Section 4

Subchapter 4C

Marine benthic invertebrates

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Key points

- Seafloor hotspots and 7,252 new benthic invertebrates have been described since the publication of the second *World Ocean Assessment*, and there has been a five-fold increase in critically endangered species and a doubling of endangered species.

- Marine benthic invertebrates are vital for ocean health but are increasingly impacted by human activities.

- There is often limited understanding of the implications of these impacts and inadequate provisions to contain them.

- Research and cooperation are still unbalanced among regions.

- Marine invertebrates are still poorly documented, particularly in the deep ocean and in the territorial waters of developing States and island States, which potentially host a high number of endemic taxa.

- Consistent funding for biodiversity monitoring is needed to prevent knowledge gaps from widening.

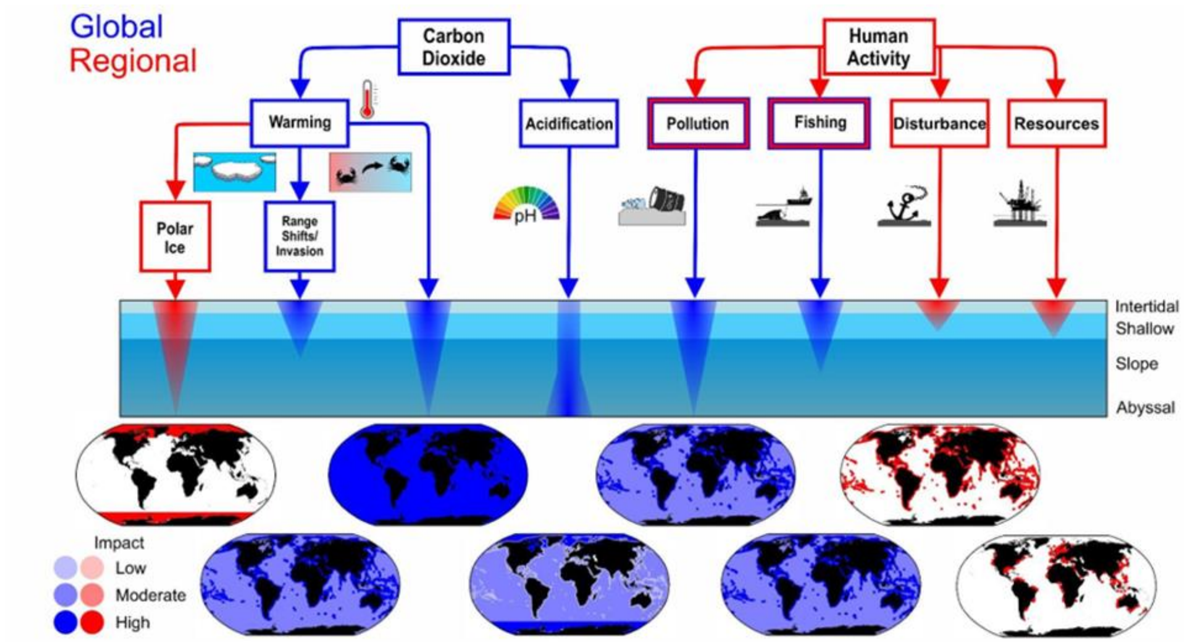
- Meaningful and ethical use of Indigenous knowledge and representation of early career professionals are required.

- Seabed mining raises concerns about negative impacts, calling for coordination and cooperation between the Conference of the Parties to the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction and the International Seabed Authority (ISA).

1. Introduction

Since the public of the second *World Ocean Assessment*, benthic species and habitats have been affected by human activities worldwide (figure I).

Figure I



Source: Prepared by the writing team.

Benthic invertebrates are vital for ocean health and human well-being but are threatened by climate change, human activities (including bottom trawling) and pollution (including microplastics and contaminants).

2. Environmental change since the second *World Ocean Assessment*

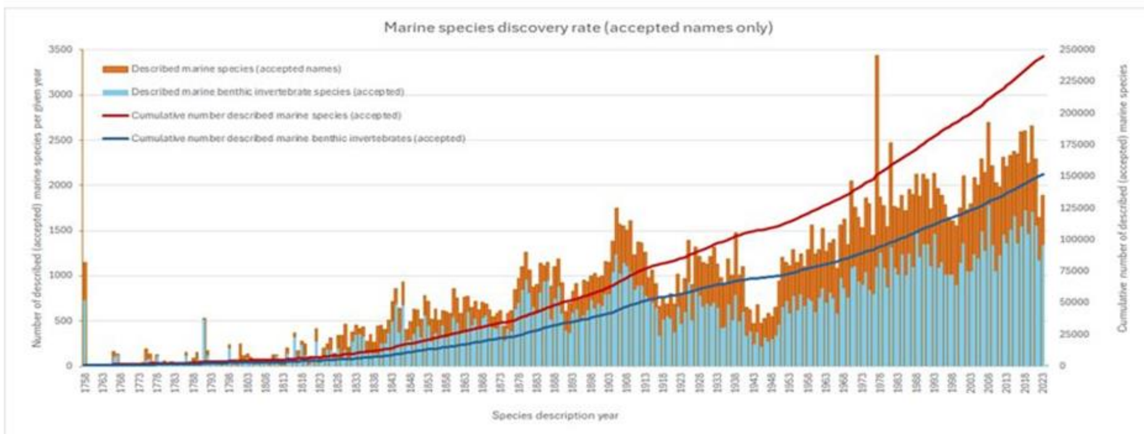
Changes in overall status

Biodiversity

The World Register of Marine Species (WoRMS), as at 29 August 2024, held 246,517 valid marine species names, including 151,902 marine benthic invertebrates. Of all the new marine species discovered each year, about 60% are benthic invertebrates. From 2019 to 2023, of the 10,742 new marine species described, 7,252 (67.5%) were benthic invertebrates (figure II).

