water column Observatory). They provide valuable tools for environmental impact assessment (EIA) in the context of rising anthropogenic activities, including climate change and potential future deep-sea mining. As such, they can contribute to inform international negotiations such as standards and guidelines of the international mining code currently being developed at the International Seabed Authority (ISA). Scientific outputs can inform MSP managers by providing baseline data including maps that illustrate the spatial distribution of seafloor features, habitats, species, wastes, and human pressures. The last decade of observation has provided a strong baseline on ecosystems' natural dynamics, paramount for evaluating their resilience. For instance, along the Mid-Atlantic Ridge (MAR), connected cameras and repeated surveys highlighted the multi-decadal stability of hydrothermal activity and associated vent communities. These results suggest that mining could have deleterious long-term or even irreversible impacts on these climax communities that rely on chemosynthetic production and the ecosystem they support, including peripheral abyssal fauna (e.g., sponges, corals).

Repeated surveys (WP2) and long-term monitoring of vent ecosystems (WP3) at the Lucky Strike vent field along the MAR highlighted a high stability of hydrothermal circulation and associated vent communities. Twenty-five years of observations suggest that these climax communities form stable but rather isolated populations, raising questions on species growth rates and lifespan that still represent important knowledge gaps in vent species biology. In such a slow-spreading ridge system, characterised by low rates of natural change, the fauna experiences very little disturbance, calling into question its capacity to recover from major perturbations such as those induced by deep-sea mining. Recolonising a site after such large-scale disturbances requires the arrival of vent species larvae from afar. However, the joint genomic studies conducted by IFREMER and SU on the gastropod species *Peltospira smaragdina* and *Lepetodrilus atlanticus* along the northern MAR (in connection with D1.5, WP1)

revealed strongly delineated populations and a limited gene flow across ~ 3,000 km, similar to that observed for *Bathymodiolus* mussel species. Deep-sea mining, by eradicating local populations and creating a spatial gap in species connectivity, could not only irreversibly impact a single vent field but could have major consequences for this ecosystem at the mid-ocean ridge scale. The result highlight how methodological multi-scale approaches across work packages help bring together various types of data to reach an integrated understanding of ecosystem functioning.

Deep-sea observatories generate large pluridisciplinary standardised data archives that can inform the implementation of any MPA management plan so that its conservation objectives take into account understanding of natural rates and scales of environmental and ecosystem changes. Technological developments, including novel (i) sensing technology (e.g., underwater mass spectrometer, eDNA collectors and *in situ* sequencing), (ii) energy efficient solutions to minimise battery consumption and harvest ocean energy, and (iv) the use of Artificial Intelligence (AI) to reduce energy and data storage, will become increasingly important to support an array of observatories assessing the intensity and rate of changes, in a standardised manner, across oceanic basins.

Source: (Jollivet et al., 2023; Matabos et al., 2022; Van Audenhaege et al., 2022)

3.1.5 Systems challenges

Interactive and cumulative effects of multiple pressures

Human activities affect natural systems, including the ocean, in a multitude of ways. Just over a decade ago, little was known about the cumulative effects of multiple pressures (Crain et al., 2008), but the scientific community has taken steps to advance available methods and scientific approaches - although caveats remain (Korpinen and Andersen, 2016). While environmental pressures stem from a diverse number of human activities, including from both land and at sea, their effects are often managed individually by sector. However, it is important for governance to consider pressures in a more integrated perspective to effectively address their impacts. Cumulative pressures on the ocean can interact in synergistic or antagonistic manners, which create knock-on effects to marine ecosystems and species, and ultimately humans, which go beyond the effectiveness of applying a single sector approach to governance.

Temporal and spatial dynamics

Ocean governance is further complicated by complex and interconnected temporal and spatial dynamics. Many ocean processes (physical, environmental and biotic) vary widely across ocean depths, while human activities, such as oil drilling, mining and fishing are rapidly expanding into deeper areas where less is known about biodiversity and impacts these processes may have (Levin et al., 2018). At the same time, conservation and management efforts for pelagic and benthic domains do not integrate the dynamic nature of the ocean into policy efforts (Levin et al., 2018). Indeed, the ocean is linked through e.g. the nutrients, organisms, species and ecosystems which are distributed throughout the ocean, both in the water column and at the seafloor (Balbar and Metaxas, 2019; DOSI, 2020; Dunn et al., 2019; Gary et al., 2020). The ocean is connected through pressures stemming from human activities (e.g. fishing, pollution, climate change) as well as human and cultural connections (Boteler et al., 2022). In addition, integrating distributional dynamics into the management of species or ecosystems, including the pressures on them, requires that appropriate temporal scales are considered, including contemporary (dynamic and ephemeral oceanographic features); intra-annual (seasonal variation); multi-annual (climatic oscillations); and multidecadal: climate change (Fox et al., 2016; Ortuño Crespo et al., 2020).

3.2 Ocean governance in key policy fields

3.2.1 Fishing

The focus of this section is on key international obligations and related political commitments governing the management of fisheries in the Atlantic Ocean and relevant to both Exclusive Economic Zones (EEZs) and in areas beyond national jurisdiction (ABNJ), including for the management of deep-sea. Within Atlantic States' EEZs fisheries are managed by a range of national fisheries regulations and policies.

Sustainable Fisheries: UNCLOS and the 1995 UN Fish Stocks Agreement

Building on provisions set out in UNCLOS, the United Nations Fish Stocks Agreement (UNFSA, 1995), the second implementing agreement of UNCLOS, establishes general obligations for the sustainable management of fisheries for straddling and highly migratory fish stocks and their impacts on the marine environment, including most of the deep-sea fisheries in international waters. It obliges States, acting individually and cooperating through RFMOs, to '*assess the impacts of fishing, other human activities and environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks*' and assess impacts on '*non-target and associated or dependent species and their environment*' (UNFSA, Part II, Articles 5 and 6). Further, they are required to: develop data collection and research programmes and plans to ensure the conservation of such species and protect habitats of special concern; protect biodiversity in the marine environment; and apply the precautionary approach widely, ensuring that caution is taken when information is uncertain, unreliable, or inadequate (UNFSA, Part II, Articles 5 and 6). These obligations are substantial in terms of assessing the impacts of fishing on non-target, associated, or dependent species and even more so regarding assessing the impacts of other human activities and environmental factors on these species. Article 7 of the UNFSA calls for compatible measures to be established for the management of fisheries for straddling and highly migratory fish stocks within areas of national jurisdiction and on the high seas consistent with Articles 5 and 6. Most, though not all, States bordering the Atlantic and/or whose flagged vessels engage in distant water fishing in the Atlantic have ratified the UNFSA. Moreover, the provisions of Articles 5 and 6 of the UNFSA are largely contained in Articles 2, 3, 6, and 7 of the 1995 UN FAO Code Conduct for Responsible Fisheries reflecting a more 'universal' acceptance of the provisions for conservation and sustainable fisheries and protection of the marine environment established in the UNFSA.

UN General Assembly resolutions: the management of deep-sea fisheries in areas beyond national jurisdiction (ABNJ)

A series of United Nations General Assembly (UNGA) resolutions have been adopted over the past two decades that commit States and Regional Fisheries Management Organisations (RFMOs) to sustainably manage deep-sea fisheries and to protect vulnerable marine ecosystems (VMEs) and marine biodiversity from the impacts of such fisheries in ABNJ.

UNGA Resolution 61/105 (UNGA, 2006) calls on States *'to take action immediately, individually and through regional fisheries management organisations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to (…) protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognising the immense importance and value of deep sea ecosystems and the biodiversity they contain*' (paragraph 80; (UNGA, 2006)). To implement these commitments, States have agreed to (paragraph 83; (UNGA, 2006)): conduct impact assessments to determine the effects of bottom fishing on VMEs and take actions or ban activities; close areas where VMEs are likely to occur; establish and implement protocols to halt vessels from fishing when a VME is encountered; and sustainably manage deep-sea fish stocks.

