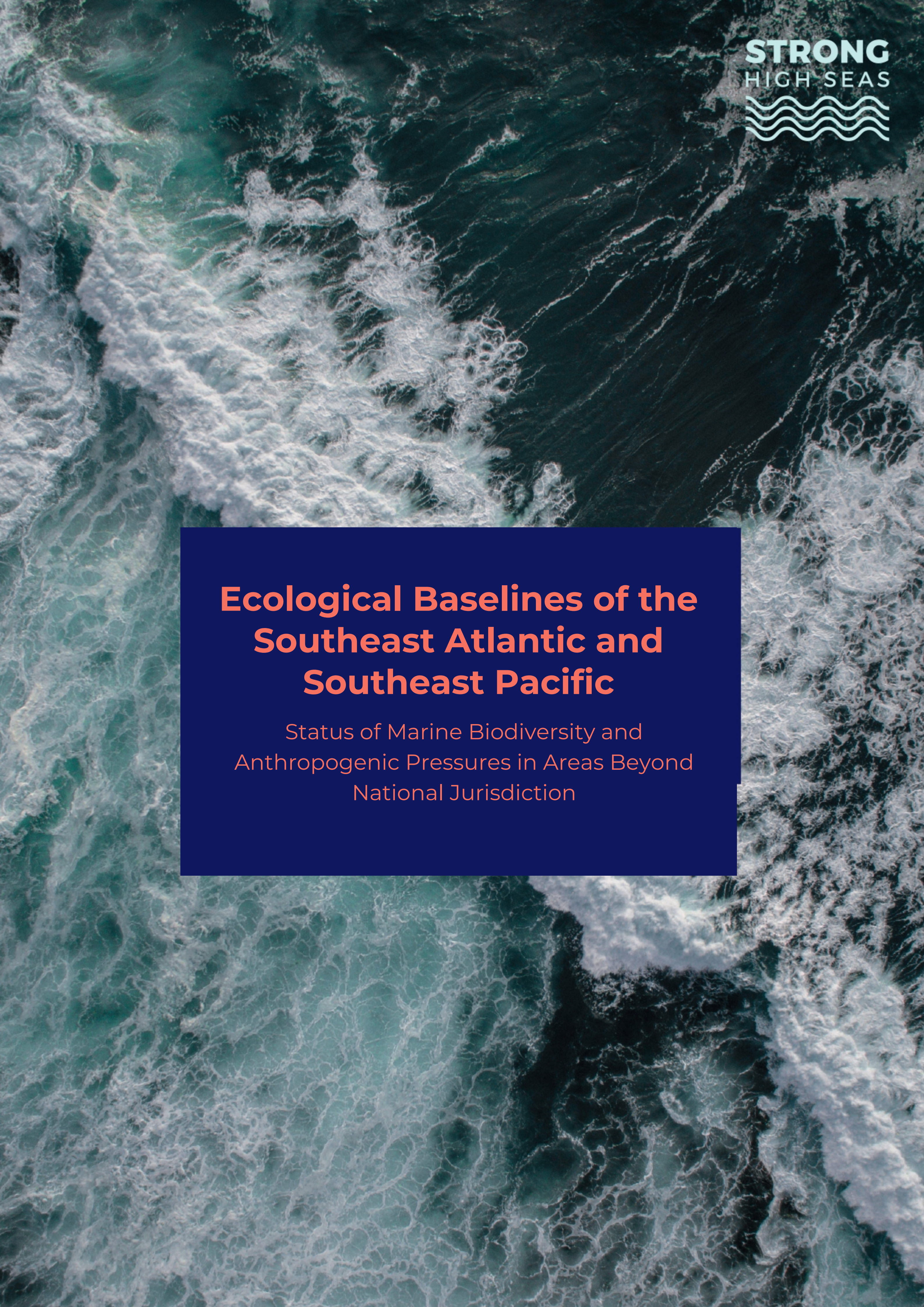

STRONG HIGH SEAS

Ecological Baselines of the Southeast Atlantic and Southeast Pacific

Status of Marine Biodiversity and Anthropogenic Pressures in Areas Beyond National Jurisdiction

Citation

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Abbreviations

Acronym	Full name
ABMT	Area-based Management Tool
ABNJ	Areas Beyond National Jurisdiction
ACC	Antarctic Circumpolar Current
AMD	Anthropogenic Marine Debris
AMO	Atlantic Multidecadal Oscillation
APEI	Area of Particular Environmental Interest
BBNJ	Biodiversity Beyond National Jurisdiction
BCLME	Benguela Current Large Marine Ecosystem
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CBD	Convention on Biological Diversity
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CECAF	Fishery Committee for the Eastern Central Atlantic
CIMAR	Centro de Investigación en Ciencias del Mar y Limnología de la Universidad de Costa Rica / University of Costa Rica's Ocean Science and Limnology Research Centre
CMM	Conservation and Management Measure
COP	Conference of the Parties
CPA	Circumpolar Antarctic Current
CPPS	Comisión Permanente del Pacífico Sur / Permanent Commission for the South Pacific
CR	Critically Endangered
CZCIGC	Convergence Zone of the Canary Islands-Guinea Currents
DOC	Dissolved Organic Carbon
DON	Dissolved Organic Nitrogen
DSCC	Deep Sea Conservation Coalition
DSM	Deep Sea Mining
EBSA	Ecologically or Biologically Significant Marine Area
EEZ	Exclusive Economic Zone
EHPZ	Equatorial High Productivity Zone
EIA	Environmental Impact Assessment
ENSO	El Niño–Southern Oscillation
ETP	Eastern Tropical Pacific Ocean
ETPA	Equatorial Tuna Production Area
ESSW	Equatorial Sub Surface Water
EU	European Union
FAD	Fish Aggregating Devices
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
GOBI	Global Ocean Biodiversity Initiative
GPA	Global Programme of Action
IATTC	Inter-American Tropical Tuna Commission
IBA	Important Bird and Biodiversity Area
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICMMPA	International Committee on Marine Mammal Protected Areas
IGC	Intergovernmental Conference
IKI	International Climate Initiative
IMMA	Important Marine Mammal Area
IMMS	International Marine Minerals Society
IMO	International Maritime Organization
IOC-UNESCO	Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization
IPOA	International Plan of Action
ISA	International Seabed Authority
IUU	Illegal, Unreported and Unregulated (Fishing)
IUCN	International Union for Conservation of Nature

Acronym	Full name
KBA	Key Biodiversity Area
LBSA	Land-based Sources and Activities
LME	Large Marine Ecosystem
MARPOL	International Convention for the Prevention of Pollution from Ships
MGR	Marine Genetic Resource
MIDAS	Managing Impacts of Deep-seA reSource exploitation
MMPATF	Marine Mammal Protected Areas Task Force
MPA	Marine Protected Areas
MSY	Maximum Sustainable Yield
NAO	North Atlantic Oscillation
NOA	Associated devices (for fishing)
NOAA	National Oceanic and Atmospheric Administration
OBIS	Ocean Biogeographic Information System
OBJ	Floating object devices (for fishing)
OMZ	Oxygen Minimum Zone
OSPAR	Oslo-Paris (OSPAR) Convention for the Protection of the Marine Environment of the North-East Atlantic
PROG	Partnership for Regional Ocean Governance
PSSA	Particularly Sensitive Sea Area
REMP	Regional Environmental Management Plan
RFMO	Regional Fisheries Management Organisation
SBSTTA	Subsidiary Body on Scientific, Technical and Technological Advice
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SEAFO	South East Atlantic Fisheries Organization
SGNR	Salas y Gómez and Nazca Ridge
SMS	Seafloor Massive Sulphide
SPRFMO	South Pacific Regional Fisheries Management Organisation
SPSG	South Pacific Subtropical Gyre
SSC	Species Survival Commission
STCZ	Subtropical Convergence Zone
SPG	South Pacific Gyre
TEU	Twenty-foot Equivalent Unit
UCN	Universidad Católica del Norte
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEA	United Nations Environment Assembly
UN Environment	United Nations Environment Programme
UNEP-WCMC	UN Environment World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNICPOLOS	United Nations Open-Ended Informal Consultative Process on Oceans and the Law of the Sea
US	United States
VME	Vulnerable Marine Ecosystem
WCPA	World Commission on Protected Areas
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation
WWF	World Wide Fund for Nature (US, Canada: World Wildlife Fund)

Executive Summary

The primary aim of the report – *Ecological Baselines of the Southeast Atlantic and Southeast Pacific - Status of Marine Biodiversity and Anthropogenic Pressures in Areas Beyond National Jurisdiction* – is to provide decision makers with relevant and useful information on the current status of the marine environment in areas beyond national jurisdiction (ABNJ), both in the Southeast Pacific and the Southeast Atlantic, as well as highlight key pressures placed upon it by human activities. Such information is intended to support decision makers with improved understanding of the functioning and importance of ecological features of ABNJ and their contribution to global human wellbeing.

The following summarises **the major findings from the assessment in regard to status of key biodiversity features** in the Southeast Atlantic and Southeast Pacific:

Areas of Special Ecological Importance

Area-based Management Tools (ABMT) to regulate activities have long been used as a mechanism for conserving and protecting biodiversity and include Particularly Sensitive Sea Areas (PSSAs; for shipping), Vulnerable Marine Ecosystems (VMEs; for fishing) and Areas of Particular Environmental Importance (APEIs; for deep-sea mining). There also exist spatial tools which are focussed on highlighting biodiversity and are used to indicate areas with special ecological importance, including Ecologically or Biologically Significant Marine Areas (EBSAs), Key Biodiversity Areas (KBAs), Important Bird and Biodiversity Areas (IBAs), and Important Marine Mammal Areas (IMMAs), which have already been applied in the study areas – and could also be used to inform the international process on a legally-binding instrument for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (BBNJ process), or other processes, and contribute to the identification of sites for formal protection in ABNJ. Although there exist gaps in knowledge, additional areas of special ecological importance could be identified in the future, further contributing towards a comprehensive and appropriately representative network of sites for protection in ABNJ.

Areas of Special Geological Importance

The deep seabed in ABNJ (commonly referred to as 'the Area') of both the Southeast Atlantic and the Southeast Pacific contains a range of areas of geological importance, in particular seamounts, hydrothermal vents and manganese nodule fields. These geological features are associated with different types of marine mineral resources, in particular: (i) polymetallic manganese nodules, (ii) cobalt-rich ferromanganese crusts, and (iii) polymetallic sulphides. While exploitation of these marine mineral resources may – under certain circumstances – allow for the generation of short-term direct economic value, the geological features themselves provide diverse long-term value for ecosystem processes, habitats and species. Knowledge gaps remain regarding the complex ecological and biogeochemical processes and interactions between geological features and biological systems in the deep ocean. Any large-scale mining of marine mineral resources from the deep seabed is expected to have severe and long-lasting impacts on the marine environment. As of today, no commercial exploitation of marine mineral resources from the deep seabed is taking place in the Area of the Southeast Atlantic or the Southeast Pacific. There is an ongoing process under the auspices of the International Seabed Authority (ISA) to develop a regulatory framework for the exploitation of marine mineral resources in the Area.[1] This regulatory framework is considered to be a prerequisite before any commercial mining activity could start in the Area. In addition, efforts are underway at the ISA towards developing a regional environmental management plan (REMP) for the Southeast Atlantic region.

Seabed Habitats (Benthic)

The Southeast Atlantic contains about 25 % of Earth's seamounts and an important number of hydrothermal vent fields. While it is still largely unexplored, some 3,412 active hydrothermal vents have been observed while 7,629 are expected to exist. Similarly, 700 seamounts have been predicted while only a small fraction has been explored. Hydrothermal vent fields in the Southeast Atlantic are located along the Mid-Atlantic Ridge, while seamounts are especially abundant at the Mid-Atlantic Ridge, the Walvis Ridge and the Guinea Rise. The Southeast Pacific is the only area of the Pacific Ocean fenced off by a ridge system, which has the Earth's fastest spreading rate. Hydrothermal vent fields occur at least at three spreading zones of the Southeast Pacific: the Galapagos Rift, the Southeast Pacific Rise and the Pacific-Antarctic Ridge. The Southeast Pacific seafloor presents high levels of volcanic activity testified by a high number of seamounts. Seamounts form biological hotspots with a distinct, abundant and diverse fauna therefore providing important feeding grounds for numerous species as well as supporting fisheries. Hydrothermal vent fields provide habitats for communities, which generally present low levels of diversity but high levels of diversity unique to a specific community (endemicity) as well as high biomass.

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[1] The "Area" refers to "The seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction." (cf. United Nations Convention on the Law of the Sea (UNCLOS) 1982, Article 1).

Water Column Habitats (Pelagic)

ABNJ of the Southeast Atlantic and Southeast Pacific share the main broad distribution of oceanographic systems. However, scales and amplitude of variability differ between systems within and between basins, in spite of atmospheric and/or ocean connections. The genetic potential of marine bacteria metabolism in surface and deep waters is just beginning to be understood by scientists, leading to previous understandings of paradigms of productivity pathways and controls to be challenged. Studies on biotechnological applications derived from bacterial and archaea genomes for biomining or greenhouse gases consumption/sequestration are increasing.

Fish

Highly migratory fish stocks are found both within exclusive economic zones (EEZs) and the adjacent ABNJ. Connectivity of fish stocks between EEZs and ABNJ is relatively poorly described for many stocks, increasing the risk of negative effects due to overfishing and other stock-impacting activities in ABNJ to coastal countries. There is a loss of genetic diversity due to the exploitation of fish in vulnerable ecosystems (e.g. seamounts) or other resource exploitation (e.g. mining, energy), which may cause damage to habitats or feeding grounds. Information regarding commercial fish species is far greater than that available for species that do not have commercial interest, making assessments challenging.

Marine Mammals and Sea Turtles

The Southeast Atlantic and the Southeast Pacific regions are important areas for the migratory movements of marine megafauna, including sea turtles and marine mammals. The interaction of the different fishing and ship traffic activities in these regions, which coincide with the migratory movements of these megafauna, poses a serious risk to these vulnerable species. The availability of new and cheaper technologies along with the participation of networks of scientists working in these regions will support the monitoring of these populations of marine megafauna in an effort to develop regional strategies for their protection.

Seabirds

Seabirds are amongst the most threatened groups of birds, with all the species found consistently in ABNJ waters exhibiting highly migratory movements, bringing them into contact with a huge diversity of fishing fleets. Accidental mortality from fishing (bycatch) is the single biggest threat to seabirds in ABNJ. The huge areas that seabirds typically cover on migrations, often spanning entire ocean basins, makes area-based management tools (ABMTs) a very challenging proposition, unless management measures can be both enacted and enforced across vast areas, which currently is not considered possible.

The following summarises the **major findings from the assessment in regard to key pressures on biodiversity** in the Southeast Atlantic and Southeast Pacific:

Extraction of Fish and Species Removal

The most significant activity in terms of the volume of extraction of both fish and other non-fish species in ABNJ is due to commercial fishing. Tuna account for 61 % of global catches in ABNJ, while non-tuna pelagic fishes account for 26 % of total catches and pelagic squids for 7 % of total catches. Other main target species in ABNJ include blue shark and billfish (swordfish, marlin), and oilfish. Fishing in ABNJ in the Southeast Atlantic and Southeast Pacific began in the 1950s and 1960s, respectively, and grew significantly before decreasing around 2000. Nevertheless, the selective extraction of fish remains a significant pressure in both the Southeast Pacific and Southeast Atlantic. ABNJ are in general less productive than the EEZs and provide only for the global 4.2 % of the annual marine capture fisheries. Measurable reductions in marine species abundance or stock levels mean that ecosystem modification is occurring, including possible complex trophic web interactions.

Physical Disturbance to and Destruction of the Seabed

The main pressures leading to the physical disturbance and destruction of the seabed are deep-sea fishing (bottom trawling), the laying of underwater cables, and deep sea mining. Fishing in the Southeast Atlantic and Southeast Pacific is predominantly done by purse seines and longlines, which cause limited or negligible disturbance or destruction of the seabed. Underwater cables for communication and information exchange are minimally distributed throughout the Southeast Atlantic and Southeast Pacific compared to other ocean spaces. The pressure extending from this activity is primarily the result of the lying or construction phase, while the pressure is negligible once the cable is in position. Several areas in ABNJ in both the Southeast Atlantic and Southeast Pacific contain important geological features with potentially commercially valuable marine mineral resources. While there is currently no deep-sea mining taking place in ABNJ of the Southeast

Atlantic and the Southeast Pacific, if opened up for exploitation, it is likely to create significant pressure on the benthic environment, potentially extending to the pelagic zone as a result of the associated sediment plume.

Marine Pollution

Marine pollution is a major threat to marine biodiversity – key sources include land-based activities (approximately 80 %), shipping and mining. Contaminants of concern in ABNJ include hazardous substances (e.g. heavy metals, pesticides), suspended solids, hydrocarbons and marine litter (primarily plastics and micro-plastics). Hazardous substances in ABNJ, including heavy metals such as mercury, have been detected in deep sea fish and tributyltins (organotin compounds commonly found in materials such as anti-fouling ship paints), and are also present in sediments along busy shipping lanes as well as ports. Marine debris – especially plastic – is transported by winds and currents and there is strong evidence that there are areas of concentrated debris in both the South Pacific Subtropical Gyre and the South Atlantic Gyre. Heavier debris, or debris that has accumulated weight from organisms settling on it, sinks and has been reported in numerous deep-sea areas, including some in the Southeast Atlantic and Southeast Pacific. Marine debris poses a threat for marine life, primarily through entanglement and ingestion, with impacts reported for several taxonomic groups across the Southeast Atlantic and Southeast Pacific. Marine debris is also a vector for the translocation of alien species across the oceans. Information on pollution levels in the study areas as well as the adjacent coastal areas is limited. Nevertheless, there is sufficient information to suggest that ABNJ are contaminated with a range of pollutants. Although deep-sea mining is still in its infancy and there is a limited understanding of potential impacts, it is likely that mining activities will result in plumes of suspended material and the release of potentially toxic elements which could travel significant distances in the plumes.

Underwater Energy

The pressure of underwater energy is at present mainly underwater noise. Main activities generating underwater noise in ABNJ are related to maritime transport, including cargo shipping, fishing, or passenger vessels, and military exercises, as well as potentially oil and gas exploration and exploitation, although not currently happening in ABNJ. There exists a range of adverse effects on marine species due to underwater noise, including interference with key biological functions such as communication, foraging, reproduction, navigation, and predator avoidance. Shipping traffic and land-based activities will grow in the future in response to increases in the global population and global trade and it will be a challenge to prevent ABNJ from becoming polluted further. The global container shipping industry is a major source of underwater noise and is forecasted to grow substantially in future decades, potentially leading to increased levels of underwater noise. Although limited data is available to assess the cumulative impacts of energy and underwater noise emissions into the marine environment, including in ABNJ of the Southeast Pacific and Southeast Atlantic, scientific assessments increasingly indicate its significant impact on the marine environment.

Climate Change

Climate scenarios indicate that the largest uncertainty regarding future trends for ocean conditions is found for the Southeast Pacific, where the least ocean warming has taken place so far, and is expected to remain among the slower sites to heat, while the contrary would be true for the Southeast Atlantic. The frequency and strength of regional and teleconnected events such as El Niño is "feared" to increase. While the cold water signature of open ocean equatorial upwelling would decrease, so would primary productivity at low latitudes. The along-shore transition zone between the coastal upwelling areas and offshore waters will likely extend and become more energetic, enhancing coastal-oceanic exchange and allochthonous input of organic matter and nutrients into ABNJ by lateral advection. Re-distribution of fish stocks are expected to shift towards higher latitudes as the climate warms, leading to changes in metabolism that would impact life cycles and rates such as faster growth and lower maximum size. However, the response to temperature would be modulated by other stressors such as acidification. Overall, fisheries production is not expected to decrease below 10 % due to climate change, although fisheries pressure scenarios would dramatically affect the figure for particular species, and some species are expected to entirely disappear – from both low and high latitudes. Nevertheless, predictions are mainly based on present day observable characteristics and relationships with the oceanographic environment. Thus, the underlying intra-specific genetic variability could produce unexpected results and large uncertainty regarding overall impact on productivity. At present, science is not aware of the genetic capacity to adapt and co-adapt to extreme environments.

1. Introduction

The ocean covers more than 70 % of the planet and is a vital support system for all life. It regulates the global climate and provides essential resources and ecosystem services, hosting immense biodiversity and a diverse array of economic activities such as fisheries, offshore oil and gas, international trade, and recreational and cultural activities. Areas beyond national jurisdiction (ABNJ) include the water column (the high seas) and the seabed (the Area) outside of the exclusive economic zone (EEZ) of coastal states. ABNJ cover about half of the Earth's surface and host a significant portion of global biodiversity. The ocean contains unique biological communities associated with topographic features such as seamounts and particularly those associated with active tectonic activities, such as hydrothermal vents and cold seeps. It also provides manifold habitats both on the seafloor and in the water column for species ranging from microorganisms to fish, turtles, sharks, whales, and supports seabirds that spend a significant time in ABNJ searching for food. It enables a range of important functions in ocean ecosystems and climatic processes (Snelgrove, 1999) as well as absorbing and storing CO_2 from the atmosphere. Many of these ecosystems, ecological features and marine species naturally span waters within and beyond national jurisdiction.

Pressure on marine biodiversity in ABNJ is largely caused by intensifying human activities, such as fishing and shipping, but also activities within the EEZs and along the coasts, such as oil and gas extraction, port development, urban expansion and tourism. Emerging activities, such as deep-sea mining, will further threaten ocean health if they come to fruition. The pressures stemming from human activities include, amongst others, extraction of living species, physical disturbance to and destruction of the seabed, pollution and plastics from land and sea, as well as underwater noise and light. Climate change, due to increases in anthropogenic CO_2 emissions, has resulted in rising ocean acidity, declining oxygen levels, warming waters and shifting ocean currents. These multiple pressures must not only be considered individually but also cumulatively, taking into account additive, synergistic and antagonistic effects to fully understand and estimate the changes they cause to marine life and the impacts they have on human wellbeing. Maintaining healthy and productive ocean ecosystems is crucial for human wellbeing, yet these combined pressures undermine the health and resilience of marine ecosystems and species around the world.

The rapid and immense social, economic and ecological changes spawned by the industrial revolution have brought the world to a time of great change, see Figure 1. It has become increasingly clear that the natural system and human development are interconnected and interdependent upon one another. It will not be possible for the global community to continue to thrive if the warning signs are ignored and the natural system is not conserved and restored to a state of health and sustainable management. It is therefore necessary to reimagine how to effectively measure, monitor and sustainably manage over half of the Earth's surface – ABNJ.

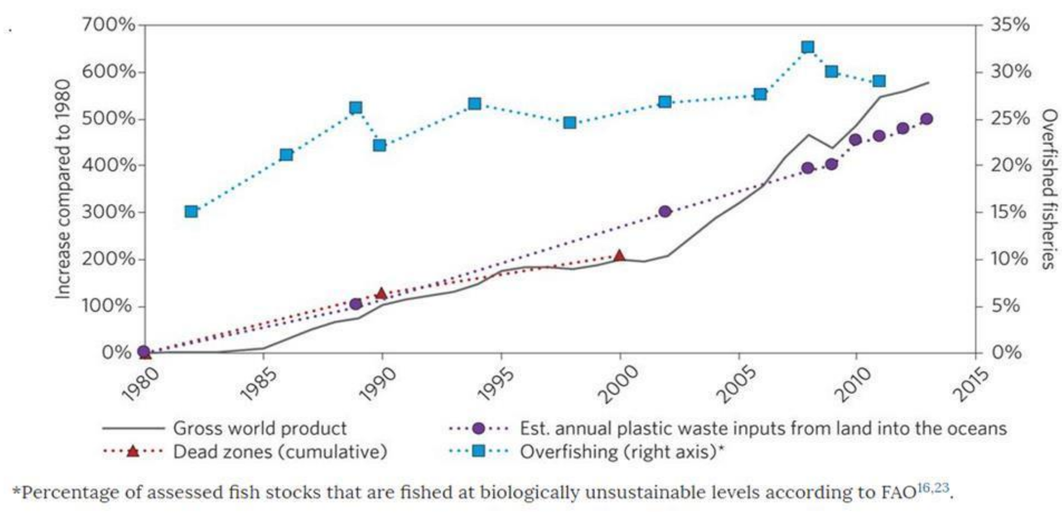

Figure 1 Trends in gross world product, overfishing and ocean pollution
Source: Golden et al., 2017

Box 1 Human activities in Areas Beyond National Jurisdiction

Shipping: Around 90 % of world trade is now carried by the international shipping industry, with 10.7 billion tonnes of cargo loaded in 2017 (UNCTAD, 2018). This leads to a range of environmental pressures, including air and underwater noise pollution, carbon emissions, collisions with cetaceans, discharge of sewage and other wastes, and the introduction of invasive species. Shipping is regulated through international conventions adopted in the framework of the International Maritime Organization (IMO).[2]

Fishing: ABNJ catches grew from approximately 450,000 tonnes (US$ 639 million) in 1950 to around 5,165,000 tonnes (US$ 10.6 billion) in 1989, far outpacing global growth in EEZ catches and value in the same period (Pauly & Zeller, 2016; Dunn et al., 2018). Since 1990, catch and value from ABNJ fisheries have remained relatively stable (FAO, no date), yet fishing effort more than doubled between 1990 and 2006 (Merrie et al., 2014). ABNJ fisheries can have significant environmental impacts. In addition to depleting stocks of target species, non-target species are also heavily impacted and vulnerable habitats are damaged through destructive fishing practices (Clark et al., 2016; Pauly & Zeller, 2016). Most fishing in ABNJ is managed at the regional level by States cooperating through regional fisheries management organisations (RFMOs).

Seabed mining: Exploration for mineral resources in the Area is underway, with 29 exploration contracts signed between contractors and the International Seabed Authority (ISA).[3] Seabed mining is likely to have a range of severe impacts on marine ecosystems, including: disturbance or even destruction of the benthic community where nodules are removed; plumes impacting the near-surface biota and deep ocean; and deposition of suspended sediment on the benthos (Morgan et al., 1999; Van Dover et al., 2018). The rules, regulations and procedures that cover prospecting and exploration are gathered in the “Mining Code”,[4] while the ISA is currently developing regulations for eventual exploitation of these resources.[5]

Pollution: The vast majority of marine pollution, around 80 %, comes from land-based sources (e.g. chemicals, particles, industrial, agricultural and residential waste). Eutrophication (the enrichment of waters by nutrients) is a result of such pollution and causes algal blooms that can lead to extensive dead-zones (Biello, 2008). Potentially toxic chemicals are taken up by plankton and concentrated upward within ocean food chains (Altieri & Gedan, 2014). Detrimental are also the effects of plastic pollution: living organisms are affected through ingestion, through exposure to chemicals within plastics, or through accumulation of micro plastics in their tissues (United Nations, 2016).

Greenhouse gas emissions: Rising sea temperatures, deoxygenation and ocean acidification resulting from anthropogenic climate change are predicted to compound the above-mentioned impacts and place further pressure on marine ecosystems (Hoegh-Guldberg, 2010; Gattuso et al., 2013; Gattuso et al., 2015).

The primary aim of this report is to provide decision makers with relevant and useful information on the current status of marine environment in ABNJ, both in the Southeast Pacific and the Southeast Atlantic, as well as highlight key pressures placed upon it by human activities. Such information is intended to support decision makers with improved understanding of the functioning and importance of ecological features of ABNJ and their contribution to global human wellbeing. This report also seeks to underscore that there is only one ocean and that it needs to be conserved and managed as a whole, emphasising the connectivity between ABNJ and EEZs. Detailed descriptions of pressures, including both spatial and temporal information, can be used to indicate key trends or hotspots of activities and therefore identify priorities for management and conservation measures. Ultimately, such an improved understanding will facilitate transboundary and holistic governance approaches for the conservation and sustainable use of biodiversity in ABNJ as well as EEZs. A further

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[2] While the IMO’s original mandate was principally concerned with maritime safety, it has adopted a wide range of environmental measures. The Marine Environment Protection Committee (MEPC) addresses issues including: the control and prevention of ship-source pollution covered by the MARPOL treaty; ballast water management; anti-fouling systems; ship recycling; pollution preparedness and response; and identification of special areas and particularly sensitive sea areas (PSSAs). See http://www.imo.org/en/OurWork/Environment/Pages/Default.aspx.

[3] The ISA was established in 1994 by an implementing agreement to UNCLOS and is the competent body through which Parties “organise and control activities in the Area, particularly with a view to administering the resources of the Area” (Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982).

[4] Available at: https://www.isa.org.jm/mining-code.

[5] In August 2017, the ISA released a first set of Draft Regulations on Exploitation of Mineral Resources in the Area, which currently remain under development. See Draft Regulations on Exploitation of Mineral Resources in the Area, issued 30 April 2018, https://undocs.org/ISBA/24/LTC/WP.1/.

objective of this assessment is to highlight scientific and research needs by pointing to gaps in data and information in regard to ecological features and pressures on ABNJ.

This report focuses specifically on the Southeast Pacific and Southeast Atlantic. For the purpose of this report, the Southeast Pacific is loosely defined as the Eastern side of the South Pacific Ocean, between Colombia and Chile. The Southeast Atlantic is loosely defined as the Eastern side of the South Atlantic Ocean, between Mauritania and South Africa (see Figure 2).

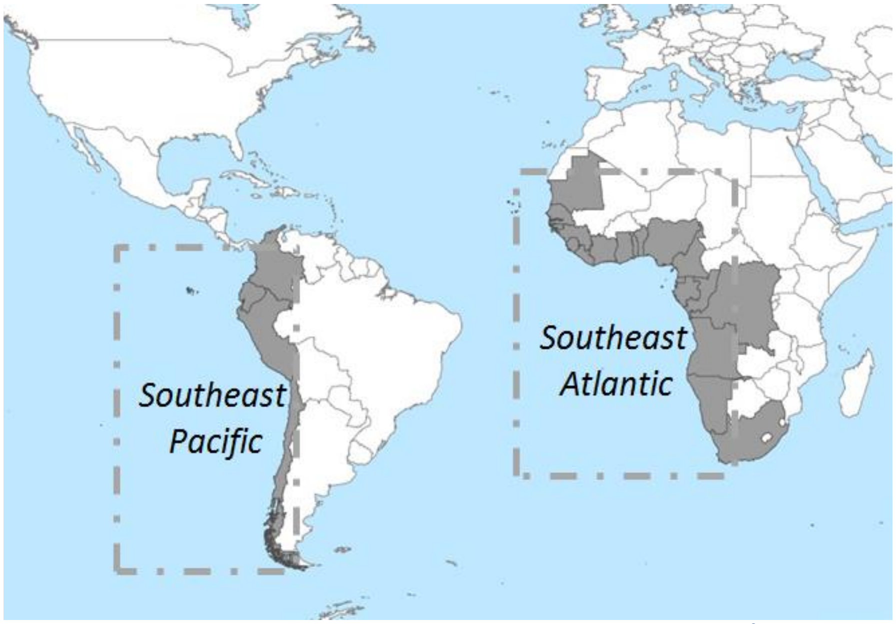

Figure 2 Focal regions of the STRONG High Seas project[6]

The existing ocean governance structure – that is the legal, institutional and policy framework established to manage human activities and ensure the conservation and sustainable use of ocean resources – is fragmented, rendering it insufficient to address the increasing threats to biodiversity in ABNJ. The UN Convention on the Law of the Sea (UNCLOS) lays down rules governing uses of the ocean and its resources, but does not specify how States should conserve and sustainably use biodiversity in ABNJ. A host of regional and sectoral agreements covering sectors such as fisheries, shipping and others were developed independently both before and after UNCLOS came into force in 1994, leading to a patchy governance framework. Moreover, there is a lack of coordination and cooperation between the numerous agencies and organisations that have a role or mandate in ocean management both at the regional and global level.

To overcome the challenges in global ocean governance highlighted above, the UN General Assembly (UNGA) decided in 2015, after a decade of discussions in UN working groups, to develop an international legally binding instrument under UNCLOS on the conservation and sustainable use of marine biological diversity in areas beyond national jurisdiction and to establish a Preparatory Committee to make substantive recommendations to the UNGA on the elements of a draft text. 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 is tasked to elaborate the text of an international legally binding instrument over the course of four negotiation rounds between 2018 and 2020.[7] The elements forming the basis for negotiations were identified in 2011 and are:

- Area-based management tools (ABMTs), including marine protected areas (MPAs);
- Environmental impact assessments (EIAs);
- Marine genetic resources (MGRs), including questions of their access and sharing of their benefits; and
- Capacity building and the transfer of marine technology.[8]

[6] Image credit: ESRI (2008): *World countries 2008*. ESRI Data & Maps.

[7] UNGA/RES/72/249 on an International legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

[8] UNGA/RES/69/292 on the development of an international legally-binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

The first round of negotiations in the IGC took place in September 2018 at the United Nations Headquarters in New York, USA. One of the key issues addressed is the relation of the new instrument to existing regional and sectoral instruments since, as stated in the UNGA Resolution, this process 'should not undermine existing relevant legal instruments and frameworks and relevant global, regional and sectoral bodies'.[9] Consequently, the new agreement will depend on effective implementation frameworks both within marine regions and at the global level with regard to managing sectoral activities and provide the unique opportunity to improve the coordination between and among existing global and regional institutions and to foster integrated management approaches (Gjerde et al., 2018).

In parallel to the negotiation process in regard to marine biodiversity in areas beyond national jurisdiction (BBNJ), the UNGA adopted in 2015 Resolution 70/01 on the 2030 Agenda for Sustainable Development, which sets out a global 'plan of action for people, planet and prosperity'. It puts forward a set of 17 globally applicable Sustainable Development Goals (SDGs) with 169 underlying targets. SDG 14 is specifically dedicated to the conservation and sustainable use of the oceans, seas and marine resources for sustainable development. SDG 14 sets 10 targets,[10] which mostly reflect existing policy agreements, such as the 2002 World Summit on Sustainable Development (WSSD) or the CBD Aichi targets.[11] The implementation of SDG 14 provides a unique opportunity to address complex sustainability issues that arise from the interaction of the wide array of SDGs that are at times contradictory (Schmidt et al., 2017). These important interactions, both positive and negative, between the SDGs cannot be considered in this report but will play an important role in determining how the regions can promote and further the achievement of SDG 14.

Under the Convention on Biological Diversity (CBD), 20 Aichi Biodiversity Targets were established in an effort to reduce pressures on biodiversity, promote its sustainable use and safeguard ecosystem functions. These targets are also a reflection of the SDGs and many are set for 2020 and are relevant to marine and coastal biodiversity. The CBD highlights the need to integrate biodiversity conservation 'into relevant sectoral or cross-sectoral plans, programmes and policies' (CBD, art. 6b). CBD Aichi 11 sets that by 2020 10 % of coastal and marine areas are conserved through ecologically representative and well connected systems of protected areas and other effective area-based conservation measures. This global goal is also reflected through compatible goals in regional strategies and policy objectives. As a result, efforts both in EEZs and ABNJ have been made to establish MPAs. Within this process, there is currently a review and update underway of these targets discussed under the Post-2020 Global Biodiversity Framework.[12]

The BBNJ process, the Aichi Biodiversity Targets and SDG targets present opportunities for States to strengthen the ocean governance framework in their respective regions and thereby contribute to sustainable development and economic growth. Because of the existing oceanographic and ecological connectivity, activities taking place in ABNJ have an impact on coastal waters and vice versa, making it important to consider conservation efforts, the sustainable use of resources, addressing threats to the marine environment and the adequate management of human activities both within and beyond national jurisdiction. Particularly, strengthened collaboration and cooperation between global, regional and sectoral organisations will be necessary to improve governance in the regions, an important step towards underpinning the global ocean governance framework in place and achieving the conservation and sustainable use of BBNJ and the SDG targets.

Both the Southeast Pacific and Southeast Atlantic are ecologically important and biologically rich, supporting valuable economic activities, such as fisheries. Both the Secretariat of the Permanent Commission for the South Pacific (CPPS) and the Abidjan Convention Secretariat in coordinating States parties to their conventions have an interest in the conservation and sustainable use of BBNJ: CPPS member States signed the 2012 Galapagos Commitment, in which they commit to promote coordinated action 'regarding their interests in living and non-living resources in ABNJ';[13] member States of the Abidjan Convention requested that the Secretariat 'set up a working group to study all aspects of the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction within the framework of the Abidjan Convention, pursuant to UNCLOS and taking into account the process underway within the framework of the United Nations, and especially the work of the ad hoc open-ended informal working group to study issues relating to the conservation and

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[9] UNGA/RES/69/292 on the development of an international legally-binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

[10] See https://sustainabledevelopment.un.org/sdg14.

[11] The report of the WSSD is available at http://www.un-documents.net/aconf199-20.pdf. For more information on the CBD Aichi targets, see https://www.cbd.int/sp/targets/.

[12] See https://www.cbd.int/conferences/post2020.

[13] CPPS, Compromiso de Galapagos para el Siglo XXI, VII Reunion de Ministros de Relaciones Exteriores de la Comision Permanente del Pacifico Sur (Galapagos, 17 de agosto de 2012), Art. VIII.20; http://cpps.dyndns.info/cpps-docs-web/planaccion/docs2016/Mayo/compromiso-galapagos-siglo21.pdf.

sustainable use of marine biological diversity beyond areas of national jurisdiction.'[14] This working group was formally established as an ad-hoc working group to the COP in June 2018 and had its first meeting in 2019. Furthermore, a 2016 decision by the second meeting of the UN Environment Assembly (UNEA 2) encourages 'the contracting parties to existing regional seas conventions to consider the possibility of increasing the regional coverage of those instruments in accordance with international law'.[15]

About STRONG High Seas

STRONG High Seas – Strengthening Regional Ocean Governance for the High Seas – is a five year (June 2017 – May 2022) research project focusing on strengthening ocean governance in the Southeast Pacific and Southeast Atlantic. Working with the Secretariat of the CPPS and the Secretariat of the West and Central Africa Regional Seas Programme (Abidjan Convention), the project will develop and propose targeted measures to support the coordinated development of integrated and ecosystem-based management approaches for ocean governance in ABNJ. States in these regions recognise the need to conserve and sustainably use marine biodiversity, including in ABNJ, and are working through these regional organisations to achieve this goal. The STRONG High Seas project is funded through the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

About this Report

This report was written by researchers within the STRONG High Seas project based on a literature review of academic articles, data analysis, stakeholder knowledge and experience gathered through workshops held within each of the regions, as well as expert opinion. This report was reviewed by multiple experts, including members of the STRONG High Seas project Advisory Board,[16] to cross check findings and ensure robust results. This report is part of a series of reports covering issues of ocean governance with a focus on the Southeast Pacific and Southeast Atlantic. Further reports by the STRONG High Seas project cover topics such as the legal and institutional framework of ABNJ, socioeconomic importance of ABNJ, options for management measures and recommendations for stakeholder engagement and capacity building in ocean governance in these two regions. After this introductory chapter, Chapter 2 – Status of Areas Beyond National Jurisdiction – provides an overview and assessment of key biological features in ABNJ of the Southeast Atlantic and Southeast Pacific while Chapter 3 – Pressures on Areas Beyond National Jurisdiction – details the main pressures on these regions stemming from human activities. Chapter 4 – Outlook – provides a conclusion and outlook in order to link the assessment to governance of ABNJ and considerations for future management measures.

[14] Abidjan Convention COP Decision CP.11/10.
[15] Outcome 2/10 of the second session of the United Nations Environment Assembly of the United Nations Environment Programme (23 to 27 May 2016), para. 13.
[16] The KBA concept is based on the IBA concept of BirdLife International, but expands it to all other taxonomic groups of animals, plants and fungi, and to other biodiversity elements (e.g. ecosystems). BirdLife International is a founding member of the KBA Partnership and a co-host of the KBA Secretariat Over time BirdLife's IBA work will transition to a primary focus on KBAs, although the IBA denomination will continue to be promoted alongside KBAs a KBAs and IBAs including marine IBAs, are used interchangeably here.

2. Status of Areas Beyond National Jurisdiction in the Southeast Atlantic and the Southeast Pacific

This chapter aims to provide an overview and assessment of marine biodiversity in ABNJ with a focus on the Southeast Atlantic and Southeast Pacific, and covers sections: 0 on Areas of special ecological importance; 0 on Areas of geological importance and benthic habitats; 0 on Seabed habitats (benthic); 0 on Water column habitats (pelagic); 0 on Fish; 0 on Marine mammals, marine invertebrates, turtles; and 0 on Seabirds.