Figure II

Global marine species discovery rate (accepted species only) since 1758

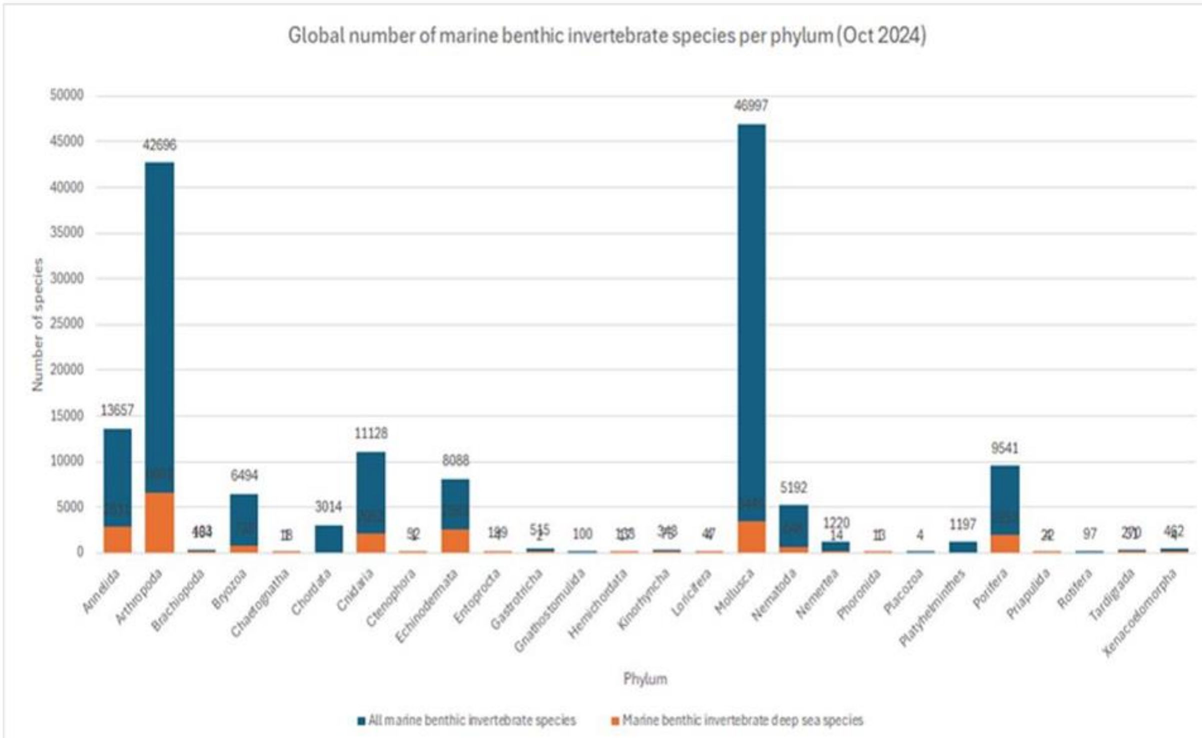


Source: Prepared by the writing team.

Of the 32 marine phyla with invertebrate species, 26 include benthic species (figure III). Among these, 21,271 species (14%) live at depths greater than 500 m.

Figure III

Global number of marine benthic invertebrate species, by group (phylum), showing total species numbers



Source: Prepared by the writing team.

Only 1.7% of marine benthic invertebrate species have been formally assigned to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (table 1). Most species (98.3%) have not been evaluated due to insufficient information.

Table 1

Number of marine benthic invertebrate species per category of the International Union for Conservation of Nature Red List of Threatened Species

Red List category	Total number of marine invertebrate benthic species	
	1964–2018	2018–2023
Extinct	2	2
Critically endangered	18	91
Endangered	45	88
Vulnerable	237	292
Near threatened	184	239

Near-threatened[a]	4	4
Least concern	1,104	1,184
Data deficient	624	657

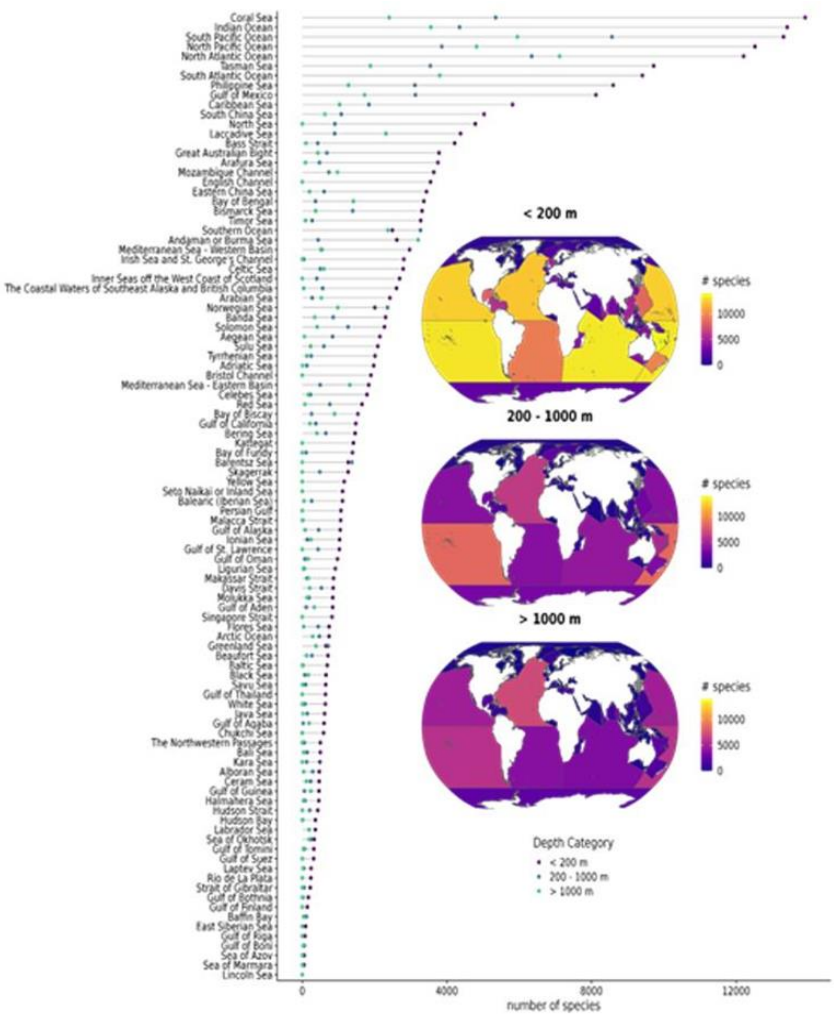
Source: Prepared by the writing team.