In 2008, States negotiated and adopted the International Guidelines for the Management of Deep-Sea Fisheries in ABNJ to assist States and RFMOs with the implementation of UNGA Resolution 61/105 (UNGA, 2006). This includes establishing internationally agreed-upon, science-based criteria to conduct environmental impact assessments of deep-sea fisheries, to identify VMEs, and to determine whether impacts on VMEs would (or already do) constitute 'significant adverse impacts'. These provisions have subsequently been incorporated into the regulations adopted by the RFMOs that manage deep-sea ABNJ fisheries in the Atlantic Ocean.

In 2009 the UNGA adopted resolution 64/72, which endorsed the FAO Guidelines and further elaborated on the actions States committed to take to manage deep-sea fisheries in ABNJ (UNGA, 2009). The resolution calls on States and RFMOs to implement the provisions of resolution 61/105, to prohibit bottom fishing unless and until Environmental Impact Assessments consistent with the FAO Guidelines have been conducted, and further calls on States and RFMOs to adopt and implement the provisions of both resolutions 61/105 and the more detailed provisions of UNGA resolution 64/72 or else 'not authorise' bottom fisheries to take place (UNGA, 2009).

The UNGA conducts periodic reviews of the implementation of resolutions related. This has resulted in calls for actions in UNGA Resolutions 66/68 (UNGA, 2011), 71/123 (UNGA, 2016) and 77/118 (UNGA, 2022). These resolutions further elaborate on the actions called for in the previous 2006 and 2009 resolutions, reinforcing the commitments in those resolutions. The resolutions broke new ground in the conduct of fisheries management and many of the commitments made by States require enhanced scientific understanding of deep-sea species, ecosystems, and biodiversity. Any new occurrences of VME indicator species, taxa and ecosystems recorded during iAtlantic fieldwork as well as connectivity, source and sink populations and the physical/topographic features and oceanographic conditions likely to support VMEs will be directly relevant to deep-sea fisheries management and regulations both in national waters as well as in ABNJ. Similarly, research concerning the potential impacts of climate change will also be of relevance because UNGA Resolution 71/123 calls upon States '*to take into account the potential impacts of climate change and ocean acidification in taking measures to manage deep-sea fisheries and protect vulnerable marine ecosystems'* (UNGA, 2016).

The fisheries sector and its management bring a range of challenges to ocean governance – both within the Atlantic region and beyond. At the forefront is the ineffective implementation of agreed upon targets for the exploitation of fisheries resources. This is particularly hindered by conflicting, or competing, interests between conservation and sustainable use objectives of States. Although the high seas fisheries sector is regulated by RFMOS, it is the members – the States – which make decisions and share responsibility for the management and protection of shared resources. Achieving conservation and sustainable use objectives through area-based management tools (ABMT) in an RFMO can be highly challenging as adopting binding conservation and management measures for fisheries in ABNJ often requires consensus. Most RFMOs do have voting procedures which allow for adopting regulations in the absence of consensus but most RFMOs also have 'opt-out' clauses which allow Contracting Parties to avoid being legally bound by decisions that they do not agree with (Wanless and Hazin, 2022).

Decision making within RFMOs is further challenged by insufficient or often lacking scientific information, particularly on relative and cumulative impacts of multiple activities on target and non-target species affected by fishing. For example, the life history characteristics of deep-sea species and populations relevant for VMEs. Further challenges stem from spatial characteristics of straddling and highly migratory fish stocks. Shifting species distributions can cause conflict between countries and fishing fleets, as fisheries management was traditionally based on population characteristics that were static while climate change has led to species shifts and associated uncertainties (Palacios-Abrantes et al., 2022; Pinsky et al., 2018). Nevertheless, when applying the precautionary approach to fisheries management, such information or scientific challenges are no excuse for insufficient management responses and necessitate a cautious approach, erring on the side of sustainability.

In addition, adequate enforcement mechanisms are required to ensure States, and all vessels flying their flag, comply with binding decisions and implement management decisions as agreed upon by RFMOs. To do this, States generally rely on monitoring, control, and surveillance (MCS). These tools enable them to monitor fishing, and other, activities at sea which may be cause for concern and allow them to take enforcement actions. Of particular concern is illegal, unreported, and unregulated (IUU) fishing. MCS is considered key to effective ocean governance, especially for ABNJ, where compliance is more challenging due to the distances from shore and the fact that flag States have primary jurisdiction over fishing vessels on the high seas, limiting in many cases the actions that can be taken by non-flag states in relation to enforcement of high seas fisheries regulations. Indeed, there is often limited awareness and

understanding of illegal human activities at sea, especially in ABNJ and the southern areas of the Atlantic, and the impacts they cause on the marine ecosystems (as well as societies). Understandably, authorities tend to focus on national waters and ABNJ is often a lower priority for national fisheries management authorities (Cremers et al., 2021).

iAtlantic research highlight: Fisheries management under climate change scenarios
Author: Jose Angel Alvarez Perez (UNIVALI)

Research by Perez and Sant'Ana (2022) indicates that the availability and abundance of commercially exploited fish stocks in the Southwest Atlantic, specifically off the Brazilian coast, have been affecting the economic viability of fishing fleets. Catches were monitored between 2000 and 2019 in the harbours of Santa Catarina State, southern Brazil. Changes in species abundances in the catches of the demersal fisheries evidence strong contrasts between the early (2000–02) and late (2017–19) periods of the time-series. Overall, catch composition maintained a 1.5:1 ratio of species with warm- and cold-water affinities from the beginning of the time series until 2012. After that, warm-water species abundance increased in the catches changing the resulting ratio to 4.1:1 in 2019. Additionally, the species abundance in the catches declined from 15 main species characterising annual catches, down to eight (mostly warm-water affinity) species.

With certain limitations, historical catch data has proven to be an effective proxy for global climate effects on marine ecosystems regionally, with the advantage of further signalling future changes in the economic performance of current fishing regimes. It could also be used to predict natural shifts in fisher's behaviour to compensate for losses and take advantage of opportunities, and management strategies to accommodate these shifts into sustainable scenarios.

Management tools are needed to understand shifting ocean dynamics to develop adaptive management approaches for the sustainable use of these stocks under climate change scenarios. For example, RFMOs such as the International Commission for the Conservation of Atlantic Tunas (ICCAT) could integrate information on shifts of species abundance of tropical and sub-tropical tuna and tuna-like species in their quota definition and design of other conservation and management measures. With changing distribution patterns of commercially interesting species, transboundary stock management will likely become more important in the future.

Source: (Perez and Sant'Ana, 2022)

3.2.2 Deep Seabed Mining: UNCLOS and the International Seabed Authority

Part XI of the 1982 UNCLOS and the 1994 Implementation Agreement relating to Part XI of UNCLOS (UNGA, 1994) establishes the legal regime for the management of mining in the international seabed (i.e., the 'Area'), including obligations to protect the marine environment. It also establishes the International Seabed Authority (ISA) as the organisation through which State Parties to UNCLOS shall organise and control all mining-related activities in the Area, with an obligation to do so on behalf of and for the benefit of humankind.

UNCLOS Article 145 establishes commitments for the protection of the marine environment. It states that '*Necessary measures shall be taken (…) to ensure effective protection for the marine environment from harmful effects which may arise from such [seabed mining] activities*'. To meet this obligation, the ISA is required to adopt appropriate rules, regulations, and procedures for (Article 145, UNCLOS, 1982); including:

- the prevention, reduction and control of pollution and other hazards to the marine environment;

- protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities;
- the prevention of interference with the ecological balance of the marine environment;
- the protection and conservation of the natural resources of the Area; and
- the prevention of damage to the flora and fauna of the marine environment.