Area-based Management Tools (ABMT), including Marine Protected Areas (MPAs), have long been used as a mechanism for conserving and protecting biodiversity and are being considered in the BBNJ negotiations. Existing work from multiple sectors to identify areas of particular interest are described here, many of which could be used to inform the BBNJ process and contribute to the identification of sites for formal protection in ABNJ. ABMTs are those tools with the main purpose to regulate activities which might impact on biodiversity including Particularly Sensitive Shipping Areas (PSSAs; for shipping), Vulnerable Marine Ecosystems (VMEs; for fishing), and Areas of Particular Environmental Interest (APEIs; for deep-sea mining). There also exist other spatial tools which do not directly fall into this category of management, but might still be useful as spatial descriptions and assessments within the BBNJ process. In particular, these include Ecologically or Biologically Significant Marine Areas (EBSAs), Key Biodiversity Areas (KBAs), Important Bird and Biodiversity Areas (IBAs), and Important Marine Mammal Areas (IMMAs).

The deep seabed in ABNJ of both regions contains a range of areas of geological importance, in particular seamounts (important for fisheries, oceanography and other ecological processes), hydrothermal vents and manganese nodule fields as well as ocean mud. These geological features are associated with different types of marine mineral resources, in particular: (i) polymetallic manganese nodules, (ii) cobalt-rich ferromanganese crusts, and (iii) polymetallic sulphides. While exploitation of these marine mineral resources may – under certain circumstances – allow for the generation of short-term direct economic value, the geological features themselves provide diverse long-term value for biogeochemical and ecosystem processes, as well as habitats for specialized species assemblages, their connectivity and deep pelagic fauna organic subsidies, sequestering carbon and methane. There also still exist many knowledge gaps regarding the complex ecological and biogeochemical processes and interactions between geological features and biological systems in the deep ocean. Any large-scale mining of marine mineral resources from the deep seabed is expected to have severe and long-lasting impacts on the marine environment. As of today, no commercial exploitation of marine mineral resources from the deep seabed is taking place in the Area of the Southeast Atlantic or the Southeast Pacific. There is, however, an ongoing process under the auspices of the International Seabed Authority (ISA) to develop a regulatory framework for the exploitation of marine mineral resources in the Area. This regulatory framework is considered to be a prerequisite before any commercial mining activity could start in the Area. In addition, efforts are underway at the ISA towards developing a Regional Environmental Management Plan (REMP) for the Southeast Atlantic region.

Within the water itself, oxygen minimum zones, bacterial metabolic pathways, biological pumps and other biological-oceanographic interactions are only starting to be uncovered. The interconnectedness of carbon, nitrogen and other nutrient cycles and transport mechanisms, including through migratory species, such as whales and seabirds, reflects the importance of protecting species and sites. As concerns around climate change grow, the role of the oceans in ameliorating heating, absorbing carbon and more comes into sharp focus. Disrupting the existing processes, through mining, overfishing (which can have chaotic, unpredictable impacts across food webs) and other anthropogenic impacts adds further to the challenges of climate change-driven ecosystem changes.

Fishing is the largest, direct human pressure on the oceans. While most fishing effort and biomass removal is within EEZs, there are massive fleets targeting fish stocks in ABNJ that have potentially significant impacts on coastal states. Many species, tunas being the most obvious, are highly migratory and overfishing in ABNJ has serious economic consequences for livelihoods and economies in coastal states.

For marine megafauna (marine mammals, turtles and seabirds), their highly mobile, migratory behaviours make them crucial vectors of connectivity, including nutrient transfers, within the oceans. They also make the identification of ABMTs exceptionally challenging, as effective design for spatial protection will require truly vast areas to have any significant impact. Unfortunately, bycatch – the incidental capture of non-target species during fishing – is causing significant population decreases amongst turtle, marine mammals and seabird populations globally, and particularly in the southern Pacific and Atlantic oceans. The impacts of, mostly failed, efforts to control overfishing in ABNJ are also writ large in the [abject] failure of States and regional fisheries management organisations (RFMOs) to exercise effective controls over bycatch rates (e.g. strictly enforcing regulations, which punish vessels for bycatch, including size, quantity, and species, which are not legal to catch).

While the distinction between ABNJ and waters under national sovereignty is clear-cut in jurisdictional and geopolitical terms, they are tightly connected ecologically. Hence pollution, overfishing, mining or geoengineering experiments in ABNJ also translate into downstream ecological and socio-economic impacts in coastal waters and vice versa. This connectivity between even distant regions – what happens out of sight of land – must be taken into account for ocean management and conservation to be effective.

Ecological connectivity derives from two mechanisms. Firstly, passive or circulation connectivity is mediated by deep and surface ocean currents, transporting plankton, larvae, but also pollution across the seas. Depending on the position, strength and direction of ocean currents, some coastal regions have a short timescale of connectivity and experience the impacts of activities occurring in ABNJ within a few weeks, while those with a longer timescale of connectivity might be impacted only after several months or even years. Circulation connectivity is inherently shifting, as ocean currents exhibit short team changes brought about, for example, by the weather, as well as seasonal, inter-annual and multi-decadal climate patterns. Secondly, active or migratory connectivity is achieved by regular movement of marine species from one place to another, often between feeding and breeding grounds. Many migratory species cross vast distances and straddle the boundaries between ABNJ and national waters in their life cycle, thereby connecting distant ecosystems (Popova et al., 2019).

It is important to note that adjacency, the geographical proximity of national waters and open ocean ABNJ, is not a reliable indicator of connectivity, as interactions between winds, currents at the surface and at depth, and varying timescales render the situation more complex. Some oceanic islands located in the subtropical gyres of the major basins, for example, are exposed only to relatively weak currents and are thus do not have a strong ecological connectivity to ABNJ, regardless of their position (Popova et al., 2019).

2.1 Areas of Special Ecological Importance

Key Messages:

- Area-based Management Tools (ABMT) to regulate activities have long been used as a mechanism for conserving and protecting biodiversity. ABMTs to regulate sectors, which might impact on biodiversity, include Particularly Sensitive Sea Areas (shipping), Vulnerable Marine Ecosystems (fishing) and Areas of Particular Environmental Importance (deep-sea mining).

- There also exist spatial tools, which are focussed on highlighting biodiversity and are used to indicate areas with special ecological importance. These include Ecologically or Biologically Significant Marine Areas (EBSAs), Key Biodiversity Areas (KBAs), Important Bird and Biodiversity Areas (IBAs), and Important Marine Mammal Areas (IMMAs) and have already been applied in the study areas. They could also be used to inform the BBNJ process, or other processes, and contribute to the identification of sites for formal protection in ABNJ.

- Although knowledge gaps exist, additional areas of special ecological importance could be identified in the future, further contributing towards a comprehensive and appropriately representative network of sites for protection in the ABNJ.

UN agencies have developed ABMTs to regulate specific human activities and protect biodiversity. The Food and Agricultural Organisation of the United Nations (FAO), for example, has developed a mechanism to identify VMEs on the basis of habitat vulnerability to impacts from fishing, while the International Maritime Organization (IMO) defines PSSAs within which there are stricter controls on shipping. Similarly, the International Seabed Authority (ISA), established under the UN Convention on the Law of the Sea, has designated a first set of APEIs to help protect benthic habitats from potential future mining activities in the Clarion-Clipperton Zone in the Pacific Ocean. In addition to ABMTs, there also exist spatial tools, which are focussed on highlighting biodiversity and are used to indicate areas with special ecological importance.

Both the UN Sustainable Development Goal 14 and the CBD Aichi Target 11 state that by 2020, 10 % of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, should be conserved through a system of ecologically representative and connected protected areas and other effective area-based conservation measures. Several mechanisms have been developed to describe and/or designate specific geographic areas as being of particular ecological importance, or particularly vulnerable to anthropogenic impacts. These mechanisms provide the best available scientific basis for formal proclamation of protected areas. For example, the Contracting Parties to the Convention on Biological Diversity (CBD) have adopted scientific criteria for the identification of EBSAs. Similarly, the IUCN and BirdLife International use the identification of KBAs as a conservation tool and to draw the attention of governments and UN agencies to their need for protection.[17] Moreover, IUCN is currently developing a system of IMMAs for similar purposes.

Although UN agencies have different mandates and therefore different reasons for the establishment of such areas, there is considerable overlap in the criteria being applied during identification (see Table 2 in the Annex). There is therefore considerable potential for interlinking these areas. The ISA, for example, recommends that information about EBSAs and VMEs should be incorporated into the identification of APEIs; marine IBAs have been used to identify EBSAs, while hundreds of IBAs overlap with World Heritage Sites and UNESCO Biosphere Reserves.

In addition to assisting in the achievement of global targets on the protection of marine biodiversity, the identification of areas of special ecological importance makes a significant contribution to the process of marine spatial planning (MSP). Although many of the areas which have been described, identified and/or designated fall within the EEZ of coastal states, in some cases these do extend into ABNJ. This is a reflection of the fact that ecosystem boundaries do not generally coincide with political ones. There is therefore a natural connection between coastal waters and ABNJ, which needs to be recognised in the identification, development and implementation of marine protection measures.

Area Based Management Tools (ABMTs)

Vulnerable Marine Ecosystems (VMEs)

VMEs are groups of species, communities, or habitats that could be vulnerable to impacts from fishing activities and typically include benthic communities associated with seamounts, hydrothermal vents, deep-sea trenches and submarine canyons, as well as oceanic ridges – such as cold-water corals and sponge fields. The concept emanated from global concern about the adverse effects of bottom fisheries. This was discussed at meetings of the United Nations Open-Ended Informal Consultative Process on Oceans and the Law of the Sea (UNICPOLOS), with UNICPOLOS recommendations subsequently being endorsed by the United Nations General Assembly (UNGA) in a series of resolutions. In particular, UNGA Resolution 61/105 called on Regional Fisheries Management Organisations or Arrangements (RFMO/As) to close areas to bottom fisheries until appropriate measures have been put in place to prevent significant adverse impacts on vulnerable marine ecosystems (VMEs).

The FAO subsequently developed the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas in 2008 and developed an FAO VME Portal and DataBase.[18] The latter is a compilation of information on management measures taken to reduce significant adverse impacts on areas where VMEs are known or likely to occur. It was developed in collaboration with the regional bodies with mandates to manage deep-sea fisheries in the ABNJ, although it is noted that other activities – such as mining, cable-laying, etc. – can also impact on VMEs (FAO, 2016).

Particularly Sensitive Sea Areas (PSSAs)

A PSSA is an area that needs special protection through action by IMO because of its significance for recognized ecological, socio-economic or scientific reasons and which could be vulnerable to damage by international shipping activities. They are designated by the IMO following the submission of an application by a Member Government – or group of Member Governments – and an assessment process based on the Guidelines for the Designation of Special Areas and the Identification of Particularly Sensitive Sea Areas. These Guidelines were initially adopted by UN Assembly Resolution A.720 (17) in 1991 but have subsequently been amended several times, with the most recent version being adopted in 2005. At the time of designation of a PSSA, an associated protective measure, which meets the requirements of the appropriate legal instrument establishing such measure, must have been approved or adopted by the IMO to prevent, reduce, or eliminate the threat or identified vulnerability. To date, the IMO has designated 14 PSSAs. Of these, four fall within national jurisdictions adjacent to the study areas. These include: Malpelo Island, Colombia (2002); Paracas National Reserve, Peru (2003); Canary Islands, Spain (2005); and The Galapagos Archipelago, Ecuador (2005).

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[17] BirdLife International has adopted the KBA standard, although some of their processes continue to use the previous Important Bird and Biodiversity Areas (IBAs) nomenclature while the transition to KBAs is being effected. KBAs and IBAs, including marine IBAs, are used interchangeably here.
[18] See www.fao.org/in-action/vulnerable-marine-ecosystems/en/.

Areas of Particular Environmental Interest (APEIs)

The ISA is responsible for regulating mining activities (prospecting and exploitation) on the seabed in ABNJ (the "Area"), including the protection thereof from environmental damage. To this end, in 2000 the ISA adopted "Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area". Similar regulations covering prospecting and exploration for polymetallic sulphides and cobalt-rich ferromanganese crusts were then approved in 2010 and 2012 respectively (ISA, 2015). All of these have subsequently been amended, while regulations for exploitation activities are still under development (ISA, 2018). The regulations provide a [comprehensive] basis for monitoring and protecting the marine environment in the Area by imposing obligations on the entities involved in prospecting or (future) exploitation. Obligations include assessment and monitoring of their activities and the development of oceanographic and environmental baseline studies (Regulations 31 and 32).

The practical mechanisms required to give effect to these regulations are still being developed. The process includes development of regional environmental management plans (REMPs), which themselves identify APEIs (UNEP-WCMC, 2018). APEIs are described as: "Areas thought to be representative of the full range of habitats, biodiversity and ecosystem structure and function within a defined management area that are closed to potential mining activities in order to protect and preserve the marine environment" (Preservation Areas) (ISA, 2011).

To date, the only APEIs which have been designated are in the Clarion-Clipperton Zone in the Central Pacific Ocean. They were adopted in 2012 as part of an Environmental Management Plan for the Clarion-Clipperton Zone which identified nine areas of environmental interest. Their identification was based on various principles, including: common heritage of mankind; precautionary approach; protection and preservation of the marine environment; prior environmental impact assessment; conservation and sustainable use of biodiversity; and transparency (ISA, 2011). It is likely that they will be further refined as additional REMPs are developed according to the preliminary strategy for the development of regional environmental management plans for the Area presented to the Council at its session in March 2018 (ISA, 2018).

Spatial Tools for highlighting Areas of Ecological and Biological Importance

Ecologically or Biologically Significant Marine Areas (EBSAs)

EBSAs are special areas in the ocean that support the healthy functioning of oceans and the many services that it provides. The identification of EBSAs is a scientific and technical exercise, which has a legal basis under Articles 7 and 17-18 of the CBD (CBD, 2017). It does not imply an economic or legally protected status, although the existence of an EBSA may be used to motivate the establishment of formal MPAs. The identification of EBSAs is the prerogative of States and competent intergovernmental organisations. EBSAs can be described in coastal waters, if the relevant costal State so wish, or in ABNJ. Reports from the expert regional workshops to describe EBSAs are submitted to the CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) for review and inserted in decisions for subsequent adoption by the Conference of the Parties to the CBD (CBD COP), prior to inclusion in the repository. The CBD Secretariat informs the UNGA, UN agencies and other relevant international organisations. Since 2011, the CBD has run numerous regional workshops aimed at identifying EBSAs. To date, 321 EBSAs have been identified, of which 169 are under national jurisdiction, 37 are transboundary within national jurisdiction (straddling two or more EEZs), 38 transboundary across national and international waters (partially in EEZ and partially in ABNJ) and 33 exclusively in ABNJ.

Key Biodiversity Areas (KBAs)

KBAs are sites contributing significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems, identified, mapped and documented by the KBA Partnership (that includes 12 partners). Criteria for the identification of such sites are described in the Global Standard for the Identification of Key Biodiversity Areas (IUCN, 2016). There are 11 criteria clustered into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and, irreplaceability and can be applied to species and ecosystems.[19]

Important Bird and Biodiversity Areas (IBAs)

Important Birds and Biodiversity Areas are places identified by BirdLife International as being of international significance for the conservation of birds and other biodiversity using standardised criteria. The IBA network is the largest subset of KBAs, from which it has developed. They comprise distinct areas amenable to practical conservation that together form part of a wider, integrated approach to the conservation and sustainable use of the natural environment. The IBA Programme is

[19] See http://www.keybiodiversityareas.org.

global in scale and to date over 10,000 sites have been identified world-wide. It aims to guide the implementation of national conservation strategies, through the promotion and development of national protected-area programmes, to assist the conservation activities of international organisations, and to promote the implementation of global agreements and regional measures. IBAs are identified criteria based on the following globally agreed criteria**:** globally threatened species; restricted range species; biome restricted species; and congregations. Additional criteria may be adopted at the regional level.

Seabirds face many serious conservation challenges and are now the most threatened group of birds. Since 2004, the BirdLife International Marine Programme has been working with the BirdLife Partnership to identify IBAs for seabirds both on land and at sea. Sites that qualify as marine IBAs include seabird breeding colonies, foraging areas around breeding colonies, non-breeding (usually coastal) concentrations, migratory bottlenecks and feeding areas for pelagic species.[20]

Important Marine Mammal Areas (IMMAs)

Important Marine Mammal Areas (IMMAs) are defined as “discrete portions of habitat, important to marine mammal species that have the potential to be delineated and managed for conservation.” A Global IMMA Network is currently in the process of development under the auspices of the Marine Mammal Protected Areas Task Force (MMPATF), which has been created by the International Committee on Marine Mammal Protected Areas (ICMMPA), the IUCN World Commission on Protected Areas (WCPA) Marine Vice Chair, and members of the IUCN Species Survival Commission (SSC). Between 2016 and 2021, the MMPATF is rolling out a tool to apply criteria to identify and potentially protect Important Marine Mammal Areas in six marine regions, through the organisation of regional expert workshops. MMAs identified to date do not occur in the study area.[21] The special areas for both the Southeast Atlantic and Southeast Pacific are indicated in the map below (see Figure 3) showing the biodiversity-based special areas (EBSAs, VMEs, and Marine IBAs).

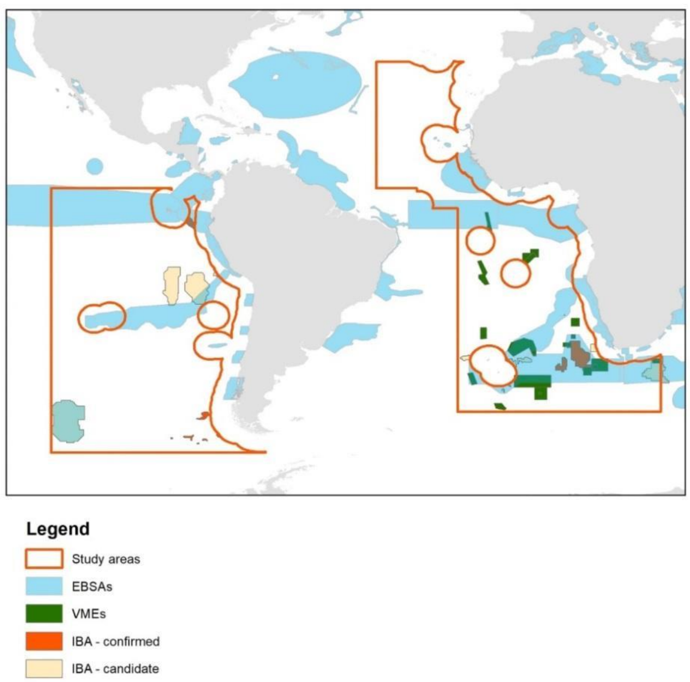


Figure 3 Areas of special ecological importance in the Southeast Atlantic and Southeast Pacific
Source: Map elaborated based on FAO, BirdLife International and CBD

[20] A map showing confirmed, proposed and candidate marine IBAs is available at https://maps.birdlife.org/marineIBAs/default.html.
[21] Further information available at https://www.marinemammalhabitat.org/activities/immas/.

Southeast Atlantic

Vulnerable Marine Ecosystems (VMEs)

Although there are several seamounts in the Eastern Central Atlantic (Major Fishing Area 34), according to FAO (2016), much of the area in question is essentially too deep for fishing, with the exception of the north-western and south-western corners over the Mid-Atlantic Ridge and at certain seamounts. In 2011, the South East Atlantic Fisheries Organisation (SEAFO) closed an area to bottom fishing in the Central Atlantic Ocean to protect VMEs on four seamounts, which overlaps with an area under the competence of the Fishery Committee for the Eastern Central Atlantic (CECAF) (NOAA, 2015). In 2016, the CECAF committee recommended that its members should respect the SEAFO VME closures in the overlapping area of competence. SEAFO stated that the majority of the surveys done on seamounts in ABNJ, so far, have focused on fish species, using underwater cameras, rather than benthic habitats and their species and are not thought to have been exposed to benthic fishing, yet (SEAFO, 2010).

According to FAO (2016) most of the waters in the Southeast Atlantic (Major Fishing Area 47) are also extremely deep, although there are a number of prominent features which rise above 2,000 m deep. These include the Walvis Ridge, the Mid-Atlantic Ridge and the Agulhas Ridge. There are also numerous seamounts, guyots, banks, and plateaus, notably the Valdivia Bank, and the Vema, Discovery and Meteor seamounts. Despite a paucity of information on benthic communities of this region, the Scientific Committee of SEAFO has adopted a proactive approach and in 2006, on the basis of the precautionary approach, developed a list of 13 seamounts which probably contain VMEs. Ten of these were then closed to fishing by the Commission. These were subsequently reviewed and there are currently 12 VME areas closed to fishing. Details of these VMEs can be found in Table 11 of FAO (2016). In addition to closing VMEs to all fishing, SEAFO has developed a range of other measures to regulate fishing in these areas, including partial restrictions (for specific types of fishing gear) and mandatory use of bycatch mitigation measures.

Ecologically or Biologically Significant Marine Areas (EBSAs)

Until today, the following areas in ABNJ of the Southeast Atlantic, sometimes extending from coastal areas (EEZs), have been described to meet the EBSA criteria: Canary Current LME (4); Guinea Current LME (11); Atlantic Equatorial Fracture Zone (12); Benguela Upwelling System (BCLME) (14); Walvis Ridge (17); and The Subtropical Convergence Zone (18). The Canary Current LME comprises a diverse array of coastal ecosystems and habitats from Senegal to Liberia, including areas under national jurisdiction and ABNJ. The offshore habitats include a significant number of seamounts. It is characterized by strong upwelling and high productivity and supports several species which are of socio-economic importance including prawns, shrimp, lobsters, molluscs, pelagic and demersal fish (including sharks) – although in the ABNJ waters, only tuna fisheries are active.

The Guinea Current LME is also characterised by strong upwelling and high productivity and is particularly important as an area of migration, reproduction and development of larvae, juveniles and adults of tunas and associated species. The Atlantic Equatorial Fracture Zone lies between the basins of the North and South Atlantic. It is characterised by multiple deep benthic habitats formed by the Mid-Atlantic Ridge and the Equatorial Fracture Zone; the circulation patterns of the deep water masses; and the surface oceanographic processes, which together result in unique patterns of biodiversity. The majority of the zone falls within ABNJ.

The Benguela LME is also an upwelling system bound in the north and south by warm water current systems and characterized by high primary production. This high biological productivity supports numerous commercial, artisanal and recreational fisheries, mostly within EEZs. It includes important spawning and nursery areas for fish as well as foraging areas for endangered and threatened bird species. Another key characteristic feature is the diatomaceous mud-belt in the Northern Benguela Current. This includes regionally unique low oxygen benthic communities that depend on sulphide oxidising bacteria.

The Walvis Ridge is a significant seamount chain forming a bridge running from the African continental margin to the southern Mid-Atlantic Ridge. It is a unique geomorphological feature likely to be of special importance to vulnerable sessile macrofauna and demersal fish associated with seamounts. Although bottom fisheries occur on the Walvis Ridge, the spatial extent of commercial fishing is limited to a relatively small area. Due to the variation in depths, ranging from slopes to summits and surface waters, it is likely that the area supports a relatively high biological diversity. The feature supports a high diversity of globally threatened seabirds.

The Subtropical Convergence Zone is delimited to the north by the subtropical gyre and to the south by the northernmost current band of the Antarctic Circumpolar Current (ACC) (Wolf-Gladrow, 2012). The area has a high productivity compared to the oligotrophic waters to the north and supports a significant diversity of biota, including the Southern Bluefin Tuna, Southern Right Whale and several seabirds recognised as threatened by the IUCN.

Key Biodiversity Areas (KBAs) and Important Bird and Biodiversity Areas (IBAs)

The KBAs in the Southeast Atlantic are all also marine IBAs, i.e. the qualifying criteria are all based on seabirds. In the southern part of the Southeast Atlantic, there are two areas (15 and 16) which have been confirmed as marine IBAs. Both are situated in ABNJ. They have the following features (BirdLife International, 2019):

- Site 15 covers 255 665 km^2 and is 598 km from the closest coastline. The depth ranges from 1,316-5,316 m, with a mean annual wind speed of 2.3 m/s, mean annual sea surface temperature falls between 13.7 and 18.3 °C and mean annual chlorophyll-a concentrations range between 0.15 and 0.48 mg/m^3. Tracking data indicate that ~1,900-3,000 non-breeding individuals of Tristan Albatross *Diomedea dabbenena* (CR) from Gough Island are present at the site from Apr-Oct.
- Site 16 covers 54,158 km^2 and is 1,164 km away from the closest coastline. The depth ranges from 2,789-5,522 m, with a mean annual wind speed of 2.56 m/s, mean annual sea surface temperature falls between 12.0 and 16.0 °C and mean annual chlorophyll-a concentrations range between 0.23 and 0.33 mg/m^3. Tracking data estimates that ~1,900-2,500 non-breeding individuals of Tristan Albatross from Gough Island are present at the site from April to October. It is to be noted that albatrosses range extremely widely and cover vast distances in relatively short times, so the estimates of individuals spending time in Sites 15 and 16 are unlikely to represent many of the same individuals.

The area around Ascension Island (main island and stacks) is a candidate marine IBA. It supports a variety of seabirds, including Red-billed *(Phaethon aethereus)* and White-tailed *(Phaethon lepturus)* tropicbirds, Ascension Frigatebird *(Fregata aquila),* Masked Booby *(Sula melanogaster)*, Black Noddy *(Anous minutus)* and Sooty Tern *(Onychoprion fuscatus)*.

Southeast Pacific

Vulnerable Marine Ecosystems (VMEs)

The Southeast Pacific encompasses FAO Major Fishing Area 87. One of the relevant fisheries management bodies in this region is the South Pacific Regional Fisheries Management Organisation (SPRFMO), its area of competence covers the whole of the South Pacific, part of the North Pacific and the easternmost part of the Indian Ocean. The FAO Report on VMEs (2016) therefore also covers this broader region.

According to FAO (2016), the bathymetry of the South Pacific Ocean is complex, with many large and important seamounts, ridges, and underwater plateaus, although the ABNJ is dominated by abyssal waters with average depths of 4,000-5,000 m. There are about 1,500 seamounts and numerous other features including the Salas y Gomez and Nazca ridges in the Southeast Pacific. In 2013 SPRFMO adopted a measure to ban the use of gillnets; including deep-water gillnets to protect fishery resources, bycatch species and deep-sea habitats. There has been relatively little bottom fishing gear effort reported in the SPRFMO area since 2010, and in early 2019, SPRFMO updated its Conservation Management Measures (CMM) to further reduce bottom fishing in the Southeast Pacific.

Areas of Particular Environmental Interest (APEIs)

The only APEIs identified to date are in the Clarion-Clipperton Zone in the Central Pacific. However, the ISA has entered into contracts with twenty-seven entities involved in exploration for polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts in the Area. In addition to the Clarion-Clipperton Zone in the Central Pacific, these contracts cover areas within the study zone such as the Mid-Atlantic Ridge, South Atlantic Ocean and the Pacific Ocean. At the 24th Council session in January 2018, the ISA presented a preliminary strategy for the development of REMPs for the Mid-Atlantic Ridge and South Atlantic for seamounts. It is therefore anticipated that APEIs for the Southeast Atlantic will be forthcoming in the near future.

Ecologically or Biologically Significant Marine Areas (EBSAs)

Until today, the following areas in ABNJ of the Southeast Pacific, sometimes extending from coastal areas (EEZs), have been described to meet the EBSA criteria: Pacific Equatorial High Productivity Zone (19); the Marine Corridor of the Eastern Pacific (20); Carnegie Range – Equatorial Front (21); and the Grey Petrel Feeding Area in the Southeast Pacific Rise (27).

The Pacific Equatorial High Productivity Zone is a feature associated with the Equatorial Current System and comprises almost the entire width of the Pacific as a narrow band spanning the equator. It has high levels of nutrients and primary production and strong benthic-pelagic coupling, i.e. high secondary production on the 4,000-5,000 m deep abyssal plains.

Historically, there was a high abundance of sperm whales (*Physeter macrocephalus*) in this area. It is highly influenced by El Niño events and potentially susceptible to climate change.

The Carnegie Undersea Range is an ascetic ridge of volcanic origin located in the Pacific Ocean between the coasts of Ecuador and the Galapagos Islands. The Carnegie Range Equatorial Front is a transition zone between the water masses transported by El Niño and the Humboldt Current and is characterized by an intense thermohaline gradient. The southern band of the equatorial front is an area of high biological productivity. It is also an area of high biodiversity with numerous endemic species as well as threatened species. It is a mating centre for larger cetaceans and the southern limit of the nesting range of sea turtles. The Grey Petrel Feeding Area in the Southeast Pacific Rise is the key feeding area for the Antipodes Island, New Zealand population of Grey Petrel (*Procellaria cinerea)* (IUCN Status: Near Threatened) during the non-breeding season from October and February.

Key Biodiversity Areas (KBAs) and Important Bird and Biodiversity Areas (IBAs)

The KBAs in the Southeast Pacific are all also marine IBAs, i.e. the qualifying criteria are all based on seabirds. There is a group of small marine IBAs in the southern part of the Southeast Pacific (numbered 20, 27, 29, 30, 31 and 32), which are situated in ABNJ (BirdLife International, 2019). They are of various sizes and depths, but they have a common characteristic in that tracking data shows that individuals of the Grey-headed Albatross (*Thalassarche chrysostoma*; IUCN Status: Vulnerable) from Islas Diego Ramirez are present during the incubation life-history stage (October-December). Further north, marine IBA 24 is an area of ABNJ between Ecuador and the Galapagos Islands. It covers an area of 44,431 km^2 and is 352 km away from the closest coastline. The depth ranges from 2,714 - 4,184 m. Tracking data indicates that 3,400-5,000 individuals of Waved Albatross (*Phoebastria irrorata*; IUCN Status: Critically Endangered) from Isla Española in the Galapagos are present at the site during the incubation life-history stage (April-August). The Galapagos Archipelago is also a KBA, but falls under the jurisdiction of Ecuador.

Conclusion

It should be recognised that if an area has not been highlighted by one of these mechanisms, it does not necessarily mean that it is not an area of ecological importance, but rather that it might not be well understood or studied. There could also be a geographic bias towards countries that place more emphasis on certain types of studies – for example South Africa has recently reviewed its EBSA network and proposed four new EBSAs as part of a larger marine spatial planning project that is underway, Namibia has identified one new EBSA, Senegal is also in the process of identifying new EBSAs (Senegal, MAMI WATA Integrated Ocean Management meeting, 2017). In this regard, it is likely that more areas will be identified or extended as data becomes available and as pressures increase on marine biodiversity. Currently, large EBSAs (e.g. Benguela EBSA or Subtropical Convergence Zone) are challenging from a governance perspective because they are too large to be managed or to be meaningfully incorporated into policies of protection. Additional governance challenges stem from the lack of a legal mandate of key actors within a region. For example, because CECAF is an advisory body and not an RFMO with regulatory power, no VME in the region could be established for potentially identified VMEs.

2.2 Areas of Geological Importance

Key Messages:

- The deep seabed in ABNJ of both the Southeast Atlantic and the Southeast Pacific contains a range of areas of geological importance, in particular seamounts, hydrothermal vents and manganese nodule fields.

- These geological features are associated with different types of marine mineral resources, in particular: (i) polymetallic manganese nodules, (ii) cobalt-rich ferromanganese crusts, and (iii) polymetallic sulphides.

- While exploitation of these marine mineral resources may, under certain circumstances, allow for the generation of short-term direct economic value, the geological features themselves provide diverse long-term value for ecosystem processes, habitats and species.

- Knowledge gaps remain regarding the complex ecological and biogeochemical processes and interactions between geological features and biological systems in the deep ocean. Any large-scale mining of marine mineral resources from the deep seabed is expected to have severe and long-lasting impacts on the marine environment.

- As of today, no commercial exploitation of marine mineral resources from the deep seabed is taking place in the Area of the Southeast Atlantic or the Southeast Pacific.

- There is an ongoing process under the auspices of the ISA to develop a regulatory framework for the exploitation of marine mineral resources in the Area.[22] This regulatory framework is considered to be a prerequisite before any commercial mining activity could start in the Area. In addition, efforts are underway at the ISA towards developing a REMP for the Southeast Atlantic region.

The world's oceans cover about two thirds of our planet (Peters, 2017) and despite the vast dimension of the oceans, numerous explorations and extensive surveys over the last decades have generated quite a solid understanding of the structure and characteristics of the subjacent seafloor (Harris et al., 2014).

Extending away from land, the oceans are generally divisible into three main regions: (i) the continental shelf, where water depths are generally less than 200 m; (ii) the continental slope; and (iii) the flat or gently sloping abyssal plain, typically occurring at depths greater than 4,000 m (Lusty & Murton, 2018; see Figure 4). Abyssal plains constitute the deep seafloor between the continental rise and oceanic ridges in water depths of 3,000-6,000 m.

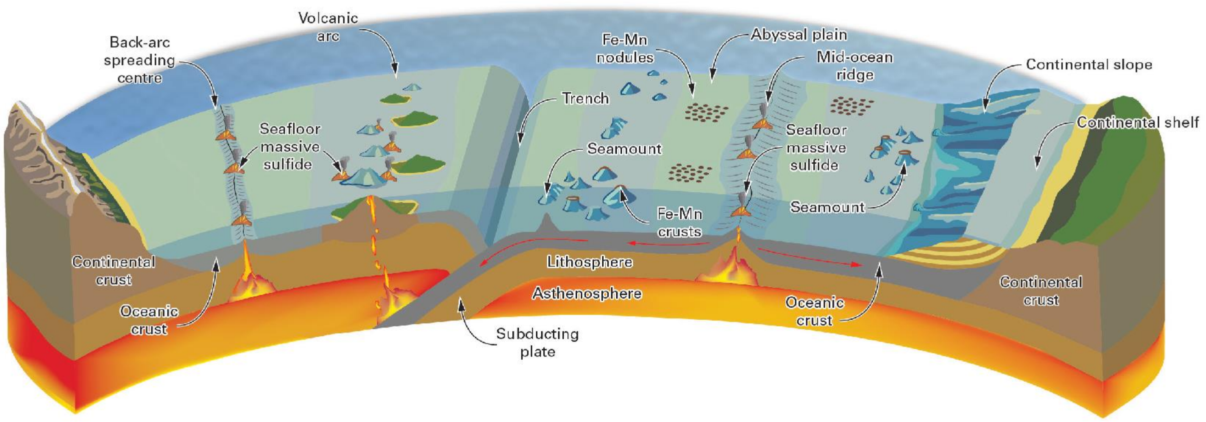


Figure 4 A cross-section through the Earth's crust showing the different types of plate boundary, the topography of the ocean floor and the distribution of the major metal-rich deep ocean mineral deposits
Source: Lusty & Murton, 2018

[22] The "Area" refers to "The seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction." (cf. United Nations Convention on the Law of the Sea (UNCLOS) 1982, Article 1).

The oceanic ABNJ of both the Southeast Atlantic and the Southeast Pacific are mainly characterized by deep seafloor. The deep seafloor covers about 60 % of the Earth's surface and hosts a spectrum of geological settings, geomorphologic features and ecosystems. This diversity, and its long and dynamic history, results in the deep seafloor hosting mineral deposits that are both similar to those found on the continents as well as types unique to the oceans (Lusty & Murton, 2018). The deep-sea ocean floor includes the abyssal plain, an extensive, relatively flat, sedimentary seabed interspersed with features including submarine canyons, oceanic trenches and ridges, hydrothermal vents, seamounts and guyots. There are also small-scale habitats such as cold seeps, pockmarks, anoxic hypersaline pools or mud volcanoes that could be important for particular species, but many of the deep-sea habitats have yet to be explored. Many of the better-understood features of the deep-sea are known because they are associated with high levels of biodiversity, rich fishing grounds, or valuable mineral deposits. Others are extremely large and self-evidently meriting of research (such as ridges) or are chanced-upon features from research expeditions; areas that remain unexplored are vast.

Hydrothermal vents are associated with mid-oceanic ridges and underwater volcanoes and provide productive and diverse ecosystems and habitats in their vicinity. The mineral-rich (particularly zinc and copper) sulphide deposits brought up by the geothermally heated (as much as 350°C) water can also include cobalt, gold, copper and other rare earth metals of economic value (Dover et al., 2018). Cold seeps also bring hydrogen sulphide and methane to the seafloor through a vent forming a brine pool, methane or gas seep, mud volcano or pockmark, but the water is not as heated as it is in a hydrothermal vent. The habitat surrounding the seeps also supports specialist chemosynthetic, endemic species. Methanotrophic bacteria use up methane, significantly impeding greenhouse gas from reaching the atmosphere. Together, cold seeps and hydrothermal vents contribute to about 10 % of benthic autotrophic production. In addition, the formation of authigenic carbonate deposits result from microbial chemical transformations contributing to carbon sequestration. Seamounts are underwater mountains rising at least 1,000 m above the surrounding surface, whereas smaller seamounts rising between 500-1,000 m are called sea knolls. These areas are at times associated with upwelling currents that bring high levels of nutrients into the photic zone, promoting high primary productivity. Seamounts are important for many charismatic megafauna species, including commercially important species such as tuna or orange roughy, and frequently quite isolated, supporting high levels of endemism. Under certain conditions, seamounts and other ridges, pinnacles and mounds are associated with cold-water coral reefs, providing important nursery and spawning habitat for a range of species. These reefs are slow growing and sensitive to physical impacts associated with mining, bottom trawling, laying of deep-sea cables and to emerging issues such as climate change and ocean acidification.

The South Pacific deep-ocean basin represents the largest contiguous ecosystem for life on our planet and contains the full range of known seafloor habitats: vast abyssal plains underlying the huge central oligotrophic gyre, eutrophic hotspots underlying equatorial and Antarctic upwelling zones and active and inactive seamount chains that extend from ocean margins into the ocean interior where they intersect mid-oceanic ridges. Furthermore, the South Pacific Ocean also contains the world's most abundant hydrothermal vents, the world's largest seep sites, oxygen minimum zones and networks of canyons. The South Pacific provides connectivity between established biodiversity and evolutionary hotspots, in a range of habitat types, as well as hosting some of Earth's most poorly studied deep-ocean regions. The abyssal plains, seamounts as well as hydrothermal vents are in many cases associated with marine mineral resources. The three main types of minerals in the deep ocean that are of interest to prospectors are described below.

Polymetallic Manganese Nodules

Manganese nodules are mineral precipitates of manganese and iron oxides. They occur over extensive areas of abyssal plains at depths of 4,000–6,500 m and grow extremely slowly (2 or 3 cm every million years). Nodules contain nickel, copper, cobalt, and manganese, as well as traces of other metals (notably rare earth elements) that are important to high-tech industries (DSCC, 2019).

The nodules provide a substrate for a variety of suspension feeders and creatures that live on or just below the surface and which are wholly dependent on nodules for their survival. These sediment communities are known to differ greatly between areas and have extremely slow restoration rates. In common with most deep-sea life forms, little is known about how much space these colonies and species need to survive (EU-MIDAS, 2019). However, scientists are increasingly recognizing that the diversity of species and ecosystems in deep abyssal plain areas are far higher than was previously thought (EU-MIDAS, 2019).

Cobalt-rich Ferromanganese Crusts

Cobalt precipitates onto rock surfaces in the deep ocean that are free of sediment (mainly seamounts). Layers build at such a slow rate that it takes one million years for a crust to grow between 1 and 5 mm. This is one of the slowest natural processes on Earth. Crusts of economic interest occur at depths of 800–2,500 m on seamounts, mainly in the Pacific

Ocean. These areas are often characterized by dense assemblages of deep-water corals, sponges, and other species which grow on the hard substrate that seamounts provide to these animals in the deep sea and they, in turn, provide the habitat for a large and highly diverse range of deep-sea species. Seamounts obstruct current flow, which results in strong eddies and upwelling, increasing primary biological productivity. However, at such deep currents production is often slow. The seamounts are biodiversity hotspots in the ocean, supporting complex ecosystems from their surface to their base. They are also known to be a stopping point for migratory species. Additionally, rare earth elements can form between layers where an overlaying oxygen minimum zone and an oxygenated deeper layer occur at seamounts. It can thus be expected that organic matter recycling is important, and that at those depths most primary biological production is chemotrophic with some surface input of organic matter to sustain the benthic community taking place, including active metazoa behaviour, plus long-term building up of tightly metabolically coupled communities with organisms such as sponges consuming bacteria. It is likely that large and migratory species not only exert bottom down predation but contribute with excretion and faeces to the trophic web. In other words, ocean systems are so interdependent that re-building them would take generations.