[a] This number category includes four "conservation-dependent" species.

According to WoRMS, the Ocean Biodiversity Information System, and the Marine Regions website (accessed Oct 2024), marine benthic invertebrates are found in all International Hydrographic Organization areas. However, significant regional variations reflect current knowledge gaps (figure IV).

Figure IV

Total number of recorded marine invertebrate benthic species for all International Hydrographic Organization sea areas for <200 m, 200-1000 m and >1000 m depth.



Source: Prepared by the writing team.

Note: The boundaries of the International Hydrographic Organization sea areas follow Claus and others, 2014, and International Hydrographic Organization sea areas, version 3 (Flanders Marine Institute, 2024a), available online at http://www.marineregions.org/. https://doi.org/10.14284/323). Species occurrences: Ocean Biodiversity Information System (OBIS), 2024. Species group information: WoRMS. Bathymetry data: European Marine Observation and Data Network (EMODnet), 2016; General Bathymetric Chart of the Oceans (GEBCO), 2015; and Provoost and Bosch, 2018.

Impacts of change on and interaction with other components of the marine system

Marine benthic ecosystems are crucial for ocean health and human well-being but are under growing pressure from human activities (Sweetman and others, 2017; Halpern and others, 2019; Gissi and others, 2021; Mamede 2024) (table 2 and regional information).

Unprecedented environmental changes are causing range shifts, novel species assemblages and extirpations. Research and scientific guidance are essential for understanding ocean changes and their effects on benthic resources, ecosystem services and socioeconomic impacts, and for developing effective mitigation strategies (Griffiths and others, 2017; Schratzberger and Somerfield, 2020; Crespo and Pardal, 2022).

Table 2

Anthropogenic stressors and activities affecting benthic marine invertebrates and ecosystems worldwide

Human stressors and activities	**References**
Global warming and ocean acidification	Isla and Gerdes, 2019; Pineda-Metz and others, 2020; Venegas and others, 2023
Fishing, especially bottom trawling	Couce and others, 2020
Resource extraction, including mining and hydrocarbon exploitation	Henry and others, 2017
Bioinvasion by non-native species, including invasive, exotic	Zaiko and others, 2024
Marine- and land-based contaminants, including an estimated 3.05 million tons of microplastics in deep ocean sediments and perturbations caused by drifting plastic bags in the deepest ocean	Gao and others, 2022; Harris and others, 2023; Ribó and others, 2023; Shahnawaz and others, 2024; Jamieson and Onda, 2022
Oil spills	Goes and others, 2023
Urbanization	Momota and Hosokawa 2021; Dreujou and others, 2023

Dredging and dumping	Prishchepenko and others, 2023; Neira and others, 2024
Offshore wind farms	Lloret and others, 2022
Anchor scour damage	Davis and others, 2022
Marine invertebrate interactions with harmful algal blooms and implications for One Health	Turner and others, 2021
Coastal defence and offshore structure installations	Wolanski and others, 2020

Source: Prepared by the writing team.

Contaminants and microplastics accumulate in the seabed, harming benthic invertebrates and ocean ecosystems (Mason and others, 2022; Ladewig and others, 2023). Widespread damage to benthic habitats and biodiversity affects marine ecosystem services in various ways across regions, highlighting the need for targeted seabed management (Wang and others, 2021; Lloret and others, 2022; Mamede, 2024).

Governance of the seabed within and beyond national jurisdiction

Deep seabed mining management has drawn significant attention from various stakeholders, including governments, research institutions, intergovernmental organizations, non-governmental organizations and the private sector. Concerns are focused on its harm to benthic invertebrates (Amon and others, 2022; Drazen and others, 2020; European Academies Science Advisory Council, 2023; Rabone and others, 2023; Stenvers and others, 2023; Sweetman and others, 2024) and inadequate management of seabed mining impacts (Picken and others, 2024). There have been calls by some for a moratorium, a precautionary pause or a ban (Deep Sea Conservation Coalition, 2024; World Wildlife Fund (WWF), 2024).

For the seabed outside of the national jurisdiction, the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction, once it comes into force, will provide management measures, including area-based management tools, such as marine protected areas (MPAs) and environmental impact assessments (Humphries and others, 2025) that could complement the existing measures for management of the seabed. To be effective, such management measures will require strong coordination and cooperation between the Conference of the Parties to the Agreement and ISA and regional fisheries management organizations (RFMOs) to ensure the conservation and sustainable use of areas beyond national jurisdiction (Muraki Gottlieb and others, 2025). Furthermore, capacity-building and the transfer of marine technology in the Agreement that encompasses all of the substantive elements, including the fair and equitable sharing of benefits of marine genetic resources of areas beyond national jurisdiction, will help to reduce gaps in scientific knowledge and to support further management measures, which is essential, especially for developing countries. For areas within national jurisdiction, select regional seabed management aspects are summarized in table 3.

Table 3

Select examples of regional management of the seabed since 2019

Regions	Governance of the seabed
Arctic Ocean	**Central Arctic Ocean** The Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean entered into force in June 2021. The Agreement prevents the signatory countries from engaging in commercial fishing for 16 years and establishes a joint programme of scientific research and monitoring to further the understanding of ecosystems in an Arctic with retreating sea ice cover, as part of a long-term strategy to safeguard healthy marine ecosystems and ensure the conservation and sustainable use of fish stocks The entry into force on 17 January 2026 of the Agreement on Marine Biological Diversity of Areas beyond National Jurisdiction may provide opportunities to address a legal gap wherein no existing legal instrument or body has the legal competence to designate area-based management tools, including MPAs, in portions of the Central Arctic Ocean that lies in areas beyond national jurisdiction. **Barents Sea** Northward expansion of commercial bottom fish has increased the risk of bottom trawling damage to vulnerable benthic species and habitats in pristine, previously ice-covered areas in the Northern Barents Sea. In 2019, the Government of Norway agreed to close 443,000 km^2 of seabed to bottom-contact gear (Jørgensen and others, 2020). **Canadian Arctic** Conservation areas have been established to protect habitat-forming cold-water corals and sponges (CWCS) (Department of Fisheries and Oceans of Canada, 2024).