Regulations for the exploitation of seabed mineral resources are currently under negotiation. Furthermore, the ISA has established a requirement for conducting prior environmental impact assessments (EIAs) and designing monitoring programs for certain types of activities that take place under the current exploration regulations, including testing of any mining equipment (ISBA/25/LTC/6/Rev.1). Contractors intending to conduct such activities are required to produce an EIA and develop a monitoring programme prior to, during, and after the activity based on the detailed provisions laid out in guidelines issued by the Legal and Technical Commission (LTC) of the ISA (i.e., Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area, paragraphs 33 to 40; (ISA LTC, 2020)). In order to conduct an EIA and to review impacts following the testing of mining equipment, contractors are required to establish baseline conditions regarding physical and chemical oceanography, as well as geological and biological parameters that characterise the environment likely to be impacted (paragraphs 13-18; (ISA LTC, 2020)). In terms of biological parameters, contractors are expected to report on, *inter alia* (paragraph 15; (ISA LTC, 2020)):

- fauna representative of the variability of habitats, bottom topography, depth, seabed and sediment characteristics, the water column and mineral resource being targeted;
- near-bottom and seafloor megafauna, macrofauna, meiofauna and microbial communities, demersal fishes, scavengers, and biota associated directly with the resource;
- pelagic communities in the water column and near-bottom (i.e., in the benthic boundary layer) that may be impacted by operations (e.g., noise and discharge plumes);
- sightings of marine mammals, other near-surface large animals (e.g., turtles, fish schools) and bird aggregations; and
- additional information is required for fauna associated with polymetallic sulphides and active hydrothermal vents (paragraph 16; (ISA LTC, 2020)), as well as cobalt-rich ferromanganese crusts and different habitat types found on seamounts (paragraph 18; (ISA LTC, 2020)). The specific information required for these resource types is relevant to the iAtlantic Project.

iAtlantic research highlight: Toxicological effects of deep-sea mining sediment plumes on cold-water octocorals

Author: Marina Carreiro-Silva (IMAR-UAZ)

The generation of potentially toxic sediment plumes from deep-sea mining activities will most likely affect deep-sea biodiversity, productivity, species abundance and ecosystem services, as well as the marine food webs and ecosystem functioning. Benthic sessile suspension-feeding fauna, such as cold-water corals, may be particularly susceptible to increased suspended sediments. In a four-week aquarium experiment by Carreiro-Silva et al. (2022) the cold-water octocoral, *Dentomuricea aff. meteor* was continuously exposed to a low concentration of 2-3 mg/L of suspended polymetallic sulphide (PMS) particles. This concentration of suspended particles can be considered an accurate simulation of particle emissions generated by PMS dewatering sediment plumes, modelled to affect an area of 25-150 km^2 around the discharge point based on Morato et al. (2022).

The results of the experiment show that after three to five days corals experienced the first negative effects of PMS exposure, including the accumulation of particles in their tissues, preventing the coral from extending its polyps and feeding. Over time, a progressive loss in tissue condition and bioaccumulation of copper in coral tissues and skeletons was observed. Increased respiration and

ammonia excretion rates in corals after 13 days of exposure indicated physiological stress and potential metabolic exhaustion. After 27 days of PMS treatment the death of all coral fragments marked the end of the experiment.

Given the dispersal potential of mining plumes and the highly sensitive nature of octocorals, marine protected areas, buffer areas or non-mining areas may be necessary to protect deep-sea coral communities. Additionally, the estimates of plume dispersal footprint might be larger than anticipated, questioning threshold values or DSM plumes and the expected harmful impacts from both from the *in situ* seabed excavation and from the wastewater pumped from surface processing vessels back down to just above the seafloor.

Sources: (Carreiro-Silva et al., 2022; iAtlantic, 2022a)

In the Atlantic Ocean, the ISA has issued (as of March 2023) four contracts for exploration: three contracts for polymetallic sulphide deposits located along the northern Mid-Atlantic Ridge south of the Azores sponsored by France, the Russian Federation and Poland, and one exploration contract sponsored by Brazil for cobalt-rich ferromanganese crusts on the Rio Grande Rise in the Southwest Atlantic. However, the latter is in the process of being withdrawn as Brazil has submitted an amendment to its extended continental shelf claim which now includes the Rio Grande Rise and which the ISA has formally recognised.

Entities with exploration contracts from the ISA – 'contractors' – are also required to '*assess regional distribution of species and communities/assemblages as well as genetic connectivity of key and representative species*' (paragraph 15(d)(vii); (ISA LTC, 2020)). As such, iAtlantic research in the areas surrounding current exploration contracts will be of relevance to mining contractors, their sponsoring States and the ISA.

iAtlantic research highlight: Limitations to coral recovery after PMS exposure

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The potential release of metals, especially copper (Cu) during mining of seafloor massive sulphides (SMS), represents a potential toxicological threat to cold-water coral (CWC) habitats. Under a deep-sea mining exploitation scenario, Cu-complexes trapped in minerals will be released to the water column and become bioavailable to benthic organisms.

In a recent experiment Martins et al. (2022) evaluated the response of the common whip coral *Viminella flagellum* to short-term acute copper (Cu) exposure. Corals were exposed to varying concentrations of copper over a 96-hour period and then returned to normal aquarium conditions to assess their recovery capacity. While no immediate mortality was detected during the short-term Cu exposure, a delayed mortality, which was concentration dependent, was observed and three weeks after exposure all corals were dead.

These results show that while *V. flagellum* may resist acute copper exposure over a 96-hour timeframe it is unable to recover when returned to ambient conditions. This baseline toxicological *ex situ* study highlights the need to identify the tolerance limits of CWC to trace metal exposure and the importance of considering delayed mortality when evaluating the potential impacts of deep-sea mining.

Source: (Martins et al., 2022)

In parallel to the negotiation of the exploitation regulations, the ISA has been working toward the development of regional environmental management plans (REMP) focused on areas where exploration contracts have been granted but where no REMP has yet been adopted (e.g., mid ocean ridge systems in the Atlantic and Indian Oceans; seamounts in the northwest Pacific). The European Commission, working with the ISA, commissioned a project to support the development of a REMP for the area of the northern Mid-Atlantic Ridge where the ISA has issued exploration contracts for polymetallic sulphides (mentioned above). This work was undertaken by a consortium of experts, following from initial work done in

conjunction with the EU-funded MIDAS project, with the objective to provide the relevant subsidiary bodies of the ISA, as well as contractors to the ISA and their sponsoring States, with a proactive area-based management tool to support informed decision-making. The draft REMP was reviewed by the ISA's Legal and Technical Commission and submitted to the Council of the ISA in 2022 for approval and adoption. However, the Council decided to postpone consideration of the draft Mid-Atlantic Ridge REMP pending the adoption of an overall approach to the development of REMPs, both in terms of procedure and content, by the ISA Council.

In regard to the negotiation of the exploitation regulations, it is important to recognise that to finalise and adopt the regulations requires a consensus of the 36 voting members of the ISA Council. However, there are numerous issues over which there is no clear consensus amongst the members of the Council. This includes requirements for assessing the impacts of mining on deep ocean ecosystems and the environmental provisions of the regulations; the content of the standards and guidelines for implementation that need to be adopted together with the exploitation regulations; the royalty regime and the formula for equitable sharing of benefits; and other issues such as compensation to developing states for loss of revenue from terrestrial mining activities due to seabed mining; operationalising the Enterprise; transparency; inspection, compliance and enforcement mechanisms and the establishment of the ISA Inspectorate; settlement of disputes; agreement on the content and procedures for the adoption of regional environment management plans; and the issue of transboundary harm.

'Managing' the environmental impacts of deep-sea mining is a major challenge faced by the ISA is whether mining can be managed to meet the obligations contained in Article 145 of UNCLOS given the paucity of scientific information on the many species and ecosystems, both midwater and benthic, that would likely be impacted by seabed mining activities and the nature, extent and severity of the potential impacts. A comprehensive study listing the many gaps in scientific information needed to be able to assess the risks and make informed decisions on whether and how deep-sea mining could be managed to prevent damage to the marine environment was published in 2022 by a multi-sectoral group of deep-sea scientists including several working for contractors, ISA member country negotiators, members of the ISA's Legal and Technical Commission, conservationists and others (Amon et al., 2022a, 2022b).

Potential impacts to ecosystem services such as carbon sequestration and loss of marine genetic resources have also been raised in discussions at the ISA. A study on costing the negative impacts or 'externalities' of deep-sea mining has been contracted by the ISA and will be delivered prior to the July 2023 meeting of the Council of the ISA for consideration by Council in terms of incorporating such costs into the negotiations over the royalty regime to provide compensation to humankind for detrimental impacts of deep-sea mining.