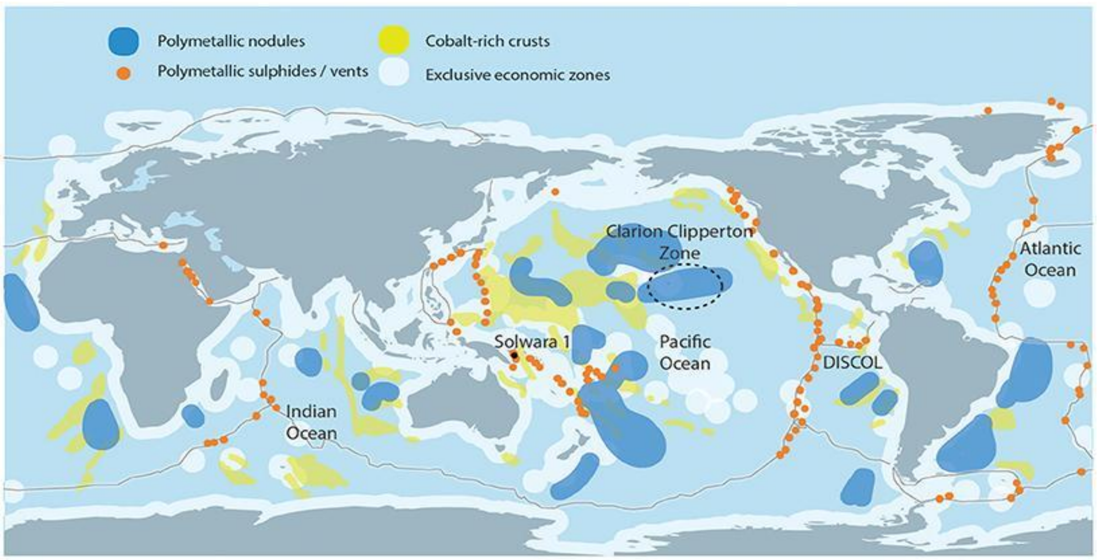


Figure 5 World map showing the location of the three main marine mineral deposits: polymetallic nodules (blue); polymetallic or seafloor massive sulphides (orange); and cobalt-rich ferromanganese crusts (yellow)
Source: Miller et al., 2018

Polymetallic Sulphides

Deep-sea hydrothermal vents, now thought to be the original cradle for the development of life on Earth, are found along mid-oceanic ridges where tectonic plates move apart to form new oceanic crust, and back-arc basins. They support some of the rarest and most unique ecological communities known to science. Sometimes called “black-smoker complexes”, the vents also form ore deposits with relatively high concentrations of precious metals – gold, silver, and copper, as well as zinc and other metals, which precipitate out of the hot water spewing from the Earth’s crust. In total, around 7.5 % of the global mid-oceanic ridges – some 6,000 kilometres – are now being explored for their mineral wealth.

Organisms at vent sites do not derive their energy from light but from sulphide chemicals in hot (~350 C) mineralized vent fluids. They are unlike any other life form on the planet. Most species discovered at vents are endemic to these areas and exist nowhere else, and the vents support communities with extremely high biomass relative to other deep-sea habitats. In addition, both active and inactive sites have extraordinary diversity, and it has recently been found that microbial diversity in inactive sites is different from both water column and active sites, and it is likely that they contribute to the trophic web (Lee Van Dover, 2019). The biodiversity of these unique, rare, fragile and geographically fragmented ecosystems is of interest to science and a potential source of new life-saving medicines and biotech applications, probably holding many secrets about evolution and adaptation of life on Earth and elsewhere in our solar system.

Areas of geological importance with associated marine mineral resources are found in the deep ocean basins of both the Southeast Atlantic and the Southeast Pacific. However, due to the vast extent of these deep ocean basins and the limited number of specific surveys conducted so far to identify major mineral deposits in these regions, knowledge about the exact location of substantial deposits consequently remains limited, too. The maps provided in this section (see Figure 5) therefore mostly provide indications of those areas where relevant marine mineral resources are likely to occur.

Conclusion

Areas of geological importance with associated marine mineral resources of potential economic value are found in the deep ocean basins of both the Southeast Pacific and the Southeast Atlantic. These geological features have formed over extremely long time-scales and they are each providing unique habitats for a variety of fragile deep-sea species assemblages, some of them being endemic to these areas.

Considering the extremely long time-scales over which these geological structures, including conjunct marine mineral resources such as polymetallic manganese nodules, cobalt-rich ferromanganese crusts and polymetallic sulphides, have formed in the deep ocean, under natural conditions no substantive changes with regards to their distribution and occurrence are expected in the foreseeable future. At the same time, however, the dynamics of plate tectonics and associated regional or local geological and geothermal processes and events will continue to cause both the creation of new hydrothermal vents as well as the expiration of others. These processes are unpredictable and likely to be restricted to specific areas of limited extent.

While a general overview and understanding of areas of geological importance and the occurrence of marine mineral resources exists, there is a lack of fine-scale assessments of these areas, including evaluations with regards to the potential economic value of resources in specified areas or possible environmental consequences of extracting these.
As only a small fraction of these vast ocean basins has so far been investigated by science or explored for extraction objectives, scores of knowledge gaps remain, including with regards to formative geological, ecological and evolutionary processes that have shaped current patterns of biodiversity and ecosystem function and that serve to sustain deep-sea biodiversity associated with the various geological features and the habitats they provide.

As of today, no commercial mining of these marine mineral resources is taking place in areas beyond national jurisdiction of the Southeast Atlantic or the Southeast Pacific. The regulatory framework for the exploitation of these minerals is currently under development by the ISA (see Section 0).

2.3 Seabed Habitats (benthic)

Key Messages:

- The Southeast Atlantic contains around 25 % of Earth's seamounts and an important number of hydrothermal vent fields. While it is still largely unexplored, some 3,412 active hydrothermal vents have been observed, while 7,629 are expected to exist. Similarly, 700 seamounts have been predicted while only a small fraction has been explored. Hydrothermal vent fields in the Southeast Atlantic are located along the Mid-Atlantic Ridge, while seamounts are especially abundant at the Mid-Atlantic Ridge, the Walvis Ridge and the Guinea Rise.

- The Southeast Pacific is the only area of the Pacific Ocean fenced off by a ridge system, which has the Earth's fastest spreading rate. Hydrothermal vent fields occur at least at three spreading zones of the Southeast Pacific: the Galapagos Rift, the Southeast Pacific Rise and the Pacific-Antarctic Ridge. The Southeast Pacific seafloor presents high levels of volcanic activity testified by a high number of seamounts.

- Seamounts form biological hotspots with a distinct, abundant and diverse fauna therefore providing important feeding grounds for numerous species as well as supporting fisheries. Hydrothermal vent fields provide habitats for communities, which generally present low levels of diversity but high levels of diversity unique to a specific community (endemicity) as well as high biomass.

In the deep seafloor, hard rocky habitats are usually dominated by sessile suspension-feeders, such as sponges, cnidarians and foraminifera, while soft sediments areas are usually dominated by assemblages of mobile, deposit-feeding or tube-dwelling polychaetes and nematodes (Smith & Demopoulos, 2003). Deep-sea sediments cover 65 % of the world's surface, which makes this type of benthic habitat one of the most extended in the world (Danovaro et al., 2008). These habitats are the largest reservoirs of biomass and non-renewable resources, they host microbial processes that are essential for biogeochemical cycles and probably a large proportion of undiscovered biodiversity (Gage & Tyler, 1992). In general, most taxa inhabiting deep soft-bottom habitats appear broadly distributed across the deep seafloor (McClain & Hardy, 2010).

The Southeast Atlantic contains around 25 % of Earth's seamounts (Zeller et al., 2016) and at least 12 active hydrothermal vent fields (Beaulieu, 2010). Similarly, the Southeast Pacific seafloor presents high levels of volcanic activity testified by a high number of seamounts (Smith and Demopoulos, 2003) (see Figure 6). A total of 945 large seamounts (i.e. with a height >1,000 m) have been predicted for ABNJ of the Southeast Atlantic (FAO areas 34 and 47) (Clark et al., 2006). Seven hundred large seamounts (i.e. with a height >1,000 m) have been predicted for ABNJ of the Southeast Pacific area (FAO area 87) (Clark et al., 2006). However, only a small fraction of them have been studied.

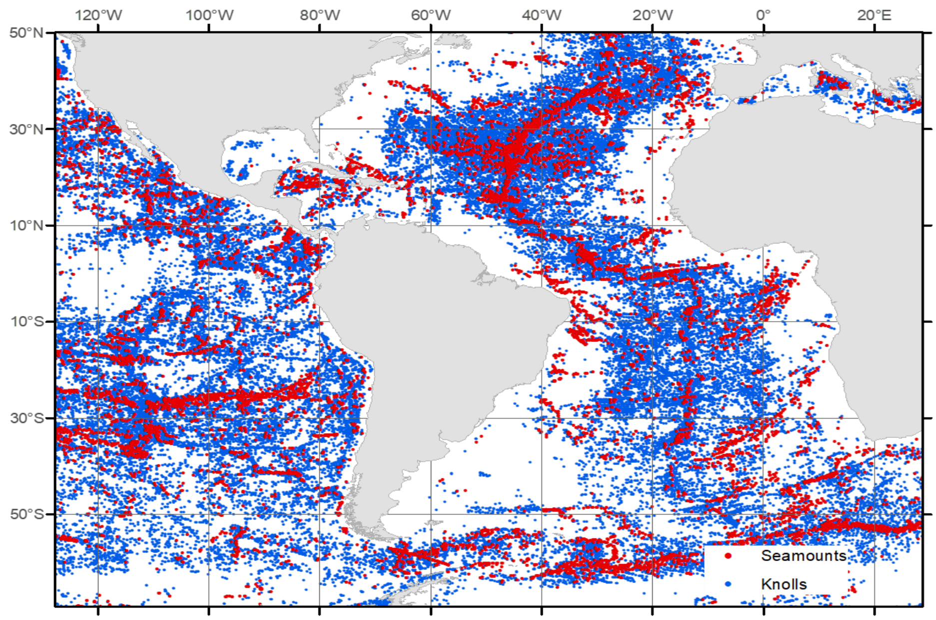


Figure 6 Seamounts and knolls in the Southeast Pacific and Southeast Atlantic
Source: Yesson et al., 2011

The food availability on and above seamounts is often higher than in surrounding waters (Clark et al., 2006). Therefore, seamounts may form biological hotspots with a distinct, abundant and diverse fauna (Morato et al., 2010). They provide sites for allopatric speciation in populations with restricted bathymetric distributions and support productive small-scale fisheries (Smith & Demopoulos, 2003). Deep-sea fish species form spawning aggregations around seamounts (Clark, 1999; Tsukamoto, 2006). Pelagic predators such as sharks, tuna, billfish, turtles, seabirds and marine mammals may also aggregate around seamounts (Worm et al., 2003). Seamounts support productive small-scale fisheries and aggregation sites for spawning and for pelagic predators (Clark, 1999; Smith & Demopoulos, 2003; Tsukamoto, 2006). A significant component of the diversity on seamounts is due to cold-water corals, which play a key ecological role supporting diverse biological communities (Clark et al., 2006). However, cold-water corals are highly vulnerable to mechanical damage and their recovery from disturbance is slow (Rogers, 1999).

Less than 20 % of Earth's entire ridge-crest has been explored for hydrothermal activity (German et al., 2011), and the seafloor of the Southeast Atlantic and Southeast Pacific areas are still largely unexplored. To date, 12 active hydrothermal vents in the Southeast Atlantic have been explored, while 29 are expected (Beaulieu, 2010). In the Southeast Pacific, only 34 active hydrothermal vents have been explored, while 76 are expected (Beaulieu, 2010). Specifically, at the Southeast Pacific Rise an important number of hydrothermal vents (35) are expected to be found (Beaulieu, 2010). Hydrothermal vent fields in the Southeast Atlantic are located along the Mid-Atlantic Ridge (Vrijenhoek, 2010), while seamounts are especially abundant at the Mid-Atlantic Ridge, the Walvis Ridge and the Guinea Rise (Kitchingman & Lai, 2004). Hydrothermal vent fields occur at least at three spreading zones of the Southeast Pacific: the Galapagos Rift, the Southeast Pacific Rise and the Pacific-Antarctic Ridge (Vrijenhoek, 2010) (see Figure 7).

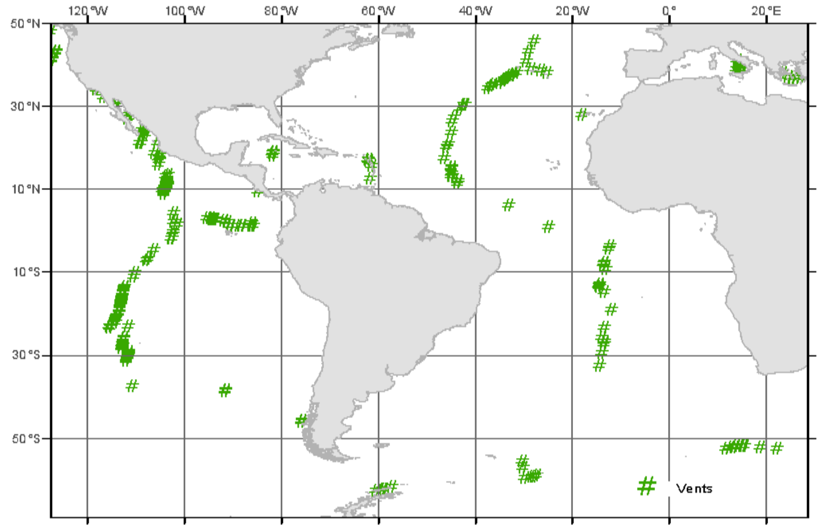


Figure 7 Active hydrothermal vents in the Southeast Pacific and Southeast Atlantic
Source: Active Submarine Hydrothermal Vent Fields, 2019

Hydrothermal vent fields occur at spreading zones, where magma chambers discharge lavas onto the ocean floor, generating black smokers and associated diffuse flow systems (Lonsdale, 1977). Hydrothermal vents provide habitats for ephemeral, spatially-discrete communities, which generally present high levels of endemicity (Desbruyères, 2006; Grassle, 1987). These ecosystems are supported by chemosynthetic primary production driven by chemolithoautotrophic bacteria capable of fixing organic carbon supported by the hydrogen sulphide present in the vent's effluents (Grassle, 1987).[23] Hydrothermal vent fields provide habitats for ephemeral, spatially-discrete communities, which generally present low levels of diversity but high levels of diversity unique to a specific community (endemicity) and high biomass (Desbruyères, 2006; Turnipseed et al., 2003).

Southeast Atlantic

The Southeast Atlantic deep-sea ocean floor is constituted by vast, relatively flat expanses of abyssal seafloor (such as the Cape Verde Plain and the Angola Plain), interspersed with features including mid-oceanic ridges (such as the Mid-Atlantic Ridge and the Walvis Ridge), hydrothermal vents, seamounts and guyots. The Mid-Atlantic Ridge has a highly variable depth range (850-3650 m) and a slow spreading rate (20-40 mm/year) (Vrijenhoek, 2010). Hydrothermal vents of the Southeast Atlantic are located along the Mid-Atlantic Ridge, which is divided into the Northern Mid-Atlantic Ridge (with 8 active-confirmed, 13 active-inferred and 15 inactive hydrothermal vents) and Southern Mid-Atlantic Ridge (with 4 active-confirmed and 4 active-inferred hydrothermal vents) (Beaulieu, 2010).

Seamounts are ubiquitous within the Southeast Atlantic, however a higher concentration of them has been predicted at the Mid-Atlantic Ridge, the Walvis Ridge and the Guinea Rise (Kitchingman & Lai, 2004). The Areas FAO 47 and 34 have 5.4 % and 20.1 % of the world's seamounts, respectively, containing together more than a quarter (25.4 %) of the world's seamounts (Zeller et al., 2016). The vent fauna of the Northern Mid-Atlantic Ridge is mostly similar to the North East Pacific Rise vent fauna (Bachraty et al., 2009). It has been observed that the vent fauna of the Northern Mid-Atlantic Ridge includes a subset of the Pacific vent fauna (Van Dover, 2000; 1995).

Southeast Pacific

The Southeast Pacific deep-sea ocean floor is constituted by vast, relatively flat expanses of abyssal seafloor, interspersed with features including oceanic trenches, mid-oceanic ridges, hydrothermal vents and seamounts. Most of the Pacific deep seafloor is covered with soft sediment. Some distinctive characteristics of the Southeast Pacific seafloor include its high levels of volcanic activity, testified by a high number of seamounts. This area also experiences intense upwelling, limited

[23] Chemolithoautotrophic means that these organisms obtain the necessary carbon for metabolic processes from carbon dioxide in their environment. They also use inorganic compounds such as nitrogen, iron, or sulphur for the energy to power these processes.

terrigenous sedimentation and the development of a very extensive oxygen minimum zone (Smith and Demopoulos, 2003). In addition, the Southeast Pacific is the only area of the Pacific Ocean fenced off by a ridge system (the East Pacific Ridge), which has the Earth's fastest spreading rate (85-150 mm/year) (Hey et al., 2006).

The hydrothermal vent fields were first discovered in the Southeast Pacific, specifically at the Galapagos vents in 1977 (Corliss et al., 1979; Lonsdale, 1977). They occur at spreading zones where magma chambers discharge lavas onto the ocean floor, generating black smokers and associated diffuse flow systems (Lonsdale, 1977). These ecosystems are supported by chemosynthetic primary production driven by chemolithoautotrophicbacteria capable of fixing organic carbon supported by the hydrogen sulphide present in the vent's effluents (Grassle, 1987). Hydrothermal vents of the Southeast Pacific are located at the Galapagos Rift (5 active, 7 active-inferred and 7 inactive), Southeast Pacific Rise (27 active, 35 active-inferred), Pacific-Antarctic Ridge (2 active) and Chile Rise (2 active-inferred) (Beaulieu, 2010).

Seamounts are abundant in the Southeast Pacific. Indeed, it has been estimated that the FAO 87 area has 8.03 % of the world's seamounts (Zeller et al., 2016). Due to the relatively high food availability on and above seamounts (Clark et al., 2006), they may form biological hotspots with a distinct, abundant and diverse fauna (Morato et al., 2010). They provide sites for allopatric speciation in populations with restricted bathymetric distributions and support productive small-scale fisheries (Smith and Demopoulos, 2003). Deep-sea fish species form spawning aggregations around seamounts (Clark, 1999; Tsukamoto, 2006), while pelagic predators such as sharks, tuna, billfish, turtles, seabirds and marine mammals may also aggregate around seamounts (Worm et al., 2003). The Northern and Southern East Pacific Rise share many of the same species. However, a dispersal filter across the equator impedes dispersal of many vent species. Eastern and Western Pacific vent fauna are mostly distinct (Vrijenhoek, 2010).

Conclusion

Deep-sea benthic habitats support rich and diverse communities. Most of the deep-sea ocean floor is constituted by vast, relatively flat expanses of abyssal seafloor, interspersed with features such as hydrothermal vents, seamounts and guyots. In the Southeast Atlantic, hydrothermal vent fields are especially abundant along the Mid-Atlantic Ridge, while in the Southeast Pacific, they are especially abundant at the Southeast Pacific Rise. They provide habitats for ephemeral, spatially discrete communities, which generally present high levels of endemicity. Seamounts are also abundant in both regions. In the Southeast Atlantic, they are mainly concentrated along the Mid-Atlantic Ridge, the Walvis Ridge and the Guinea Rise, while in the Southeast Pacific, they are mainly concentrated along the Nazca and Sala and Gómez Ridge. Seamounts support productive small-scale fisheries and constitute spawning aggregations as well as aggregations sites for pelagic predators.

Despite their ecological, economical and biogeochemical importance, deep-sea benthic habitats are currently exposed to several threats. For instance, the extraction of fish and species removal (see Section 0) affects the availability of organic matter for benthic organisms as well as the generation of transient habitats on the sea bottom, which has an impact on the connectivity of deep-sea communities. The physical disturbance and destruction of the seabed (see Section 0) due to fishing and other human activities has direct impacts on benthic habitats, especially on vulnerable ones. Finally, climate change (section 0) affects the physical-chemical environment of benthic habitats.

2.4 Water Column Habitats (pelagic)

Key Messages:

- ABNJ of the Southeast Atlantic and Southeast Pacific share the main broad distribution of oceanographic systems, including tropical (upwelling), subtropical (convergence), and sub Antarctic ecoregions and surface to deep water habitats (epi-, meso-, and bathy-pelagic zones). Mid-depth Oxygen Minimum Zones are also a characteristic of the tropical region in both ABNJs.

- Mesotrophic to ultra-oligotrophic waters are found in these ABNJ. Epipelagic plankton richness in oceanic waters shows a poleward decline in diversity, with temperature being one of the important drivers.

- Current knowledge on the structure of the microbial communities dominating in the deep sea, including both ABNJs, is very limited. Recently, it has been found that about 50% of the operational taxonomic units (OTUs) found in the bathyal zone belong to previously unknown prokaryotic taxa.

The genetic potential of marine bacteria metabolism in surface and deep waters is just beginning to be understood by scientists, leading to previous understandings of paradigms of productivity pathways and controls to be challenged. Studies on biotechnological applications derived from bacterial and archaea genomes for biomining or greenhouse gases consumption and sequestration are increasing.

The pelagic open ocean waters provide habitats throughout surface warmer and lighted areas to the deepest cold dark trenches, from continental margins to the farthest point offshore. ABNJ of the Southeast Atlantic and Southeast Pacific share the main broad distribution of oceanic systems, including tropical, subtropical, and sub Antarctic ecoregions and surface to deep water habitats (epi-, meso-, and bathy-pelagic zones). Oceanographic variables including light, temperature, salinity, oxygen, depth of the mixed layer, depth of the photic layer, and macro-nutrients (nitrate, phosphate, and silicate) or micro-nutrients (e.g., iron), contribute to spatial and temporal variability between and within each basin (Longhurst, 2006; Reygondeau et al., 2013, 2018).

The supply of a range of nutrient elements to surface waters is an important driver of oceanic biological production and the subsequent cycling of the nutrients and carbon (Arrigo, 2005). Equatorial upwelling in both ABNJ systems contribute with the injection of nutrient from subsurface waters to the upper lighted layer (mesotrophic environment), whereas the subtropical ecoregions are characterized by downwelling (oligotrophic to ultra-oligotrophic environments) in the area of the subtropical gyres, so that nutrients are very low in the upper layer; nutrients increase again in subantarctic waters (Longhurst, 2006). Mid-depth (100-900 m) Oxygen Minimum Zones are also a characteristic of the tropical region in both ABNJs, being more intense and extended in the Pacific (Karstensen et al., 2008).

In the pelagic realm of both ABNJ, planktonic (limited movement) and nektonic (active swimming) organisms coexists. Microbial unicellular organisms (from femto- to micro-plankton) make up the bulk of ocean biomass and drive biogeochemical cycles of major and minor nutrients and elements. They are also responsible for the evolution of atmospheric gas composition, climate regulation and the formation of mineral deposits (Cavicchioli et al., 2019). The diversity of microbial organisms in the plankton is usually described either in terms of taxonomic, genomic, and/or size composition, or as functional groups according to a combination of ecological traits (Salazar et al., 2016; Sunagawa et al., 2015).

Global patterns of marine phytoplankton diversity in the open ocean, including these ABNJs, remain poorly characterized in terms of taxonomic composition, which includes prokaryotes (cyanobacteria) and several groups of protistan eukaryotes (diatoms, flagellates, ciliates, coccolithophores) (Not et al., 2012; Estrada et al., 2016; Kashtan et al., 2017). At a global scale, phytoplankton richness in oceanic waters of the tropics has been found to be about three times more that in higher latitudes, with temperature being one of the important driver (Righetti et al., 2019). Temperature also emerges as the best predictor of epipelagic plankton diversity, with a poleward decline in diversity (Ibarbalz et al., 2019).

In the open ocean, species richness across several pelagic forms decreases with depth at the global scale (Costello and Chaudhary, 2017) and species endemicity is lower than in coastal regions at the same scale (Costello et al., 2017). Current knowledge on the structure of the microbial communities dominating in the deep sea in both ABNJs is very limited and about 50% of the operational taxonomic units (OTUs) found in the bathyal zone belong to previously unknown prokaryotic taxa (Salazar et al., 2016).

Southeast Atlantic

The Southeast Atlantic, beyond western African countries, comprises diverse oceanographic systems. These are influenced by the offshore extension of coastal upwelling along the western African coast. From north to south these include: the North Atlantic Subtropical Gyre (NASG) on its south eastern portion; the Eastern Tropical Atlantic, the South Atlantic Subtropical Gyre (SASG) on its eastern half, and the Sub Antarctic Atlantic system. Important temperature and salinity gradients delimit these broad areas at latitudes that experience seasonal to inter-annual and decadal temporal scale variability (Pelegri et al, 2015; Stramma and England 1999). The mean characteristics and temporal anomalies of oceanographic variables in this region as well as the position of convergent zones translate into particular pelagic productivity patterns and food web structures, diversity, fisheries productivity, as well as suitability of habitats for and behavioural patterns of megafauna.

Surface currents follow the general atmospheric circulation patterns: northern and southern hemispheres subtropical gyres flowing clockwise and anticlockwise respectively; North (9-15N) and South Equatorial (10S-5N) currents flowing to the west are separated by a shallow eastward surface current: the North Equatorial Counter Current. Along the equator, in the subsurface, the Equatorial undercurrent flows eastward, feeding the equatorial upwelling and lifting the thermocline towards the east. Temperatures above 25°C are typical of westward flowing Equatorial currents, and surface tropical chlorophyll-a maxima are associated with upwelled waters. The colder equatorial temperature signature of upwelled waters extends out from coastal Africa. The intertropical convergence zone, where large precipitation due to atmospheric convection occurs, shifts seasonally about a few degrees in the northern hemisphere, with northward displacement during boreal summer (Pelegri et al., 2015). The influence of West Africa coastal waters and coastal dynamics on the eastern portion of the adjacent ABNJ is extremely relevant because coastal organic matter and nutrients enhance food webs in ABNJ, extending relevant habitats for different species (Pelegri et al., 2005).

Southeast Pacific

At least four regions in the Southeast Pacific can be identified from an oceanographic perspective: the Eastern Equatorial Pacific, Humboldt Current System transition zone, South Pacific Gyre (SPG) and the Sub Antarctic Eastern Pacific. The hydrography as well as prevailing forcing mechanisms driving spatio-temporal variability differ in spite of the prominent role of the South Pacific atmospheric anticyclone on the Eastern South Pacific circulation (REF). These areas also differ due to temporal patterns of productivity levels, drivers and planktonic community structure. Seamount chains across and along the meridional axis impose an important topographic constraints on North-South flow and mid-depth water flow, but also constitute a connectivity corridor from the coastal to central Pacific gyre environments or offshore oceanic islands (REF).

The Tropical Equatorial Eastern Pacific Ocean is known for its high productivity due to equatorial oceanic upwelling that drives colder and nutrient rich waters from the underlying current to the surface as a response to equatorial easterly winds (Pennington et al., 2006). Inter-annual to inter-decadal variability in atmosphere-ocean conditions are the result of climatic cycles, such as El Niño-Southern Oscillation (ENSO) and the Antarctic Oscillation (REF). A distinctive feature of the Southeast Pacific is the presence of a mid-depth Oxygen Minimum Zone (OMZ), extending along the Equatorial Pacific from mid to coastal longitudes, and poleward to 38°S along the coastal border of western South America. Biodiversity is typically low in the OMZ and only a few species dominate in terms of biomass (Levin et al., 2001). Another distinctiveness of this ABNJ is the ultra-oligotrophic waters of the SPG, which harbours the deepest chlorophyll maximum of the ocean (Masquelier and Vaulot, 2008; Walsh et al., 2015). South of this region, colder and fresher Sub-Antarctic waters are found. These regions, as in the South eastern Atlantic, are separated by frontal features, including the Subtropical Front and the Subantarctic Front (Chaigneau and Pizarro, 2005). At the southern extreme, the Antarctic Circumpolar Current connects all major ocean basins of the global ocean and separates the Antarctic ecoregion from the ABNJs analysed here (Giglio and Johnson, 2016).

Conclusion

Beyond the EEZ off the western African and South American countries, ABNJs are characterized by diverse oceanographic settings that constitute different pelagic habitats and ecoregions, including the tropical upwelling band, the coastal-ocean transition zone, the subtropical convergence, and the sub Antarctic region. This spatial variability, in combination with intra-seasonal to multi-decadal time scales ocean-atmosphere variability, influence the distribution of planktonic and nektonic organisms, pelagic biodiversity, and the productivity in each system. Key issues regarding ocean-atmospheric connections and temporal variability in both ABNJs remain to be solved in the context of their impact on species distribution and biodiversity. Satellite studies, as well as data from Argo floats have increased the capacity to understand and analyse the physical dynamics in these areas, but in situ sampling efforts covering the whole of the water column (epipelagic to bathyal) are still a demand for covering biogeochemical and biological-ecological processes and how they are affected by natural and anthropogenic disturbances. In particular, ocean's microbial diversity remains under-sampled and poorly understood albeit the role these organisms have on climate and the enormous potential they have as genetic resources for humankind.

2.5 Fish

Key Messages:

- Highly migratory fish stocks are found both within EEZs and the adjacent ABNJ.
- Connectivity of fish stocks between EEZs and ABNJ is relatively poorly described for many stocks, increasing the risk of negative effects due to overfishing and other stock-impacting activities in ABNJ to coastal countries.
- There is a loss of genetic diversity due to the exploitation of fish in vulnerable ecosystems (e.g. seamounts) or other resource exploitation (e.g. mining, energy) which may cause damage to habitats or feeding grounds.
- Information regarding commercial fish species is far greater than that available for species that do not have commercial interest, making assessments challenging.

Fish occupy different levels in trophic structure (see Figure 8) in ABNJ, particularly, from an ecological and energy-flow perspective, in connecting first-tier consumers (e.g. zooplankton) with intermediate and large predators. This role is played mainly by the fish of the family *Myctophidae* (or lantern fish), which are mesopelagic fish and include about 250 species grouped into 33 genera. They inhabit all oceans except the Arctic. These fish are adapted to inhabit minimal oxygen zones, greater than 2,000 metres deep and also carry out diel vertical migrations between meso- and epipelagic regions (Catul, et al., 2011; Greely, et al., 1999; Pearcy, et al., 1979; Watanabe, et al., 1999).

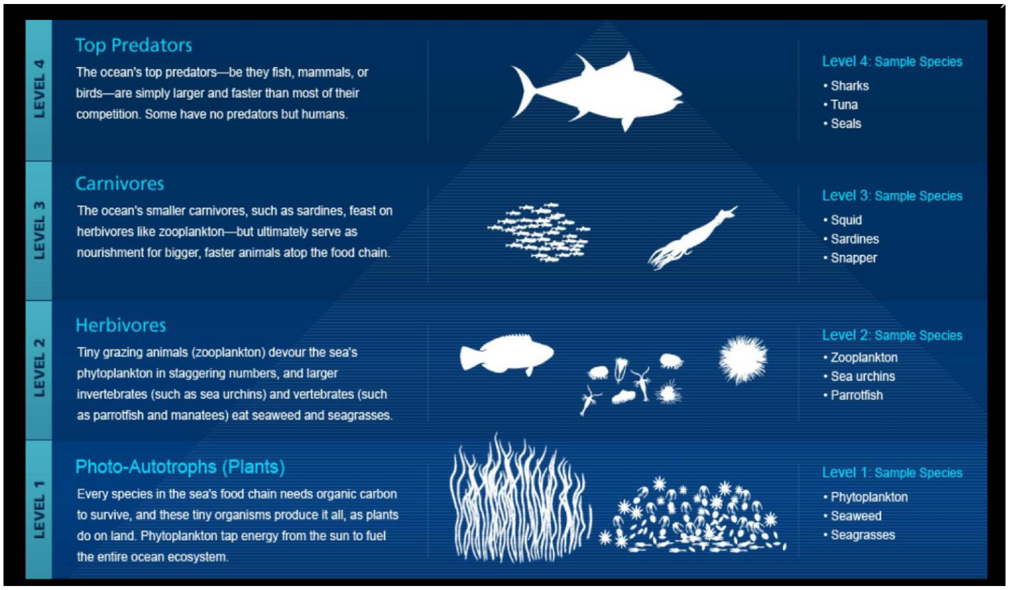


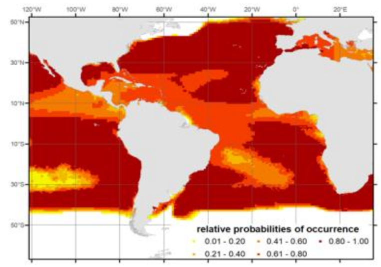
Figure 8 Marine food chain levels
Source: National Geographic, 2010

Myctophids reach large biomasses and, as secondary consumers, they connect primary consumers, such as copepods and euphausiids, to higher trophic level predators, such as squids, toothed cetaceans, pinnipeds and seabirds (Catul, et al., 2011). Their great abundance is important in biogeochemical flows, providing organic carbon through faeces that sink and accumulate in the ocean floor (Rodríguez & Castro, 2000; Catul, et al., 2011). In addition, myctophids are an important part of the diet of various commercially exploited resources, such as fish (FIP, 2004) and giant squid, among others (IFOP, 2017; Brunetti, et al., 1999).

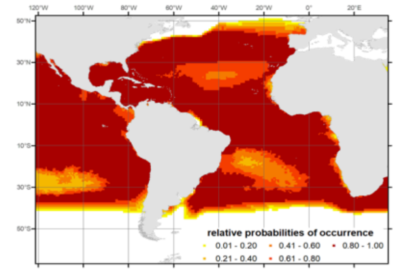
The role of vertical migrations in transferring energy from the highly productive euphotic zone to the deeper layers, also known as bottom layers, is an important energy flow route in the waters of the continental shelf, the continental slope and the open ocean (Willis & Pearcy, 1982). Biogeochemical consequences of vertical diel migration are not yet well known. The vertical flow of material in the ocean, biologically mediated (also known as "biological pump") is an issue of great interest and concern, as it is believed to play an important role in regulating carbon storage in the oceans and, by extension, the carbon cycle. Recent studies covering multiple trophic levels from fish to dinoflagellates have led to a concept of coupled vertical migrations called "cascade migrations" (Bollens et al., 2011).

FAO defines straddling stocks as fish stocks that migrate between the EEZs and ABNJ; they include in these migratory processes the movement during the different stages of the life cycle (FAO, 2006), defining the following stock types: (1) Pelagic stock: population of organisms that spend most of their life near the surface or in the water column with little dependence on the seabed; (2) Demersal stock: population of organisms that spend most of their life on or near the seabed; (3) ABNJ stock: group of organisms that live only in ABNJ. Straddling stocks of broadly distributed species, and species with life cycle shifts in distribution may occur in ABNJ and in one or more EEZs. The distributions and migratory characteristics of many fish stocks represent a challenge for fisheries management and conservation. The major commercial tuna species (*Thunnus alalunga, T. obesus, T. albacares*, *T. maccoyii, T. thynnus, T. orientalis* and *Katsuwonus pelamis*) are highly migratory and have extensive distribution in ABNJ and EEZs (see Figure 9) (FAO, 2006). The skipjack tuna lives for 8-12 years, spawns year-round starting at ages 1-2 years, and has a wide distribution in tropical and temperate waters. By comparison, the southern Bluefin tuna (*T. maccoyi)* is long lived (≥ 40 years old), reaches sexual maturity at 11-12 years old, and has well defined breeding and migration patterns. These very different life history strategies have obvious implications for stock productivity, resilience to fishing pressure and thus vulnerability to overfishing. Marlins, sailfish and swordfish are categorized as tuna-like species, and have an extensive geographical distribution. Two species-pairs have mutually exclusive ranges, centring on the Atlantic Ocean. The Atlantic white marlin (*Kajikia albida)* and Atlantic sailfish (*Istiophorus albicans)* are endemic to the Atlantic Ocean, while the striped marlin (*K. audax)* is marginal or absent in the Atlantic Ocean (see Figure 10).

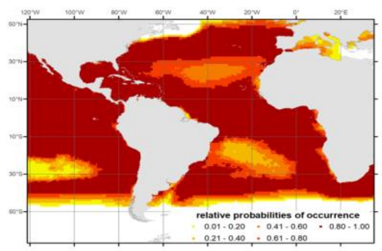
Albacore tuna *(Thunnus alalunga)*



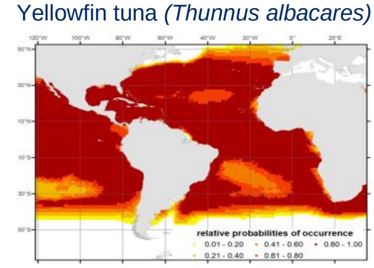
Bigeye tuna *(Thunnus obesus)*



Skipjack tuna *(Katsuwonus pelamis)*



Yellowfin tuna *(Thunnus albacares)*



Southern Bluefin tuna (Thunnus maccoyii)

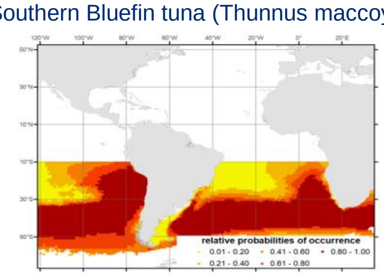
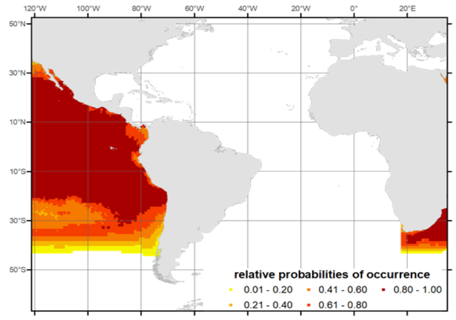


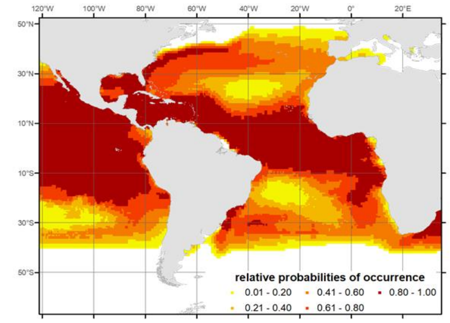
Figure 9 Relative probabilities of occurrence of tuna species in the Southeast Atlantic and Southeast Pacific
Source: Kaschner et al., 2019[24]

[24] Relative probabilities of occurrence are shown in colours

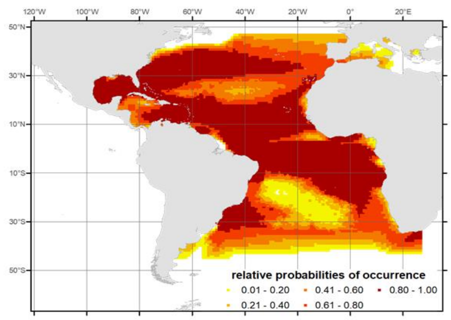
Black marlin *(Makaira indica)*



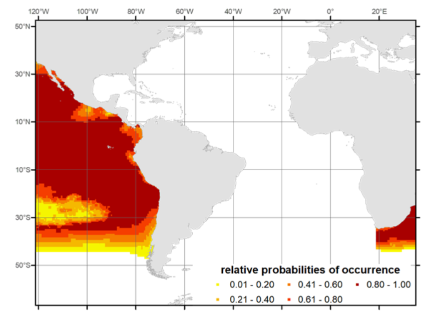
Blue marlin *(Makaira nigricans)*



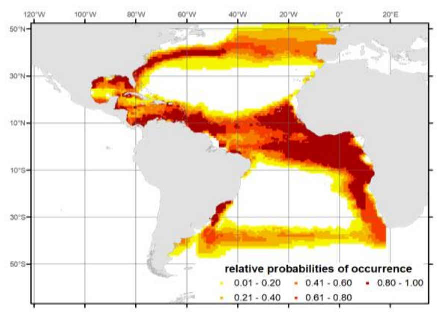
Atlantic white marlin *(Kajikia albida)*



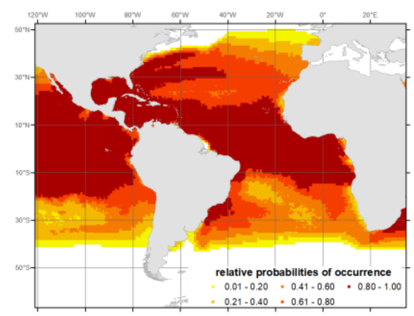
Striped marlin *(Kajikia audax)*



Atlantic sailfish *(Istiophorus albicans)*



Indo-pacific sailfish *(Istiophorus platypterus)*



Swordfish *(Xiphias gladius)*

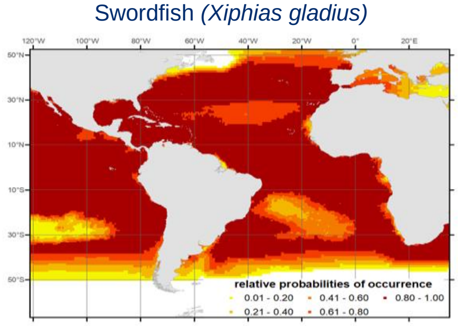


Figure 10 Relative probabilities of occurrence of sailfish and swordfish species in the Southeast Atlantic and Southeast Pacific
Source: Kaschner et al., 2019[25]

[25] Note: Relative probabilities of occurrence are shown in colours

Southeast Atlantic

For the South-eastern Atlantic (FAO areas 34 and 47), four areas of biological interest are important: Convergence Zone of the Canary Islands-Guinea currents (CZCIGC), Equatorial Tuna Production Area (ETPA), Walvis Ridge (WR) and the Subtropical Convergence Zone (STCZ).