Baltic Sea, North-east Atlantic Ocean, Mediterranean Sea and Black Sea	**North Atlantic Ocean** While 18 benthic habitats are already the focus of status assessments in the maritime area of the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), remote and deep-water habitats remain understudied. Regulations concerning pollution or pressure and the creation of MPAscontinue to be enacted across all regions. Currently, 10.8% of the OSPAR maritime area has been designated an MPA, but challenges remain with respect to generating sufficient ecological coherence (OSPAR, 2023). Green finance (e.g. nutrient, carbon or biodiversity credits) could provide the investment greatly needed for effective management and to support restoration at the seascape level (Preston and others, 2025).
South Atlantic Ocean and wider Caribbean	**South-West Atlantic** Cumulative impact assessment and conservation planning is under way to strengthen MPAs in the Brazilian exclusive economic zone (Magris and others, 2020). Marine spatial planning is ongoing in the Brazilian exclusive economic zone. **Africa (South Africa and Namibia)** In 2019, South Africa increased its MPA from 0.4% to 5% of its ocean territory through the implementation of 20 new MPAs (Sink and others, 2023). In South Africa and Namibia, trawl fisheries are receiving eco-certification, and routine benthic monitoring is carried out through commercial fishing activities. Enhanced mitigation measures are being undertaken for seabed damage caused by trawl fishing. Ecosystem-based management was identified as a suitable approach to effectively govern the most impactful human activities in marine systems (Skein and others, 2022).

Indian Ocean, Arabian Sea, Bay of Bengal, Red Sea, Gulf of Aden and Persian Gulf

Persian Gulf and the Sea of Oman

- The Islamic Republic of Iran, Oman, Qatar and the United Arab Emirates have established MPAs to protect critical habitats.
- Bottom trawling restrictions, establishment of no-take zones within MPAs and seasonal fishing bans protect spawning seasons.
- National regulation targets have been introduced to reduce pollution from oil and chemical spills.
- The Regional Organization for the Protection of the Marine Environment is composed of the countries of the Cooperation Council for the Arab States of the Gulf , Iraq and the Islamic Republic of Iran.

Arabian Sea, Lakshadweep Sea and Bay of Bengal MPAs have been introduced (for coral, seagrass and sea cucumbers), and fishing regulations and pollution control have been implemented. Marine resource management is supported by initiatives such as the Bay of Bengal Programme. Relevant national authorities enforce pollution control measures and regulate scientific research activities.

Andaman Sea, Strait of Malacca and South China Sea

- National regulations and conservation strategies are being implemented by Association of Southeast Asian Nations (ASEAN) countries through domestic laws and strategies (e.g. artificial reef). MPAs (marine park, no-take zone) is currently increasing in area.
- ASEAN countries are implementing, and have committed to further strengthening, measures to protect the marine environment and resources.
- Illegal, unreported and unregulated (IUU) fishing still happens. Overlapping laws and responsibilities between enforcement agencies create loopholes in enforcement. Issues with maritime borders creates a grey area for enforcement when it comes to marine resources.

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Bangladesh, India, Myanmar, Pakistan and Sri Lanka

- Bangladesh (7.99% coverage), India (0.31%), Myanmar (0.48%), Pakistan (1.23%), and Sri Lanka (0.08%) have established MPAs to protect critical habitats such as corals, mangroves and seagrass.
- Bangladesh, India, Myanmar, Pakistan and Sri Lanka, as members of various regional organizations dedicated to environmental protection (ASEAN, South Asia Co-operative Environment Programme, Bay of Bengal Large Marine Ecosystem and Indian Ocean Rim Association), collaborate to address common maritime challenges. These include tackling pollution, combating piracy and developing joint conservation strategies to protect shared marine ecosystems

Fishing regulations, including seasonal fishing bans, are implemented.

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<tr><td>North Pacific Ocean</td><td>

Various regions in the North Pacific

There are a number of recent conservation initiatives focused on preserving benthic biodiversity (e.g. Tang.ɢ̱wan – ḥačxwiqak – Tsig̱is MPA and glass sponge reef marine refuges in Canada; the Lianyungang Ganyu Wetlands and Dongling Tongzhou Bay intertidal zone in China; and the Muan tidal wetland protected area in the Republic of Korea).

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<tr><td>South Pacific Ocean</td><td>

South-East Pacific

To achieve sustainable management of the marine resources in the South-east Pacific, coastal community harvest of benthic marine invertebrates must be included in data and reporting that informs fisheries management. In Chile and Peru, there is no authority to monitor community harvesting of benthic invertebrates or associated ecosystem impacts (Undersecretariat for Fisheries and Aquaculture of Chile (SUBPESCA), 2024; Marine Institute of Peru (IMARPE), 2024).

- New marine parks and associated management plans have been established in various parts of the South Pacific, including a large network around Australia, although only around 25% of it is fully protected.

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Southern Ocean	**Antarctica** The Protocol on Environmental Protection to the Antarctic Treaty officially designates Antarctica as a ”natural reserve, devoted to peace and science”. The Commission for the Conservation of Antarctic Marine Living Resources is the international body responsible for the conservation of marine life and ecosystems in waters surrounding Antarctica.

Source: Prepared by the writing team.