The ISA faces a major challenge in 2023 regarding the triggering of the so-called '2-year rule' by Nauru. The two-year period triggered by Nauru in 2021 expires on 9 July 2023. If the ISA Council has not adopted the exploitation regulations and related instruments by then, any country can apply for a contract with the ISA to mine after that date. Under these circumstances, until the Council adopts exploitation regulations, the provisions of section 1, paragraph 15 of the Annex to the 1994 amendments to Part XI of UNCLOS require the Council of the ISA to '*consider and provisionally approve such plan of work [an application for a contract for mining] based on the provisions of the Convention and any rules, regulations and procedures that the Council may have adopted provisionally…*' (1994 UNCLOS Part XI Agreement).

Many Council members have expressed concern over approving an application for exploitation on a provisional basis before fully developed regulations have been adopted, with some citing the inability to meet the obligation in Article 145 of UNCLOS to ensure the effective protection of the marine environment from the harmful effects of mining activities in the absence of adequate scientific information as a key reason. The company that Nauru has sponsored – The Metals Company headquartered in Canada through its subsidiary Nauru Ocean Resources Inc. – has stated that it intends to apply to the ISA for a mining

contract before the end of 2023 (TMC, 2022). The procedures by which the ISA decides upon any such applications after 9 July 2023 are currently under discussion and any decisions made by Council of the ISA will have profound implications for the future direction of the ISA and deep-sea mining in the international seabed area.

A number of Council members, including Germany, Spain, Chile, Fiji and Costa Rica, and other ISA members such as New Zealand, Panama, Palau, Samoa and Ecuador, have called for a precautionary pause or moratorium on deep-sea mining, while France has called for a ban. The 15th Conference of Parties of the CBD in December 2022 (COP15) adopted a position on deep-sea mining and the ISA, calling on States to ensure that before deep-sea mining takes place, the impacts on the marine environment and biodiversity are sufficiently researched and the risks understood; that deep-sea mining does not cause harmful effects to the marine environment and biodiversity; and that appropriate rules, regulations and procedures are put in place by the ISA, in accordance with the best available science and the traditional knowledge of indigenous peoples and local communities with their free, prior and informed consent (CBD, 2022). The European Commission, in its international ocean governance agenda communication in June 2022 (European Commission, 2022), called for protecting the seabed as a 'key priority' through prohibiting deep-sea mining until scientific gaps are properly filled, no harmful effects arise from mining and the marine environment is effectively protected. The European Parliament adopted a resolution in 2021 (European Parliament, 2021), which also called for reform of the ISA. Similarly, the IUCN World Conservation Congress, in September 2021 adopted a resolution calling for a moratorium on deep-sea mining and reform of the ISA (WCC, 2020). The resolution was supported by 44 government agencies or ministries from 37 countries and more than 500 civil society and indigenous peoples' organisations. Over 700 marine science and policy experts have signed a statement calling for a precautionary pause on deep-sea mining (Deep-Sea Mining Science Statement, 2023) and numerous companies, financial institutions including the European Investment Bank, fishing industry organisations and others have also called for, or otherwise supported, a moratorium on deep-sea mining (DSCC, 2023).

3.2.3 Marine Biodiversity in Areas Beyond National Jurisdiction

There is a clear challenge for States to govern ABNJ due to its vastness and distance from land, which is further exacerbated by the number of regulations, organisations, and economic actors participating in governance and activities in ABNJ (Durussel et al. 2018). Under the UNCLOS, States can define a 200 nautical mile (about 370 km) Exclusive Economic Zone (EEZ) in which they have the exclusive right to exploit and manage all resources under certain conditions. Beyond these national zones, all countries have the equal opportunity to benefit from the resources contained in these areas while are also collectively responsible for managing environmental challenges, including overfishing, pollution, and climate change. In this regard, UNCLOS establishes the legal framework outlining the rights and duties of States as well international organisations with respect to maritime delimitations and the regulation of human activities at sea. However, it does not comprehensively address the conservation and sustainable use of biodiversity, leaving many spatial, institutional, and sectoral gaps in governing ABNJ.

Global negotiations for a legally binding instrument for the conservation and sustainable use of marine biodiversity in ABNJ (also known as the BBNJ Agreement) formally began in 2018 after preparation within the framework of the United Nations. Following four sessions of the Preparatory Committee, the UNGA decided in 2017 to convene an Intergovernmental Conference (IGC) under the auspices of the United Nations. The IGC was tasked to elaborate the text of an international legally binding instrument over the course of four negotiation rounds between 2018 and 2020; however, as no agreement was reached in the agreed time the negotiations continued with the last rounds held in August 2022 and March 2023. Agreement on the treaty text was reached in the last round, while a further session is required to review text after it has been translated into the six official UN languages and gone through a process of 'legal scrubbing' to ensure consistency across the text.

The elements forming the basis for the BBNJ Agreement are:

- Area-based management tools (ABMTs), including marine protected areas (MPAs);
- Environmental impact assessments (EIAs);
- Marine genetic resources (MGRs), including questions on access and benefit sharing; and
- Capacity building and the transfer of marine technology.

When concluded, the treaty will apply to nearly 60% of the Earth's surface and, potentially, close a critical gap in international ocean governance. Area-based management tools, including marine protected areas, will be one of the primary mechanisms by which to conserve biodiversity in ABNJ. The preparation and review of new ABMT proposals, and in particular decision-making and voting rules, will help to ensure that individual States cannot actively stifle decision making in regard to ABMTs. This is established in Art. 19bis on decision making in the Agreement which establishes that if no consensus can be reached decision making can still be made through voting procedures (UNGA, 2023). A critical issue to the success of ABMTs is the relationship of the treaty, and its implementation, with existing regulations and bodies (e.g., for fisheries or deep-sea minerals) with a mandate in ABNJ. It is important that the treaty must 'not undermine' existing regulations so that it respects the legal mandates of existing or potential legal instruments and bodies. Art. 19 on the establishment of area-based management tools sets out that the decisions through the treaty can be taken which are '*compatible with those adopted by relevant legal instrument and frameworks*' and '*where proposed measures are within the competencies of other (…) bodies make recommendations (…) to adopt relevant measures through such instruments'*. In other words, the BBNJ Agreement should help to create a framework by which States can cooperate and collaborate on cross-sectoral issues relevant to the conservation and sustainable use marine biodiversity in ABNJ (UNGA, 2023).

Thus, for the future treaty to be successfully implemented, it will require arrangements and mechanisms for communication and exchange between governing bodies and sectoral organisations. Such tools can underpin cross-sectoral exchange and enable complementary decision making. In particular, the Conference of the Parties (COP) and its subsidiary bodies established in the treaty require coordination mechanisms that would empower them to collaborate across organisations, sectors, and governance levels. Such mechanisms could include advisory bodies or multi-institutional working groups for issues related to the future BBNJ Agreement. Establishing a Preparatory Commission and interim working groups to prepare for the first COP and identify open issues left in the Agreement to be developed by the COP or one of its subsidiary bodies could begin once the treaty is adopted (Gjerde et al., 2022).

Environmental impact assessments (EIAs), within the BBNJ Agreement, should aim to ensure that proposed activities are assessed against agreed upon environmental criteria and thresholds. The agreed treaty text (March 2023) obliges States to conduct EIAs for activities that could have a potential impact on the marine environment taking place both within and beyond national jurisdiction (Art. 22) and provides thresholds and factors to guide States within their impact assessments (Art. 24). While the treaty allows for the EIAs to be conducted by national authorities based on national practices it creates a process by which States will need to report on and share information about the planned activity and potential environmental impacts, thereby enabling other States to register concerns and so that alternatives or mitigation measures can be pursued (Art. 30) (UNGA, 2023).

An integrated approach, through e.g., regional environmental assessments (REAs) together with strategic environmental assessments (SEAs) (included in Art. 41ter) can be used to provide broader information (i.e., beyond the activity level) (Gjerde et al., 2021) and include essential baseline information and context for EIAs. They can also support the development and application of strategies, action plans, and ABMTs that contribute to IOM (Gjerde et al., 2021). Their application can therefore help to underpin a shift away from single-sector approaches and support region-wide (e.g., Atlantic basin-scale) assessments of the state and health of the ocean.