The CZCIGC encompasses the ecosystems and habitats of the coastline from southern Senegal to northern Liberia and the adjacent ABNJ and it is an area of ecological, economic and biological importance for fish, including some highly exploited stocks (CBD, 2015). However, the predominant commercially exploited species in the ABNJ areas are tunas and sharks.
The ETPA in the Congo marine basin extends either side of the equator and into ABNJ westward from Africa. This area is heavily exploited by purse seine and longline fishing fleets operating under the International Commission for the Conservation of Atlantic Tunas (ICCAT). The upwellings and marine currents in the region, including environmental parameters, form the basis of phytoplanktonic and zooplanktonic blooms that contribute to the development of larvae, juveniles and adults of tunas, minor tunas and swordfish (CBD, 2015).

The WR is a significant seamount chain forming a bridge running east to west entirely outside national jurisdiction, extending from the Namibia – Angola continental margin (19.3°S) to the Tristan da Cunha island group at the Mid-Atlantic Ridge (37.4°S). It is a unique geomorphological feature likely to be of special importance to vulnerable sessile macrofauna and demersal fish associated with seamounts. Although bottom fisheries occur on the Walvis Ridge, the spatial extent of commercial fishing is limited to a relatively small area. The primary demersal fisheries target red crab, orange roughy, alfonsino, southern boarfish, and marginally in the southern extent, Patagonian toothfish (*Dissostichus eleginoides)*. The ABNJ fisheries in this area are managed by the South East Atlantic Fisheries Organisation (SEAFO) (CBD, 2015).

The STCZ is a high productivity oceanographic feature in the South East Atlantic Ocean with distinct oceanographic signatures such as strong gradients in salinity, temperature and nutrients (strong surface nitrate gradient). The enhanced productivity supports a high diversity of epipelagic species, and the zone is inhabited by globally threatened fish species such as southern Bluefin tuna. The area furthermore recognizes ecological linkages and includes the Cape Basin and Vema Seamount, one of the few seamounts in this area that extends to the photic zone (CBD, 2015).

Southeast Pacific

For the Southeast Pacific region, two areas of biological interest are important: The Equatorial High Productivity Zone (EHPZ) and Salas y Gómez and Nazca Ridge (SGNR). The first one is located in the Eastern Tropical and Temperate Pacific, from latitudes of approximately 5° N to 5° S of the equator, and longitude of approximately 165° E to the Galápagos Islands. The area is characterized by high kinetic energy and high front density, both measures of ocean boundaries and indicators of areas with high productivity (CBD, 2015). The area is remote, however, is commercially fished and may be vulnerable to climate change (CBD, 2015).

The SGNR is considered a biological hotspot, with one of the highest levels of marine biological endemism (41.2 % in fishes and 46.3 % in invertebrates) in the world, even surpassing the rates for hydrothermal vent ecosystems (CBD, 2015). The ABNJ portion of the SGNR covers about 415 638 km^2, which represent approximately 1.68 % of the international waters surface in the FAO area 87. Further, it contains about 110 seamounts with summits between the sea surface level and 2000 m depth (fishable depths), which represent 41 % of the seamounts in the Southeast Pacific. The fishes of the area are much more closely related to the Indo-West Pacific than to the eastern Pacific fauna. Currently, 171 fish species of 64 genera are known to inhabit the 22 explored seamounts of the ridge). Considering the overall number of seamounts in the region, many more species can be expected. Further, the bottom areas of Salas y Gómez and Nazca ridges have not been sampled biologically. The ridges offer habitat to a number of low resilience and long-lived species like deep water sharks (CBD, 2015), oreos and alfonsino. The seamounts of the ridges were found to host aggregations of vertically migrant, seamount-associated mesopelagic fishes and migratory pelagic fishes: pelagic sharks, in particular schools of large (>2 m) adult male blue sharks have been observed to aggregate over Nazca ridge. Also bigeye thresher sharks *(Alopias superciliosus)* were more abundant over seamounts than in the surroundings. The ridges function as recruitment and nursery areas for swordfish (Yañez et al., 2004, 2006, 2009) and are part of the breeding zone described for Chilean jack mackerel *(Trachurus murphyi)* (Arcos et al., 2001; SPRFMO, 2007).

Conclusion

The scarce knowledge of ABNJ species, as well as of their habitats, ecosystems and biodiversity are identified as one of the main obstacles to carry out an adequate management of the fish species that inhabit these areas, both from a perspective of fisheries management and the management of other activities that are developed in ABNJ, since they constitute highly vulnerable ecosystems.

Up to the present, the task of evaluating and formulating diagnoses on the state of the populations of the different sharks, rays and bony fish species has been made difficult due to the limitations of fisheries statistics and the lack of research surveys to determine stock status.

2.6 Marine Mammals and Sea Turtles

Key Messages:

- The Southeast Atlantic and the Southeast Pacific are important regions for the migratory movements of marine megafauna, including sea turtles and marine mammals.
- The interaction of the different fishing and ship traffic activities in these regions with the movements of these megafauna poses a serious risk to these vulnerable species that require regional strategies.
- New and cheaper technologies should help to monitor the populations of many species of marine megafauna in these regions with the participation of networks of scientists working on the ground in these two regions.

Marine megafauna species, which include sea turtles and marine mammals, are a key component of the ocean's biodiversity (see Figure 11 for megafauna species richness in the Southeast Atlantic and Southeast Pacific regions). Their decline due to anthropogenic activities can lead to changes in ecosystem functioning (Lewinson et al., 2014), ultimately affecting the ecosystem services that humans derive from the ocean.

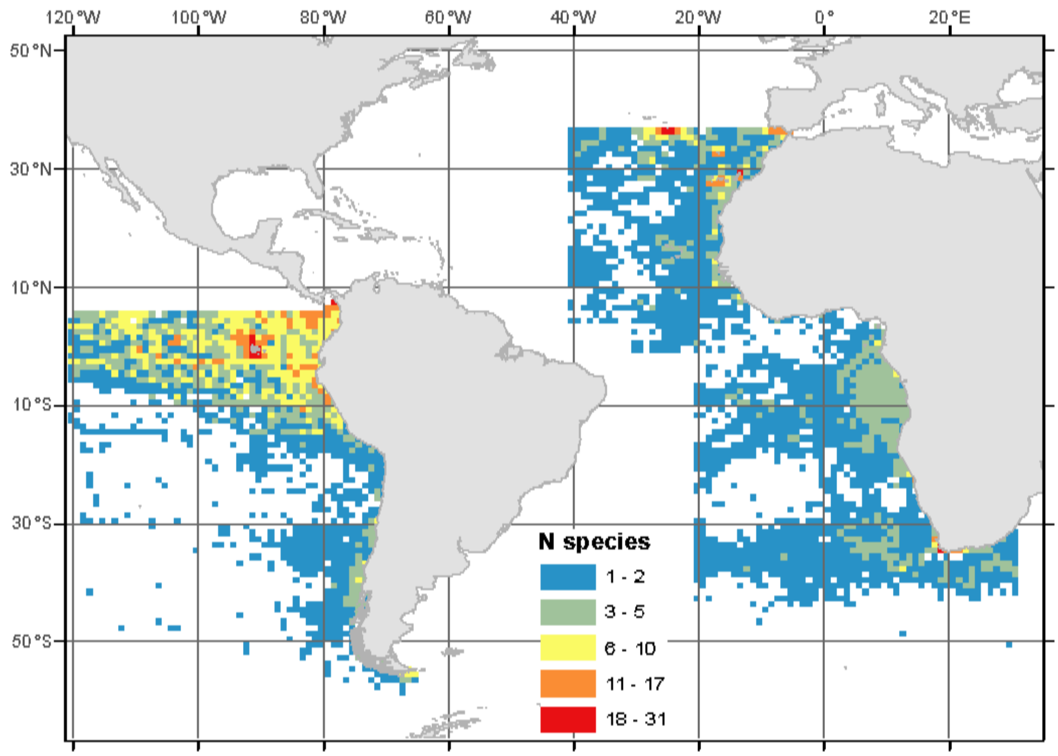


Figure 11 Megafauna species richness
Source: OBIS SEAMAP, 2019[26]

[26] Includes marine mammals and sea turtles. Number of species per 1° grid cell.

Southeast Atlantic

The Eastern Central Atlantic and Southeast Atlantic (FAO Statistical Regions 34 and 47) have approximately 37 species of marine mammals and five species of sea turtles (Polidoro et al., 2017). Of these marine mammals, four are considered Endangered, three Vulnerable, 13 Least Concerned and 17 as Data Deficient according to the categorizations of the International Union for the Conservation of Nature (IUCN). Similarly, one sea turtle species is considered Critically Endangered – the Hawksbill (*Eretmochelys imbricate*), one is considered Endangered – the Green (*Chelonia mydas*), and the three others are considered Vulnerable – the Loggerhead (*Caretta caretta)*, Olive ridley (*Lepidochelys olivacea)*, and Leatherback *(Dermochelys coriacea*) (Polidoro et al., 2017; see also Figure 12 on turtle bycatch). The Mediterranean monk seal (*Monachus monachus*) is considered as Endangered by IUCN whereas the Afro Australian fur seal (Arctocephalus pusillus) and the Sub Antarctic fur seal are both considered as Least Concern.

Humpback whales (*Megaptera novaeangliae*) inhabiting the Southeast Atlantic Ocean are considered by the International Whaling Commission (IWC) as part of the Breeding Stock B. Abundance estimates for this breeding stock range between 4,000 and 7,000 individuals and an estimated annual range of increase of 3.1 % (Branch 2011). This last estimate contains broad confidence intervals. Humpback whales in this area overwinter in the Greater Gulf of Guinea that includes Angola, Congo and Gabon and some of the migratory routes extend into ABNJ of the region (Carvalho et al., 2014; Rosenbaum et al., 2014). Similarly, there is evidence of migratory behaviour of sea turtles in this region. For example, leatherback turtles that were tagged in Gabon, the world's largest nesting area for this species, spent most of the time in ABNJ (Witt et al., 2011). This study suggested that at least 11 countries in the Southeast Atlantic needed to be involved in the conservation of this species plus the distant fleet fisheries of the European Union, Eastern Europe and Asia operating in this region.

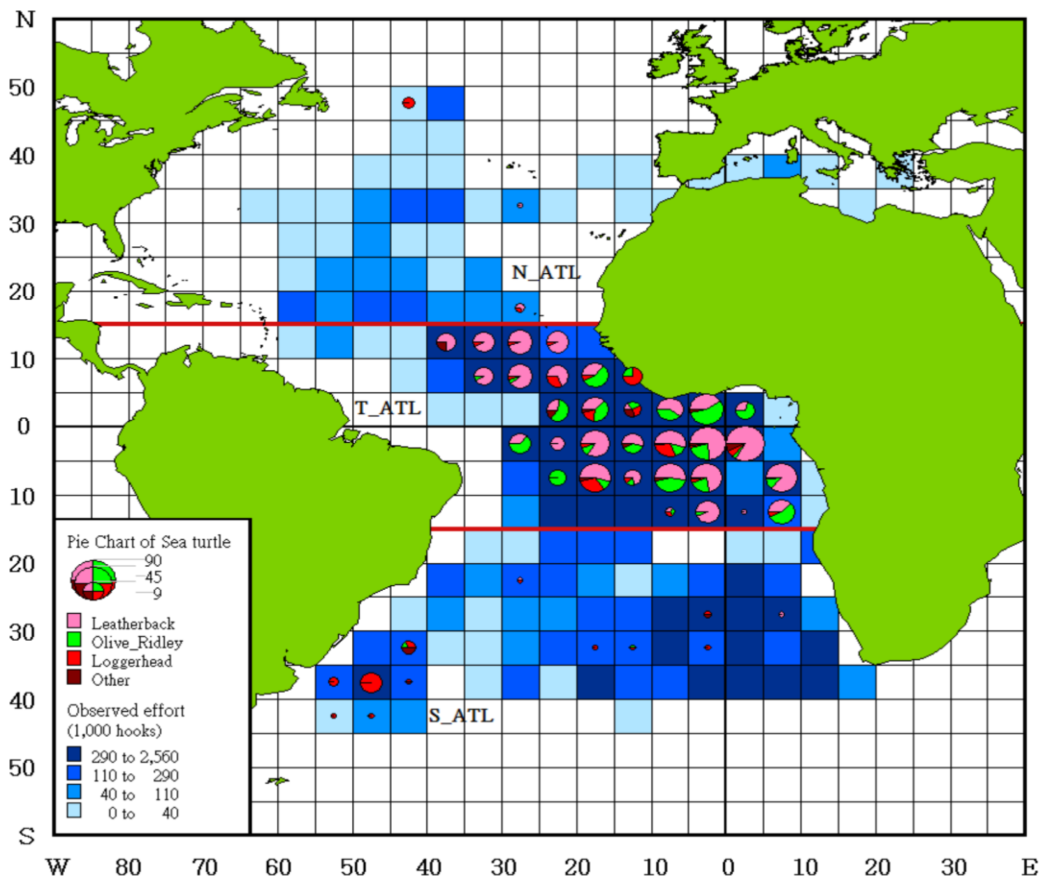


Figure 12 Observed fishing effort and number of sea turtle bycatch by species in 5*5-degree grid from 2002 to 2013 in all Taiwanese longline fleets in the Atlantic Ocean

Source: Huang, 2015

Box 2 Migratory connectivity of Leatherback sea turtles in the Southeast Atlantic Ocean

By Sarah Poulin and Corrie Curtice (Marine Geospatial Ecology Lab, Duke University), and Daniel Dunn (University of Queensland)

Understanding how the oceans are used and connected by migratory species is crucial for their conservation and sustainable use. With improvements in animal tracking technology, researchers are able to gain greater insight about the migratory connectivity of populations and species. The Migratory Connectivity in the Ocean (MiCO)[27] system is a freely available, open-access, web-based mapping application that seeks to provide actionable knowledge on migratory connectivity for hundreds of marine species to inform worldwide conservation and sustainable use efforts.

Leatherback turtles *(Dermochelys coriacea)* are a highly mobile species that can migrate across entire ocean basins. MiCO has synthesized contributed data of 37 nesting female leatherbacks tagged in Gabon, Africa, generating areas of use (nodes and corridors) that highlight and support previously published migration patterns (Witt et al., 2008; Witt et al., 2011; Pikesley et al., 2018). Analysis results show various post nesting migration strategies (Figure 13), with some making directed trans-Atlantic migrations to the coasts of South America and others migrating southward towards southern Africa (MiCO 2019; Witt et al., 2011). Alternatively, others demonstrate a ranging type of activity for several months following the nesting season, performing undirected swimming and foraging behaviours in a widespread area throughout Equatorial Atlantic (Figure 13).

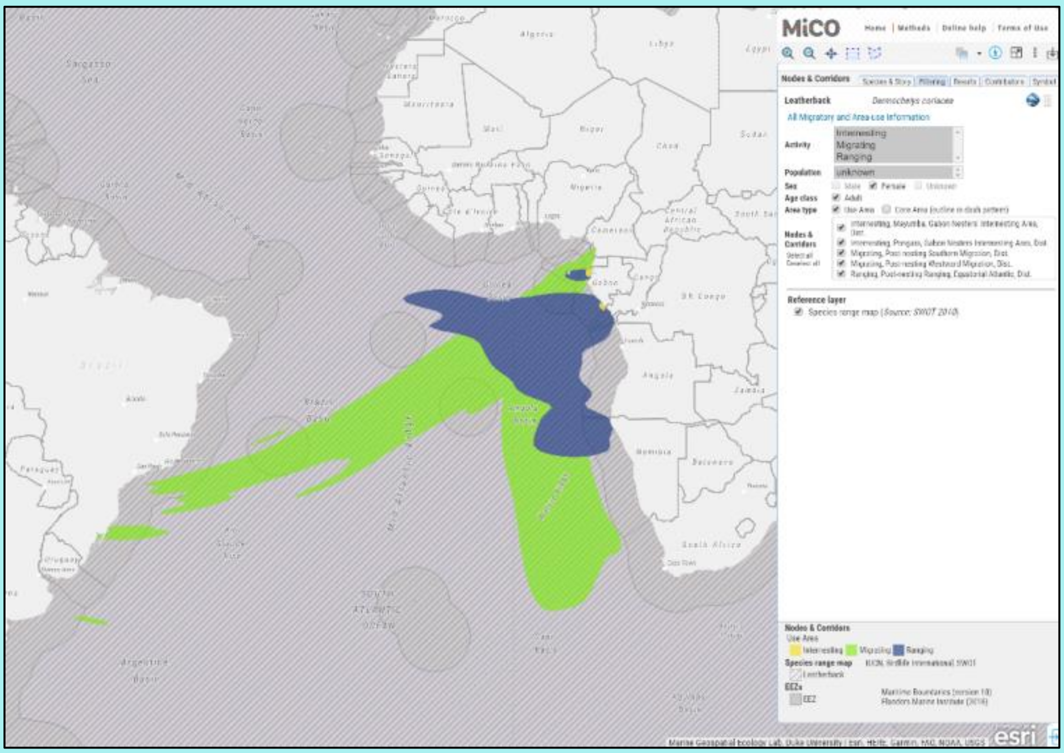


Figure 13 The MiCO system interface displaying migratory connectivity of Leatherback sea turtles. Yellow denotes nesting areas; green denotes migration corridors; and blue denotes their ranging areas. Source: MiCO, 2019[28]

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[27] See https://mico.eco.

[28] Areas are generated from 37 tagged individual animals via the 90 % utilization distribution from a kernel density estimate. All turtles were tagged while nesting in Gabon (yellow interesting areas). Some animals show limited migration movements and appear to be “ranging” along the west coast of Africa (blue ranging areas) while others clearly demonstrate a migration to the east coast of South America (green migratory corridors) and south along the west coast of Africa. Telemetry data contributed by: Annette Broderick, Michael Coyne, Angela Formia, Brendan Godley, Matt Witt, Philip Doherty, and Stephen Pikesley (Pikesley et al., 2018; Witt et al., 2008; Witt et al., 2011).

Intersecting the MiCO nodes and corridors with the boundaries of EEZs highlights just how complex management of this species is: over 80 % of their total area use is outside of any national jurisdiction. They crossed through the waters of 11 nations, with the highest percentage of area within national waters spent in the EEZs of Brazil (5.9 %), the United Kingdom (Saint Helena, 3.1 %), Equatorial Guinea (2.8 %), and Gabon (2.1 %). From the other perspective, the nodes and corridors cover over 90 % of the national waters for three countries: Democratic Republic of the Condo, Gabon, and Republic of the Congo. Though the data used to determine this information encompasses just a portion of the total leatherback population and only partial migrations, it begins to reveal evidence of the use of many jurisdictional boundaries by the species.

Given the complexity of these interactions with multiple jurisdictions, recognizing the political biogeography of this population is especially important (Harrison et al., 2018). Using the MiCO system, we can begin to link both *when* and *where* turtles from specific populations may encounter major threats in both national and international waters, working to ensure their long-term survival in the region. For further information on how migratory behaviour of marine mammals, seabirds, sea turtles and fish connect the world (see http://mico.eco).

Acknowledgements: This case study was developed by the Migratory Connectivity in the Ocean (MiCO) initiative. The MiCO system is developed by a consortium led by the University of Queensland, Duke University and the Smithsonian Migratory Bird Center. Many thanks to the steering committee members, partners, and data contributors involved in the MiCO initiative. Funding for MiCO was provided by a grant from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) International Climate Initiative (IKI) to the Global Ocean Biodiversity Initiative (GOBI).

Southeast Pacific

The Southeast Pacific region has been recognized as a migratory route for marine megafauna (Peavey et al., 2018; Felix and Guzman, 2014) and therefore an area of specific concern in terms of conservation (Wallace et al., 2011). An approximate number of 30 species of cetaceans and five species of sea turtles can be found in this region (Ballance et al., 2006; Wallace et al., 2011). Of these 30 species of cetaceans, probably the most well studied species in terms of its ecology and biology is the Humpback whale (*Megaptera novaeangliae*). The population of Humpback whales in the Southeast Pacific is known for undertaking the longest migration of all stocks of this species in the world (>16,000 kilometres) (Felix and Guzman, 2014). The migration route of Humpacks can be either coastal or oceanic, in some cases to 800 kilometres offshore (Felix and Guzman, 2014). The International Whaling Commission recognizes the humpback whale population in the Southeast Pacific as the Breeding Stock G. This breeding stock contained between 5,000 and 8,000 individuals by the mid 2000s, with numbers increasing 5-10 % per year (Branch, 2011). At the global level, humpback whales are considered under the category Least Concern according to IUCN (Cooke, 2018).

Of the five species of sea turtles – Loggerheads *(Caretta caretta)*, Green *(Chelonia mydas)*, Leatherbacks *(Dermochelys coriacea)*, Hawksbills *(Eretmochelys imbricata)*, and Olive ridleys *(Lepidochelys olivacea)* that occur in the Southeast Pacific region, probably the most emblematic is the Leatherback sea turtle (classified as Vulnerable by IUCN). The East Pacific subpopulation of leatherback sea turtles has declined by > 97 % over three generations (Tomillo et al., 2007). Loggerheads *(Caretta caretta),* despite having only a small sub-population in the East Pacific is also considered as Vulnerable according to IUCN (Casale and Tucker, 2017). Green sea turtles *(Chelonia mydas)* are considered as Endangered by IUCN, taking into consideration that the nesting populations in the Eastern Pacific (Mexico and Ecuador) have declined 89 % to 94 % (Seminoff, 2004). Hawkbills *(Eretmochelys imbricata)* are considered as Critically Endangered by IUCN and its presence in the Southeast Pacific is considered rare although more recent studies have identified a few nesting beaches along the eastern Pacific Ocean (Gaos et al., 2010). Finally, probably the most common sea turtle in the Southeast Pacific is the Olive ridley. It is considered Vulnerable according to IUCN (Abreu-Grobois & Plotkin, 2008). Among the eight species of eared seals of the family *Otariidae* present in the Southeast Pacific, three are considered Least Concern, two are considered Endangered, two are Near Threatened and one is Vulnerable according to IUCN (Polidoro et al., 2012). Finally, from the true seals family (*Phocidae*), the two species present in the region are considered Least Concern.

Box 3 Large whales in the Southeast Pacific

By Fernando Félix of Comisión Permanente del Pacífico Sur (CPPS)

The diversity of smaller and larger cetaceans in the Southeast Pacific is striking: About 50 % of living cetacean species are represented here. Great whales are especially important in terms of ecological connectivity between EEZ and ABNJ. In this region, nine of the fourteen great whale species so far described have been reported, including some subspecies or discrete stocks which are only found here, such as the Blue whale (*Balaenoptera musculus*).

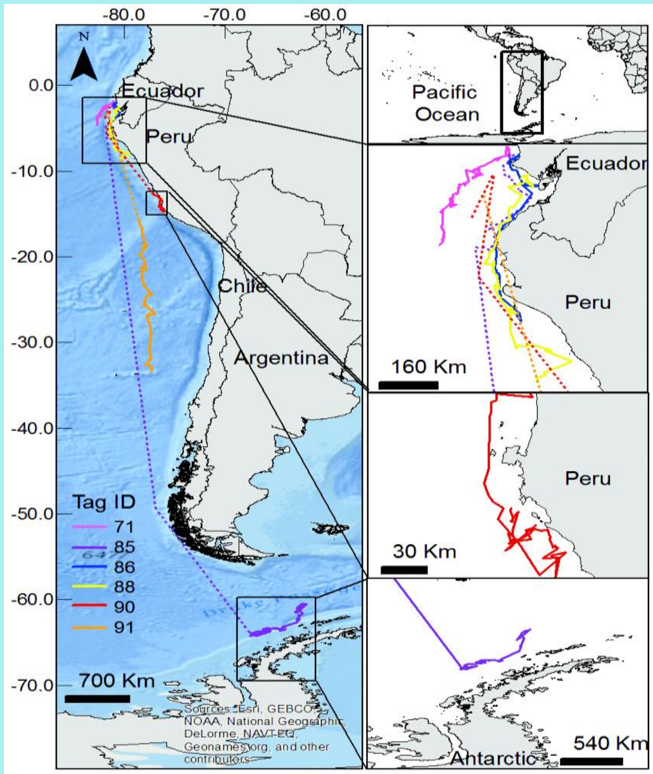


Figure 14 Migration of humpback whales from Ecuador to Antarctic waters

Source: Félix and Guzmán, 2014

Most large whale species are seasonal migratory species and undertake extensive annual migrations, which we are only beginning to understand. Potential exceptions are Tropical whales (*Balaenoptera brydei*) and Sperm whales (*Physeter macrocephalus*), which are not known to migrate extensively. The best-understood species are the Humpback whale (*Megaptera novaeangliae*) and the blue whale, which have been fitted with satellite devices to identify migratory routes and behaviour. Both species show complex migratory behaviours, probably reflecting their physical and sexual maturity, sex, as well as energy needs.

Humpback whale tags in Ecuador and Panama have shown that these whales follow two basic migratory routes on their way to the feeding grounds in Antarctica: a coastal one that borders the north western coast of South America to about 12°S in mid-Peru and then becomes oceanic, and another that is oceanic from its inception in Ecuador (Felix and Guzmán, 2014) (see Figure 14). Both routes seem to converge in the area of the Nazca mountain range and continue south through the Chilean oceanic archipelagos of the Desventuradas Islands and Juan Fernández Islands.

Blue whales have been tagged in the southern feeding areas and followed north towards the tropics. Most migrate to the Galapagos Islands in Ecuador, whereas some head mainly northwest into ABNJ waters thousands of kilometres from the coast (Hucke-Gaete et al., 2018) (see Figure 15). Thanks to the type of tags placed on these whales it is possible to know where the animals change from migratory to resident behaviour, indicating possible feeding or reproduction sites.

Blue whales heading directly to the Galapagos and the humpback whales coming down from Ecuador share the migration corridor through the Desventuradas and Juan Fernández islands. These transit sites may be important for other activities such as feeding as well.

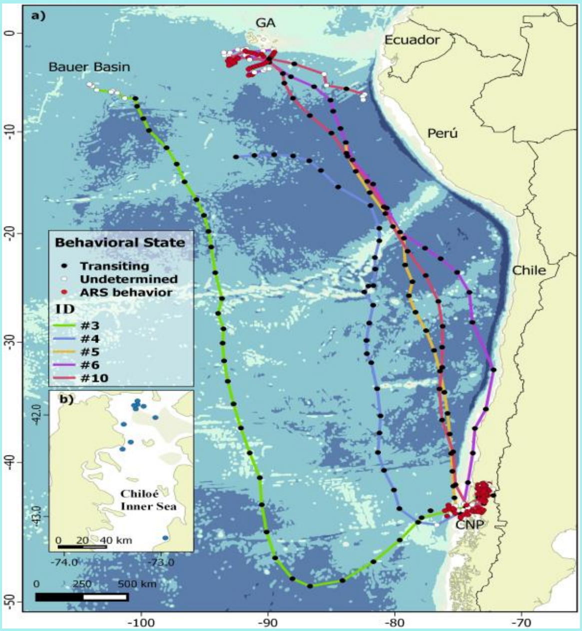


Figure 15 Migration of blue whales from Chile north
Source : Hucke-Gaete et al., 2018

Conclusion

Probably the most important threat to marine megafauna in ABNJ of the Southeast Atlantic and the Southeast Pacific regions is the interaction with fisheries that causes significant mortalities to the populations of this charismatic group of species. Additionally, marine pollution (e.g. plastics and micro plastics) is a major threat that is becoming increasingly recognized in these regions. These pressures are covered in Chapter 3 and in particular sections 3.1 and 3.3 of this report.

Most information collected on the migratory routes of marine megafauna in the Southeast Atlantic and Southeast Pacific has been collected in coastal areas. In the specific case of Humpback whales, it seems that, apart from a coastal migratory route, there is a more oceanic route that is less understood and necessitates further investigation. The use of satellite tracking in the last decades has revolutionized the understanding of the reproduction and feeding routes of sea turtles and marine mammals, however, the sometimes prohibitive cost of this technology has prevented a much widespread used by local scientists that rely on photo-identification techniques. Reduced costs of this technology in the future will provide great benefits for the understanding of the ecology and biology of these megafauna species. Matching distributional maps of this fauna with the distribution of fishing effort in the region will prove a useful tool to design management strategies that strive to protect these charismatic species.

The Southeast Pacific and Southeast Atlantic regions contain key areas for both latitudinal and longitudinal migrations of marine megafauna. Sea turtles like the Leatherback turtle (*Dermochelys coriacea)* have important migratory and foraging areas in the two regions. Similarly, the humpback whale (*Megaptera novaeangliae*) has important migration corridors along the EEZ of the countries and ABNJ of the Permanent Commission for the South Pacific (CPPS) and Abidjan Convention regions. The increasing fishing pressure and ship traffic in ABNJ of both the Southeast Pacific and the Southeast Atlantic regions is a clear threat to the populations of various species of marine megafauna that live in these areas. Research and management efforts, especially in the Southeast Atlantic region, to understand and protect the migratory, foraging and migratory routes of these charismatic taxa are needed at the regional level. For this, building local capacity and cooperation linkages between neighbouring countries will be essential.

2.7 Seabirds

Key Messages:

- Seabirds are amongst the most threatened groups of birds, with all the species found consistently in the ABNJ waters exhibiting highly migratory movements, bringing them into contact with a huge diversity of fishing fleets.
- Accidental mortality from fishing (bycatch) is the single biggest threat to seabirds in the ABNJ.
- The huge areas that seabirds typically cover on migrations, often spanning entire ocean basins, make ABMTs a very challenging proposition, unless management measures can be both enacted and enforced across vast areas, which currently is not considered possible.

Seabirds are amongst the most threatened groups of birds (BirdLife International, 2018). Furthermore, the rate of deterioration in the Red List Index for seabirds is faster than for many equivalent groups (BirdLife International, 2018). In short, seabirds face significant, ongoing threats that remain at best partially addressed, but in many cases are not meaningfully addressed at all. Seabirds, being inhabitants of both the terrestrial realm during breeding, and the marine realm for almost all other activities, are subject to threats and pressures on land and at sea. The list of pressures on land is long and includes the unsustainable, directed take of adults, chicks and eggs by humans, destruction of habitats for human needs, introduction of diseases and more. But by far the overwhelming terrestrial pressure for the majority of seabirds is from invasive alien species, notably terrestrial predators (Dias et al., 2019). Management, preferably eradication, of mammalian predators is an ongoing effort for a number of island nations. However, these are mentioned only in passing here, as the focus here is ABNJ. The primary risk to seabirds in ABNJ is from fishing. Those threats can be divided into direct impacts (from mortality associated with fishing, including the illegal, directed take of seabirds for consumption), and indirect impacts (e.g. from overfishing/competition with fisheries). Figure 16 shows the number of globally threatened seabird species classified as Vulnerable, Endangered or Critically Endangered in the IUCN Red List in the Southeast Atlantic and Southeast Pacific.

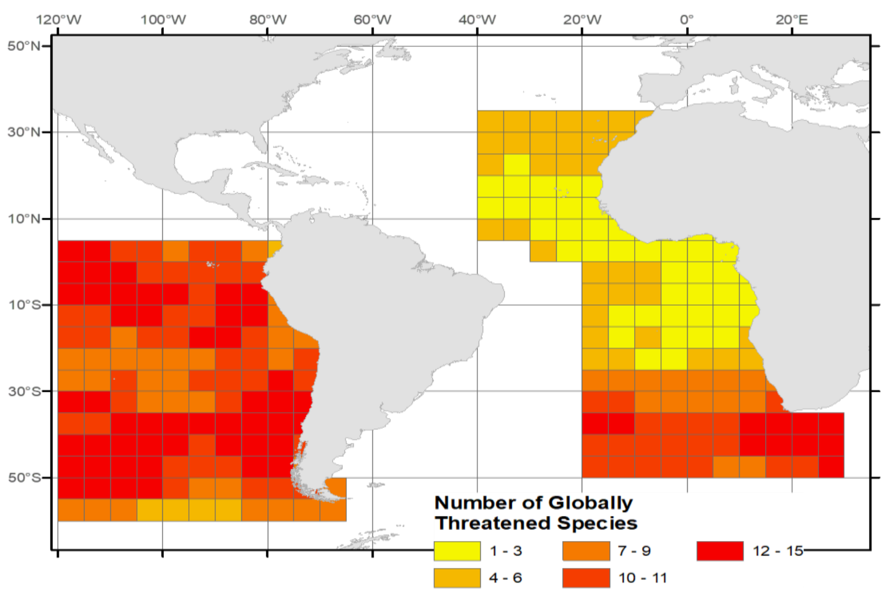


Figure 16 Number of globally threatened seabird species classified as Vulnerable, Endangered or Critically Endangered in the IUCN Red List in the Southeast Atlantic and Southeast Pacific

Source: BirdLife International, 2019[29]

Longline and trawl fisheries are known to have direct, negative, widespread and significant impacts on albatrosses and petrels, including from longline operations in ABNJ. Principally this is through accidental mortality when seabirds scavenge

[29] Map based on range distribution maps available at http://datazone.birdlife.org.

baited hooks and get caught, and drown. Formerly there was significant bycatch in ABNJ from demersal longline operations targeting Patagonian toothfish. However, stringent application of Best Practice measures to reduce bycatch mortality by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) has virtually eliminated seabird bycatch within its area's mandate (Waugh et al., 2008). There are few data to suggest that fisheries using these gear types have similar scales of impacts north of 25°S in the Atlantic. Nevertheless, the scale of seabird bycatch in the south is substantial (Tuck et al., 2011). Populations of some seabirds that scavenge around fishing vessels, particularly trawlers, may increase through provision of food in the form of fishery waste and discards, which can have unexpected impacts on the species in question and the ecosystem more generally. However, there are negligible levels of bottom fishing in ABNJ, it being mostly confined to demersal trawling on southern Atlantic seamounts, managed by the South East Atlantic Fisheries Organisation (SEAFO). In addition, Lewison et al. (2014) analyses suggest that the intensity of seabird bycatch from longline and trawl operations in the eastern Pacific Ocean were significantly higher than in other regions where data are available.

Indirect impacts of fishing are difficult to quantify, but are likely pervasive, particularly in heavily overfished tropical regions. Indirect impacts include competition between fisheries and seabirds (e.g. overfishing), but this is unlikely to play out in ABNJ, where tuna fishing is, by virtually any measure, the overwhelming fishing activity. Tuna fishing does, however, pose a significant concern of indirect competition with seabirds. Many seabird species in the tropical and subtropical regions forage in association with large, predatory fish such as tuna (Correia et al. 2019; Le Corre et al., 2012). The tunas drive small forage fish species to the surface, bringing the forage fish within the range of seabirds. If the abundance of tuna is reduced significantly through fishing (without necessarily requiring 'overfishing'), these and other seabird species may experience lower foraging success or higher foraging effort (Le Corre et al., 2012). The species most likely to be affected by this in the Afrotropical and Pacific regions covered here, are the three tropicbird species (*Phaethon spp.*), boobies (*Sula spp.*), frigatebirds (*Fregata spp.*), noddies (*Anous spp.*), and Bridled (*Onychoprion anaethetus*) and Sooty terns (*Onychoprion fuscatus*).

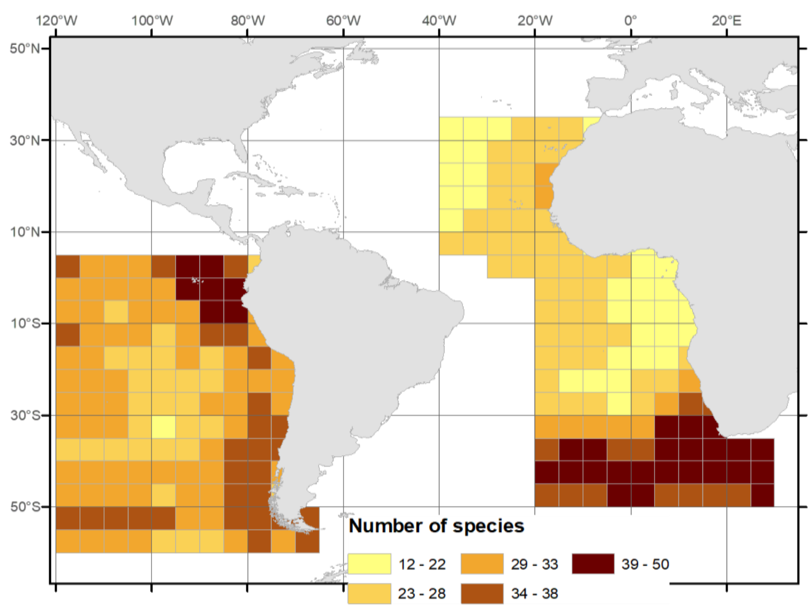


Figure 17 Number of seabird species occurring in the Southeast Atlantic and Southeast Pacific
Source: BirdLife International (2019)[30]

Seabirds are the most overtly visible elements of marine biodiversity. They are also amongst the best known marine megafauna, because they breed on land (many species almost exclusively on islands), making annual counting of breeding adults, reproductive success and recruitment rates and ages, and other demographic parameters considerably more tractable to quantify with precision than for most marine species. Furthermore, due to their almost universal and unusually strong site fidelity to breeding sites, the confidence in demographic trends is high. This contrasts strongly with cetacean,

[30] Maps also available by request at http://datazone.birdlife.org. Figure 17 follows the taxonomy and classification of BirdLife International 2019; complete list of seabirds in the worlds available at http://datazone.birdlife.org.

shark, tuna and other marine megafauna, where population sizes are estimated using very sophisticated statistical models to overcome what is, in essence, a lack of easily analysed data.

The advent of miniaturized, and relatively cheap, remote tracking devices some 20 years ago has led to an explosion of seabird tracking studies, and this in turn has allowed the development of standardized statistical tools to analyse patterns. BirdLife International has, since 2004, developed marine Important Bird and Biodiversity Areas (IBAs; Key Biodiversity Areas) for seabird 'hotspot' identification (Lascelles et al., 2016). Figure 17 below shows the number of seabird species occurring in the Southeast Atlantic and Southeast Pacific.

Unlike many other marine species, which give birth at sea and move with seasons and currents, seabirds are tied to islands when breeding, making them central-place foragers (except for procellariform seabirds: albatrosses, petrels and allies) and their foraging distributions are heavily skewed towards the waters around their breeding colonies, which are inside EEZs. Non-breeding ranges, and the ranges of procellariform seabirds, are where this chapter will focus, because these are where seabirds spend time in ABNJ. The proliferation of tracking datasets means that for species >300 g bodyweight, there is substantial confidence in understanding the migration routes and non-breeding distributions of tracked populations.

Nine seabird families occur within the geographical scope of this report as breeding species. They are typically referred to as penguins (*Spheniscidae*), albatrosses (*Diomedeidae*), petrels and allies (*Procellariidae*), southern storm-petrels (*Oceanitidae*), tropicbirds (*Phaethonidae*), gannets and boobies (*Sulidae*), frigatebirds (*Fregatidae*), skuas (*Stercorariidae*), gulls and terns (*Laridae*). Birds from two additional families occur in the area during their non-breeding periods: northern storm-petrels (*Hydrobatidae*) and phalaropes (*Scolopacidade*), and two species of Auks (A*lcidae*) have their distributions marginally overlapping with the area in the Atlantic. All these occur in ABNJ to greater or lesser extents. One seabird group, the cormorants (*Phalacrocoracidea*), are exclusively coastal and are therefore not considered further.