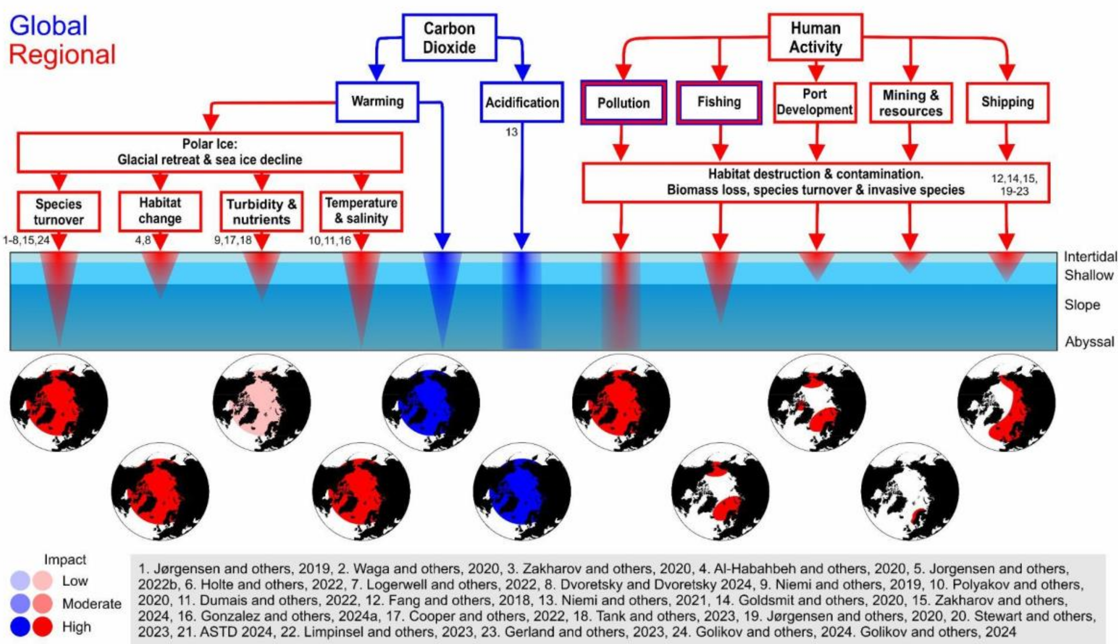
Region-specific changes

Arctic Ocean

The Arctic is an ecologically and culturally important marine region that remains largely untouched but is facing rapid environmental changes. Recent studies have established quantitative baselines of marine benthic biodiversity in previously underresearched areas (e.g. Azovsky and Kokarev, 2019; Pierrejean and others, 2020; Wei and others, 2020; Zakharov and others, 2020; Dumais and others, 2022; Gianasi and others, 2022; Vedenin and others; 2022, Bilous and others, 2022; Holte and others, 2022; Jacobs and others, 2022; Jørgensen and others, 2022a; Kenchington and others, 2022; Christie and others, 2023; McNicholl and others, 2024; Prozorkevich and others, 2024; Udalov and others, 2024). The Arctic faces major global and local threats such as warming, acidification, fishing, mineral extraction, port development and increased vessel traffic (figure V and citations therein). Microplastics are also a growing concern (Fang and others, 2018). Recent ecological changes include infaunal and epibenthic invertebrate population declines and species moving northward (e.g. Jørgensen and others, 2022b; Logerwell and others, 2022; Holte and others, 2022; Stewart and others, 2023; Gerland and others, 2023; Golikov and others, 2024). The status of commercially important crab and shrimp stocks varies from variable to healthy (Niemi and others, 2019; Gonzalez and others, 2024a). As the potential for commercial fishery expansion, new shipping routes and oil and gas extraction increases in the region, further mapping and monitoring efforts are necessary.

Figure V

Arctic Ocean: global and local stressors, associated pressures, and recently documented consequences for marine benthic invertebrates



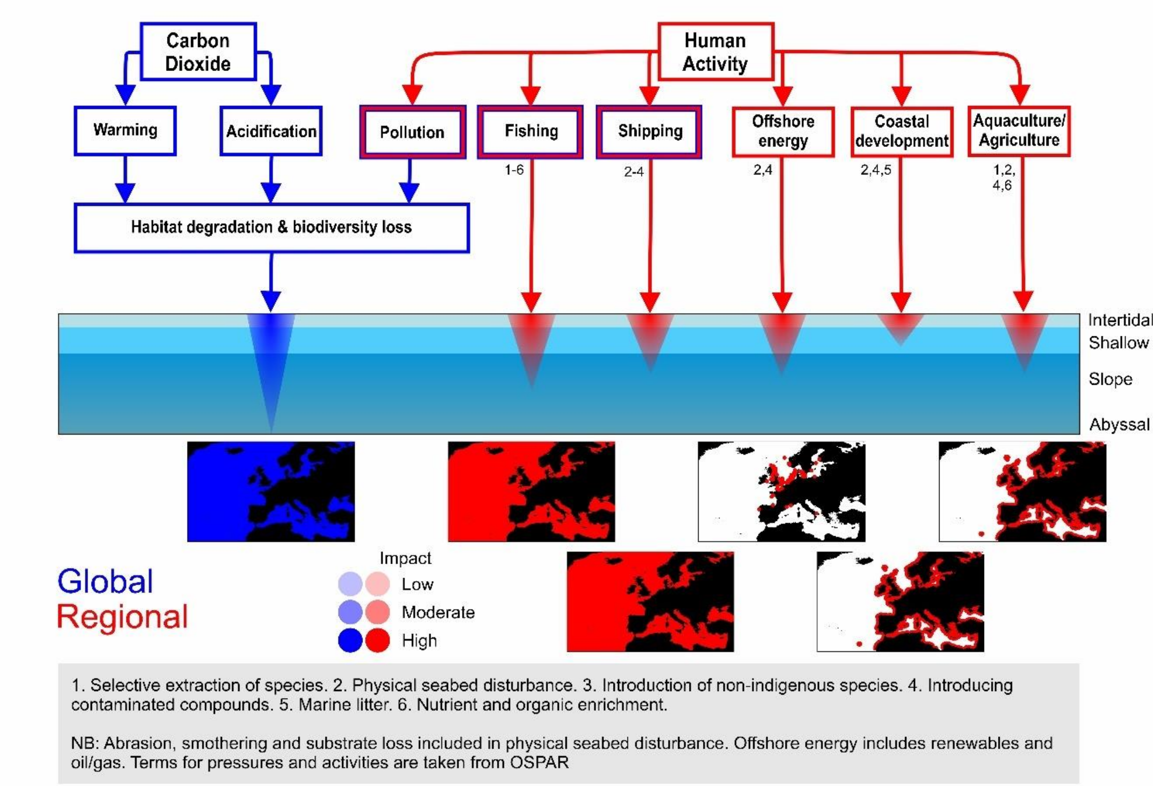
Source: Prepared by the writing team.