Marine genetic resources (MGRs) include the marine genetic material of commercial interest such as, biotechnological applications (excluding commercial fish species)[2], often used for pharmaceuticals or cosmetics (Durussel et al., 2018). A critical sticking point during the negotiations, many countries, especially developing, consider that fair access to and the equitable distribution of the benefits arising from MGRs is essential for all States to participate in the long-term efforts of the BBNJ Agreement (Mohammed, 2017). This includes the access to and benefits from these resources (Collins et al., 2019). Access to MGRs, and associated data, could help to spur participation, inclusive innovation, capacity building, collaboration between actors and across regions, and provide a potential funding stream to take management and conservation action. The final agreement (March 2023) ensures the sharing of both monetary and non-monetary benefits from MGRs through Art. 11 Fair and equitable sharing of benefits. Non-monetary benefits include access to information such as MGR samples and collections as well digital sequence information (DSI). Monetary benefits shared through the Agreement are to be done through the established financial mechanism (Art. 52) and contribute to the overarching objective of the Agreement – the conservation and sustainable use of marine biodiversity. The specifics of the monetary benefit sharing shall be negotiated through the first Conference of the Parties and equal 50% of a Party's contribution to the overall budget (Art. 58.5e). In addition, the Agreement establishes (Art. 11bis) an access and benefit sharing committee 'as a means for establishing guidelines for benefit-sharing, in accordance with article 11, providing transparency and ensuring a fair and equitable sharing of both monetary and non-monetary benefits' (UNGA, 2023).

The Agreement provides a basis for enhancing capacity building and technology transfer to successfully implement the BBNJ Agreement. In particular, the Agreement provides an indicative list of the types of capacity building and technology transfer to be included (Art. 46) as well as a monitoring and review process (Art. 47) to assess activities taken under this part of the treaty (UNGA, 2023). Adequate capacity is considered a key enabling factor to understand the marine environment, make informed decisions, and develop adequate policies and management measures (Cicin-Sain et al., 2018). However, few States have the means and capacity to conduct research in ABNJ (Harden-Davies et al., 2022). But it is not just effort in the natural sciences that is required; improved understanding of the legal, political and management approaches available for governing ABNJ is also needed (Gjerde et al., 2022). To date, limited efforts have been aimed at building specific capacities relevant to the elaboration of management efforts in ABNJ and many efforts have remained limited in scope and provided short-term skill-building courses instead of creating long-term and self-sustaining educational programs (Hampton et al., 2022). The BBNJ Agreement offers an opportunity to not only boost existing capacity building efforts but also to establish new long-term initiatives by strengthening the international governance framework for capacity building, such as by ensuring steady funding and facilitating information-sharing (Hampton et al., 2022; Harden-Davies et al., 2022).

3.2.4 Convention on Biological Diversity

The 1992 Convention on Biological Diversity (CBD) came into force in 1993 and has since been ratified/acceded by 196 countries, providing a legally binding commitment for the conservation and sustainable use of biological diversity.

In addition, the CBD's Kunming-Montreal Global Biodiversity Framework (GBF), that replaced the 20 Aichi Biodiversity Targets for the CBD 2011-2020 Strategic Plan for Biodiversity, was adopted in December 2022 at CBD COP 15 in Montreal. The new plan, which extends the CBD's strategy until 2030 (in relation to targets) and 2050 in relation to goals, includes four overarching goals and 23 targets including to protect 30% of Earth's lands, oceans, coastal areas, inland waters (Target 3, commonly known as the 30x30 target). The GBF also includes additional targets for the restoration of degraded ecosystems (including marine),

[2] Commercial fish species are regulated under existing treaties and therefore excluded from the BBNJ Agreement. See Section 3.2.1.

reducing the risks of pollution, minimising the impact of climate change, including acidification and deoxygenation, and sustainably managing fisheries.

Within the CBD framework, in 2008 Parties adopted a set of scientific criteria to describe Ecologically or Biologically Significant marine Areas (EBSAs), with a view to provide the scientific knowledge and evidence base for enhanced protection or management by competent authorities. Some 338 EBSAs have been identified to date, including 24 EBSAs relevant to the iAtlantic project. The 17 most recently identified EBSAs in the NE Atlantic (see Figure 3) were described according to scientific and technical criteria set out by the EBSA process, based on available scientific data and evidence (including evidence compiled by the European ATLAS project). Within these areas, documented rates of biodiversity loss should highlight and inform the need for management measures.

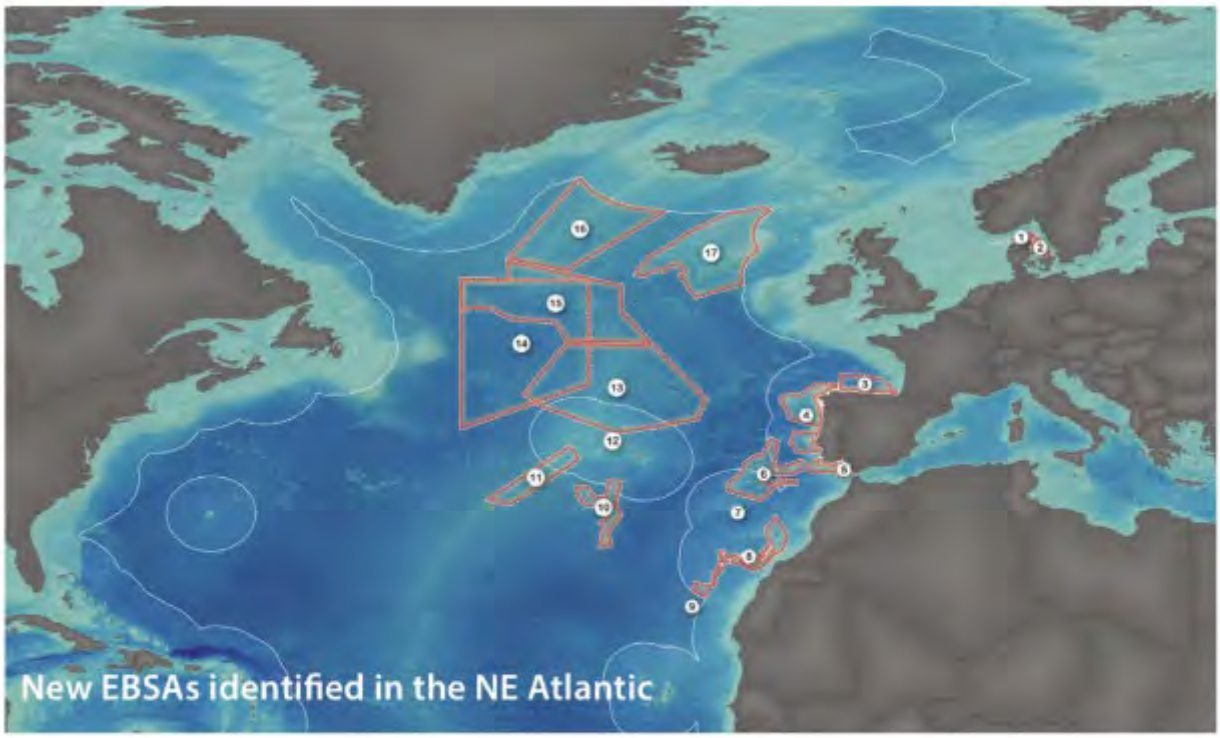

Figure 3: Location of the 17 newly approved EBSAs in the North-East Atlantic

Source: (GOBI, 2022)

3.2.5 United Nations Framework Convention on Climate Change

Ocean deoxygenation and acidification

The ocean plays a vital role in mitigating the full extent of climate change impacts, by absorbing excess heat and providing a sink for carbon emissions. Associated changes in seawater chemistry, however, have led to an increase in ocean acidity levels and oxygen loss, while simultaneously reducing the ocean's capacity of storing carbon dioxide and acting as a climate regulator. These changes have severe impacts on marine life, including deep-sea biodiversity and associated ecosystems (IPCC, 2022).