BirdLife International has identified 11 marine IBAs in ABNJ (all for Procellariiform species), of which 4 are already confirmed and the remaining still classified as "candidate", i.e., more information is being collected to confirm the importance of the site (see Figure 18).

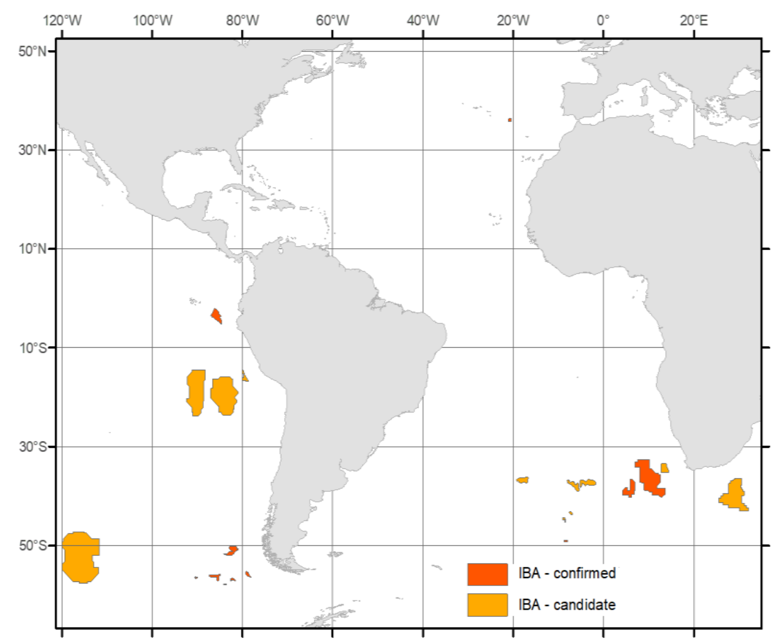


Figure 18 Location of marine confirmed and candidate IBAs in the Southeast Atlantic and Southeast Pacific
Source: BirdLife International, 2019

Southeast Atlantic

There is a tremendous diversity of habitat types and seabird communities, varying in both space and time, in all ocean regions. Nevertheless, broadly speaking it is convenient to group the East Atlantic into three biogeographic zones with characteristic species assemblages. These are tropical waters (approximately between the tropics of Cancer and Capricorn), the temperate and sub-Antarctic, Procellariiform-dominated waters, and the neritic and coastal waters, with a subtype of particular importance being the two upwelling regions of the Benguela and Canary currents.

The tropical waters are dominated numerically by the tropicbirds (two species), boobies (three species), Frigatebirds (two species, including the Atlantic, single-island endemic and eponymous Ascension Frigatebird *Fregata aquila*) and terns (>10 species), with *Calonectris, Puffinus* and *Ardenna* shearwaters also common or migratory, but less abundant and usually less visible than the other groups. None has substantial ranges during breeding, while dispersive and migration patterns are not well understood for most tropical seabird species. This is because the majority of non-procellariiform seabirds in the tropics are listed as globally Least Concern and are typically pan-tropical in distributions. Understanding their movements is more of scientific interest than of conservation concern, and consequently it is considerably more difficult to secure funding for tracking studies. With few exceptions, tropical seabirds associate very strongly with tuna, and feed in association with them (Le Corre, 2012; Correia et al., 2019). As a consequence, their post-breeding dispersal is likely to extend appreciably into ABNJ and linked to broad-scale oceanic features (such as productive upwelling or mixing areas) to which forage fish, and consequently tunas, are attracted.

A key feature of the tropical areas (for both Atlantic and Pacific regions) is that they are regions through which the temperate species – terns, jaegers and shearwaters in particular – migrate. Thus, in March-May, and again in August-September, there are substantial movements of seabirds that are not typically considered to be tropical species, through tropical waters. There is a significant gap in our understanding of storm-petrel movements, simply because tracking devices have only recently become small enough to track these diminutive (<100 g), but highly pelagic seabirds.

In ABNJ areas of sub-Antarctic and cool-temperate regions in the northern part of the Southeast Atlantic, are dominated by procellariiform seabirds and a cameo role from the Southern Skua *Catharacta antarctica*. In addition, several species of near-shore-foraging Larids and cormorants breed here, with only one breeding species (Antarctic Tern *Sterna vittata*) migrating northwards during the austral winter.

The procellariiform seabirds are prodigious travellers, even when provisioning chicks (Weimerskirch et al., 1997; Croxall & Gales, 1998; Reid et al., 2013). Circumnavigating the Southern Ocean is a regular activity for some species, as are 8-figure movements around the Atlantic annually, such as by the Atlantic-endemic Great Shearwater *Ardenna gravis* (BirdLife International 2019.). Consequently, efforts to identify areas of conservation importance or marine IBAs, are challenging and often encompass vast expanses of ocean (e.g. Delord et al. 2014; Oppel et al. 2018).

Box 4 Neritic waters

While these waters are not the focus of this assessment, it would be remiss to disregard the massive impacts that the coastal upwelling waters have on seabirds in the Atlantic and the Southeast Pacific. The biogeographical peculiarities in the south has given rise to the evolution of a suite of endemic seabirds, although none of these spends any significant time in ABNJ, and are therefore not covered further in this section. But it is the highly productive shelf waters, particularly the Humboldt Current off South America, the Benguela system of southwestern Africa and in the Canary Current predominantly off Mauritania and Senegal that draw in non-breeding seabirds from very distant breeding sites, and hence where we find strong connectivity across ocean basins.

The entire east Atlantic has strong north-south connectivity between multiple EEZs mediated by seabirds. That connectivity is particularly strong with the northern hemisphere seabirds, including common and Arctic terns (*Sterna hirundo* and *S. paradisaea*), three jaegers, Sabine's gull *Xema sabini* and the *Calonectris* shearwaters that breed in Europe and migrate to highly productive southern hemisphere waters in the austral summer (e.g. González-Solís et al., 2007; Egevang et al., 2010; Dias et al., 2010; Stenhouse et al., 2012; Gilg et al., 2013). This highlights the need for responsible ocean governance and resource management across the entire range of the highly mobile seabirds of the Atlantic Ocean. While the terminal points of these seabird migrations are almost exclusively in EEZs, their distributions while on passage extend well into ABNJ.

In the eastern Pacific, the connectivity is more powerfully east-west, as Earth's procellariform epicentre, New Zealand, provides the breeding grounds for a vast array of seabirds that migrate eastward during non-breeding periods, to Earth's most productive marine ecosystem, the Humboldt Current. There is relatively little north-south connectivity in the Eastern Pacific Ocean, unlike in the Western Pacific Ocean.

Southeast Pacific

The geographical scope of this program in the Pacific extends into the Antarctic waters more naturally than for the Atlantic, because the South American continent extends into those waters, whereas Africa only extends into the temperate waters (not even the cool temperate). The broad divisions in community structure covered in the Southeast Atlantic section remain true for this region. In a classic comparison of oceanic seabird communities, Ainley & Boekelheide (1983) distinguished four major sets of species for the Pacific Ocean as a whole. Considering only oceanic waters, these authors identified 23 species in the Antarctic (all with circumpolar distributions), 39 in the sub-Antarctic, 52 in the subtropics, and 51 in the tropics.

Two sites bear particular mention for the region in terms of seabirds that move into ABNJ: Galapagos and Juan Fernandez archipelagos. The Critically Endangered (CR), Galapagos-endemic Waved Albatross *(Phoebastria irrorata)* spends a marginal amount of its time in ABNJ, mostly en route from its breeding site at Española Island, to the neritic waters off continental Ecuador and Peru. By contrast, the Galapagos Petrel *(Pterodroma phaeopygia)* (CR) and Galapagos Shearwater *(Puffinus subalaris)* (Least Concern) both make extensive, dispersive movements to the surrounding ABNJ, but also eastwards and northwards into waters of EEZ.

The second archipelago hosts three Pterodroma petrels and a shearwater that are Southeast Pacific-breeding endemics, all of which are classified as Vulnerable: Stejneger's *Pterodroma longirostris*, Juan Fernandez *(P. externa)* and De Fillipi's *(P. defilippiana)* petrels and the Pink-footed Shearwater *(Ardenna creatopus)*. These also migrate to ABNJ to the north during non-breeding periods, with the De Fillipi's Petrel being the only true endemic to the Southeast Pacific, as the non-breeding ranges of other two species extend well into the northern hemisphere. During the non-breeding period the Pink-footed Shearwater migrates along the coastal waters as far north as Alaska and the Aleutians, but at the equator it also disperses widely into the tropical eastern Pacific.

Given the massive drawcard that is the exceptionally productive Humboldt Current, it is perhaps not too surprising that there are not many seabirds that venture into ABNJ from their coastal breeding sites in the Southeast Pacific. Two notable exceptions are the Black-browed Albatross *(Thalassarche melanophris)* that breeds at Diego Ramirez Island, and the Chilean Skua *(Catharacta chilensis)*, both of which are found in ABNJ waters in the Southern Ocean, although both are far more abundant within EEZs.

Conclusion

Trends for most seabirds are generally very poorly documented (the majority of species in the area have very few population time series within the region) or are downward or stable, and there are few exceptions to this rather depressing fact in the eastern Atlantic and eastern Pacific communities. Within the Atlantic, 21 Globally Threatened seabird species occur regularly with significant presence in the area (i.e. excluding species with marginal overlap): one critically endangered Tristan albatross (*Diomedea dabbenena*), 10 endangered Northern royal albatross (*Diomedea Sanfordi),* Northern rockhopper penguin *(Eudyptes moseleyi),* MacGiliviray's Prion *(Pachyptila macgillivrayi),* Sooty albatross *(Phoebetria fusca),* Bermuda petrel (*Pterodroma cahow), Atlantic petrel (P. incerta),* Zino's petrel *(P. madeira),* Indian Yellow-nosed albatross *(Thalassarche carteri),* Atlantic Yellow-nosed albatross *(T. chlororhynchos)* and Grey-headed albatross *(T. chrysostoma*) and 10 vulnerable Southern royal albatross (*Diomedea epomophora),* Wandering albatross *(D. exulans),* Macaroni penguin *(Eudyptes chrysolophus),* Ascension frigatebird *(Fregata Aquila),* Leach's Storm petrel *(Hydrobates leucorhous),* White-chinned petrel *(Procellaria aequinoctialis),* Spectacled petrel *(P. conspicillata),* Trindade petrel *(Pterodroma arminjoniana),* Desertas petrel *(P. deserta),* and Salvin's albatross *(Thalassarche salvini*) (BirdLife International, 2018).

Within the Pacific, 32 Globally Threatened seabird species occur regularly with significant presence in the area: two critically endangered species Waved albatross (*Phoebastria irrorata)* and Galapagos petrel *(Pterodroma phaeopygia*), nine endangered Galapagos penguin (*Spheniscus mendiculus)*, Polynesian storm petrel (*Nesofregetta fuliginosa)*, Northern royal albatross *(Diomedea sanfordi)*, Antipodean albatross *(Diomedea antipodensis)*, Grey-headed albatross *(Thalassarche chrysostoma)*, Westland petrel (*Procellaria westlandica)*, Black-capped petrel *(Pterodroma hasitata)*, Peruvian diving petrel *(Pelecanoides garnotii)*, Peruvian tern *(Sternula lorata*) and 20 vulnerable Macaroni penguin *(Eudyptes chrysolophus), Southern rockhopper penguin (Eudyptes chrysocome), Humboldt penguin (Spheniscus humboldti), Southern royal albatross (Diomedea epomophora),* Wandering albatross *(Diomedea exulans),* Chatham albatross *(Thalassarche eremita),* Salvin's albatross *(Thalassarche salvini),* White-chinned petrel *(Procellaria aequinoctialis),* Black petrel *(P. parkinsoni),* De Filippi's petrel *(Pterodroma defilippianat),* Stejneger's petrel *(P. longirostris),* Cooke's petrel *(P. cookie),* Chatham petrel *(P. axillaris),* Juan Fernandez Petrel *(P. externa),* Gould's petrel *(P. leucoptera),* Leach's Storm petrel *(Hydrobates leucorhous),* Buller's Shearwater *(Ardenna bulleri),* Pink-footed shearwater *(Ardenna creatopus),* Flightless cormorant (*Nannopterum harrisi)* and Lava gull *(Leucophaeus fuliginosus)*.

The effects of periodic oceanographic and atmospheric anomalies, like ENSO, have been a clear source of demographic problems for seabirds in the Pacific (Anderson, 1989). However, the effects of multi-decadal anomalies have not been considered previously as a potential problem for colonial seabirds. This effect could induce demographic variation at large and short-term scales (Champagnon et al., 2018), and these variations are induced primarily for a regime shift between sardines and anchovies as dominant prey species in the Pacific (Tompkins et al., 2017). The complete understanding of these effects and their possible ecological variations are basically unknown, mostly because there is an almost total absence of long-term studies in the Eastern Tropical Pacific except for colonies that have been studied on the Galápagos for more than three decades.

Tracking data and at-sea distributions of small seabirds and many Least Concern tropical species is lacking, and therefore the spatial conservation of those species will continue to lag behind tracked species'. The nature and scale of the impacts of indirect fisheries pressures from depleted tuna stocks on tuna-associated seabirds in the tropical areas, remains a key unknown. Climate change impacts on large-scale ocean productivity and circulation patterns, and the attendant disruption to migration systems or food availability, remain unquantified but a significant threat. Understanding population trends, and initiating multi-year census efforts, for seabirds in tropical areas, are major gaps. Indeed, many species are known to have as-yet-undiscovered breeding colonies. Further, several tropical seabirds breed on variable, non-annual cycles (i.e. they don't have clearly defined breeding seasons and can breed twice in the same year). Thus to estimate the breeding populations requires quite significant, long-term census efforts.

2.8 Summary of Status

The Southeast Atlantic and Southeast Pacific are highly important and productive ecosystems in ABNJ. These regions play an essential role underpinning marine biodiversity and sustaining marine species providing habitats and feeding grounds as well as underpinning the functioning of the marine food web. These regions also help to regulate global processes (e.g. climate), as well as contain mineral resources deep on the ocean floor. The health of ABNJ, and its ability to continue to contribute to human well-being, is in a precarious position which requires action.

There is enormous pressure on most biodiversity within both Southeast Pacific and Southeast Atlantic regions covered in this report (and these are not uniquely impacted; similar levels of threats to ecosystems and species are found in most ocean areas). The Red List Index for seabirds demonstrates that they have the worst status of all birds on earth. Marine mammal populations are slowly recovering, but commercial whaling has fundamentally altered marine ecosystems forever, and we cannot predict to what level, and with what consequences, whale populations will recover. Sea turtle populations continue to decline. The majority of fish stocks in ABNJ are at unprecedented, record lows. Despite this, nations that target stocks (particularly tunas and sharks) in ABNJ continue to fail to apply regulations that limit the risk of collapse of these top predators. Those same nations struggle to comply with the regulations that have been agreed, to limit effort, reduce bycatch, and end destructive practices. And IUU fishing continues to cause unquantifiable damage to all manner of marine ecosystems. The added threats of climate change and expansion of exploitation to include deep sea mineral deposits pose enormous risks to already depleted populations, heavily exploited stocks and trophic webs at some risk of unravelling. While there have been almost no extinctions of any megafauna, and although certain fish stocks have gone commercially extinct, the species remain present in the wild but at a declining rate.

3. Pressures on Areas Beyond National Jurisdiction in the Southeast Atlantic and the Southeast Pacific

This chapter aims to provide an overview and assessment of major pressures stemming from human activities on marine biodiversity in ABNJ with focus on the Southeast Atlantic and Southeast Pacific, and covers: 3.1 Extraction of fish and species removal; 3.2 Physical disturbance to and destruction of the seabed; 3.3 Marine pollution; 3.4 Underwater energy; and 3.5 Climate change.

Fishing is the most significant human activity taking place in ABNJ, and creates significant pressures on biodiversity in the form of the extraction of fish and species removal. Fishing effort in ABNJ has seen significant growth over the last 50 years, as new fishing technologies became available and stocks closer to shore decreased. Today, the economic viability of fishing in ABNJ is in question, with subsidies for fishing activities being highly controversial with proposals in the World Trade Organisation for them to be banned. Major fishing fleets in ABNJ come from China, Spain, Chinese Taipei (Taiwan), Japan and the Republic of Korea (South Korea) and target various tuna species as well as shark and billfish species. Fishing in ABNJ is governed by regional fisheries management organisations (RFMOs), tasked to manage specific stocks within different regions, yet lack of lack of strong management measures combined with weak or non-existent enforcement mechanisms, means that many fish stocks have been overfished or fished to capacity.

Along with fisheries, physical disturbance and destruction of the seabed are caused by physical smothering, disturbance, sediment resuspension, organic loading, toxic contamination or plume formation, and can lead to a loss in biodiversity, declining energy flow back to higher trophic levels, and impacts on physiology from exposure to toxic compounds. The main activities contributing to this are bottom trawling from commercial fishing and the laying of cables for communication and information transfer. The majority of bottom trawling has been brought to an end, while the laying of cables is considered to cause negligible damage to the seafloor. Nevertheless, deep sea mining, although currently in an exploratory phase, has the potential to cause significant destruction and disturbance to the seabed if opened up for commercial exploration.

Marine pollution is the introduction of substances (e.g. chemicals, pesticides, plastics) into the marine environment and stems from maritime transport, offshore prospecting and mining activities, land-based activities, and dumping of waste at sea. The result of their introduction is the degradation of living resources and ecosystems, as well as hazards to human health, hindrance to marine activities including fishing, as well as the impairment of quality for use of sea water. Marine plastic – has become a significant issue in recent years, while other hazardous substances have also been detected in deep sea environments and fish.

A range of maritime activities introduce anthropogenic energy into the marine environment, including sound, light, heat, and radioactive energy. The most widespread and pervasive kind of anthropogenic energy is underwater noise mostly from maritime transport related shipping activities, but is also being introduced by other activities such as fishing as well as oil and gas extraction and associated maintenance operations, including vessel operations. Sound is highly important for most marine animals, including marine mammals, serving key biological functions, including communication, foraging, reproduction, navigation, and predator avoidance. The predominantly low-frequency sounds associated with large vessels directly overlap typical low-frequency communication sounds and hearing of many marine mammals, particularly large whales and some seals and sea lions. However, there are still substantial knowledge gaps, including with regard to how underwater noise affects the physiology of marine species like fish or invertebrates.

Climate refers to the mean values and patterns of variability of atmospheric conditions such as temperature and precipitation, characterized over long time periods at global or regional scales. Atmosphere-ocean interactions largely moderate earth's climate, and climate responds to radiative solar forcing. Climate change refers to the long-term change in that balance, and the derived trends on atmospheric conditions. Atmospheric heat retention capacity depends on the concentration of greenhouse gases. Carbon dioxide (CO_2) in particular has shown an overall atmospheric concentration increase since the onset of the Industrial Revolution. The result is positive radiative forcing (aka heating), with an overall increase of about 1.3°C on atmospheric temperature since the 17th Century. This trend has been ascribed to the large release of CO_2 from fossil fuels (i.e. carbon that has been excluded from the carbon cycle for millions of years) and other "greenhouse gases" such as methane from anthropogenic sources. Yet the effects of climate change on ocean dynamics should not be considered exclusively, because ocean processes themselves are modulating climate change. Instead, it is important to consider at which rate ocean circulation and biogeochemical processes are changing at present day and in the future. The rate of change is of concern because previous changes have occurred over geological timescales of thousands, or tens of thousands of years, allowing for adaptability and evolution. When changes have happened over shorter time periods they have caused massive extinction events and fundamentally changed almost all living communities.

It is important to note, that while it is essential to review and assess pressures in ABNJ individually in order to clearly present evidence these pressures should ultimately not be considered in isolation. Cumulative pressures on the marine environment affect ecosystems in complex ways. Certain combinations of pressures can have negative environmental effects that are far worse than the sum of their individual parts. Other combinations of human activities could enhance environmental resilience, and have an effect that is greater than the sum of their parts. Ecosystem-based management is a way to better identify and account for the cumulative pressures of multiple activities by recognising the different pressures causing change, and how they interact cumulatively (see Figure 19), and then developing management approaches which consider such pressures holistically as well as across different spatial and temporal scales.

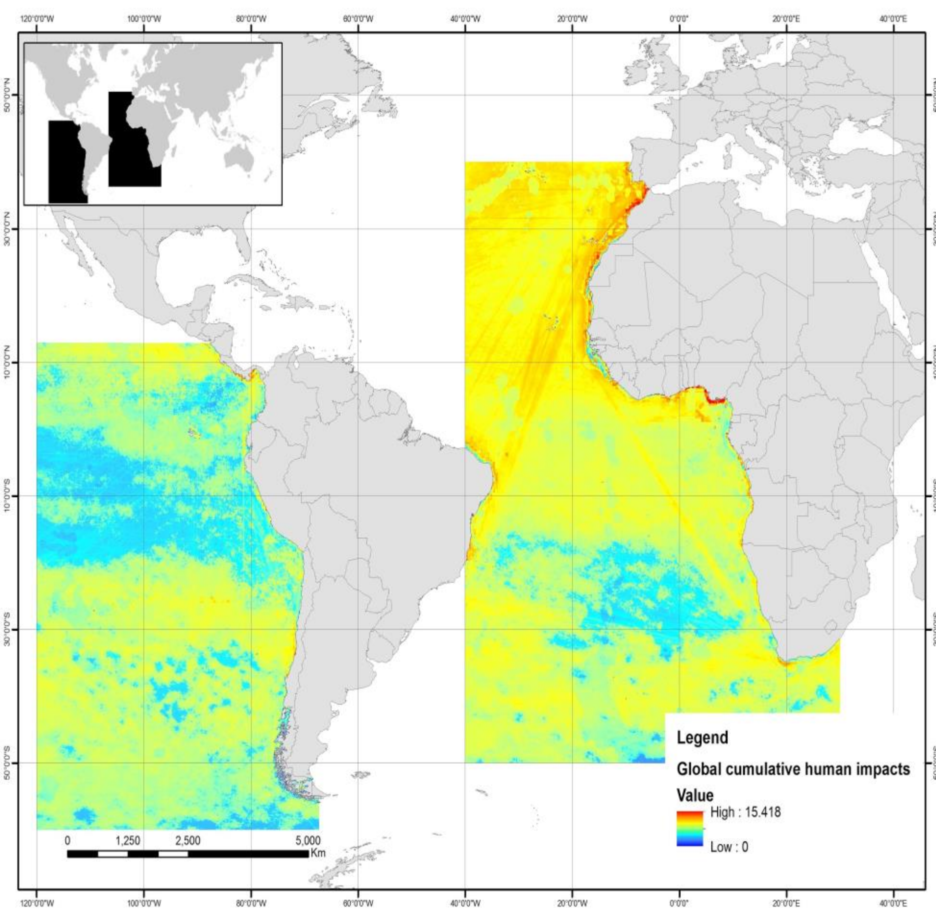


Figure 19 Spatial cumulative human impacts

Source: Halpern et al. (2015)

Note: Spatial and temporal changes in cumulative human impacts on the world's ocean. Data from KBN Ecoinformatics

3.1 Extraction of Fish and Species Removal

Key Messages:

- By far the most significant activity in terms of the volume of removed fish and other non-fish species in ABNJ is due to commercial fishing.
- Tuna account for 61 % of global catches in ABNJ while non-tuna pelagic fishes account for 26 % of total catches and pelagic squids 7 % of total catches. Other main target species in ABNJ include blue shark and billfish (swordfish, marlin), and oilfish.
- Fishing in ABNJ in the Southeast Atlantic and Southeast Pacific began in the 1950s and 1960s, respectively, and grew significantly before decreasing in around 2000. Nevertheless the selective extraction of fish remains a significant pressure in both the Southeast Pacific and Southeast Atlantic.
- ABNJ are in general less productive than the EEZs and provide only for the global 4.2 % of the annual marine capture fisheries.
- Measurable reductions in marine species abundance or stock levels mean that ecosystem modification is occurring, including possible complex trophic web interactions.

Fish and other species are being removed from ABNJ both intentionally (i.e. target species) and unintentionally (i.e. bycatch), including turtles, marine mammals and seabirds, through different human activities. The most significant activity by far in terms of the volume of removed fish and other species is fishing. Intensive fishing aiming to maximise the amount of fish caught can have negative effects on fish populations as well as age-profiles (i.e. as larger and more mature fish are sought for consumption). These efforts can change the biological structure of marine food webs, by eliminating top-down control from large predatory fish and mesopredator release impacts, and can also change genetic structure of fish populations.

Seafood is an important source of protein for the world population and contributes to global food security. According to Schiller et al. (2018), 39 fish and invertebrate species account for 99.5 % of species targeted in ABNJ. Only one species, the Antarctic toothfish *(Dissostichus mawsoni)*, is exclusively caught in ABNJ, all others are straddling stocks, and are caught in both ABNJ as well as within national jurisdictions.

Fishing effort in ABNJ increased rapidly from the late 1970s onwards due to decreasing fish stocks in the EEZs (Osterblom et al., 2015) and the availability of improved fishing gear, loading- and processing facilities (Schiller et al., 2018). The result for world capture fisheries was stagnation in catch with an increase in effort, resulting in a decline in catch per unit effort, suggesting a “continuing decline in abundance of traditionally harvested species as well as major economic inefficiencies” (Zhou et al., 2015). Recent findings suggest that fishing in ABNJ would in many cases not be profitable in the absence of subsidies (Sala et al., 2018). Further, fishing in ABNJ plays a negligible role in ensuring global food security, as the vast bulk of catches go to food-secure nations such as Japan, the EU, and the US (Schiller et al., 2018). Moreover, subsidies for fishing activities in EEZs are highly controversial with the World Trade Organization (WTO) discussing their ban for decades, calling into question their use in ABNJ where fishing is even more expensive and providing even smaller returns.

Currently, the fleets from China, Spain, Chinese Taipei (Taiwan), Japan and the Republic of Korea (South Korea) combined account for >85 % of the total fishing effort in ABNJ (Kroodsma et al., 2018). Globally, a substantial portion of fishing targets overfished stocks in ABNJ (Sumalia et al., 2015). A lack of strong governance from multilateral bodies such as RFMOs, particularly weak or non-existent enforcement mechanisms, means that overfishing is more likely than well-regulated stocks due to the open access nature of most ABNJ fisheries resources.

Fishing activities can also lead to impacts beyond the targeted stocks, with ecosystem-wide implications in some fisheries. The most indiscriminate gear type is gillnetting, but gillnets in ABNJ were banned by a UN resolution in 1994. It continues to some extent, but is not considered to be highly problematic in the areas covered by this assessment. Longline and bottom trawl gears are somewhat more selective than gillnets, but still results in problematically high rates of bycatch, including seabirds, turtles and other non-commercial species and commercially valuable shark species. Bottom trawling is highly destructive to coral and sponge communities (OECD, 2016). Although bycatch of seabirds and turtles is problematic, the risk of ecological cascade effects from the wholesale removal of top predators (i.e. tunas and sharks) from ecosystems in ABNJ is deeply concerning, with clear implications for EEZs as well. Such wider impacts on the ecosystem can lead to alterations of communities of linked species, ecological processes and marine ecosystems (OECD, 2016).

Southeast Atlantic

Catches from industrial fishing in ABNJ in the Southeast Atlantic (FAO areas 34 and 47) between 1987 and 1990 quadrupled, from 200,000 tons in 1987 to >800,000 tons in 1990 (see Figure 20). This is largely due to the expansion of Chinese and Spanish fleets into the region. After this record high, catches fell to around 400,000 tons. In 1995, 1998 and 2010 catches peaked again at above 500,000 tons. Catches fluctuate strongly with 400,000 tons being the average.

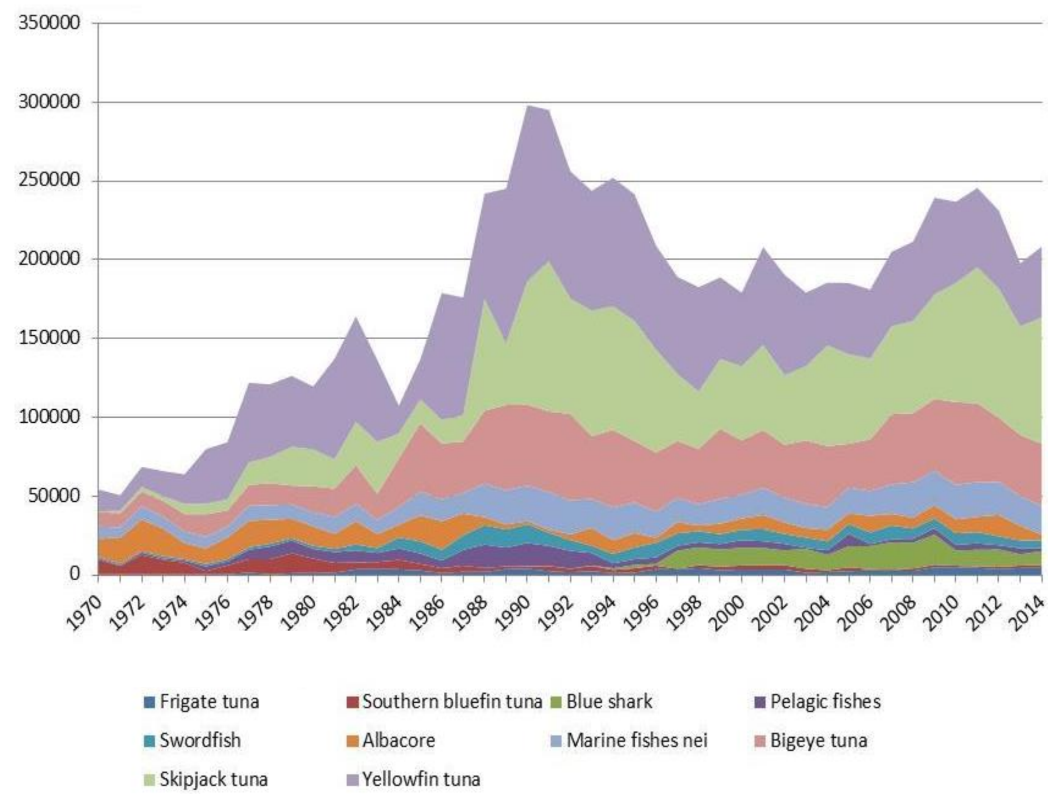


Figure 20 Catch by taxon in tons in ABNJ of the Southeast Atlantic in 2014 (Eastern Central FAO area 34 and Southeast Atlantic FAO area 47)

Source: Seas Around Us (2019)

In 2014, the most active countries fishing in the Southeast Atlantic region in terms of catch were Saint Vincent and the Grenadines, Ghana, Spain, France, Japan, Panama, Chinese Taipei (Taiwan), Namibia, Republic of Korea and Portugal. The reflagging of many Asian vessels to 'Flags of Convenience' states represents a very problematic process, as those states exert minimal controls over the vessels carrying their flags (Ewell et al., 2017).

Typically, purse seines and longlines are the most dominant gear type being used to fish in ABNJ areas of the Southeast Atlantic, while there was limited trawling over seamounts under the South East Atlantic Fisheries Organisation (SEAFO) between 2007 and 2014 but that fishery has since ceased.

The majority of species targeted in the Southeast Atlantic are tunas as well as shark and sailfish (swordfish) (see Figure 21). Fishing effort has the highest concentration in the East Central Atlantic (FAO area 34) off the coast of West African States, with lower concentrations scattered throughout the Southeast Atlantic (FAO area 47) (see Figure 22).

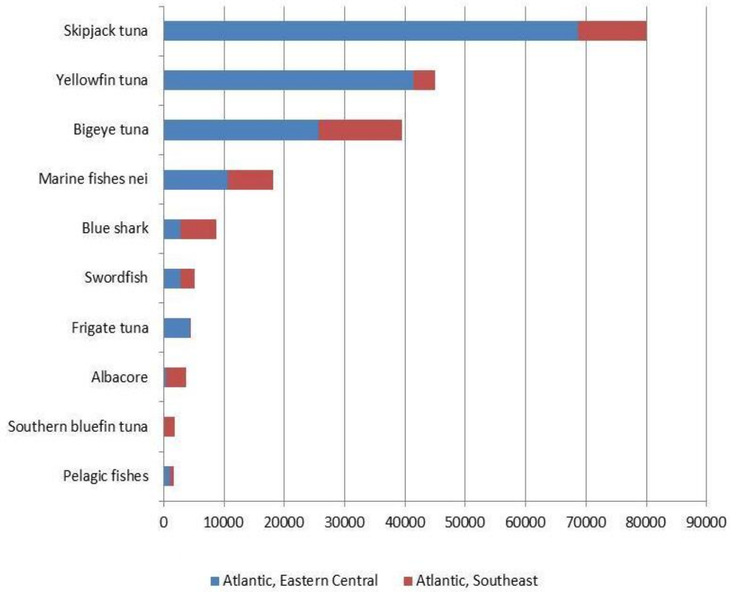


Figure 21 Top ten fish types caught in ABNJ in the Southeast Atlantic in 2014 (Eastern Central Atlantic FAO area 34 and Southeast Atlantic FAO area 47) (tons)

Source: Seas Around Us (2019)

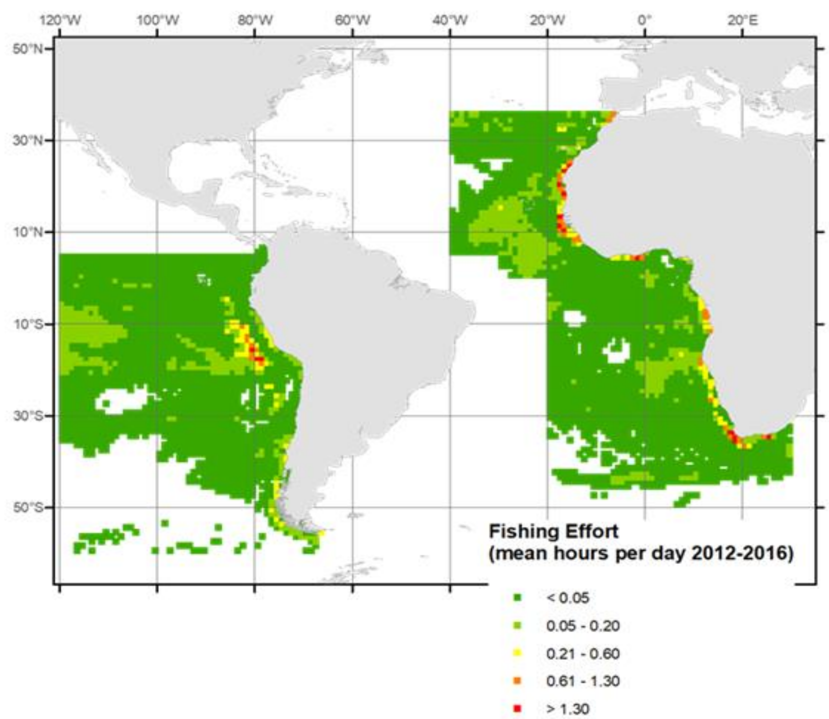
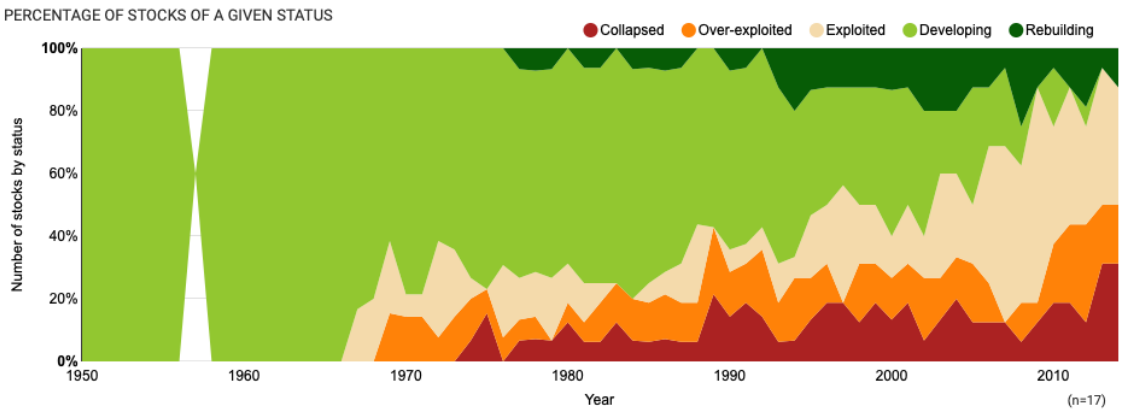


Figure 22 Fishing effort in the Southeast Atlantic and Southeast Pacific (2012 – 2016) (mean hours per day)

Source: Global Fishing Watch, 2019

It is important to note that the UN Food and Agriculture Organization (FAO) has defined its objectives for fisheries to be fished at, or close to, the Maximum Sustainable Yield (MSY). Therefore, fisheries classed as fully exploited are, in theory, performing well. However, allowing fleets to push the boundaries of MSY makes the likelihood of tipping into overexploited considerably higher, and the premise that fisheries can be well managed, and not cross into overexploited territory, has been proved through negative stock status in the overwhelming majority of fisheries in ABNJ. In the FAO area 34, since 1990 almost 40 % of stocks are over-exploited or collapsed, increasing to around 50 % by 2010 (see Figure 23). For area 47 the situation is similar, however overfishing began in the 1980s and so a higher proportion of stocks are overfished (Seas Around Us, 2019) (see Figure 23).



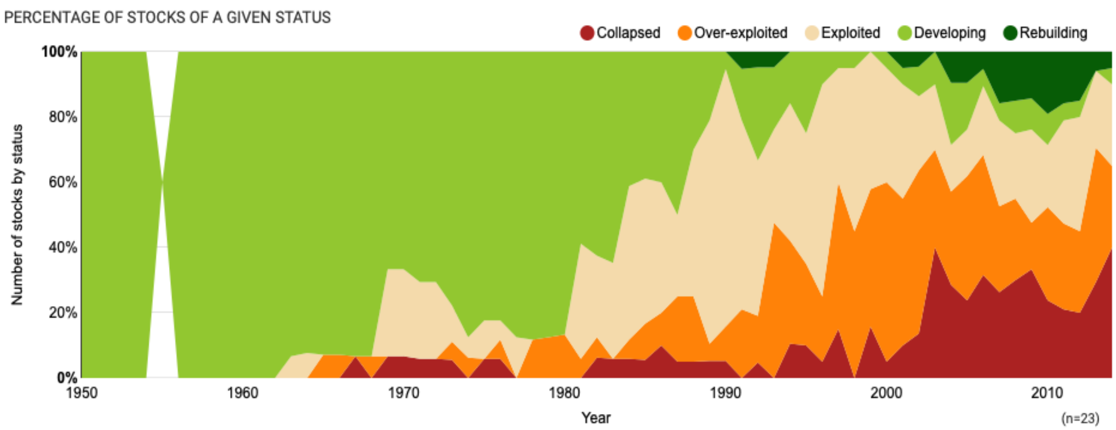


Figure 23 Status of stocks in the Southeast Atlantic - FAO area 34 (upper) and 47 (bottom) since 1950 (number of stocks by status)

Source: Seas Around Us, 2019

Note: Stock-status categories are defined using the following criteria (all referring to the maximum catch [peak catch] or post-peak minimum in each series): Developing (catches ≤ 50 % of peak and year is pre-peak, or year of peak is final year of the time series); Exploited (catches ≥ 50 % of peak catches); Over-exploited (catches between 50 % and 10 % of peak and year is post-peak); Collapsed (catches < 10 % of peak and year is post-peak); and Rebuilding (catches between 10 % and 50 % of peak and year is after post-peak minimum). Note that (n), the number of 'stocks', is defined as a time series of a given species, genus or family (higher and pooled groups have been excluded) for which the first and last reported landings are at least 10 years apart, for which there are at least 5 years of consecutive catches and for which the catch in a given area is at least 1,000 tonnes.