North Atlantic Ocean, Baltic Sea, Black Sea, Mediterranean Sea and North Sea

Except for oceanic ridges and hydrothermal vents, benthic habitats across subregions remain in poor status (Bevilacqua and others, 2020) with benthic diversity moderate or low for most subregions and none showing increases (OSPAR, 2024). Global warming affects habitats at all depths (Mediterranean Experts on Climate and Environmental Change (MedECC), 2020; see also figure VI). Fishing affects 48% of OSPAR-assessed areas via species extraction and seabed disturbance. Agriculture, aquaculture and tourism all drive nutrient enrichment, while green technologies increase contaminant inputs (Herbert-Read and others, 2022; OSPAR, 2024). Pressures disrupt ecosystem functions, exacerbate the effects of other stressors such as epizootic events (Katsanevakis and others, 2022) and compromise ecosystem services (Heckwolf and others, 2021). Benthic biodiversity improvements can benefit coastal communities through processes such as nutrient bioremediation (Watson and others, 2022).

Figure VI

North Atlantic Ocean, Baltic Sea, Black Sea, Mediterranean Sea and North Sea: global and local stressors, associated pressures and recently documented consequences for marine benthic invertebrates



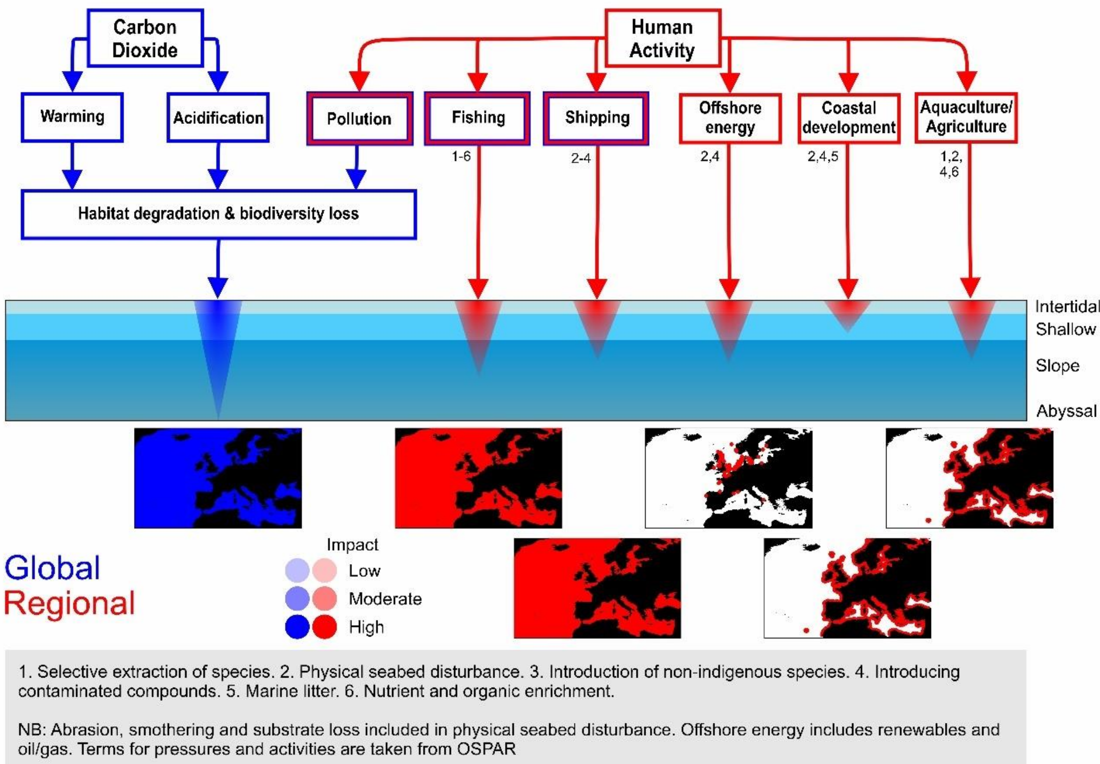
Source: Prepared by the writing team.

South Atlantic Ocean and wider Caribbean

Despite limited and fragmented data, progress has been made. Research now focuses on deep environments, habitat mapping, identification of foundational species, and ecology (Sumida and others, 2020; Etnoyer and others, 2022). Changes have been noted in shallow habitats, including coral bleaching and mortality, shifts in benthic communities and commercially valuable invertebrate stocks, and the spread of non-indigenous species (NIS) (see figure VII and studies cited therein). Climate-driven physical changes increasingly affect benthic ecosystems. Local threats include fishing, coastal development, shipping, mining, aquaculture causing overexploitation, illegal fishing, pollution, bioinvasions and habitat damage (figure VIII). Shifts in fishery stocks also have significant socioeconomic impacts (Vögler and others, 2023; Engelhard and others, 2024). Considering the rapid changes under way, along with the potential expansion of the petroleum industry (Rodrigues, 2023), seabed mining (Bridges and others, 2023; Paiva and others, 2023), and the installation of offshore wind farms (Gorayeb and others, 2024), there is a need to expand the monitoring of benthic communities in this region, especially in deep habitats.

Figure VII

South Atlantic Ocean and Wider Caribbean: global and local stressors, associated pressures and recently documented consequences on marine benthic invertebratesArrows width indicates relative importance of stressors at global and local scales



Source: Prepared by the writing team.