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overarching framework for intergovernmental efforts to cope with current and upcoming challenges from climate change. The Convention was adopted in 1992 and is the parent treaty to both the Kyoto Protocol (1997) and the Paris Agreement (2015). The Paris Agreement's central aim is to limit human-induced climate change by keeping the global average temperature rise to well below 2°C, preferably to 1.5°C, above pre-industrial levels. The overriding objective of all three agreements under the UNFCCC is to 'stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system' in a timeframe which allows ecosystems to adapt naturally and enables sustainable development (UNFCCC Art. 2.).

Mitigating ocean acidification requires global efforts to reduce atmospheric CO_2 emissions, including a combination of measures to reduce fossil fuel use, decarbonising the energy supply sector and carbon capture through enhancement of natural sinks and engineering techniques (Gattuso et al., 2018). However, it is important to note that because ocean acidification is considered a slow onset event it remains unclear whether it is best addressed as a concurrent problem to climate change, rather than as a mere consequence of it (Herr et al., 2014). This leaves ocean acidification in a legal grey zone (Baird et al., 2009). According to (Harrould-Kolieb, 2016) the perception of ocean acidification as a parallel threat to climate change explains why it receives little policy attention, as policies designed to focus solely on climate change will not necessarily integrate mitigation of ocean acidification. As a result, it is vital that ocean acidification be further incorporated into the policies and activities of the UNFCCC – and other environmental agreements (Downing, 2013; Oral, 2018).

The large-scale decrease of ocean oxygen as a result of climate change may not be reversible and needs to be mitigated by accelerating efforts from the international community to reduce greenhouse gasses that cause atmospheric and ocean warming (Laffoley and Baxter, 2019). The ocean has lost about 2% (or over 150 billion tons) of oxygen over the last 50 years (Levin et al., 2019). Deoxygenation causes significant harm to marine species, habitats, and ecosystems with small declines in oxygen leading to significant effects on biodiversity (Levin et al., 2019). However, ocean deoxygenation remains primarily a hidden threat to biodiversity loss and is often not included in policy and governance processes.

While not originally envisioned to address ocean acidification or deoxygenation, the UNFCCC is considered an appropriate regime to do so as it is already regulating carbon dioxide emissions and thus provides the framework that allows to integrate both ocean acidification and climate change in one forum (Oral, 2018). Ocean action under the UNFCCC slowly started to receive attention when the Chair of the Subsidiary Body for Scientific and Technological Advice (SBSTA) was tasked with establishing an ocean-climate dialogue to consider adaptation within this context. Parties to the COP and non-Party stakeholders were invited to submit inputs to inform this dialogue, which was held for the first time in December 2020 as a virtual meeting under the aegis of the SBSTA (UNFCCC, 2020). The summary report informed discussions at the COP26, where – in adopting the Glasgow Climate Pact – the ocean was officially integrated into all areas of work at the UNFCCC (COP26, 2022).

Since then, advances to integrate the ocean into the UN climate system, including ocean-based climate action at the national and international levels have moved slowly. At COP27, the Sharm el-Sheikh Implementation Plan established that 'the ocean and climate change dialogues will, from 2023, be facilitated by two co-facilitators, selected by Parties biennially, who will be responsible for deciding the topics for and conducting the dialogue, in consultation with Parties and observers, and preparing the informal summary report to be presented in conjunction with the subsequent session of the Conference of the Parties' (UNFCCC, 2022a). The Sharm el-Sheikh Implementation Plan further encourages '*Parties to consider, as appropriate, ocean-based action in their national climate goals and in the implementation of these goals, including but not limited to nationally determined contributions, long-term strategies and adaptation communications*.' (UNFCCC, 2022a). According to the 2022 synthesis report on the Nationally Determined Contributions (NDCs) under the Paris Agreement (UNFCCC, 2022b), there seems to be a growing mention of coastal and marine nature-based NDCs. However, the number of ecosystems that

have international guidelines for their inclusion in national greenhouse gas inventories is limited to three – mangrove forests, seagrass meadows, and saltmarshes (IPCC, 2014) – neglecting the fact that most marine habitats contribute to carbon uptake. Understanding and monitoring additional blue carbon ecosystems will improve GHG reporting (UNFCCC, 2022c) and increase the perceived value of these habitats, potentially increasing efforts to protect them.

Carbon dioxide removal

The ocean is often considered to offer opportunities to help tackle the climate crisis. This may be increasingly relevant, as the emission reduction pledges under the 2015 Paris Agreement are insufficient to keep global temperatures below necessary thresholds and thus additional actions are considered necessary (Lopez, 2021). In particular, the risk of failing to meet climate targets has increased interest in options for carbon capture and storage. Indeed, the emissions pathways identified in the IPCC Fifth Assessment Report for limiting warming to 1.5°C above pre-industrial levels assume some level of greenhouse gas removal, as do most of the IPCC's 2°C-consistent emissions pathways (Edenhofer et al., 2015). To account for sectors that are unlikely to be completely decarbonised, some propose that international climate change policy consider large-scale removal and sequestration of greenhouse gasses from the atmosphere. This will help to reach a balance between the amount of greenhouse gasses emitted and removed from the atmosphere in the second half of the century. However, this assumption is not unchallenged. The European Academies Science Advisory Council states 'Having reviewed the scientific evidence on several possible options for CO_2 removal using negative emission technologies (NETs), we conclude that these technologies offer only limited realistic potential to remove carbon from the atmosphere and not at the scale envisaged in some climate scenarios (as much as several gigatonnes of carbon each year post-2050)' (Courvoisier et al., 2018).

There are a variety of ocean-based carbon dioxide removal (CDR) techniques. They all aim to reduce CO_2 in the atmosphere, to capture and store CO_2 by means of ecosystem restoration, ocean fertilisation, modification of ocean chemistry and carbon dioxide storage (Webb et al., 2021). However, their effectiveness remains in question as few ocean-based carbon dioxide removal techniques have been tested outside a laboratory. The Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), in their high-level review of a wide range of proposed marine geoengineering techniques, concluded that for many marine geoengineering approaches the available knowledge is considered insufficient for evidence-based decision-making (GESAMP, 2019). However, policy decisions often must be made despite a lack of knowledge and certainty. But since the proposed marine carbon dioxide removal techniques would potentially have significant transboundary impacts, thus affecting the entire marine environment (GESAMP, 2019; Williamson, 2016; Williamson and Bodle, 2016), evaluating the adequacy of existing governance frameworks and potentially developing new ones remains highly relevant (McGee et al., 2018).

While there seems to be a growing interest in ocean-based climate mitigation action under the UNFCCC regimen (UNFCCC, 2022c), of the initial pledges to reduce emissions – the National Determined Contributions (NDCs) – only 27 discuss blue carbon mitigation contributions. Blue carbon mitigation actions encompass ocean carbon storage and the protection, replantation, or management of mangroves, salt marches, sea grass beds, or other marine ecosystems (GESAMP, 2019; Röschel et al., 2022).

4. Integrated Ocean Management for the Atlantic Ocean and contributions from iAtlantic research

This Chapter aims to provide several recommendations and possible governance improvements towards overcoming the challenges identified in Chapter 2 and 3 and propose ideas to shift towards IOM for the Atlantic region – and thereby help to create an ocean governance framework for the Atlantic region that is fit to address the dynamic changes facing the ocean. The recommendations therefore focus on the five

specific categories as identified in IOM (see section 1.3). In addition to these five specific categories of IOM, it is important to consider key enabling conditions that are also important to underpin progress. The IOM categories and enabling conditions will also have significant interplay between them, whereby improving or enhancing one could lead to progress in the others. Whilst it was not the aim to assess such enabling conditions for IOM or ocean governance more broadly, it is essential to acknowledge their importance. Enabling conditions include political will by decision makers, States, and governance institutions; sufficient and consistent financing and capacity for governance initiatives; participatory and inclusive approaches to ensure stakeholder engagement in governance processes; reliable and knowledge-based information and data, and transparent and reliable communication of decision making and other information.

This chapter also highlights several key findings from the iAtlantic project relevant to the governance and policy processes of the Atlantic region, as well as globally, as discussed in the previous chapters. iAtlantic research contributes new scientific knowledge and understanding of essential processes and functions of the Atlantic Ocean to improve management and conservation measures as well as drive innovation with in the region (Perez et al., 2023).[3] More specifically, iAtlantic research has focused on measuring Atlantic Ocean circulation, mapping Atlantic ecosystems, identifying the drivers of ecosystem change, and understanding the impacts of multiple stressors on Atlantic ecosystems in an effort to support sustainable ecosystem management and regional and capacity building.