In addition to pressures placed on fish and marine species, fishing on in ABNJ causes significant pressures on seabird communities (see Section 0). The bycatch of seabirds from fishing efforts in ABNJ in the region is unknown for the regions north of 25°S. This does not mean that catch does not occur; only that it has not been quantified, reported, and/or assessed in a systematic way. It is known that tuna purse seine vessels pose negligible bycatch risks to seabirds. However, catch of seabirds from tuna longline operations in the waters from 25°S and southwards, is substantial. The ecosystem-wide impact of the removal of these predator/scavenger species remains unknown (Tuck et al., 2011).

Box 5 Illegal, unreported and unregulated (IUU) fishing

Illegal, unreported and unregulated (IUU) fishing bypasses regulation and conservation efforts and thereby poses a serious threat to the sustainable management of fisheries, with implications as well for efforts to counter hunger and malnutrition. Its importance is underlined by Sustainable Development Goal 14 (SDG14), which stipulates the elimination of IUU fishing by 2020. Given the complexity of the issue, it will be challenging to achieve this goal.

The FAO defines IUU fishing as:

- Illegal fishing activities conducted in violation of fishery laws of the relevant national authority or RFMO;
- Unreported fishing activities or activities which have been misreported to the relevant national authority or RFMO, including unreported discards; and
- Unregulated fishing refers to fishing by vessels without nationality, by vessels flying the flag of a State not party to the concerned RFMO, or fishing in unregulated areas (FAO, 2001).

IUU fishing has environmental, economic, social, as well as legal ramifications. By undermining regulation and conservation efforts designed to prevent overexploitation, IUU fishing contributes to the depletion of fish stocks. This negatively impacts ecosystem health and threatens the commercial viability of target species, which in turn has social and economic consequences for communities dependent on the fisheries sector. In some cases, the food security of local communities dependent on marine resources can also be threatened. IUU fishing is often associated with illicit activities, such as bribery and corruption (Metuzals et al., 2009).

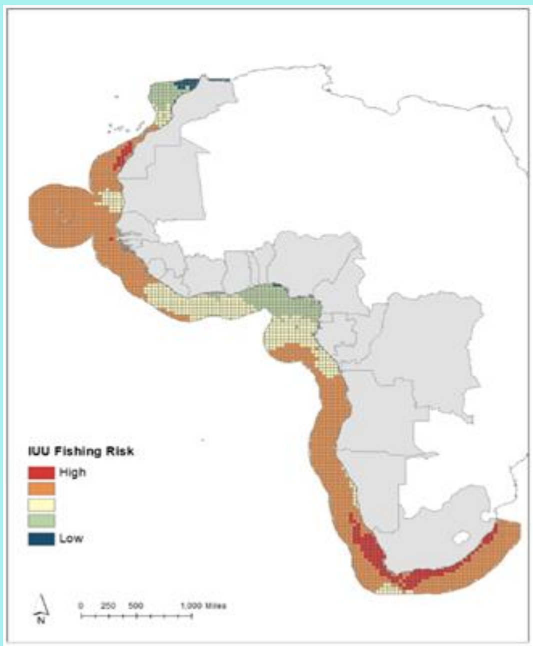


Figure 24 IUU Fishing Risk in the EEZs of 23 West African countries

Source: Petrossian, 2018

IUU is a problem both in ABNJ and in EEZs. Given the clandestine nature of IUU fishing, reliable estimates of the extent of it are hard to come by. A widely cited study by Agnew et al. (2009) estimated that illegal und unreported (IU) fish in 2003 was 11-19 % of reported catches, representing 10-26 million tonnes of fish valued at US$ 10-23 billion (note that they did not consider unregulated fishing). Moreover, they estimate that since the 1990s IU fishing has declines by 13-31 %. However, these global estimate masks significant regional differences. IU fishing was most prevalent in the Eastern Central Atlantic (FAO Area 34), estimated at 37 %. In the Southeast Atlantic (FAO Area 47) it was only 7 %, and in the Southeast Pacific (FAO Area 87) it was 19 % (Agnew et al., 2009).

IUU fishing combines with the rising demand for seafood and the concurrent decline of stocks to form a vicious circle. By undermining sustainable fisheries schemes it aggravates the problem of declining catches, which in return increases the incentive to exceed quotas and other regulation attempts. A significant factor driving IUU fishing is its high profitability. It is profitable because IUU fishing mostly targets high value species, but also keeps overhead costs low due to an avoidance of safety standards and labour laws. Another significant driving factor is the overcapacity of fleets, in some cases further aggravated by fisheries subsidies, which leads vessels to exceed regulations. Further enabling IUU fishing are poorly designed regulations and weak enforcement, insufficient cooperation between national and international agencies, corruption, as well as the failure to regulate fisheries in ABNJ and the prevalence of flags of convenience (Metuzals et al., 2009; Flothmann et al., 2010; Petrossian, 2018).

IUU fishing has also been increasingly studied from an environmental crime perspective, investigating which risk factors attract crime. An analysis of the micro-spatial opportunity structure in the EEZs of 23 West African countries showed that IUU fishing is facilitated by the presence of illegal fish landing ports, so-called ports of convenience, and by the abundance of commercially significant and desired fish (Petrossian, 2018; see Figure 24). Effective fisheries management and have strong patrol surveillance capacity, on the other hand, decreases illegal fishing (Petrossian, 2015).

Southeast Pacific

Industrial fishing in ABNJ of the Southeast Pacific (FAO area 87) started in the 1960s. From then on, fisheries steadily increased until the mid-1980s, when catches amounted to around 500,000 tons. Between 1987 and 1990, catches tripled from 600,000 tons in 1987 to 1,800,000 tons in 1990. After this record high, catches fell to around 900,000 tons. From 1994 to 1997 and in 2001 and 2004, catches peaked again at around 1.2 million tons (see Figure 25) (Seas Around Us, 2019).

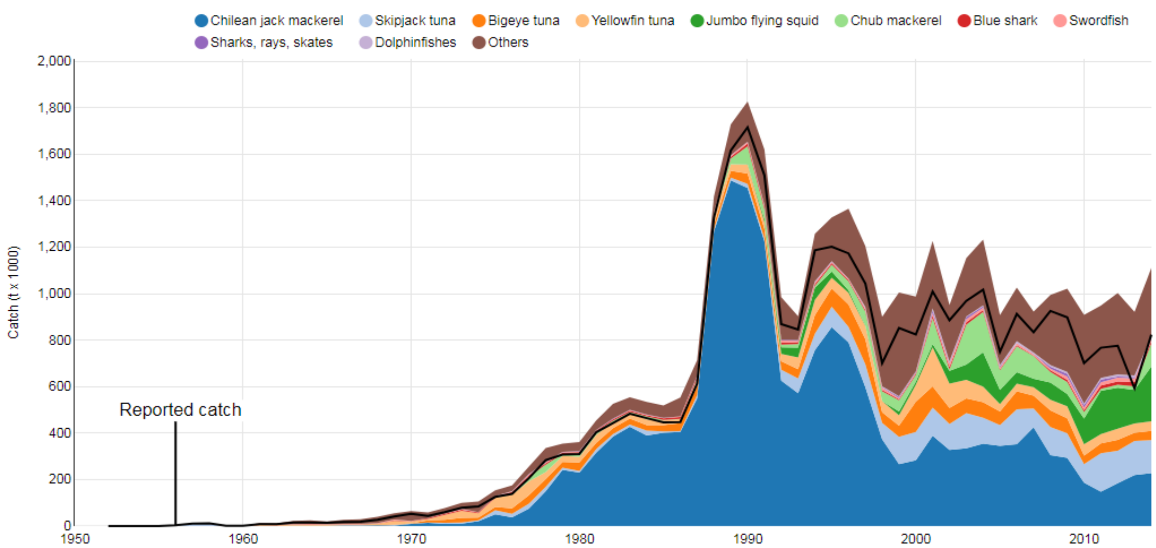


Figure 25 Catch by taxon in 1000 tons in ABNJ of the Southeast Pacific (catches in tons)
Source: Seas Around Us, 2019

The main countries fishing in the region are Chile, Ecuador and China (Pauly & Zeller, 2015). Purse seines and longlines are the major gear types employed to fish in ABNJ areas of the Southeast Pacific, while both bottom trawling and pelagic trawling decreased in the past years and by 2014 accounted for only 2 % together of the total gear used in the region (Pauly & Zeller, 2015).

Currently, overall catches in ABNJ of the Southeast Pacific fluctuate between 900,000 and 1,000,000 tons with jumbo flying squid, Chilean jack mackerel and tuna being the main target species (see Figure 25). From 1980 until 1991, Chilean jack mackerel made up around 80 % of all catches, but has since declined to around 60 % of the catches and most recently (2014) to around 20 % (Figure 26).

Chilean jack mackerel is commonly targeted for the production of fish meal, of which most is used in aquaculture (Schiller et al., 2018) as well canned or sold fresh for human consumption (FAO, 2019).

Fishing efforts in the Southeast Pacific show dispersed efforts across the region, with the highest levels of concentrations of fishing effort extending into ABNJ beyond the EEZs of Colombia and Peru (see Figure 27).

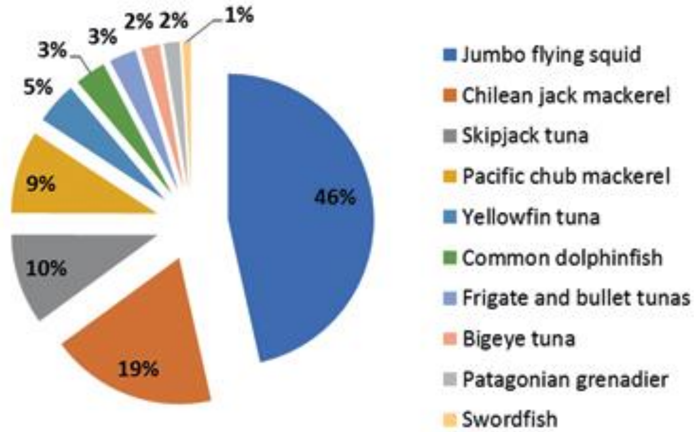


Figure 26: Top ten oceanic species caught in the Southeast Pacific in 2015
Source: Durussel et al. (2017)[31]

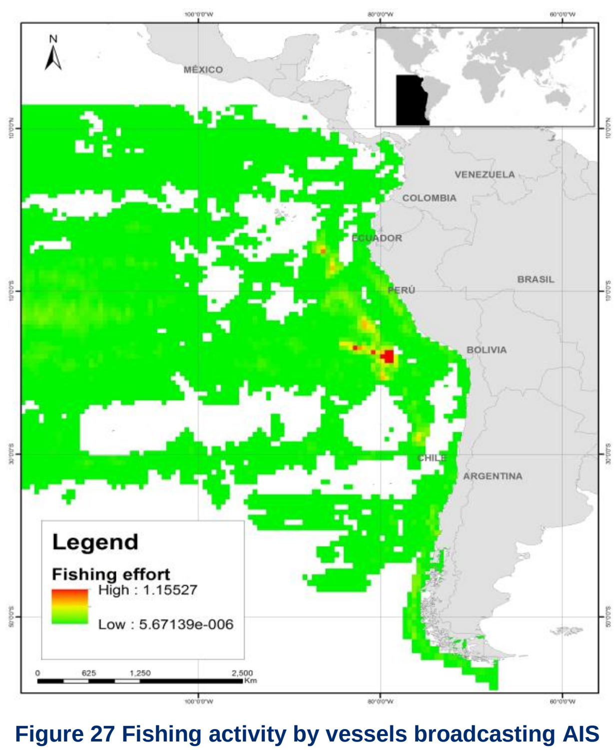


Figure 27 Fishing activity by vessels broadcasting AIS
Source: Kroodsma et al., 2018

[31] Updated from C C Durussel, 'Challenges in the Conservation of High Seas Biodiversity in the Southeast Pacific (Doctor of Philosophy Thesis, University of Wollongong, 2015), http://ro.uow.edu.au/theses/4415, at p. 42. Data obtained from FAO Fisheries and Aquaculture Department, Statistics and Information Service FishStatJ: Universal software for fishery statistical time series. Copyright 2017. FishstatJ Version 3.02 was used to analyse the data.This version includes the FAO Capture Production data 1950–2015 released in March 2017. Source: http://www.fao.org/fishery/statistics/software/fishstatj/en (accessed: 3 April 2017). The percentage is based on the ten most caught species only and not on the whole catch.

Since 2000, most of the fish stocks in the Southeast Pacific are subject to overexploitation. The status of fish stock in 2014 was about of 77 % of stock in overexploited condition and 14 % in exploited condition (see Figure 28). A total of 4.5 % of stock were in collapsed condition (Seas Around Us, 2019). According to FAO, for the area 87, the Eastern Pacific Bonito has ranged from overexploited to depleted category and the South Pacific hake has ranging from fully exploited to depleted category.

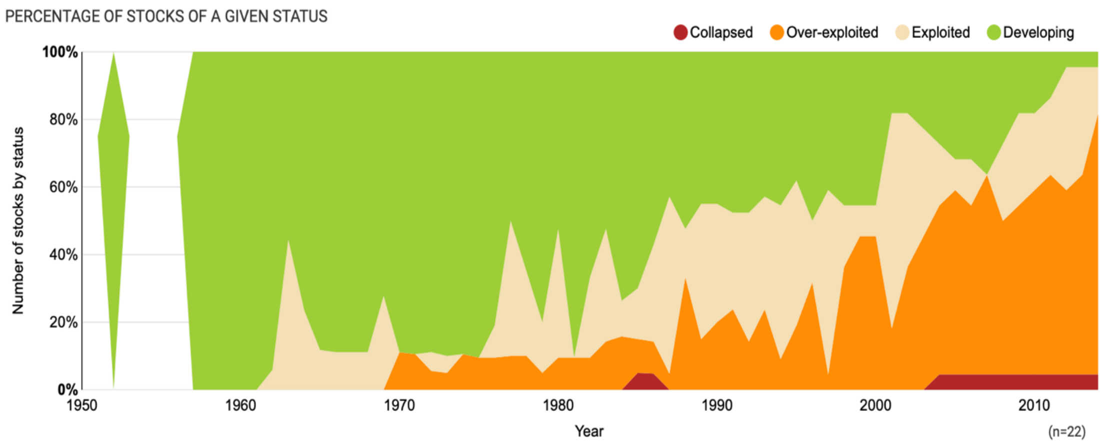


Figure 28 Stock status plots assessed by number of stocks in the FAO area 87 since 1950
Source: Seas Around Us, 2019

Note: Stock-status categories are defined using the following criteria (all referring to the maximum catch [peak catch] or post-peak minimum in each series): Developing (catches ≤ 50 % of peak and year is pre-peak, or year of peak is final year of the time series); Exploited (catches ≥ 50 % of peak catches); Over-exploited (catches between 50 % and 10 % of peak and year is post-peak); Collapsed (catches <10 % of peak and year is post-peak); and Rebuilding (catches between 10 % and 50 % of peak and year is after post-peak minimum). Note that (n), the number of 'stocks' is defined as a time series of a given species, genus or family (higher and pooled groups have been excluded) for which the first and last reported landings are at least 10 years apart, for which there are at least 5 years of consecutive catches and for which the catch in a given area is at least 1,000 tonnes.

The bycatch of seabirds from fishing efforts in ABNJ in the region is negligible north of 20°S, and observer coverage from pelagic longline operations south of that latitude is particularly poor, so overall bycatch in the region is very poorly understood. It is known that tuna purse seine vessels pose negligible bycatch risks to seabirds. Bycatch of seabirds from tuna longline operations in the waters from 25°S and southwards is probably substantial, although the relevant authority for managing tuna fishing in the region, the Inter-American Tropical Tuna Commission (IATTC), has not conducted an assessment of seabird bycatch. Further, in contrast to tuna commissions managing other marine areas, the IATTC does not require that tuna longline vessels use only best practice measures to mitigate seabird bycatch. The ecosystem-wide impacts of removal of these predator/scavenger species remains unknown.

Box 6 Managing tuna through stock assessments and ecosystem modelling

By Dr. Shane Griffiths, Inter-American Tropical Tuna Commission (IATTC)

Fishing mortality (*F*) occurs in the IATTC Convention Area on target species of tuna and tuna-likes fishes and other non-target species (e.g. dorado, wahoo) that are retained for economic reasons. Unintentional (often loosely classes as "non-target") mortality impacts species that are caught in the process of catching "target" species – although the notion of target species using unselective gear remains a debatable principle. These species are generally referred to as "bycatch" and are typically discarded at sea due to their low economic value (e.g. snake mackerel), or conservation and management measures prohibiting their retention, such as silky, oceanic whitetip and whale sharks, mobulid rays, marine mammals, sea turtles and seabirds.

A change in the population status of a species impacted by tuna fisheries in the eastern Pacific Ocean is dependent on many factors, but the primary factors are excessive fishing effort, either in terms of the number of fishing operations (e.g. individual sets), gear efficiency (or 'fishing power') or size and/or capacity of the fleet (i.e. the number of vessels and the biomass of fish they can each hold). Environmental factors can also have significant influence on a species' status. Dramatic negative impacts may be expected where fishing effort and gear efficiency is high, but recruitment is low. Unfortunately it is almost impossible to predict recruitment levels in real time, as they are usually only assessed from catch composition and length-frequency data, and are back-calculated, not predicted.

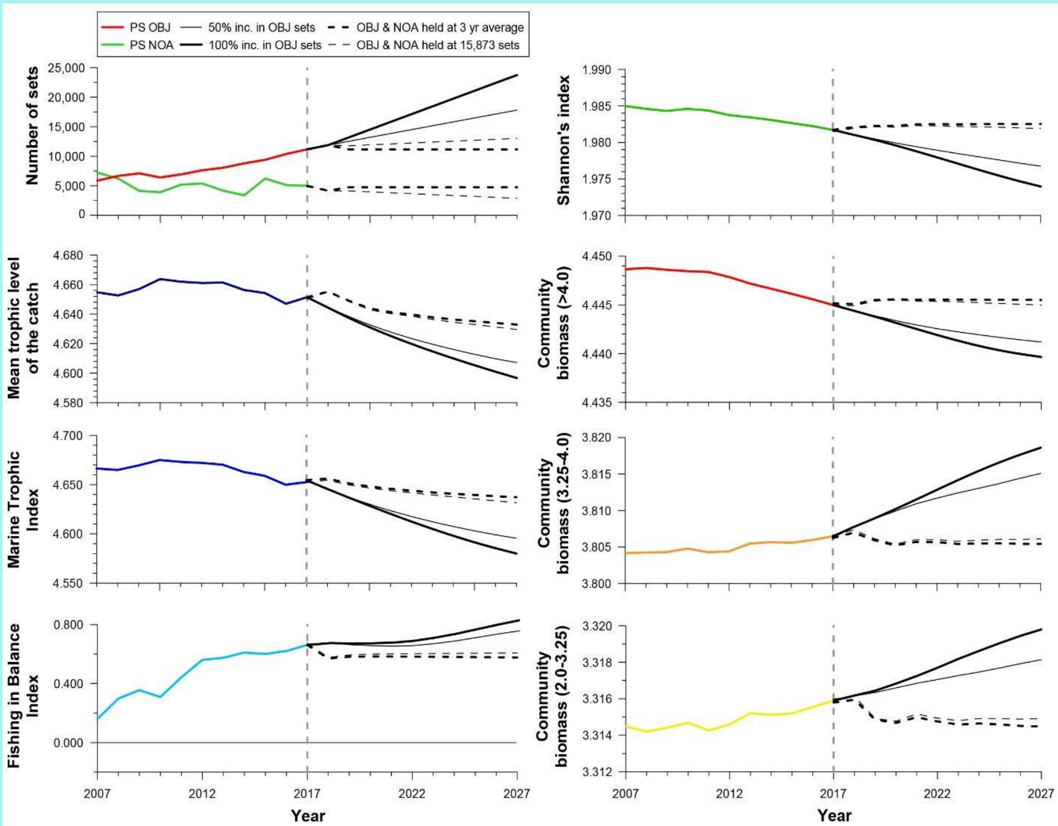


Figure 29 Estimated changes in annual values for seven ecological indicators after the simulation of four hypothetical scenarios changing the effort of the purse-seine fishery on floating objects (or OBJ) over a 10-year period initiated in 2017 and concluding in 2027

Source: provided by IATTC[32]

Stock assessments are undertaken by the IATTC staff annually on the three primary target tuna species in the eastern Pacific Ocean (skipjack, yellowfin and bigeye tunas), while assessment on other species under the auspices of the IATTC Convention (e.g., swordfish, blue marlin) are undertaken periodically. The general trend over the past 5 years is a declining spawning biomass of the three target species, in particular bigeye and yellowfin tuna. This is believed to be a direct result of the dramatic increase in the purse-seine fishery setting on drifting artificial devices (e.g. Fish Aggregating Devices (FADs), anchored buoys) since they attract small sizes of fish representing these species.

The IATTC staff has also developed an ecosystem model of the eastern tropical Pacific Ocean to better understand the impacts of fishing on marine biodiversity. Seven ecological indicators from the model have been reported and monitored by the IATTC staff since 2017. The results clearly show that the ecosystem structure has changed substantially over the history of the fishery, first due to the increase in industrial fishing from the 1970s, but most markedly since the purse-seine fishery that set on floating objects (fish aggregating devices; FADs) began in earnest around 1993 and has continued to expand dramatically to the present day.

[32] The scenarios included a 50 % and 100 % linear increase in the number of floating object (OBJ) sets over the 10-year period from the level in 2017; a combined limit of 15,831 sets for OBJ and associated (or NOA) fisheries that was held constant for 2017–2027; and a combined limit of 15,831 sets for the OBJ and NOA fisheries where the annual proportion of OBJ and NOA sets was simultaneously increased and decreased, respectively, from 2017 to 2027. Effort for all other fisheries remained at their 2017 levels. The vertical grey dashed lines denote the year (2017) when the simulations began.

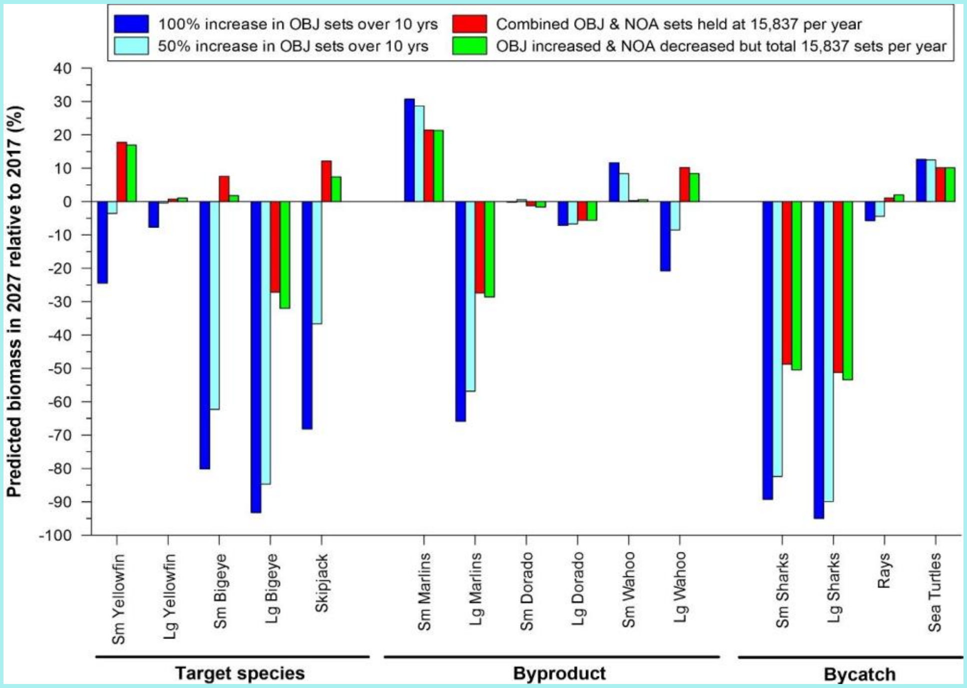


Figure 30 Ecosim predicted relative changes in the biomass of key functional groups representing primary target species, byproduct, and bycatch of the purse-seine fishery in the eastern tropical Pacific Ocean in 2027 relative to 2017 under four hypothetical management scenarios

Source: IATTC[33]

The ecosystem model has also been used to predict the ecological consequences of continued increases in effort, and the potential impacts of implementing effort limits as a conservation and management measure. The model simulations indicate that even if the rate of effort increase observed over the past 10 years is halved immediately, further degradation of ecosystem integrity (Figure 29) will continue and the biomass of some target tuna species may collapse by up to 62 % (Figure 30). Implementing a combined effort limit was predicted to maintain the ecosystem structure in its present state and slightly increase the biomass of most target tuna species (Figure 29). However, a significant reduction in effort by the purse seine, and most likely the longline fishery, would be needed to restore the eastern Pacific Ocean ecosystem back to a state that existed prior to the expansion of the FAD fishery.

The trophodynamics of the ecosystem is likely to have changed significantly, bringing into question the realism of current model predictions. Significant environmental changes have been observed in the eastern Pacific Ocean over the past decade, in the form of some of the strongest El Niño events on record. Given this, it stands to reason that there is a critical need to collect trophic information from not only species of economic (e.g. tunas) or conservation (e.g. sharks) importance, but also their prey, and the base of the food web (i.e. phytoplankton), which can have a significant impact in oligotrophic oceanic ecosystems that are often thought to be controlled by 'bottom-up' processes.

[33] The scenarios included a 50 % and 100 % linear increase in the number of OBJ sets over the 10-year period from the level in 2017; a combined limit of 15,831 sets for the OBJ and NOA fisheries that was held constant for 2017–2027; and a combined limit of 15,831 sets for the OBJ and NOA fisheries where the annual proportion of OBJ and NOA sets was simultaneously increased and decreased, respectively, from 2017 to 2027. Effort for all other fisheries remained at their 2017 levels.

Conclusion

Total fishing pressure worldwide is expected to grow in the coming years due to the growing world population and rising incomes resulting in increasing demand for seafood (OECD, 2016), and it is assumed that the Southeast Atlantic and Southeast Pacific are included. While aquaculture production is growing (FAO, 2016) and is likely to provide a large amount of the supply, the fishing effort in marine capture will probably increase as well. Fish-based inputs for carnivorous farmed fishes are increasingly being replaced with plant-based fish feed and herbivorous fish as demand for seafood rises (OECD, 2016).

The spatial distribution of fishing pressure as well as the targeted species is likely to change due to climate change impacts as these are expected to bring about shifts in species distribution. Species are projected to move towards relatively colder areas and into deeper waters, leading to higher abundances in mid-trophic levels and higher latitudes and lower abundances in high trophic levels and lower latitudes (OECD, 2016). There is a clear need for enforcement of fisheries legislation to improve, including through more widespread use of satellite technologies and Electronic Monitoring and Reporting systems (OECD, 2016). The use of traceability systems for both fishing activity and catch is widely viewed as a strong countermeasure to IUU fishing.

3.2 Physical Disturbance to and Destruction of the Seabed

Key Messages:

- The main pressures leading to physical disturbance and destruction of the seabed are deep-sea fishing (bottom trawling) while the laying of underwater cables is considered negligible. Deep sea mining (minerals) has the potential to greatly contribute to this pressure if the seabed is opened up to this activity in the future (see Section 0).

- Several areas in ABNJ in both the Southeast Atlantic and Southeast Pacific contain important geological features (see Section 2.2) with potentially commercially valuable marine mineral resources. While there is currently no deep-sea mining taking place in ABNJ of the Southeast Atlantic and the Southeast Pacific, if opened up for exploitation under the International Seabed Authority, it is likely to create significant pressure on the benthic environment (see 2.3) potentially extending to the pelagic zone (see Section 2.4) as a result of the associated sediment plume.

- Fishing in the Southeast Atlantic and Southeast Pacific (see Section 3.1) is predominantly tuna fishing and bill fish which use purse seines and longlines and causes limited or negligible disturbance or destruction of the seabed.

- Underwater cables for communication and information exchange are minimally distributed throughout the Southeast Atlantic and Southeast Pacific compared to other ocean spaces. The pressure extending from this activity is primarily the result of the lying or construction phase, while the pressure is negligible once the cable is in position.

Physical disturbance and destruction of the seabed are a result of physical smothering, disturbance, sediment resuspension, organic loading, toxic contamination or plume formation, and can lead to a loss in biodiversity, declining energy flow back to higher trophic levels, and impacts on physiology from exposure to toxic compounds. It results from human activities such as mining for minerals along the seafloor. Bottom trawling from commercial fishing and the laying of submarine cables for communication and information purposes is a negligible concern in ABNJ.

High base metal and sulphide content are commonly associated with hydrothermal vent sites, and are frequently associated with unique seabed (benthic) communities (see Sections 2.2 and 2.3). Mining the seafloor (deep-sea mining) can result in the partial or complete destruction of benthic habitat at the site level. Habitat and fauna can be crushed, dispersed or removed during the mining process. This process can further result in sediment plumes, which have the potential to impact downstream communities through, for example, smothering, and change in water quality or reduction in primary productivity. Simulation studies have shown that the long-term impacts are unpredictable, with some organisms recovering although the community composition is unlikely to return to the pre-mining levels after a disturbance. The ISA is responsible for issuing permits for mining in ABNJ. The regulations that govern both prospecting and exploration for massive sulphide deposits on the seafloor, require environmental assessments. These must identify the state of the environment near the site and establish a baseline in order to monitor the impact of mining and for measures to be taken to prevent, reduce and control pollution and other impacts on the marine environment (ISA, 2015). No commercial mining has occurred in the international Seabed Area thus far, but this is likely to change as demand for resources increases and technology improves and becomes more economically viable.

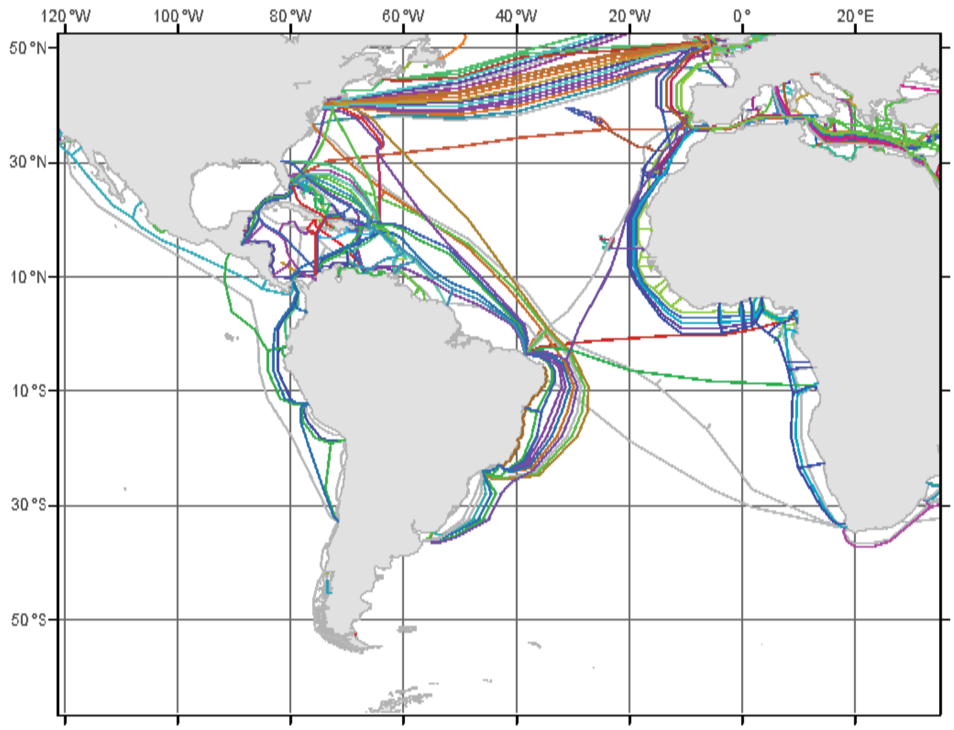


Figure 31 Submarine cables in the Southeast Atlantic and Southeast Pacific
Source: Submarine Cable Map, 2019[34]

Submarine cables have been used for communication since approximately 1850 – the first being laid between England and France (see Figure 31 for the location of submarine cables in the Southeast Atlantic and Southeast Pacific). Of course the nature of the cables has changed and now cables are used for high speed data transfer. At the start of 2019 there were approximately 378 submarine cables linking the world together. Although there is estimated to be over 1.3 million kilometres of cable, the cables are only about 17 – 20 mm in diameter (they are slightly wider, 28 – 50mm, in coastal waters to allow for extra protective casing in these busy waters). In waters greater than 1500 metres deep, the cables are not buried, but rest on the benthic surface and therefore the laying of submarine cables causes less disturbance in the deep seas than it does in coastal waters where cables are typical buried to protect them from damage from other ocean users. Disturbance is more likely in the event of cable failure and subsequent repair work because the cable needs to be retrieved; either a grapnel is dragged across seabed, or a Remotely Operated Vehicle is used. This can disturb the seabed around the cable and is it also likely to cause significant disturbance to any plant or animal life that has settled on the cable. However, at the scale of an ocean basin, these impacts are relatively small. Cables are also likely to only be optimally efficient and cost effective for approximately 20 – 25 years; thereafter the cable could be retrieved or left on the seabed. From 1988 to 2013, approximately 50 000 kilometres of cable were laid annually, with a spike in the early 2000s, followed by some contraction in cable laying after 2002. There has subsequently been some recovery in the industry and in 2014 there were ~1.3 million kilometres of cable globally. Although new technologies in data transfer are emerging (e.g. 5G network), it is unlikely that laying submarine communication cables will stop in the near future.

[34] Each cable is represented by a unique colour.

Conclusion

There is great potential for seabed damage that would have knock on impacts throughout the ecosystem, as a result of mining and mineral extraction. This is difficult to quantify at present because it is an emerging threat. A precautionary approach is strongly advised given the number of unknowns, including whether the ecosystems will recover from this kind of vast, destructive activity. Fortunately, benthic trawling is less prevalent in the deep seas and there is societal pressure to reduce fishing subsidies that make fishing in the ABNJ financially viable. Effective management of the FAO's Vulnerable Marine Ecosystems (see Section 2.1) can help protect those areas where deep sea fishing is likely to cause damage to sensitive benthic habitats. Submarine cables are unlikely to have a large impact on the ecosystems of the ABNJ but effective communications channels need to be established to prevent damage to undersea cables that would result in potentially damaging recovery operations.

Box 7 Deep Sea Mining

By Dr. Sandor Muslow of the Universidad Austral de Chile (UACH)

If Deep Sea Mining (DSM) is permitted to go forward, it will take place within the same marine space (i.e. the Area) which hosts a range of biodiversity, supporting habitats, species, ecosystems and food webs. Operationally, the exploitation of the non-living resources from the seafloor is done by: 1) the removal of ore and life inhabiting the water-sediment interface at the deep basins as well as the removal polymetallic nodules; 2) the removal of ore and life of the inhabitants of water-rocks interfaces from seamounts and mid ocean ridges including the removal cobalt-rich crusts and massive sulphides from hydrothermal vents. This means that biodiversity (living organisms) will consequently be removed during deep sea mining operations.

Among the commodities that deep sea mining is aiming at are: Copper, Zinc, Cobalt, Manganese and rare earth elements. Interest in these metals stems primarily from potential future demand. Production includes digging, crushing, grinding and metallurgical processes of virgin ore from the seafloor, seamounts and hydrothermal vents. Indeed, deep sea mining is an extension of land-based mining, that is, primary production of metals from ores. However, there is little attention to the reserves available to date on land as well as to the end-of-life cycle of each one of them.

Deep-sea mining for marine mineral resources, if eventually permitted by the International Seabed Authority (ISA), will, without doubt, disturb the marine environment and alter the seafloor. Currently only exploration activities are being conducted. Mining lease holders must assess if serious, harmful effects to vulnerable marine ecosystems, such as those associated with hydrothermal vents, will occur as a result of mining activity. Applications for mining can be rejected where substantial evidence indicates the risk of serious harm to the marine environment. Without precedents of large-scale mining in the deep-sea environment, predicting its impact is challenging and the Precautionary Approach should be applied in order to protect the ecosystem function of these environments. Moreover, it remains unclear how a future internationally legally binding agreement on marine biodiversity in ABNJ, currently being negotiated at the UN, will be able to ensure possible future deep sea mining operations do not lead to extreme environmental damage in ABNJ.

There are two main codes of conduct issued by stakeholder groups that are concerned with activities at SMS deposits; the InterRidge Statement of Commitment to Responsible Research Practices, and the International Marine Minerals Society (IMMS) Code for Environmental Management of Marine Mining. The InterRidge Statement acknowledges that scientific research can affect communities at hydrothermal vents and signatories agree to avoid activities that can impact the sustainability of vent communities or lead to long-term degradation of vent sites, including avoiding non-essential collections and transplanting material between sites. The IMMS Code consists of a statement of environmental principles for marine mining and operating guidelines for application by industry, regulatory agencies, scientists and other interested parties. It is a voluntary code that aims to encourage environmental best practice and transparency in commercial operations. The Code also emphasises the precautionary approach, the involvement of local and scientific communities and responsible and sustainable development. The Code emphasises a need to "consider biological resource potential and value of living organisms at potential marine mining sites as well as the mineral resource potential and value". The IMMS Code also highlights the need for procedures that aid in the recruitment, re-establishment and migration of biota following mining activities and supports the study of undisturbed, comparable habitats that are close to the mining site before, during and after mining activities.

3.3 Marine Pollution

Key Messages:

- Marine pollution is a major threat to marine biodiversity – key sources include land-based activities (approximately 80 %), shipping and mining. Contaminants of concern in ABNJ include hazardous substances (e.g. heavy metals, pesticides), suspended solids, hydrocarbons and marine litter (primarily plastics and micro-plastics).
- Information on pollution levels in the study area as well as the adjacent coastal areas is limited. Nevertheless, there is sufficient information to suggest that ABNJ are contaminated with a range of pollutants.
- Hazardous substances in ABNJ, including heavy metals, such as mercury, have been detected in deep sea fish and tributyltins (organotin compounds commonly found in materials such as anti-fouling ship paints) are present in sediments in ports and along busy shipping lanes.
- Marine debris – especially plastic – has become a significant issue in recent years with evidence of it in marine habitats worldwide. Floating debris is transported by winds and currents and there is strong evidence that there are areas of concentrated debris in both the South Pacific Subtropical Gyre and the South Atlantic Gyre. Heavier debris, or debris that has accumulated weight from organisms settling on it, sinks and has been reported in numerous deep-sea areas including some in the South Pacific and South Atlantic.
- Marine debris poses a threat for marine life, primarily through entanglement and ingestion, with impacts reported for several taxonomic groups across the Southeast Pacific and Southeast Atlantic.
- Marine debris is also a vector for the translocation of alien species across the oceans.
- Mining in the deep-sea is still in its infancy and there is a limited understanding of potential impacts, although it is likely that mining activities will result in plumes of suspended material and the release of potentially toxic elements which could travel significant distances in the plumes.
- Shipping traffic and land-based activities will grow in the future in response to increases in the global population and global trade and it will be a challenge to prevent ABNJ from becoming polluted further.

Marine pollution is the introduction of substances by human activities, directly or indirectly, into the marine environment resulting in the degradation of living resources and ecosystems, hazards to human health, hindrance to marine activities including fishing, as well as the impairment of quality for use of sea water (GESAMP, 1991). The types of pollution addressed include hazardous chemicals (e.g. heavy metals, pesticides), nutrients (e.g. ammonia, nitrates, nitrites and phosphates), suspended solids, microbiological contaminants (e.g. bacteria and viruses), hydrocarbons, as well as marine litter (primarily plastics and microplastics). The main sources of marine pollution stem from maritime transport, offshore prospecting and mining activities, land-based activities, and dumping of waste at sea.

Pollution from shipping activities comprises two main categories: i) pollution resulting from the ship's day-to-day operational activities; and ii) pollution as a result of accidents. In addition, shipping is an important pathway for invasive alien species. Operational pollution varies depending on the class and size of the ship. It includes oily waste from the ship's engines and bilges, atmospheric emissions from the engines, incinerators, refrigeration and fire-fighting systems, sewage and garbage arising from the domestic needs of passengers and crew, and tributyltins and other anti-fouling compounds which leach from the painted surfaces. Shipping accidents can give rise to major oil spills, although depending on the specific circumstances, these do not necessarily have massive impacts. However, they can result in the loss of their cargo, which can potentially cause significant damage, for example, if the ship is carrying hazardous chemicals as cargo.