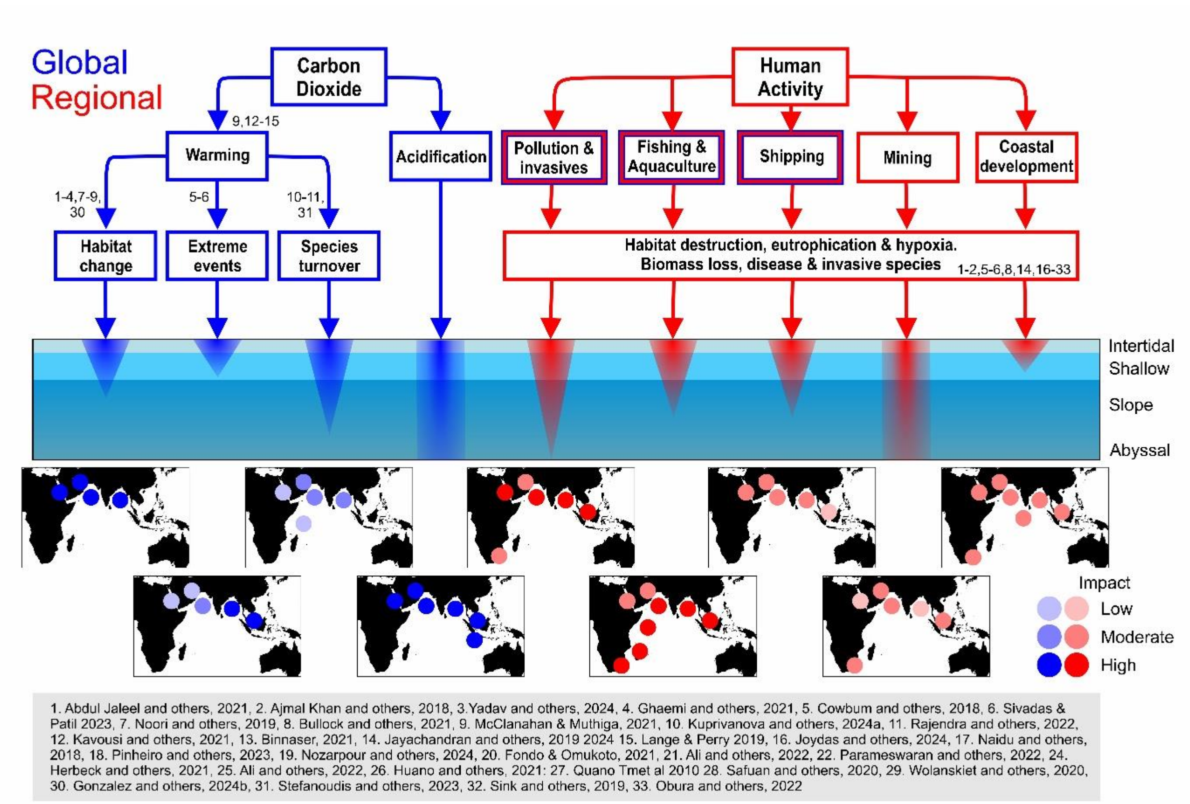
Note: Arrow width indicates relative importance of stressors at global and local scales.

Indian Ocean, Arabian Sea, Bay of Bengal, Red Sea, Gulf of Aden and Persian Gulf

Multiple global and local stressors impact marine invertebrates in this region (figure VIII). Thermal stress causes coral bleaching and declines in abundance, even at depth (Diaz and others, 2023). Overfishing and destructive fishing practices degrade benthic habitats and threaten food security (Obura and others, 2022). Marine debris leads to marine life entanglement (Pattiaratchi and others, 2022), while oil spills and invasive species disrupt native biodiversity (Jayachandran and others, 2019, 2024; Huang and others, 2021). Coastal development and untreated wastewater discharge alter benthic communities (Sink and others, 2019) with prospective offshore mining likely to worsen impacts (Fennessy, 2024). Long-term studies on these pressures are limited (Sink and others, 2019), but new biodiversity surveys (such as Amjad and others, 2024) and ecological research provide insights into ecosystem resilience (Delfan and others, 2021; Stefanoudis and others, 2023). Functional ecology can help in the assessment of biodiversity roles and responses to environmental changes, while biogeography and metacommunity ecology can help to identify large-scale patterns and habitat connections for conservation planning. Experimental research can provide information on how marine invertebrates respond to natural variability, climate change and pollutants. Key ecosystem services at risk include food security through fisheries, coastal protection and tourism (United Nations Environment Programme-National Center for Wildlife (UNEP-NCW), Nairobi Convention and Western Indian Ocean Marine Science Association (WIOMSA), 2024).

Figure VIII

Indian Ocean, Arabian Sea, Bay of Bengal, Red Sea, Gulf of Aden and Persian Gulf: global and local stressors, associated pressures and recently documented consequences for marine benthic invertebrates



Source: Prepared by the writing team.

Note: Arrow width indicates relative importance of stressors at global and local scales.