4.1 Governance integration

- Establish and facilitate ocean governance arrangements and initiatives that build on existing arrangements and mechanisms (see Chapter 2) to increase collaboration and coordination and serves to identify opportunities for collective action to address common goals (e.g., CBD 30x30 target) and shared challenges (e.g., biodiversity loss, climate change including acidification and deoxygenation). This includes through the future BBNJ Agreement, UNFCCC and including key sectoral specific organisations such as fisheries (RFMOs) and deep-seabed mining (ISA and mining code).
- Take collective action for the ocean particularly through the integration of relevant targets and objectives for ocean pressures, taking special consideration for ocean challenges (acidification and deoxygenation) which may fall between existing or established governance processes to ensure these challenges do not 'slip through the crack'.
- Employ existing tools and mechanisms such as REMPS, within the auspices of the ISA, EBSAs, within CBD, or MCS more broadly to link existing processes and governance challenges, thereby broadening the scope of their application beyond single sectors or impacts.

4.1.1 Contributions from iAtlantic research

Research outputs from the iAtlantic project are highly important for establishing and improving management and conservation measures within the Atlantic region. This is particularly relevant when considering spatial management measures, as impacts on ocean ecosystems are spatially heterogenous and thus require site-specific management approaches. In this regard, effective area-based management, including MSP and MPAs, depend on sufficient accurate baseline data and clear objectives that consider the diversity of stakeholder interests. Under conditions of change, modelling and forecasting developments for specific scenarios becomes ever more relevant to identify suitable management approaches and initiate action. For example, such findings will be especially relevant when considering the

[3] For additional information please visit the iAtlantic website for all relevant publications under the project, check out the webinar series, or consult the recent Perspective paper outlining a blueprint approach to basin-wide ecosystem assessment, which is exemplified in iAtlantic.

identification and establishment of ABMTs in the Atlantic through the future BBNJ agreement or when considering REMPs within the scope of the ISA.

It is important to understand the potential contribution to ocean health of implementing management and conservation measures within the Atlantic region. Brito (2021) evaluated the ecosystem-wide effects of MPAs in deep-sea ecosystems of the Atlantic, under the objective of, by 2040, rebuilding fish stocks of commercially important deep-sea benthic species in the Azores to the level prior to 1990. The study indicates that the implementation of 'no-take areas', while simultaneously maintaining current levels of fishing efforts, may have limited positive effects on the overall ecosystem and potential detrimental effects on some coastal fish stocks. The benefits of an MPA are expected to spill over into surrounding areas, but if fishing activities merely shift towards these areas, potential negative effects on circumjacent areas might outweigh the positive effects of an MPA. These evaluations and modelling help to assess what management actions are needed to prevent these – across regulatory borders. These insights are highly relevant to evaluate the effectiveness of MPA networks (such as through the BBNJ Agreement) and can contribute to the identification of suitable indicators of effectiveness and ultimately help to inform MPA decisions such as in regard to the 30X30 target – to protect 30% of the Ocean by 2030 under the CBD.

Building from research in the European ATLAS project, Combes et al. (2021) created a framework for systematic conservation planning applicable to the deep sea across the North Atlantic, focussing on the identification of conservation priority networks for VMEs. Their results show that 'continental margin slopes, the Mid-Atlantic Ridge, and deeper areas of large and productive shelves housing fishing grounds appeared as crucial zones for preserving the deep-sea biodiversity of the North Atlantic'. They specifically highlighted how conservation objectives could only be achieved if currently exploited fishing areas and deep seabed mining exploration licence areas were integrated into the identified priority network. Van Denderen et al. (2022) identified management options for protecting VMEs through the EU's 'deep-sea access regulations'. Based on data-driven scenarios, their results showed that the management approach and outcome will depend on the desired level of risk aversion in protecting VMEs and on the importance of avoiding socio-economic restrictions such as creating numerous small closure sites as opposed to fewer large sites. The work contributes to ongoing efforts to facilitate basin-scale conservation networks via marine spatial planning and is directly relevant to inform the ABNJ negotiations and ISA REMP design, including possible future exploitation licencing.

4.2 Stakeholder integration

- Create a shared Atlantic vision to address interlinked challenges and adopt complementary policy objectives, targets, and timelines. Such a shared vision will help to agree upon goals, roles, and actions across different groups of stakeholders, sectors, and existing governance arrangements. This should build on existing and ongoing governance processes (e.g., BBNJ Agreement; ISA; FAO and RFMOs; CBD; 2030 Agenda for Sustainable Development) and be developed through an inclusive and transparent stakeholder process.

- Building on the creation of a shared Atlantic vision, establishing an independent stakeholder platform, including diverse stakeholders from across the Atlantic would support engagement in planning, decision-making, and managing governance initiatives as well as IOM strategies within the region. Such a platform would also support joint learning processes and knowledge exchange across different sectors and stakeholder groups to help inform governance discussions.

4.2.1 Contributions from iAtlantic research

Within the iAtlantic project, efforts towards transparent ocean basin-scale management scenarios for the whole Atlantic, as well as regional case studies, are currently underway (please check the iAtlantic website for updated information). The scenarios can support the creation of a joint vision and offer a basis for exploring different management decisions, evaluating the resulting impacts across a set of pre-defined

policy targets e.g., through the iAtlantic Systematic Conservation Planning (SCP) prioritisation approach and scenario development. SCP can support the transparent and inclusive development of ABMTs by helping to identify the necessary actions needed to achieve a defined set of objectives. iAtlantic builds on previous work from the ATLAS Project in the North Atlantic and in the Azores, where SCP approaches at the North Atlantic spatial scale were developed, to inform the identification of priority areas for the conservation of Vulnerable Marine Ecosystems (Combes et al., 2019). Based on sustainable management and conservation objectives identified within political commitments, declarations and legal obligations related to the Atlantic marine environment, an iAtlantic SCP exercise will be conducted (Morato, 2021). The exercise aims to establish a SCP framework tailored to the deep-sea environment and is currently open for stakeholder consultation.

4.3 Knowledge integration

- An Atlantic-wide knowledge and capacity needs assessment building on the findings of iAtlantic and other research projects (e.g., ATLAS, All Atlantic Ocean Research Community, Atlantic Ocean Research Alliance (AORA), AquaVitae, TRIATLAS, SO-CHIC, AtlantECO, ASTRAL, AtlantOS, EuroSea, and NAUTILOS) and including natural sciences, social sciences, law, governance, policy, and management as well as traditional forms of knowledge should be conducted to map existing knowledge and capacity, including gaps, and form the basis for establishing future research and capacity initiatives. Such an assessment can be underpinned through the capacity building component of the future BBNJ Agreement and other policy processes such as the UN Decade of Ocean Science.

- Ensuring that existing and future data (and datasets) are Findable, Accessible, Interoperable and Reusable (FAIR) will be necessary to ensure that information is obtainable and useful to governance processes and decision makers. This includes ensuring that data, including for MGRs, can be identified (i.e., unique identifier), of high quality, and that available data sets are aligned and appropriately linked across the Atlantic research realm. In addition to the iAtlantic Geonode (https://www.geonode.iatlantic.eu/), iAtlantic is spearheading an Atlantic Community GEOSS data portal through Task 7.5 that will provide new means to search relevant datasets across multiple repositories.

- Creating a shared Atlantic knowledge base (e.g., across research, institutions, governing bodies) through regional scientific cooperation and exchange of research findings, data, and information, including traditional, indigenous, and local knowledge (e.g., through cross-sectoral working groups), is imperative to improve understanding of Atlantic ecosystem dynamics including climate change, pressures, and threats from human activities. Including information on governance and policy arrangements can also help to provide a common understanding for improving existing governance arrangements and creating tailored management solutions for the region. It will also be important to establish improved and integrated ways for scientists and researchers to work together – across disciplines, and methods, and establish new ways of thinking and learning – including increasing involvement from the Global South.