In the offshore petroleum sector, accidental discharges can be as a result of blow-outs, pipeline ruptures, tanker spillages and collisions – for example, when ships are docking at the platforms. Operational discharges include oil in produced water,[35] drill cuttings and muds (which can contain toxic contaminants), production chemicals (e.g. residual process water, drilling additives, well treatment fluids), sewage, garbage, deck drainage, and atmospheric emissions. During drilling operations, specially formulated drilling muds are pumped down the drill shaft to lubricate the drilling bit, transport the

[35] Produced water is a by-product of the process.

cuttings to the surface and to replace ("weight") the rock removed from the well-bore. These muds and rock fragments could then be discharged into the sea. In the past, drilling muds were often mineral oil-based but present practice is to use water-based muds or, in difficult drilling conditions, low-toxicity synthetic oil-based muds.

Offshore prospecting and mining activities can cause pollution both as a consequence of accidents and operational discharges during both exploration and production phases. Marine pollution from production phases take place over longer periods of time, and therefore have a potential to contribute to greater impacts.

Mining for other substances in the marine environment has, until recently, been limited to fairly shallow areas (less than 50m) and has focussed on aggregates, diamonds, tin, magnesium, salt, sulphur, gold and heavy minerals. More recently mining has been in deeper waters with phosphate, massive sulphide deposits, manganese nodules and cobalt-rich crusts regarded as prospects. Phosphates are generally found on continental shelves and upper slopes, oceanic islands, seamounts and flanks of atolls. At present, mining in deep sea areas is limited to exploratory drilling for polymetallic manganese nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts. The methodologies for mining manganese nodules being considered are primarily based on the hydraulic suction system during which nodules are vacuumed up from the seabed and transferred to a mining vessel while a second pipe returns wastewater and tailings (usually fine particles) to the seabed or for release in the water column. Mining systems for polymetallic sulphides and cobalt-rich ferromanganese crusts are still under development but it is predicted that they could cause substantial physical damage. The impacts of deep sea mining include: i) the physical destruction of the seabed (see Section 0); ii) the effects of particle-laden plumes in the water column (i.e. suspended solids), and iii) the release of toxic chemicals during the mining process. The latter two are addressed below.

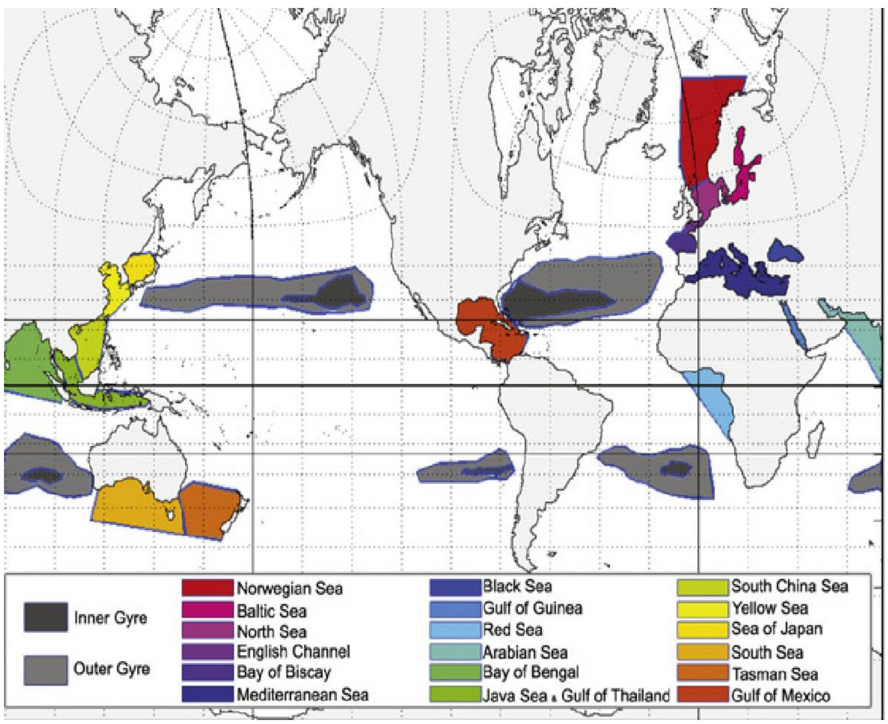


Figure 32 The accumulation of floating material after 30 years of simulated input and circulation. Map showing the boundaries of the various accumulations zones

Source: Lebreton et al., 2012

Some 80 % of the pollution load in marine environment originates from land-based sources, including: municipal wastewater (mainly domestic sewage); industrial wastewater (including discharging of contaminated seawater that was used for industrial purposes on land, e.g. coastal mining activities and seafood processing industries); urban stormwater runoff; agricultural and forestry return flows; atmospheric sources of pollutants; and litter (solid waste). Contaminants can reach coastal waters via natural runoff and rivers, or through specifically constructed marine outfalls and stormwater drains. Marine litter or Anthropogenic Marine Debris (AMD) has been defined by UN Environment (2009) as "any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment." AMD has a number of different sources, including direct littering on coasts and water bodies, river run-offs, fisheries and aquaculture activities, shipping, etc. It comprises various types of material including plastics, metal, glass, processed timber, paper and cardboard, rubber and even clothing and textiles (United Nations, 2016) and comes in a wide range of sizes, from microscopic particles to large household and industry items. Once at sea, AMD goes through various transformation processes with, for example, saltwater, sunlight and wave action causing plastic pieces to lose material integrity, erode and break apart into smaller pieces. Items with densities similar to or lower than seawater generally float and are transported by winds and currents, while high density items sink and accumulate in subtidal areas – including the deep sea (Woodall et al., 2015; Chiba et al, 2018; see Figure 32).

In recent years, plastic debris – which generally makes up between 60 and 90 % of AMD – has become an issue of increasing concern due to its impacts on marine biodiversity and public health (Vince and Hardesty, 2018). Plastic debris can be categorized into three main sizes: macroplastics (>200 mm), mesoplastics (5-200 mm) and microplastics (<5 mm). Its impacts on marine life are primarily due to entanglement and ingestion, which can cause death or have sublethal impacts such as reducing reproductive success and impeding movement (Secretariat of the CBD and GEF, 2012). However, microplastics in particular can also accumulate hydrophobic persistent, bio-accumulative and toxic substances (PBTs) that are present in the oceans from other sources (UN, 2016). The CBD-GEF Report (2012) stated that: "*all known species of sea turtles, about half of all species of marine mammals, and one-fifth of all species of sea birds were affected by entanglement or ingestion of marine debris over 80 % of the impacts were associated with plastic debris.*" The report also identified those species for which the rates of entanglement and ingestion are amongst the highest globally, including the Green turtle (*Chelonia mydas*) and the Loggerhead turtle (*Caretta caretta*), both of which occur in the regions of concern and listed on the IUCN's Red List as Endangered and Vulnerable, respectively.

Southeast Atlantic

Hazardous substances

Sources of hazardous substances include land-based activities, shipping and mining. Although the most significant route to ABNJ is through the atmosphere either as aerosols or gases (UN, 2016), deep-sea ore deposits themselves comprise complex mixtures of potentially toxic elements, which could be released into the sea during different stages of the mining process (MIDAS, 2016). Once they have been introduced into the marine environment, they can remain suspended for long periods, or could be adsorbed onto particles which then sink to the seabed. They can also be taken up by filter feeders and concentrated up the food chain (bioaccumulation). Concentrations of these substances are likely to be higher closest to where the relevant activity takes place. Tributyltins, for example, tend to be concentrated in the sediments in ports and along shipping lanes (Strand et al., 2003). However, those that are introduced via atmospheric emissions are likely to be far more widely distributed. According to the First Global Assessment (United Nations, 2016): "*the lack of data makes it impossible to develop a general assessment of the relative impacts of hazardous substances on the open ocean in the different parts of the world*". There are, however, some exceptions. For example, it has been reported that "*mercury levels in deep-sea fishes, such as morids and grenadiers, are substantially higher than in shelf-dwelling fishes, such as cod; notably long-lived fishes on seamounts, such as orange roughy and black cardinalfish, have mercury levels near or at the levels normally regarded as permissible for human consumption (0.5 ppm)*" (United Nations, 2016). It should be noted, however, that concentrations of mercury (and other heavy metals) are higher around hydrothermal vents – for example those at the Mid-Atlantic Ridge (Martins et al., 2006).

According to the First Global Assessment (United Nations, 2016) there is limited empirical research on pollution in the open ocean (including heavy metals and other hazardous substances), particularly in areas outside of the North Atlantic. Most of the information available pertains to coastal areas. In Togo, for example, discharges from phosphate mining have resulted in high levels of cadmium and lead being found in fish and crustaceans (Gnandi et al., 2006). Moreover, samples of sediments from coastal lagoons in Ghana, Côte d'Ivoire and Nigeria were shown to have high concentrations of various heavy metals including cadmium, mercury and lead (GCLMEP, 2003).

Other research regarding land-based sources of pollution in this area identifies a number of "hot spots" in the proximity of the principal coastal cities along the west coast of Africa in the context of the various Large Marine Ecosystem Programmes. Heileman (2008) suggested that the impacts are largely limited by the strong current systems to the immediate areas of discharge. However, the use of mercury in artisanal gold-mining in West Africa is a potentially significant problem, with high levels of mercury having been found in many West African rivers (Donkor et al., 2006). Similarly, phosphate mining in Togo discharges tailings and other wastes which contain high levels of cadmium and lead (Gnandi et al, 2006).

In terms of the open ocean, samples of skipjack tuna from the South Atlantic tested for brominated flame retardants as a marker for widely dispersed persistent organic pollutants (POPs), show levels that are lower than in the open ocean of the Pacific (United Nations, 2016).

Suspended Solids

The most likely source of suspended solids in the Southeast Atlantic is from mining and their primary impact is likely to be on the benthos, although plumes can also occur in mid-water. The extent of the impact depends on the amount and physical characteristics of the material being discharged and the environmental conditions that disperse these discharges. Currents in the deep-sea are complex and variable (MIDAS, 2016) and would need to be determined for each site. However, it is likely that impacts in the immediate vicinity of a discharge would include smothering, burial or habitat change in addition to toxic impacts. Mid-water plumes might impact photosynthetic microalgae or animals within the water column (MIDAS, 2016). In addition, increases in concentrations of suspended material in the water column could have deleterious effects on water column or reef-dwelling biota due to increased turbidity which can reduce photosynthesis and clog gills. It can also lead to ingestion of particulates with adsorbed toxins.

Hydrocarbons

Crude oils are complex mixtures of hydrocarbons ranging from the very light, highly volatile ones, to others such as waxes and asphaltenes, which are heavier. They also contain other substances - such as sulphur and vanadium - and their overall composition can be highly variable depending on where they originate. During the refining process, the lighter and heavier fractions are separated with the resulting products ranging from gasolines (which have the greatest proportion of light fractions) through kerosenes, to gas oils, and fuel oils. Another group of refined products are lubricating oils which again vary widely and which generally contain a variety of additives, some of which may be toxic. Shipping activities and hydrocarbon exploration and production are sources of chronic oil pollution. Oils can also be divided into non-persistent and persistent categories. Non-persistent oils are highly volatile and disappear rapidly from the sea surface. They include gasoline, naphtha, kerosene and diesel. Persistent oils, on the other hand contain a higher proportion of heavy hydrocarbons and therefore do not evaporate or disperse as rapidly. They include the Polycyclic Aromatic Hydrocarbons (PAHs), which are also listed as hazardous substances due to their persistence and toxicity.

Hydrocarbons can enter the oceans from land-based sources, shipping or mining activities – or natural seeps. Following introduction to the sea, the lighter fractions evaporate fairly rapidly depending on sea conditions, whereas the heavier components persist – moving with the wind and currents. The weathering process can lead to the formation of tarballs, which are commonly found with accumulations of floating debris, but which eventually sink to the bottom or become stranded. Hydrocarbons are also a food source for certain bacteria and will therefore be broken down naturally over time.

Toxic impacts are primarily due to the more water soluble aromatic hydrocarbons, and the higher molecular weight polycyclic aromatic hydrocarbons (PAHs), which are also thought to be carcinogenic. Where tarballs or heavier components of oil sink to the bottom they have a smothering effect on the benthos. Probably the most widely publicised impact of hydrocarbons is that on seabirds.

South Africa's Cape of Good Hope is known as the “Cape of Storms” because of the rough sea conditions which commonly occur in the area. It is also a significant transit point for oil tanker shipments across the globe; in 2011 flows past the Cape accounted for roughly 11 % of all seaborne traded oil, or 6 % of oil traded worldwide, with approximately five million barrels of oil moving through the Cape each day in 2012 (BCLME ProDoc, 2016). There is also a considerable volume of container traffic, with South Africa having an annual container throughput of three million twenty-foot equivalent units (TEUs), while Namibia has an annual container throughput of 250 000 TEUs, Angola does not record this information.

The potential for pollution from ships in any particular area is dependent on the density of the shipping traffic in that area, together with the weather patterns. The density of marine traffic in the Southeast Atlantic is far greater than that in the Southeast Pacific with major routes between South Africa and South America, North America and Europe. (see Section 0).
Petroleum exploration in the waters off West Africa from Guinea-Bissau to South Africa date from World War II or even earlier. However, significant oil production in Nigeria, Gabon and Angola began in the 1960s and massive investment into exploration and production has taken place throughout the region since the 1990s. The most significant development in the offshore petroleum industry is the discovery and production of oil from ever-increasing water depths i.e. from depths well over 1000 metres. The technology that has permitted this has led to previously neglected areas, e.g. off Ghana, becoming the recent focus of development. To date, the majority of exploration wells drilled in the Southeast Atlantic region have been in depths of 200 m or less. However, deep water (1,000 m-2,000 m) oilfields are now being brought into production in Angola. More recently there has also been interest in glauconite (phosphate) deposits and manganese nodules along the

west coast of southern Africa. In Namibia, an Environmental Impact Assessment Report and an Environmental Management Plan were submitted in March 2012 for the Sandpiper Phosphate Project, which proposed to dredge phosphate-enriched sediments south of Walvis Bay, Namibia, in depths of 180-300 m (Midgley, 2012). The company planned to extract 5.5 Mt of phosphate-enriched marine sediments on an annual basis, for over 20 years. The environmental impact assessment (EIA) identified low-level potential adverse impacts including biogeochemical changes, benthic habitat loss, loss of biodiversity and cumulative impacts (Namibian Marine Phosphates, 2012; Midgley, 2012; McClune, 2012).

Marine Litter

As far back as the 1970's, it was reported that plastic debris – especially industrial pellets – was accumulating in the Southeast Atlantic (Morris, 1980). Plastics comprised 97 % of litter items in a survey by Ryan (2014) in the same area and were present in higher densities further away from the African coastline, thus seeming to confirm the models developed by Lebreton et al. (2012), which predicted that floating debris would accumulate in the South Atlantic gyre (and others). However, their sampling area was south of the core area of the gyre and it was suggested that additional surveys be conducted. Ryan (2014) also concluded that the majority of this litter was from land-based sources.

Research on the interaction between marine debris and wildlife in this region appears to be limited and has generally been focussed on seabirds. Moreover, much of the work has addressed levels of ingestion and the use of volumes of plastic ingested as a mechanism to monitor levels in the environment (Ryan, 1987; Ryan, 1988; Ryan and Fraser; 1988; Ryan, 2008). Birds included in these studies were species of *Procellariiformes* (including Blue Petrels, Great Shearwaters, White-faced Storm-petrels and Pintado Petrels), which generally tend to accumulate more plastic than other species (Azzarello and van Vleet, 1987; Ryan, 1987). Shaughnessy (1980) recorded numbers of Cape fur seals (*Arctocephalus pusillus)* entangled with man-made objects during harvests of immature seals from 1972 to 1974 and from 1977 to 1979 in colonies off the South African and Namibian coastline. The highest incidence of entanglement was at the Cape Cross colony (0.56–0.66 %) from 1977 to 1979. The seals were entangled in string, monofilament line, fishing net, rope, plastic straps, rubber O-rings and wire. Ryan (1990) also reported entanglement and ingestion in a number of other taxa in the seas off southern Africa and the Southern Ocean, although some of these records were likely from the east coast of South Africa. They included: entanglement (5 species of marine mammals, 13 seabird species, 2 turtles, and 6 shark species) and ingestion (7 marine mammal species, 36 seabird species, 2 marine turtle species, and 7 shark species).

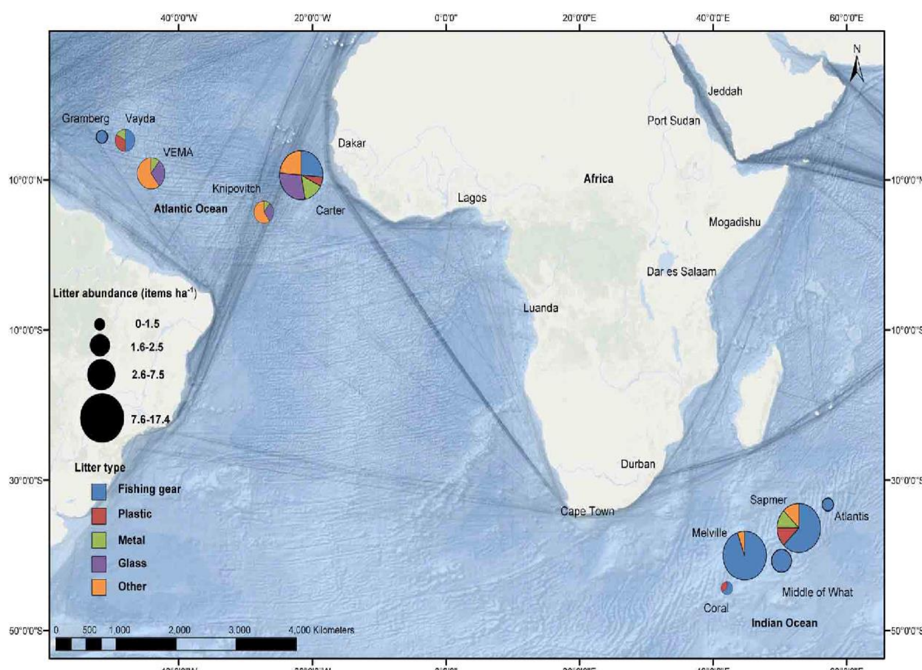


Figure 33 Survey locations benthic litter densities (itemsha−1) and composition for individual submarine features observed by remotely operated vehicle video systems. Commercial shipping activity is overlaid with the darkest lines representing areas with greatest shipping activity

Source: Woodall et al., 2015; Halpern et al., 2008

The work by Morris (1980) indicated that floating litter was more abundant in areas of the Southeast Atlantic some 1500 to 3,600 kilometres off the South African Cape coast than those closer to shore. This is consistent with the various modelling studies which, in addition to predicting accumulation in the South Atlantic sub-tropical gyre, suggested an area of low litter density in the Benguela current region (cited in Ryan, 2014). Ryan (2014) also detected higher densities of litter further offshore – despite the fact that the sampling sites were somewhat south and east of the core of the gyre.

Also of interest is that the majority of the litter in the South Atlantic sub-tropical gyre appears to come from land-based sources in South America rather than from the African coastline (Ryan, 2014).

A study on the distribution of deep-sea litter (Woodall et al, 2015) found it to be present at all sites surveyed, including seamounts, banks and ridges in the Atlantic Ocean with a predominance of items associated with food packaging. These sites were mainly in areas with relatively high volumes of shipping traffic (see Figure 33).

Southeast Pacific

Hazardous Substances

Information regarding hazardous substances in the Southeast Pacific is limited and only available for coastal areas. Heavy metals (especially copper) from mining waste were identified as a problem in Chile, while agricultural pesticides were also identified as a serious issue in coastal areas of Panama, the extreme south of Colombia, Ecuador, Peru, and Chile (UN, 2016).

Suspended Solids

A survey conducted in 2000 by the Permanent Commission of the South Pacific (CPPS, 2000 – cited in UN, 2016) identified that the pollution of the marine environment in the Southeast Pacific region comes from a range of threats that notably include land-based sources, oil spills, untreated sewage, eutrophication, and heavy metals. The main pollutants in the Southeast Pacific region come from organic waste originating from the fishing industry, aquaculture and untreated urban effluents. The 2014 CPPS Report highlights that the Colombian Pacific coast is considered to be in good condition due to low population density compared to the Colombian Caribbean coast. The Gulf of Guayaquil in Ecuador and the Bays of Callao and El Ferrol in Chimbote, Peru, are particularly affected by pollution coming from sewage, and domestic and industrial wastewater, respectively. Heavy metals are found in coastal waters and seabed sediments of the Southeast Pacific, particularly in the Bays of Callao and Chimbote in Peru, and the north of Chile. Severe pollution by heavy metals has also been reported in Chile in Puerto Chacabuco, as well as more moderately in Puerto Natales. Mining waste had also been dumped on beaches in the north of Chile, from which heavy metals (especially copper) were leaching into the sea. Heavy metals originate from mining, metalworking and chemical industries, including from mining activities taking place in the high regions of the Andes. The 2014 CPPS Report highlights that no evidence of deleterious effects could be identified. a major problem with waste from coastal mining activities, particularly in the south of Peru and the north of Chile. Untreated waste is disposed of either directly into the sea or into rivers resulting in high levels of pollution at the mouth of the River Rímac and between Pisco and Ite in Peru, and around Chañaral in Chile. Mining waste had also been dumped on beaches in the north of Chile, from which heavy metals (especially copper) were leaching into the sea. Pollution from agricultural pesticides was also identified as a serious issue in coastal areas of Panama, the extreme south of Colombia, Ecuador, Peru, and Chile (CPPS, 2014).

Hydrocarbons

Hydrocarbons can enter the sea from shipping, offshore oil and gas exploration and production and land-based sources. However, apart from the persistent components – for example, Polycyclic Aromatic Hydrocarbons, which are also toxic, and tarballs – they are unlikely to be a significant problem in the Southeast Pacific as they either evaporate, or are broken down by bacteria fairly rapidly. Possible exceptions are areas where there is chronic oil pollution, for example, around production platforms.

Marine Litter

Anthropogenic marine debris (AMD) is found throughout the Southeast Pacific with the predominant source being land-based activities (Thiel et al., 2018). The main reported type is plastics (Thiel et al., 2011), which can be found floating at sea or stranded on high tide lines on sandy beaches and in rocky intertidal areas from the southernmost Patagonian Fjords and islands up to Ecuador. Towards the centre of the South Pacific Subtropical Gyre (SPSG) floating AMD abundance and microplastic concentrations dramatically increase, reaching highest values close to the Polynesian Islands (e.g. Rapa Nui).

The abundant AMD in the Southeast Pacific poses a serious threat to marine wildlife. Sharks, turtles, dolphins, whales, sea lions and birds have been found entangled with AMD across the Southeast Pacific coastline and oceanic islands, with turtles and mammals seemingly most threatened as they frequently get trapped in abandoned or active fishing gear (Thiel et al., 2018). However, it is often difficult to tell apart what is debris and what is active fishing gear – as some gear may be actively left, although illegally. Further, a high percentage of sea turtles in Peru and northern Chile have been reported to contain plastics in their digestive tract (Jiménez et al., 2017; Thiel et al., 2018).

Of the seabird species reported to have ingested plastics in the Southeast Pacific, 83 % correspond to oceanic or Polynesian seabirds (Thiel et al., 2018). Additionally, Polynesian planktivorous fishes have been reported to actively consume small plastic fragments due to colour and shape resemblance with their prey items (Ory et al., 2017; Markic et al., 2018). In contrast, planktivorous fishes from Ecuador to southern Chile have low microplastic ingestion (Ory et al., 2018), which probably relates to the relatively low microplastic abundances described for the Southeast Pacific coastline, contrasting with the extremely high microplastic accumulation towards the centre of the SPSG and around oceanic islands (e.g. Rapa Nui). However, evidence of entanglements and interactions between AMD and marine animals in the Southeast Pacific is still mostly anecdotal (Thiel et al., 2018), and more rigorous monitoring studies are required.

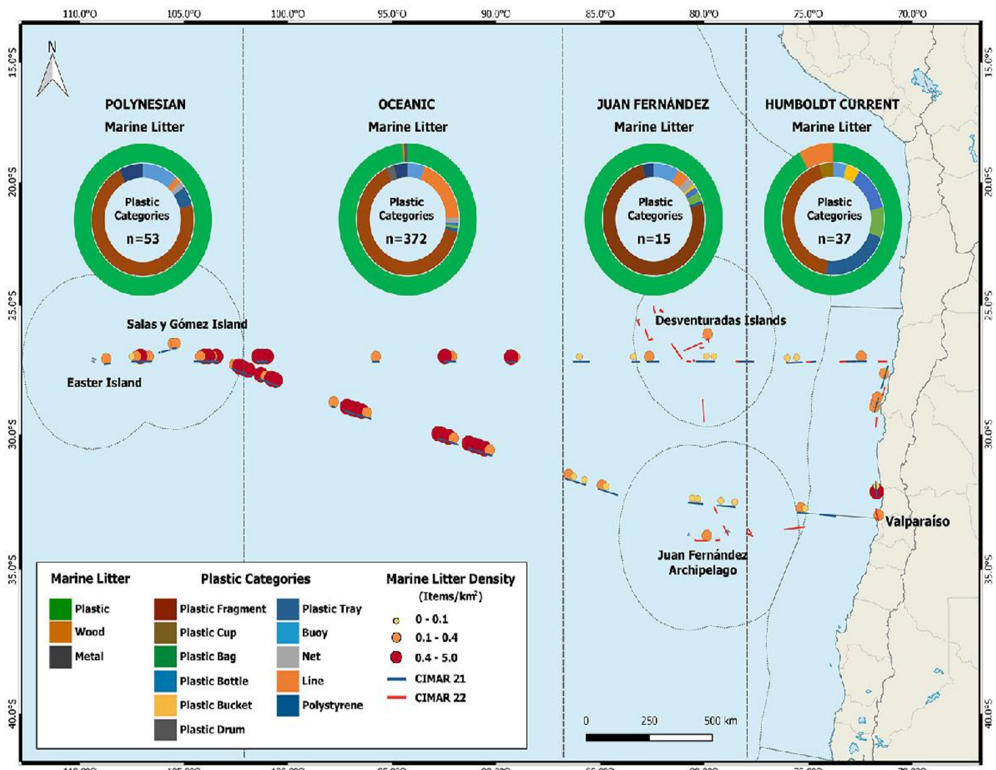


Figure 34 Types and density of marine debris in different sectors of the central Southeast Pacific, in 2015 (CIMAR 21) and 2016 (CIMAR 22)

Source: Thiel et al., 2018[36]

Floating AMD also offers suitable colonization substrate for fouling communities and benthic organisms (Astudillo et al., 2009; Bravo et al., 2011; Rech et al., 2018). Along the central-northern Chilean coast floating AMD can act as a potential dispersal vehicle for over 116 benthic species (Astudillo et al., 2009). Given the fact that plastic litter (particularly buoys and other abandoned floating devices) can float for long time periods (and consequently become dispersed over large distances), it represents a potential transport vector for non-indigenous species that might eventually invade new habitats (Rech et al., 2018). Additionally, fouling communities living attached to floating AMD can eventually cause a loss of buoyancy due to increased weight produced by a large load of epibionts, and sink, reaching subtidal areas (Galgani et al.,

[36] Open circles at the top indicate the proportions of different plastic types; numbers inside the circles represent the total of items observed in each sector. Dots show the density of marine debris from visual ship surveys (for details see Miranda-Urbina et al., 2015). Thin lines show the Exclusive Economic Zone.

2000; Pham et al., 2014). However, quantifications of benthic AMD in the Southeast Pacific are still missing. The movement of floating marine litter is determined by a number of factors including size, buoyancy, wind and currents (Fazey & Ryan, 2016). Lebreton et al. (2012) undertook a modelling study of floating debris using various scenarios, which identified five major accumulation zones globally including one in the Southeast Pacific (South Pacific Gyre) and one in the South Atlantic (South Atlantic Gyre) (see Figure 32). Their results corroborated earlier modelling studies and, in turn, seem to be supported by actual data on floating debris.

AMD is found across the coastline, coastal waters and open ocean areas throughout the Southeast Pacific. Along the Pacific coastline of South America, the AMD distribution is closely related to the main litter sources. Domestic waste is one of the main components of floating AMD found across Chilean coastal waters (e.g. plastic grocery bags), reaching higher concentrations close to large port cities and population centres (Thiel et al., 2003, 2013; Hinojosa et al., 2011). During the rainy winter season, mainly in central and southern Chile, when river runoff peaks, a higher amount of litter illegally dumped in river beds is being washed towards river mouths and adjacent beaches (Rech et al., 2014, 2015).

Overall, AMD has been sampled in coastal waters and on sandy beaches along the entire Chilean coast. A national beach litter sampling survey across 43 beaches in Chile (from 18°28'S to 51°44'S) reported AMD on all sampled beaches, with an average density of 1.8 items m^2 (Bravo et al., 2009). Further studies using the same procedures (as part of the long-term citizen science project "Científicos de la Basura"[37]) have reported similar abundances across an 8-year time scale, with no increase or decrease in overall litter abundances from beaches across Chile (Hidalgo-Ruz et al., 2018). Along the coasts of the Southeast Pacific small plastic debris has been reported from 9°S down to 51°S. On four sandy beaches of Peru (from 9°S to 14°S) microplastics concentrations (size between 1 and 2.5 mm) values ranged from 4.67 items m^2 up to 463 items m^2 (Purca & Henostroza, 2017), while on 39 sandy beaches along the continental coast of Chile (from 18°S to 51°S) small plastic debris (size range between 1 and 10 mm) reached an average of 27 items m^2, while maximum concentrations reached 169 items m^2 (Hidalgo-Ruz and Thiel, 2013). Between Chiloé Island and the Chonos Archipelago (42°S-50°S), where most aquaculture activities take place (nearly 100 % of salmon and mussel farming production in Chile) (SUBPESCA, 2018) the principal AMD items are aquaculture related, mainly buoys, ropes and salmon food sacks that can be easily associated to certain aquaculture sources (Hinojosa & Thiel, 2009; Hinojosa et al., 2011; Hidalgo-Ruz & Thiel, 2013). Not only the type of litter items, but also the overlapping distributions of floating litter and aquaculture centres strongly point at this sector as main source of AMD in the fjord area (Hinojosa & Thiel, 2009).

Off coastal waters and outside the influence of the Humboldt Current System floating AMD abundances and micro plastic concentrations diminish (Miranda-Urbina et al., 2015). However in open ocean waters, within the centre of the SPSG, the amounts of floating litter and micro plastic concentrations strongly increase (Eriksen et al., 2013; Miranda-Urbina et al., 2015; Ory et al., 2017), reaching floating AMD abundances as high as 51.68 items km^2 (Miranda-Urbina et al., 2015), and micro plastic concentrations of ~50,000 particles km^2 (Eriksen et al., 2013; 2018; Ory et al., 2017). In ABNJ and on oceanic islands, AMD is mainly from distant sources. Inhabited oceanic islands within the South Pacific Subtropical Gyre (SPSG) hold small populations (e.g. Rapa Nui), where people are highly committed to keeping the environment and in particular their beaches free from litter (Kiessling et al., 2017). AMD found in the SPSG is mostly litter from the continental coasts or dumped by the high-seas industrial fishery (Miranda-Urbina et al., 2015). This AMD slowly moves with the low-velocity currents of the gyre, to get 'pulled' into the SPSG, from where it only escapes by breaking down, sinking or stranding on the remote oceanic islands (Martinez et al., 2009; Hidalgo-Ruz and Thiel, 2013; Eriksen et al., 2013; Kiessling et al., 2017).

Conclusion

In general, information on contaminants in ABNJ is limited, in part due to the technical difficulties of sampling and monitoring such areas, but also because coastal states are focussed on areas within their own jurisdictions (Boelans & Kershaw, 2016). Nevertheless, Boelens & Kershaw (2016) concluded that the deep ocean – including all major ocean basins – has been significantly contaminated by human activities. Table 1 provides an overview of the current state of knowledge for selected contaminants.

The levels of marine debris appear to be increasing, despite efforts by regulators to tighten controls. The CBD – GEF Report (2012), for example, noted that impacts of marine debris were reported for 663 species representing a 40 % increase since the last review in 1997, which reported 247 species (Laist, 1997).

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[37] See www.cientificosdelabasura.org.

Information on AMD in the Southeast Pacific is concentrated in the Chilean EEZ and influence zone (including oceanic islands), while studies in other countries from the Southeast Pacific are scarce and of a very local scale. There is an urgent need to fill gaps in the information on marine litter for the northern coasts of the Southeast Pacific (Peru, Ecuador, and Colombia). While there is strong evidence of litter accumulation towards the South Pacific Subtropical Gyre (SPSG), AMD transport dynamics are not fully understood; sinking rates, marine litter and microplastics retention in coastal currents, proportion of coastal litter that gets pushed further offshore towards the centre of the SPSG, rates of plastic transformation into microplastics, litter input rates to the sea, are some of the processes and issues needing further investigation.

Information for the Southeast Atlantic is primarily out of South Africa and Namibia. Studies in West Africa are more limited, and are largely focussed on coastal areas. Scheren et al. (2002), for example, reported that a beach debris monitoring programme in the Gulf of Guinea region found that plastics (fishing related products, packing materials, and carrier bags) make up 62 % of the waste. The average number of items found on the beaches was 23/m^2. Extremely limited information, if any, on floating marine litter is available from the areas between the gyres of the South and North Atlantic although there are some reports on marine debris in coastal areas – for example, off of Nigeria (Oguguah et al., 2011). Information on debris in the deep-sea areas is even scarcer with the only study found being that on the surrounds of the Atlantic Ridge (Woodall et al., 2015).

Ryan (2008) suggested that the consistent decrease in pellets in birds indicated that there had been a global change in the composition of small plastic debris at sea over the previous two decades but that more data was needed on the relationship between plastic loads in seabirds and the density of plastic in their foraging areas.

Additionally, at present there is no information about benthic litter. There are several anecdotal reports (e.g. Thiel et al., 2011), but there is no rigorous data about composition or abundance of benthic litter in the peer-reviewed literature. Car tyres, concrete and construction debris, high-density plastics, as well as plastic debris that lost buoyancy are just some items among the benthic litter observed in Chile by sport-divers and fishermen (Hermoso, Munizaga and Thiel, unpublished data). Valid scientific information is still missing, and many questions are yet to be answered. Both the modelling of floating plastic and evidence from various investigations suggest that the majority of litter in the South Atlantic Sub-tropical Gyre comes from South America rather than Africa. This poses an additional challenge in trying to address the source.

Table 1 A summary of the state of knowledge for selected contaminants

Contaminant	Natural occurrence	Human input	Impacts	Trend	Significant hazard?
Hydrocarbons	Y	Y++	Y	Stable	Y
Marine debris	N	Y++	Y	Increasing	Y
Persistent Organic Pollutants/Persistent Bioaccumulative and Toxic	N	Y+++	Y	Increasing	Y
DDE	N	Y+++	Y	Decreasing	N(?)
Lead	Y	Y++	N	Decreasing	N(?)
Copper	Y	Y++	Y	Increasing	Y
Mercury	Y	Y+++	Y	Increasing	Y
Nitrogen	Y	Y+++	Y	Increasing	Y
Carbon dioxide	Y	Y+++	Y	Increasing	Y

Source: based on Table 7.1 of Boelens and Kershaw (2016)
Note: + = low ++ = moderate +++ = high

3.4 Underwater Energy

Key Messages:

- The pressure of underwater energy is at present mainly underwater noise. Main maritime activities generating underwater noise in ABNJ are related to maritime transport, including cargo shipping, fishing, or passenger vessels, and military exercises, as well as potentially oil and gas exploration and exploitation although not currently happening in ABNJ.
- There exists a range of adverse effects on marine species due to underwater noise including interference with key biological functions, including communication, foraging, reproduction, navigation, and predator avoidance.
- The global container shipping industry is a major source of underwater noise and is forecasted to grow substantially in future decades, potentially leading to increased levels of underwater noise.
- Difficult to assess the cumulative impacts of energy/underwater noise emissions into the marine environment, including in ABNJ of the Southeast Pacific and Southeast Atlantic, resulting from a variety of human maritime activities.

A range of maritime activities introduce anthropogenic energy into the marine environment. This includes sound, light, heat, and radioactive energy, while the most widespread and pervasive kind of anthropogenic energy is underwater noise (Van der Graaf et al., 2012). Underwater noise stems predominantly from maritime transport related shipping activities, but is also being introduced by other activities, such as fishing activities (due to trawling, sonar or operational purposes) as well as oil and gas extraction (drilling), and associated maintenance operations, including vessel operations. Sound is also a result of military activities, which use sonar to identify the location of other ships or objects, such as torpedoes (Guan et al. 2017). Anthropogenic sounds emitted to the marine environment may be of short duration (e.g. from seismic surveys, drilling, piling for platforms, or explosions) (Van der Graaf et al., 2012) or long lasting (e.g. shipping and fishing). The different sources of anthropogenic underwater noise will lead to different effects, depending upon the frequency range, intensity, and whether it is an intermittent, pulsed, or continuous sound (EEA, 2015).

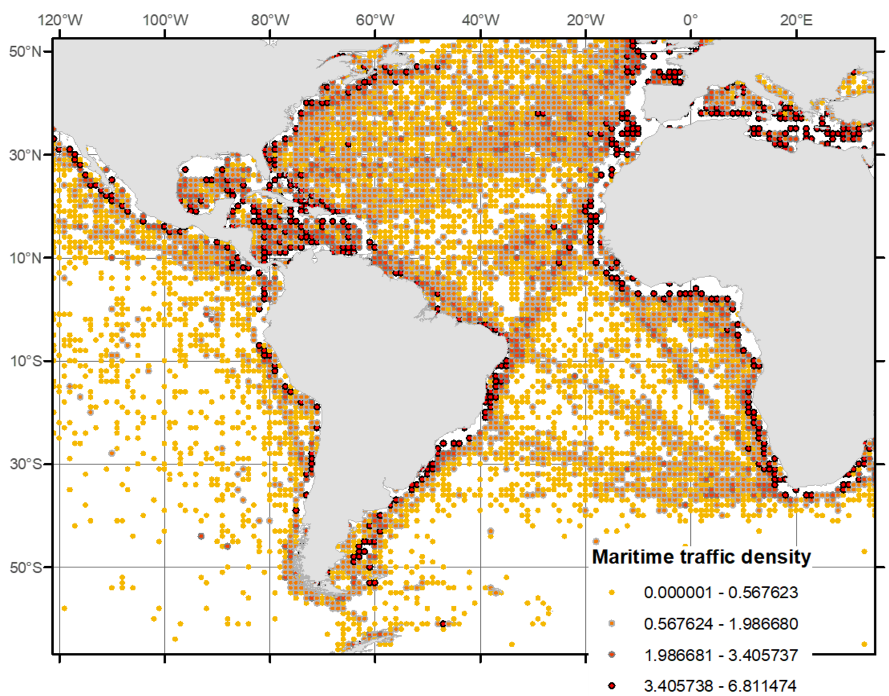

Figure 35 Maritime traffic density in the Southeast Atlantic and the Southeast Pacific
Source: European Commission, 2010

Underwater noise introduced by ships into the ocean environment originates from a number of sources, either deliberately produced for navigational purposes or incidentally emitted as a function of mechanical operations. Ship-related operational noise has numerous sources, such as the engine, propeller, pumps, or sonar. However, the main source of noise from ships is from the engine operation (loud continuous noise). On average, ship noise (large commercial ships) ranges from 10 to 1,000 Hz (Southall et al., 2017), with similar noise ranges for fishing trawlers (Malme, 1989). Maritime traffic density maps (see Figure 35), indicate that there is a concentration of ships scattered throughout the ocean and virtually no area is left unexposed to underwater noise from shipping activities. For the Southeast Atlantic and Southeast Pacific specifically, the highest levels can be found in major shipping lanes, as well as coastal zones and surrounding the southernmost parts of Africa and South America.

Global forecasts for container ships, as part of the largest source of anthropogenic underwater noise, show likely growth between 2016 and 2066 for Twenty Foot Equivalent Units (TEU). In a low-case scenario, container capacity grows from 182M TEUs in 2016 to 464M TEUs by 2066, while in a high-case scenario capacity grows to 858M TEUs by 2066 (see Figure 36).

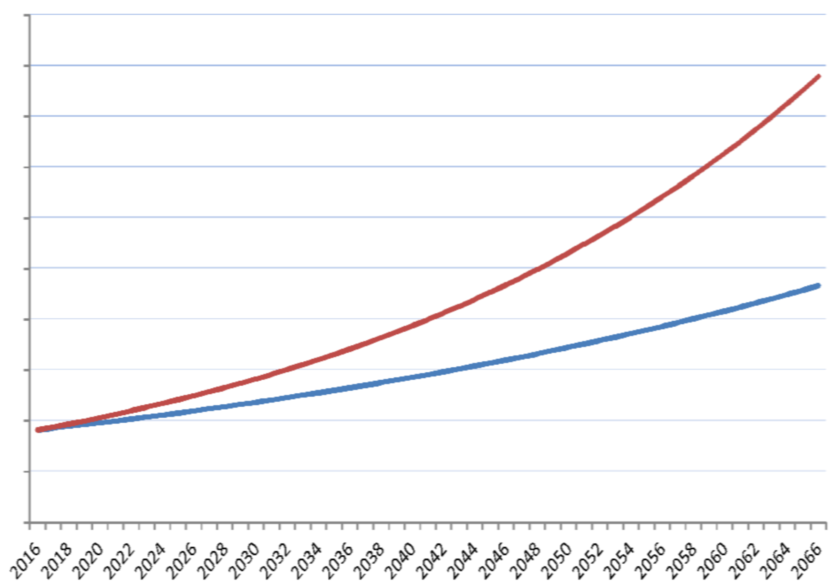

Figure 36 Forecasted growth in TEUs – global container ships (number of TEUs)
Note: The blue line shows the low-case scenario while the red line shows the high-case scenario
Source: Own elaboration based on Hampstead, 2017

Activities related to the exploration and exploitation of oil and gas resources from the deep-sea produce both underwater sound and light. While these activities currently take place almost exclusively within national jurisdictions, they may still be important to consider both because they move further out to sea with growing interest to explore oil reserves in ABNJ and because the large differences which underwater noise can travel. Significant energy levels are being introduced during the exploration stage, mainly by form of seismic surveys used to assess subsurface geology and locate oil reservoirs. There is also increased vessel activity during these early stages leading to increases in underwater noise in the survey area. The level of sound from such surveys will vary considerably; while some instances have been shown that soundwaves can be measured up to 4000 kilometres from the survey site (Cordes et al., 2016). In addition to enhanced underwater noise levels, oil exploitation activities introduce a substantial amount of artificial light (e.g. electric lighting, gas flares) that affect ecological processes in the ocean including the migration of plankton. Artificial light can also be an attraction for species such as squid, large predatory fishes, and birds (Cords et al., 2016).

Sound is highly important for most marine animals, including marine mammals, serving key biological functions, including communication, foraging, reproduction, navigation, socialising and predator avoidance. Many species rely upon specialized communication systems adapted for their behaviour and interactions. For example, dolphins and porpoises have biosonar capabilities for near-range feeding and orientation while large baleen whales have systems adapted to long-range use of sounds needed for reproduction and social interactions (Southall, 2017). The predominantly low-frequency sounds associated with large vessels directly overlap typical low-frequency communication sounds and hearing of many marine mammals, particularly large whales and some seals and sea lions (Southall, 2017) (see Figure 37). Reported effects of noise on marine mammals include disrupting behaviour (e.g., feeding, breeding, resting, migration), masking of sounds used for communication and navigation, localized displacement, physiological stress, or even physical injury including temporary or permanent hearing damage (Cordes et al., 2016). Numerous mass stranding events of whales have been associated with military exercises involving sonar (Guan et al., 2017). According to exposure experiments and modelling results looking at the impacts of the offshore oil extraction industry, hearing damage to mammals can occur within a few 100 metres to kilometres from the source, while behaviour disruption (e.g. feeding, breeding, resting, and migration) has been demonstrated at event further distances (Cordes et al., 2016).

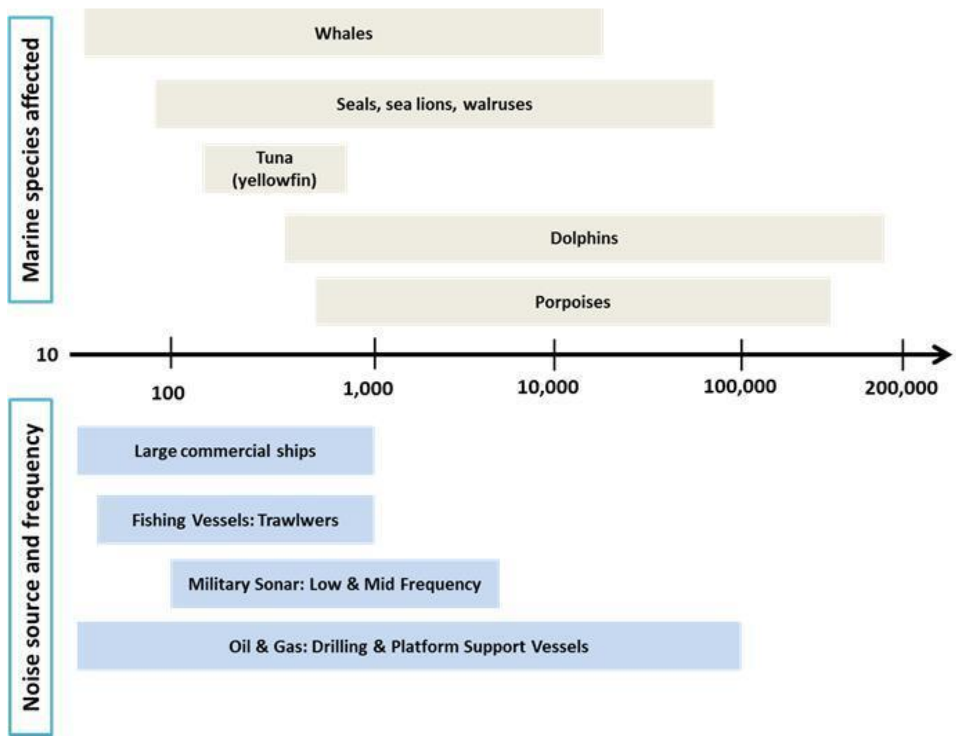

Figure 37 Audiogram for selected species and ship types

Source: Own elaboration based on, Evans and Nice, 1996; Hildebrand, 2009; Malme, 1989; Nadwell et al., 2003; OSPAR, 2009; Richardson et al., 1991; Sarà et al., 2007; Southall et al. 2017; Zimmer, 2004

However, there are still substantial knowledge gaps, including with regard to how underwater noise affects marine species like fish or invertebrates. The effects may be significant as suggested by development delays and body malformations recorded in scallop larvae exposed to seismic pulses. Underwater broadband sound fields resembling offshore shipping and construction activity have also been shown to affect the activity and behaviour of bioturbation species in sediments (Cordes et al., 2016).

Another potential source of emissions of anthropogenic energy is submarine cables, though their number in the Southeast Pacific or Southeast Atlantic is limited. Submarine cables can serve multiple functions (electricity or telecommunication transmission) and are made from different materials (Meißner et al., 2006). There are still knowledge gaps regarding the effects of underwater telecommunication, which is the main type of underwater cables in ABNJ, while several disturbances (electromagnetic fields, heat disputation) have been documented for electricity transmission which usually happens closer to the shore. The International Cable Protection Committee claims underwater cables to be environmentally neutral (ICPC, 2016). However, noise impacts associated with subsea cables do occur during the construction phase as well as during maintenance or repair of existing cables and arise due to machinery used. Construction activities include removing existing support structures and cables, installing new support structures and cables, and trenching and backfilling (Meißner et al., 2006).

Conclusion

Despite the limited data availability in the two study areas, assessments done elsewhere have highlighted the significant pressures created by underwater energy and particular noise. Data availability allowing for a detailed assessment of impacts due to the introduction of underwater noise in the Southeast Pacific and Southeast Atlantic is however limited. There exists even less information regarding light, heat, and radioactive energy making a thorough assessment of these pressures not possible. Moreover, while many anthropogenic activities contribute to increased noise levels in the marine environment, it is not possible to provide a complete assessment of the cumulative impact on marine life due to noise. In addition, other variables such as distance to noise sources and noise intensity as well physiological and behavioural characteristics of different marine species would also need to be considered to gain a more complete understanding of impacts. A more holistic approach considering species interactions would be desirable but obviously more difficult than studying impacts on a single species. Species interact at multiple levels and they form complex networks, i.e. food webs, which also interact with the abiotic components of the sea forming the ecosystem. Changes at a species level cascade up and down along the food-web making it a challenging task to forecast shifts in the food web or at the ecosystem level. The species diversity could therefore be an issue to consider in noise impact and risk assessments.

3.5 Climate Change

Key Messages:

- Climate scenarios indicate that the largest uncertainty regarding future trends for ocean conditions is found for the Southeast Pacific, where the least ocean warming has taken place so far, and is expected to remain among the slower sites to heat, while the contrary would be true for the Southeast Atlantic. The frequency and strength of regional and teleconnected events such as El Niño are expected to increase.

- While the cold water signature of open ocean equatorial upwelling would decrease, so would primary productivity at low latitudes. The along-shore transition zone between the coastal upwelling areas and offshore waters are likely extend and become more energetic, enhancing coastal-oceanic exchange and allochthonous input of organic matter and nutrients into the ABNJ by lateral advection.

- Re-distribution of fish stocks are expected to shift towards higher latitudes as the climate warms leading to changes in metabolism that would impact life cycles and rates such as faster growth and lower maximum size. However, the response to temperature would be modulated by other stressors such as acidification.

- Overall, fisheries production is not expected to decrease below 10 % due to climate change, although fisheries pressure scenarios would dramatically affect the figure for particular species, and some species are expected to entirely disappear - from both low and high latitudes.

- Predictions are mainly based on present day observable characteristics and relationships with the oceanographic environment. Thus, the underlying intra-specific genetic variability could produce unexpected results and large uncertainty regarding overall impact on productivity. At present, science is not aware of the genetic capacity to adapt and co-adapt to extreme environments.

Climate refers to the mean values and patterns of variability of atmospheric conditions such as temperature and precipitation, characterized over long time periods at global or regional scales. Atmosphere-ocean interactions largely moderate earth's climate, and the climate responds to radiative solar forcing. Imbalances between incoming and out-coming solar energy at the top of the troposphere will cause net heating or cooling of the atmosphere. Because the heat capacity of water is larger than that of the atmosphere, the ocean absorbs heat in the tropics, redistributes it towards higher latitudes, where water cools at the ocean-atmosphere interface. Fluid density is dependent on temperature, and density gradients force processes such as convection. Surface salinity reflects the balance of precipitation and evaporation patterns, as well as high latitude ice melting-freezing cycles – the balance between these cycles drives ocean circulation and regional climate patterns.

At geological timescales, glacial and inter-glacial periods have alternated as the result of long-term trends of heat loss or gain of the climate system. Climate change refers to the long-term change in that balance, and the derived impact those trends have on atmospheric conditions. Atmospheric heat retention capacity depends on the concentration of greenhouse gases. Carbon dioxide (CO_2) in particular has shown an overall atmospheric concentration increase since the onset of the

Industrial Revolution. The result is positive radiative forcing (i.e. heating), with an overall increase of about 1.3°C on atmospheric temperature since the 17th Century (IPCC, 2013). This trend has been attributed to the large release of CO_2 from fossil fuels (i.e. carbon that has been excluded from the carbon cycle for millions of years) and other "greenhouse gases", such as methane from anthropogenic sources. Ocean waters also exchange gases with the atmosphere, meaning that surface waters may absorb or release gases depending on the relative concentration in the fluids as well as the temperature-dependent saturation. In the case of CO_2, biological activity can sequester or release inorganic CO_2, affecting overall C levels. Not all anthropogenic CO_2 has been retained in the atmosphere, but an important part has been absorbed by the ocean leading to a decrease in oceanic pH. Because organic matter produced in surface waters is also drawn down to deep waters (the biological carbon pump), it also contributes to reduce the overall impact of carbon released to the atmosphere, so ameliorating the rate of increase of heat retention in the system.

Because of the above, one should not consider exclusively the effects of climate change on ocean dynamics, because ocean processes themselves are modulating climate change. One should rather ask how and at which rate ocean circulation and biogeochemical processes are changing at present day and in the future. The rate of change is of concern because previous changes have occurred over geological timescales of thousands, or tens of thousands of years, allowing for adaptability and evolution. When changes have happened over shorter time periods they have caused massive extinction events and fundamentally changed almost all living communities.

Southeast Atlantic

Water temperature has increased in surface waters off the coast of Africa. Offshore-temperatures have been rising by 0.17°C between the 1950s and the 1980s and high-resolution global circulation models (GCMs) predict that these warming trends will continue (Clark, 2006; Monteiro et al., 2008). However, contrasting lines of argument have been followed to infer coastal upwelling future trends: i) while subtropical anticyclones could diminish their intensity, and shift their position towards high latitudes with consequences on the distribution of alongshore upwelling favourable winds, overall decrease and changes on the frequency and amplitude of variability, which add to warming surface waters, could compromise subsurface nutrient inputs and overall export into ABNJ; ii) because of larger and increasing amplitude of day-night terrestrial heat cycles as compared to the marine environment, strengthening of coastal upwelling could be expected. Evidence is not conclusive so far.

The southern Benguela system lies at a major choke point in the "Global Climate Conveyor Belt." Warm surface waters move from the Indo-Pacific into the Atlantic Ocean mainly in the form of rings shed from the retroflection of the Agulhas. The Southeast Atlantic is the only ocean in which there is a net transport of heat towards the equator. The inter-annual variability in the Benguela system is relatively small, and major events are less frequent than in the Pacific as well as less predictable. The occasional extreme sustained events in the Benguela system have resulted in major perturbations of the ecosystem and mass mortalities of marine fauna have impacted fisheries. These types of events are expected to increase their frequency and intensity. The major variability and changes in the Benguela system physical environment have manifested themselves in the following forms: sustained intrusions of anomalously warm, nutrient poor equatorial/tropical water across the northern and southern boundaries of the ecosystem, and Benguela Niños and Agulhas intrusions.

In regard to the effect of climate change on the Southeast Atlantic ecosystem, it has been predicted that changes in life-history characteristics consistent with empirically estimated growth parameters and distributions of most of the 120 studied fish and invertebrates in the area will shift northwards. With the considerations of physical and biogeochemical factors, species distribution shifted at an average rate of 52.1 kilometres per decade between 2005 and 2050. These responses are stronger than those when considering physical forcing alone or ignoring metabolic specific responses to acidity, oxygen concentration and phytoplankton community structure. With the projected changes in the distribution of relative abundance and primary production, the total maximum fisheries catch potential may change substantially in the Northeast Atlantic region, beyond the previously estimated decrease of 8 % to 10-20 %. Ecophysiology and plankton dynamics are recently being incorporated into modelling approaches and can have a decisive influence on outcomes (Cheung et al., 2011).

The large scale warming and cooling related to the Atlantic Multidecadal Oscillation (AMO) interacts with anthropogenic warming. It has been suggested that the combined effects of anthropogenic climate change and the positive phase of the AMO since the 1990s has caused a more rapid warming than would be expected from climate change alone (Andronova & Schlesinger, 2000; Belkin, 2009; Knudsen et al., 2011). Similarly, cool (negative) phases of the AMO in the past may have masked the effects of climate change. The combination of warming trends from AMO and from anthropogenic climate change since the 1970s makes it difficult to distinguish the cause of changes in ecological time series unless the record length extends back before the mid to late 20th century. There are several mechanisms by which the AMO may influence marine species. Temperature affects all physiological processes of organisms, especially ectotherms (Fry, 1971; Hoar, 1953). Thus, growth, consumption, metabolism, migration and reproductive output may be affected by AMO-related temperature changes. Changes in temperature alone may affect the population growth rates of lower trophic levels (phytoplankton and zooplankton) much more than upper trophic levels, by reducing generation time under optimal temperature conditions, changing dormancy cycles for certain planktonic species, and altering phenology. These changes in lower trophic levels could cascade through the food web and fundamentally alter ecosystem state.

North Atlantic Oscillation (NAO) influences ecological dynamics in both marine and terrestrial systems, and its effects may be seen in variation at the individual, population and community levels. The ecological responses to the NAO encompass changes in timing of reproduction, population dynamics, abundance, spatial distribution and interspecific relationships such as competition and predator-prey relationships. This indicates that local responses to large-scale changes may be more subtle than previously suggested (Ottersen et al., 2001).

Southeast Pacific

Over the last decades a surface cooling of the equatorial Pacific has been observed, so it has been absorbing an important part of heat from the atmosphere. It is likely that global temperature increases have been slowed, thanks to the tropical Pacific cooling. This cooling reflects increased upwelling of cold water. Whether this is a natural oscillation or a contemporaneous response to climate change is currently unknown. Many coupled atmosphere-ocean models predict decreasing equatorial winds, and therefore decreased tropical upwelling, which could reduce the rate of heat uptake and expedite atmospheric heating. The Northern Tropical Convergence is expected to shift northwards and the ocean thermocline would become shallower towards the east. Also the South tropical convergence would shift northwards. Biogeochemical models tend to predict lower primary production in the tropics and increased production in the subtropics. El Niño-Southern Oscillation (ENSO) events are predicted to become far more frequent, in contrast to the current cycle of every 10-15 years. The surface temperature redistribution along the Pacific equator associated with the ENSO cycle is related with the eastward displacement of western pacific tuna stocks, so shifts could become more frequent. Other types of warmings (e.g. coastal El Niño) could also become more frequent but they are only beginning to be studied.

For the Humboldt Current, coastal upwelling is predicted to increase as a response to stronger upwelling winds, and the waters are currently cooler than in the decades preceding the 1980s. The kinetic energy then in the area of influence of ABNJ would increase in meso- and sub-mesoscale processes that could be transporting larger primary production biomass and nutrients from EEZS to ABNJ. This will also likely increase mixing, enhancing productivity. Pelagic fish feeding on plankton or herbivorous organisms could benefit, although long distance larval transport to nursery grounds could be impacted due to increased turbulence. Most coupled global models lack the necessary resolution to capture processes at these scales, so actual values are lacking. The offshore extension of small pelagic upwelling stocks determine the extension of larger predators feeding grounds that may extend from the ABNJ to the EEZ at inter-annual and long term scales. Further, it is expected that the South Pacific gyre would shift northward and transport would slow down. Heating would increase water column stability and a shallower, summer-like thermocline would develop. Productivity is predicted to decrease due to a reduction in the (already low) nutrient input from deep waters.

Within the sub-Antarctic region, ice melting from Antarctica will cause low salinity, resulting in the Circumpolar Antarctic Current (CPA) current extending southwards. Primary production is expected to increase according to all biogeochemical models, especially because of the reduction of ice cover. Light penetration in the absence of ice would also extend the productive season.

Although Oxygen Minimum Zones (OMZs) are predicted to expand in general, and the expansion of the Southeast Pacific OMZ has been reported for recent decades, it is the least affected OMZ of the world ocean. It is predicted to expand vertically and horizontally and become more intense until 2100, and then recede. Because OMZ waters are the subsurface waters with high nutrient level, which fertilize coastal upwelling, and also underlie the thermocline offshore in the Pacific, it could also contribute to keep productivity levels mediated by meso- and sub-mesoscale processes and topographic interaction. OMZ allows for the occurrence of metabolic processes of relevance for greenhouse gas production and chemosynthesis. Many processes are still being discovered, so predictions from simple biogeochemical simple models should be taken with more than caution.

Trophic webs are expected to change, but it is not clear what the nature and impacts of the changes would be for fisheries or for biodiversity. Species and communities would change spatial distribution as their typical habitat characteristics would shift in horizontal and vertical axes. Fauna in many seamounts could be more strongly or negatively affected, since they are less likely to be able to shift with the moving climate envelope in which they evolved. The range of effects would only be evaluable when information on local communities and depth ranges of sea mounts are evaluated. Shallow mounts could be more affected, as well as those prone to the influence of an extended OMZ, than deeper ones.

Conclusion

Considering biological responses to biogeochemical as well as physical trends, future climate scenarios might have very important impacts on fauna distribution and productivity projections, leading to moderate productivity decreases and poleward shifts of species distributions. Nevertheless, even as modelling implies a simplification of reality in itself, the misinterpretation of critical processes might have determinant biases on results. The contrast of expected trends, and even the evaluation of past trends based on data, is contrasting. Few studies relate surface temperature regional variability and trends to the underlying mechanisms for such observations. Therefore, implications of temperature as a proxy verse a driver are not always explicitly stated, and the overall statement: higher temperature, shallower and more intense stratification, lower productivity seems to be used more often than justified.

Box 8 Ecological connectivity and climate change

As a result of climate change also the global redistribution of species and currents is changing. This alters already dynamics patterns of ecological connectivity, posing additional challenges to ocean management.

Ocean connectivity, mediated through migratory and circulatory connectivity, is already being altered by climate change, and changes are anticipated to become move pronounced in the future. Firstly, CO_2 emissions lead to ocean warming, acidification, deoxygenation and reduced productivity. As species attempt to adapt they shift their habitat to areas where ocean conditions match with their preference and tolerance limits, generally poleward or into deeper waters. These changes in biogeography consequently also recast established patterns of migratory connectivity. In addition, climate change is predicted to change ocean circulations; observational evidence indicated that changes already begin to take place. As ocean currents disperse reproductive or juvenile life stages of marine organisms, changes to the strength or direction of currents influence the distribution of populations.

Estimating the impact of climate change on marine ecosystems is challenging, as global climate models, from which changes in temperature, acidity, oxygen level, productivity and currents can be derived, have to be run along alongside complex models of biological behaviour (van Gennip et al., 2017). Considering ecological connectivity, dynamic in itself, alongside the changes induced by climate change, renders making predictions about marine ecosystems an even more daunting task.

These difficulties aside, ocean conservation and management regimes must nonetheless both consider climate change effects and ecological connectivity in order to be effective at preserving marine biodiversity. In addition, understanding the implications of both is important for managing the socio-economic impacts of climate change. Fisheries catches will lead to a net decrease due to climate change, but there are winning and losing regions. We need to know which regions are affected how, and considering ecological connectivity is indispensable, even if challenging. Who these will be is even harder to discern when considering ecological connectivity. This requires approaches which go beyond currently proposed adaptive management (Popova et al., 2019).

3.6 Summary of Pressures

The Southeast Atlantic and Southeast Pacific are under significant stress putting the health and resilience of the ocean in risk. This is due to a range of pressures, both directly such as fish and species extraction, destruction and disturbance to the seabed, bycatch, marine pollution and underwater noise as well as indirectly such as climate change. These pressures stem from human activities at sea (e.g. fishing) as well as land based (e.g. pollution), while new activities (deep sea mining) may also be added to this list of pressures, adding further stress to the marine environment.

Ecological connectivity between ABNJ and EEZs means that the continued, or new, pressures placed on ABNJ will have devastating affects not only marine life and ABNJ, but also cause significant impacts on coastal areas. Ultimately, such affects will impact human wellbeing in these coastal areas in the form of loss of revenue and jobs as fish stocks decrease, hazards to human health as toxic substances enter the food web, and increased challenges due to climate change as the ocean loses capacity to contribute to the regulation of global climate processes.

In regard to species extraction, commercial fishing is by far the most significant activity in terms of the volume of removed. Fishing in ABNJ in the Southeast Atlantic and Southeast Pacific began in the 1950s and 1960s, respectively, and grew significantly before decreasing in around 2000. ABNJ are in general less productive than the EEZs and provide only for the global 4.2 % of the annual marine capture fisheries. The selective extraction of fish remains a significant pressure in both the Southeast Pacific and Southeast Atlantic. Reduction in marine species abundance or stock levels means that ecosystem modification is occurring, including possible complex trophic web interactions.

Destruction and disturbance of the seabed in ABNJ is considered limited at the current state. This is primarily because bottom trawling has been reduced in Southeast Atlantic and Southeast Pacific as fishing practices employs purse seines and long lines which does not impact the seafloor. Moreover, the pressure created by underwater cables is considered negligible. Nevertheless, while there is currently no deep-sea mining taking place in ABNJ of the Southeast Atlantic and the Southeast Pacific, if opened up for exploitation, it is likely to create significant pressure on the seabed (benthic environment), which could potentially extend into the water column (pelagic zone) as a result of the associated sediment plume.

Information on contaminants entering ABNJ is limited, although it is generally agreed amongst researchers that all major ocean basins have been significantly contaminated by human activities such as oil exploration and production, mining (land based), land based activities (e.g. waste management) and shipping. Marine litter, including plastics, is a major and globally recognised problem. There is clear evidence that litter and plastics are accumulating in ocean basins, as well as in coastal areas and along shores. Their input into the marine environment comes from numerous sources such as shipping, coastal tourism, poor waste management practices and many more. The transport dynamics of marine litter is not clearly understood, although it is widely recognised that litter can travel great distances along ocean currents, thereby being present in all areas of the ocean.

Detailed assessments of underwater noise and energy are highly limited and it is not possible to provide a complete assessment of the cumulative impact on marine life due to noise. Further studies, with a more holistic approach considering species interactions are needed, yet difficult to achieve. Nevertheless, it is commonly agreed that species interact at multiple levels and they form complex networks, i.e. food webs, which also interact with the abiotic components of the sea forming the ecosystem.

Climate change is the long-term change in the balance of global climate processes. However, it is important to consider the effects of climate change on ocean dynamics, and vice versa, because ocean processes themselves are modulating climate change. The rate of change in the global climate system is of great concern and particularly its potential to lead to massive extinction events and fundamentally change almost all living communities. More directly, trophic webs are expected to change within the ocean, although it is not clear what the nature and impacts of the changes would be for fisheries or for biodiversity. This could lead to species and communities shifting into new areas as their habitats and feeding grounds are impacted.

4. Outlook

The aim of this report is to provide decision makers with relevant and useful information on the current status of the marine environment in ABNJ as well as highlight key pressures placed upon it by human activities. This is essential for decision makers to have a better understanding on the complex dynamics of marine ecosystems, including the importance of biodiversity and ecological systems and contribution to global human wellbeing. Understanding that status of marine biodiversity and pressures placed upon it, including both spatial and temporal information, can be used to identify key trends or hotspots of activities and therefore identify priorities for management and conservation measures.

The Southeast Atlantic and Southeast Pacific regions are both characterised by their high biological productivity, supported by important oceanic currents, and under extreme pressure from human activities. This report provides a collection and assessment of available data and information on key issues for ABNJ for these regions. Although many challenges and gaps in knowledge exist, these are not a justification for not taking coordinated and cross-sectoral policy action. The cumulative pressures arriving from human activities, both on land and at sea emphasise that there is only one ocean and that it needs to be conserved and managed as a whole. Moreover, Ecological connectivity, that is the connectivity between ABNJ and EEZs, demands transboundary and holistic governance approaches for the conservation and sustainable use of biodiversity.

Considerations for Governance

The fragmented global governance structure for ABNJ makes it extremely difficult to achieve holistic protection at the requisite scale to be effective. Of even greater concern, and of far greater urgency, is the patent failure of many multilateral instruments, e.g. tuna RFMOs, to enforce responsible, sustainable practices in ABNJ. This precedent of failure bodes extremely poorly for newly established multilateral bodies, particularly the International Seabed Authority and the UN Framework Convention on Climate Change. But the connectivity between EEZs and the adjacent ABNJ (and, indeed, of even more distant lands and waters via migratory marine megafauna) is deep and fundamental to many aspects of coastal states' economies. Unfortunately the connectedness is often difficult to discern, and to date, States have been able to ignore those connections without consequence. But as pressures mount on already-stressed systems, the risk of collapse, or very deleterious change, increases. And coastal States may never know what they have lost by ignoring ABNJ. And they will surely come to regret a failure to insist on strong conservation actions in all governance arenas. The current trends in declining populations, deteriorating status of many key species, and altered productivity metrics in ABNJ threaten marine capture fisheries inside EEZs, regardless of how well those fisheries are managed nationally. Sustainable and non-consumptive activities such as recreational angling and tourism hold great potential for coastal states to benefit from the ocean, and yet those barely tapped opportunities may disappear for short-term exploitation of global common resources such as seabed minerals and migratory tunas. There is a pressing need for coastal States to insist that their rights and futures are not compromised, but to do so, they must become more actively engaged in driving sustainable, responsible practices in ABNJ, at all the relevant fora.

International conventions, such as the Stockholm Declaration (1972), the Rio Declaration (1992), the Convention on Biodiversity (1993), and the World Summit on Sustainable Development (2002), influence the drafting of legislation for marine activities by signatory countries. The Stockholm and Rio Declarations emphasise the need for environmental protection and environmental impact assessment in sustainable development, alongside the need to share scientific knowledge and adopt the 'precautionary principle'. The Convention on Biodiversity also supports the precautionary principle alongside endorsing an ecosystem approach to management and area-based management tools. The World Summit on Sustainable Development calls for representative networks of marine protected areas to promote conservation and management of the oceans. Globally, there are regulations or programmes in place to try and reduce the amount of litter reaching the oceans. Annex V of MARPOL deals with the disposal of garbage from ships while land-based sources are covered by UNEP's Global Programme of Action (GPA) and the Conventions underpinning the Regional Seas Programmes. Land-based sources of marine litter are covered under the Land Based Sources and Activities (LBSA) Protocol of the Abidjan Convention where they are listed as a substance of concern in Annex I.

The main marine mineral resources of interest are manganese nodules, cobalt-rich ferromanganese crusts and seafloor massive sulphide (SMS) deposits. At the moment, only exploratory activities are being conducted and various exploration licenses have been granted by the International Seabed Authority (ISA), including in the Pacific Ocean. It is likely that the interest in deep-sea mining will grow as knowledge of occurrence and distribution of marine mineral resources will grow (UN, 2016). The commencement of commercial activities, i.e. the exploitation of marine mineral resources, will be dependent upon the demand and supply through alternative land-based sources as well as the cost effectiveness of deep-sea mining and environmental concerns associated with large-scale mining activities (OECD, 2016).

The negotiation of a new international legally binding agreement for BBNJ is an important opportunity to build on the provisions of UNCLOS and other global and regional instruments to promote an integrated, coherent and consistent approach to governance of ABNJ and support improved cross-sectoral cooperation also at the regional level. The negotiations began in September 2018 at the United Nations Headquarters in New York, USA. One of the key issues addressed is the relation of the new instrument to existing regional and sectoral instruments since, as stated in the UNGA Resolution, this process 'should not undermine existing relevant legal instruments and frameworks and relevant global, regional and sectoral bodies'.[38] Consequently, the new agreement will depend on effective implementation frameworks both within marine regions and at the global level with regard to managing sectoral activities and provides the unique opportunity to improve the coordination between and among existing global and regional institutions and to foster integrated management approaches (Gjerde 2018).

States could therefore seek to champion the adoption of a strong agreement that can enhance regional and global efforts, including: overarching governance and environmental principles to guide decision-making; global biodiversity conservation objectives, targets and obligations; rules and standards for practices and procedures to ensure that the impacts of human activities are assessed effectively and transparently; rigorous requirements for ecosystem-based management, protection of marine biodiversity, and transparency; and for the establishment or strengthening of regional and global integration mechanisms.

Gaps in Knowledge

The importance of establishing a robust scientific knowledge base to develop informed and sound governance approaches cannot be underestimated. Many gaps in knowledge exist and are required to be filled in order to identify a comprehensive and appropriately representative suite of sites for marine biodiversity conservation in ABNJ. In particular, additional areas of special ecological importance could be identified in the future as new data and information become available. Improving the knowledge base will also be essential to support the establishment of conservation and management measures and ensure the consistency and complementarity of sectoral measures. Furthermore, the exploration and exploitation by new activities in ABNJ, such as deep sea mining or harvesting of MGRs, depends on scientific research to ensure that they do not create added pressures which exasperates an ocean already in poor health. The establishment of a scientific knowledge base will also be important to build capacity and provide the necessary impetus for transfer of marine technology and therefore requires coordination and collaboration between scientific institutions at the national, regional and global levels.

Most ABNJ research cruises in these areas have been conducted by Asian (especially Japan), North American and European countries, with the eventual participation of coastal States researchers. International collaboration between coastal States and countries from the northern hemisphere as well as regional collaboration among South Pacific costal States has focused mainly on the productive coastal upwelling areas.

It is typical of virtually any review or compilation of texts such as this to call, at various junctures, for more research. The reality is that much remains unknown and gaps in knowledge and understanding are vast for many sectors in ABNJ. Yet, paradoxically, the more that is researched, the more questions arise; more research reveals a greater depth of lack of understanding. Still, there is always and unquestionably a great need to undertake more research to better inform decisions about how and when to act in a sustainable way. However, there is easily sufficient evidence to show that ecosystems in ABNJ, and the many denizens that inhabit these areas beyond national jurisdiction, are close to being fundamentally and irrevocably changed. But it is unknown how to predict those changes and how they will end, and whether the resulting ecosystems and species assemblages, distribution, patterns and/or migrations will allow humanity to continue to exploit them and achieve global food security from marine resources. Therein lies the problem – much of humanities current economies are heavily reliant on healthy marine ecosystems and productive capture fisheries. Humanities activities are driving unprecedented change that we cannot predict, but is likely to be generally worse for the planet.

Ecological Connectivity

The main imperative deriving from ecological connectivity is that ocean management should be based on ecologically-defined management units rather than jurisdictional boundaries. When designating marine protected areas (MPAs), for example, not only the ecological and biological significance of the area in question, but also its connectivity to other ecosystems should be considered. And when conducting environmental impact assessments (EIAs) and strategic

[38] UNGA/RES/69/292 on the development of an international legally-binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction.

environmental assessments (SEAs), also downstream ecological as well as socio-economic effects should be considered. Moreover, this ecological connectivity implies coastal States must not only cooperate with their neighbouring States but extend their actions across the EEZ-ABNJ divide.

Ecological connectivity is essential to healthy marine ecosystems across the globe. The oceans are not a uniform blue expanse but comprise diverse biological and oceanographic features. Some regions such as upwelling sites or seamounts, which have an especially high biological productivity, are important to restock marine resources also in other ecosystems. If, for example, ABNJ used for spawning or nurturing of juveniles are disturbed, this directly impacts fish stocks in coastal areas. ABNJ are also important for the life cycle maintenance of many migratory species and deterioration forces them to find alternative habitats and thus disrupts recruitment. Circulation connectivity also transports pollution such as from oil spills, shipping or mining, thereby threatening coastal zones.

Ecological connectivity is of interest to a range of actors. First of all, a range of species with high economic value rely on ecosystem services provided by ABNJ. The negative effects of overfishing or habitat degradation in ABNJ will not be contained, but also impact commercial fisheries in coastal zones. The downstream effects of activities in ABNJ are especially critical for a range of developing countries, where large parts of the population rely on marine resources not only for revenue, but also for food security. The most ABNJ-connected Least Developed Countries (LDCs) are Kiribati in the Pacific Ocean, Tanzania and Somalia in the Indian Ocean; and Liberia in the Atlantic Ocean. For these countries healthy ecosystems in ABNJ and achieving SDG 14 'Life under Water' have especially important implications also for SDG 1 'No Poverty' and SDG 2 'Zero Hunger'. Beyond revenue and food security, some migratory species hold special cultural value in certain regions, establishing a cultural connectivity between the ABNJ and coastal areas. Degradation of ecosystems in ABNJ affects the development of marine tourism, which is often around the presence of migratory species, such as turtle nesting, whale watching, bird watching.

A lack of understanding and data is impeding the thorough consideration of connectivity in conservation and management measures. Studies of circulatory connectivity rely on ocean float and satellite-derived observations as well as ocean modelling, which are getting more precise due to by better computational power and more abundant observations. Confidence about migratory connectivity is also increasing thanks to progress in genetic and isotopic techniques and aquatic telemetry used to track animals. Nonetheless, our understanding of both active and passive connectivity remains incomplete and predictions are difficult to make. This uncertainty underscores the need for the application of the precautionary principle in ocean management.

Link to other STRONG High Seas Outputs

The project STRONG High Seas, working with the Secretariat of the Comisión Permanente del Pacífico Sur (CPPS; Permanent Commission for the South Pacific) and the Secretariat of the West and Central Africa Regional Seas Programme (Abidjan Convention), aims to develop and propose targeted measures to support the coordinated development of integrated and ecosystem-based management approaches for ocean governance in ABNJ. Therefore, this report provides a critical step to build a baseline understanding of ecological considerations to select and prioritise governance efforts. The outputs and findings concluded here will be considered in detail along with an assessment on the legal and institutional framework of the ABNJ (Durussel et al. 2018)[39] as well as planned research on the socioeconomic importance of ABNJ, options for management measures, and stakeholder engagement and capacity building.

[39] See https://www.prog-ocean.org/wp-content/uploads/2019/03/Online_IASS_Report_190227.pdf.

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Annex

Table 2 Comparison of criteria for various Areas of Special Ecological Importance

Organisation	UNE : CBD	FAO	IMO	ISA	IUCN	Birdlife	IUCN
Special Area	**EBSA**	**VME[40]**	**PSSA[41]**	**APEI**	**KBA**	**IBA**	**IMMA**
Criterion							
Uniqueness or rarity	Uniqueness or rarity	Uniqueness or rarity	Uniqueness or rarity	Unique habitats	Geographically restricted biodiversity		Flagship/ catalytic species
Special importance for life history stages	Special importance for life history stages	Functional significance of the habitat	Spawning or breeding grounds				
Importance to threatened or endangered species	Importance for threatened, endangered or declining species and/or habitats	Functional significance of the habitat	Critical habitat		Threatened biodiversity	Globally threatened bird species	
Vulnerability, fragility, sensitivity or slow recovery	Vulnerability, fragility, sensitivity or slow recovery	Vulnerable to fishing impacts	Vulnerable to degradation, fragility		Irreplaceability		Vulnerability of marine mammals
Productivity	Biological productivity	NA	Productivity				
Biological diversity	Biological diversity	NA	Diversity, representivity, bio-geographic importance	Representative			Umbrella species
Naturalness	Naturalness	NA	Naturalness, integrity		Ecological integrity		
Ecological Structure	NA	Structural complexity	Dependency on specific habitats (eg. coral reefs) or migratory routes.	Ecosystem structure and funtion	Biological processes		

[40] VMEs are benthic environments (e.g. seamounts, hydrothermal vents and cold water corals) at risk of slow recovery (greater than 5 – 20 years) and impaired ecosystem function from damage caused by fishing gear. (FAO, 2009).
[41] Particularly Sensitive Sea Areas (PSSAs) are areas within which there are stricter controls on shipping.

Table 2 Comparison of criteria for various Areas of Special Ecological Importance (cont.)

Organisation	UNE : CBD	FAO	IMO	ISA	IUCN	Birdlife	IUCN
Special Area	**EBSA**	**VME**[42]	**PSSA**[43]	**APEI**	**KBA**	**IBA**	**IMMA**
Criterion							
Importance for scientific research and monitoring			Important for scientific and biological research and monitoring				Indicator species, relatively easy to monitor
Socio-economic criteria			Economic, social, cultural, and historical value				
Vulnerability to shipping impacts			Traffic volumes, characteristics; natural factors;				

[42] VMEs are benthic environments (e.g. seamounts, hydrothermal vents and cold water corals) at risk of slow recovery (greater than 5 – 20 years) and impaired ecosystem function from damage caused by fishing gear (FAO, 2009).
[43] Particularly Sensitive Sea Areas (PSSAs) are areas within which there are stricter controls on shipping.

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About the STRONG High Seas Project

The STRONG High Seas project is a five-year project that aims to strengthen regional ocean governance for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. Working with the Secretariat of the Comisión Permanente del Pacífico Sur (CPPS; Permanent Commission for the South Pacific) and the Secretariat of the West and Central Africa Regional Seas Programme (Abidjan Convention), the project will develop and propose targeted measures to support the coordinated development of integrated and ecosystem-based management approaches for ocean governance in areas beyond national jurisdiction (ABNJ). In this project, we carry out transdisciplinary scientific assessments to provide decision-makers, both in the target regions and globally, with improved knowledge and understanding on high seas biodiversity. We engage with stakeholders from governments, private sector, scientists and civil society to support the design of integrated, cross-sectoral approaches for the conservation and sustainable use of biodiversity in the Southeast Atlantic and Southeast Pacific. We then facilitate the timely delivery of these proposed approaches for potential adoption into the relevant regional policy processes. To enable an interregional exchange, we further ensure dialogue with relevant stakeholders in other marine regions. To this end, we set up a regional stakeholder platform to facilitate joint learning and develop a community of practice. Finally, we explore links and opportunities for regional governance in a new international and legally binding instrument on marine biodiversity in the high seas.

Project duration: June 2017 – May 2022
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Regional partners: Secretariat of the Comisión Permanente del Pacífico Sur (CPPS), Secretariat of the Abidjan Convention
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