- Building on a shared knowledge base, a science-policy-society interface comprising key Atlantic actors is necessary to help identify information needs and effectively transfer research findings into evidence-based decision making. Such an interface could also include common repositories for data and information, potentially through the Clearing House Mechanism established through the BBNJ Agreement.

- Investing in understanding new technologies such as carbon dioxide removal or emerging pressures such as deep-seabed mining within the Atlantic should be a top priority to establish a robust knowledge base before activities take place. Enhanced understanding about potentially significant transboundary impacts affecting the marine environment is needed, and the evaluation

of the adequacy of existing governance frameworks or potentially developing new ones remains highly relevant.

4.3.1 Contributions from iAtlantic research

The limited availability of information and data on deep-sea ecosystems hinders the assessment of environmental status the deep sea – necessary to identify priorities for management measures as well as monitor and assess progress made with existing policy measures. With this in mind, Orejas et al. (2020) assessed existing international frameworks that address the conservation and protection of biodiversity in the deep sea in ABNJ (OSPAR Ecosystem Assessments, UNGA Significant Adverse Impacts, and CBD Safe Ecological Limits), comparing it with the European Marine Strategy Framework Directive (MSFD). As a result, they highlighted the challenges of the descriptors and indicators when applied to the deep sea and proposed a set of new indicators. Such a common set descriptors and indicators could be highly useful for identifying shared challenges and developing joint actions to key Atlantic challenges which span stakeholder groups and ocean governance processes.

In an aquarium-based experiment investigating the tissue regeneration of a cold-water coral in response to simulated IPCC climate change scenarios, eight distinct variations of temperature, dissolved oxygen levels, and pH are being utilised to assess the effects of multiple stressors. The study involves the deliberate infliction of a wound on the coral, followed by the monitoring of the wound and its subsequent regeneration using photogrammetry techniques (iAtlantic, 2022b). Examining the effects of multiple stressors, as opposed to singular stressor in isolation, can provide valuable insights that have implications for a wide range of stakeholders and could serve as a catalyst for inspiring collaborative efforts towards a common goal – or at least a set of joint objectives.

Additional contributions to support effective management of the Atlantic are made through data sharing. By contributing to open access data platforms, standardising South and North Atlantic Ocean observations, and the development of easy-to-use interfaces for all stakeholders to consult the data, e.g. the GEOSS All-Atlantic Ocean Data Community site, iAtlantic facilitates a new level of data sharing and supports policy communication. The provision of deep-sea images and live streams, maps, and 3D models of specific habitats support stakeholder understanding. By extending information and data gathering in ocean science to a diversity of knowledge from beyond the scientific community, such as NGOs, citizen science, and indigenous and local communities the iAtlantic project supports the objectives of the UN Decade of Ocean Science for Sustainable Development (2021-2030).The iAtlantic Diverse Knowledge Systems Working Group continuously undertakes efforts to obtain and integrate previously privately held data(sets) from different ocean sectors such as marine tourism, fisheries and energy to include industry and societal needs, and to serve coastal communities' and local interests (iAtlantic, 2022c).

The technological advances driven by the project, such as the development of the Azor drift-cam, which enables a low investment visual exploration of deep-sea benthic habitats up to 1,000 m depth (Dominguez-Carrió et al., 2021) and helps to make the acquisition of data more accessible to low funded researchers. As the drift can may be deployed from non-specialist vessels and because it allows for rapid assessments of deep seabed areas along vide spatial extents it can support developing States to survey their national waters, monitor protected areas and identify ecologically relevant locations.

Based on the FAIR-framework, Schoening et al. (2022) explored the use of image FAIR Digital Objects and how to create, validate, manage and store visual data to reduce management and create dataset consistency.

4.4 Transboundary integration

- Interactive and cumulative effects of multiple pressures must be addressed through integrated approaches that consider the ocean as well as land-based pressures. The use of environmental

assessments (EIAs, SEAs, and REAs), can help to establish baseline information including for transboundary, activities, pressures and impacts and therefore help to inform the identification and design of management approaches such as ABMTs, including MPAs. In particular, the future BBNJ Agreement can act as a platform for convening organisations and actors to create joint environmental assessments for the Atlantic region.

- Information and data on connectivity should be considered in the development of conservation measures for the Atlantic region to include temporal and spatial dynamics for identifying and establishing conservation measures such as ABMTs, including MPAs. Supporting research to contribute to the development of comprehensive indicators for understanding and assessing connectivity within the region (and beyond), can help to underpin decision making and monitoring of management measures.

4.4.1 Contributions from iAtlantic research

Burmeister and Jones (2021) examined the various physical properties, such as circulation patterns, water temperature, salinity and extreme events at present state and extrapolated oceanographic trends to 2070. Their work establishes a 3D view of the Atlantic Ocean, as data was collected throughout ocean depth. Work like this supports efforts to assess ecosystem health and identify governance strategies and ocean actions that will maintain ecosystem health and connectivity of the dynamic regime present in the Atlantic Ocean. The computational power of the sophisticated computer model VIKING20X allowed iAtlantic to integrate hundreds of parameters to simulate the complex currents and hydrography on the North Atlantic on a few kilometre grid (Jackson et al., 2022). These data can be used to create ultra-high resolution regional models to inform studies on spatial distribution of deep-sea organisms and ecosystem connectivity. Continuous monitoring efforts are the best strategy to analyse ongoing and predict future changes in the variability of the AMOC. From these models, further predictions on habitat and species distribution can be made, avoiding the need to rely on primary data which is difficult to obtain over time and scale in the open and deep ocean.

iAtlantic research has explored shipwrecks to understand population and habitat connections which might otherwise not be possible. In this regard, the Titanic shipwreck, which is outside national jurisdictions, has provided iAtlantic researchers the opportunity to study its role in marine connectivity, demonstrating the role of Mesoscale ocean eddies in determining the dispersal and connectivity of corals (iAtlantic, 2023; Schulzki et al., 2023 in submission).

Climate-adaptive fisheries management requires information on climate-driven shifts in species distribution and abundance, to inform sustainable catch-rates across jurisdictional boarders, as populations might shift into new areas. Perez and Sant'Ana (2022) collected historical catch data and extrapolating trends regarding commercially exploited fish stocks in the Southwest Atlantic, specifically off the Brazilian coast, supporting regional fisheries-related decision-making.

iAtlantic research was also dedicated to studying the impacts of multiple stressors on Atlantic ecosystems (Roberts et al., 2023), including ocean warming, acidification, reduced oxygen, increased salinity and lower food quality, as well as sediment plumes (Carreiro-Silva et al., 2022; Hennige et al., 2020; Morato et al., 2022).

4.5 System integration

- Research and scientific programmes should, in particular, focus on developing tools, methods and approaches which bridge scientific fields and areas of expertise in order to advance understanding and assessments of the complex and interconnected system relevant for the Atlantic Ocean and especially for emerging challenges such as acidification or deoxygenation where little is known and taken up into policy processes.

- Long-term financing should be established for programmes which foster understanding between shifting ocean dynamics and the knowledge, tools (e.g., models), and management responses available to best address Atlantic challenges.

- States and stakeholders should foster an all-Atlantic governance approach which aims to integrate complex, systems dynamics into decision-making. For example, management organisations should be equipped to respond effectively and efficiently to observed or expected systems changes, based on a growing knowledge- and database.

4.5.1 Contributions from iAtlantic research

Regarding the deep-sea, the scarcity of data to establish baseline information has been mentioned repeatedly as impeding the identification of robust governance strategies and management priorities. Across scales and water depth, the iAtlantic project has gathered and compiled data on e.g. ocean circulation (Burmeister and Jones, 2021; Chidichimo et al., 2023), habitat-building cold water corals (Carreiro-Silva et al., 2022; Price et al., 2021), hydrothermal vent communities (Marticorena et al., 2021), pelagic taxa (Hoving et al., 2020), and more.

Thse data can inform policy discussions and support for example the development of guidelines for REMPs at the ISA. Feeding this data into models allows for predictive habitat mapping, which can be applied in a diversity of management applications, such as designation of MPAs (e.g., through the BBNJ Agreement or RFMOs) or forecasting the impacts of climate change on specific species (e.g., for application within UNFCCC).

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