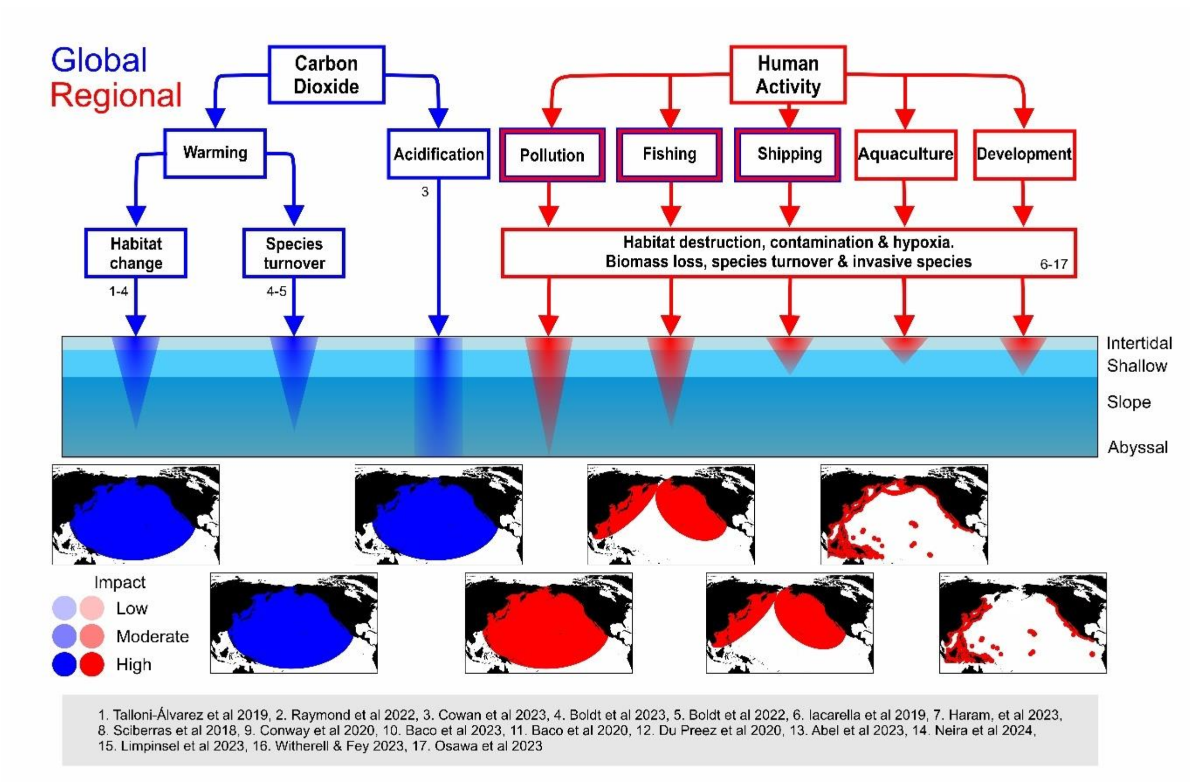
North Pacific Ocean

Ocean temperatures have increased over the long term (Talloni-Alvarez and others, 2019; Guo and others, 2020; Chen and others, 2020; Boldt and others, 2022, 2023; Alma and others, 2023; Cowan and others, 2023; Han and others, 2023), leading to widespread intertidal die-offs from heatwaves and hypoxia (Raymond and others, 2022; Chen and others, 2020; Hesketh and Harley, 2023), species turnover, range shifts and the spread of invasive species (Buser, 2023; Wang and others, 2019, 2023; Hu and others, 2021; Xu and others, 2020, 2023, 2024; Drinkwin and others, 2019). The Puget Trough and the Piip volcano are hotspots of seafloor biodiversity in the North Pacific (Wei and others, 2020; Rybakova and others, 2023) (figure IX).

Trawl fisheries are a major fishery type in the region (Morgan and Baco, 2021). Many invertebrate stocks, including crabs, oysters, geoduck, Pacific oysters and northern abalone,-have declined across the North Pacific, with severe losses species such as the Bering Sea snow crab (Szuwalski and others, 2023). Aquaculture faces challenges from ocean acidification, hypoxia, temperature anomalies and invasive species (Alma and others, 2023; Cowan and others, 2023; Qu and others, 2024). In 2021, a sea star outbreak in the Jiaozhou Bay in China caused major damage to shellfish farming and fisheries.

Figure IX

North Pacific Ocean: global and local stressors, associated pressures and recently documented consequences for marine benthic invertebrates



Source: Prepared by the writing team.

South Pacific Ocean

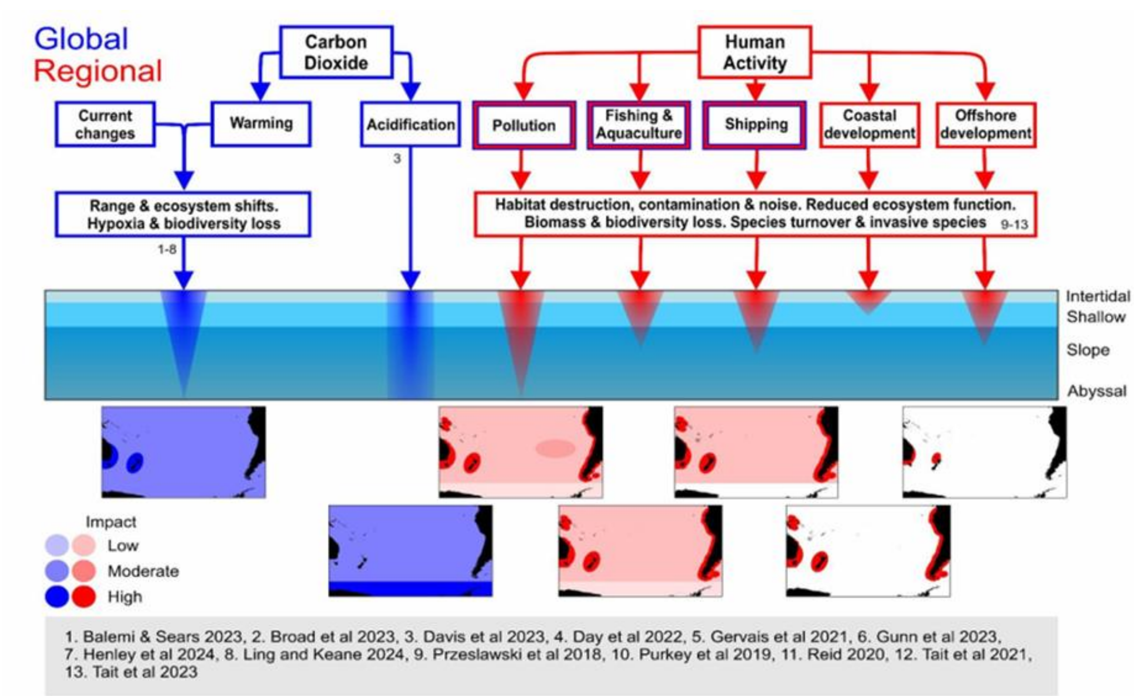
Deep-sea biodiversity of the South Pacific has recently expanded through taxonomic discoveries on the south-eastern Australian slope and abyss (Gunton and others, 2021; O’Hara and others, 2020) by means of, inter alia, species inventories (Kupriyanova and others, 2024a), the discovery of new species (Flaxman and Kupriyanova, 2024; Wu and others, 2021; Blake, 2023; Gunton and others, 2023; Georgieva and others, 2023; Zhang and others, 2020) and taxonomic revisions (Zhang and others, 2019). Underwater imagery and samples from the Coral Sea have provided new data on black corals (Horowitz and others, 2022), carnivorous sponges (Ekins and Hooper, 2023) and mesophotic reefs (Huang and others, 2024).

Warming waters have caused range shifts of benthic invertebrates across the region (Davis and others, 2023; Gervais and others, 2021), leading to ecosystem changes, especially in photic zones, such as kelp gardens shifting to urchin barrens (Ling and Keane, 2024; Balemi and Shears, 2023).

Warming waters and marine heatwaves (figure X) have reduced key habitat for marine invertebrates, such as giant kelp forests (Tait and others, 2021) and coral reefs (Henley and others, 2024), including through repeated bleaching events around Lord Howe Island, the world's southernmost coral reef (Moriarty and others, 2023). In Australia, extreme flooding, bushfires and heatwaves have been associated with freshwater plumes, sedimentation, turbidity and high temperatures, all of which have been shown to negatively impact certain benthic invertebrates (Larkin and others, 2024; Glasby and others, 2023; Barros and others, 2022).

Figure X

South Pacific: global and local stressors, associated pressures and recently documented consequences for marine benthic invertebrates



Source: Prepared by the writing team.

Note: Arrow width indicates relative importance of stressors at global and local scales.

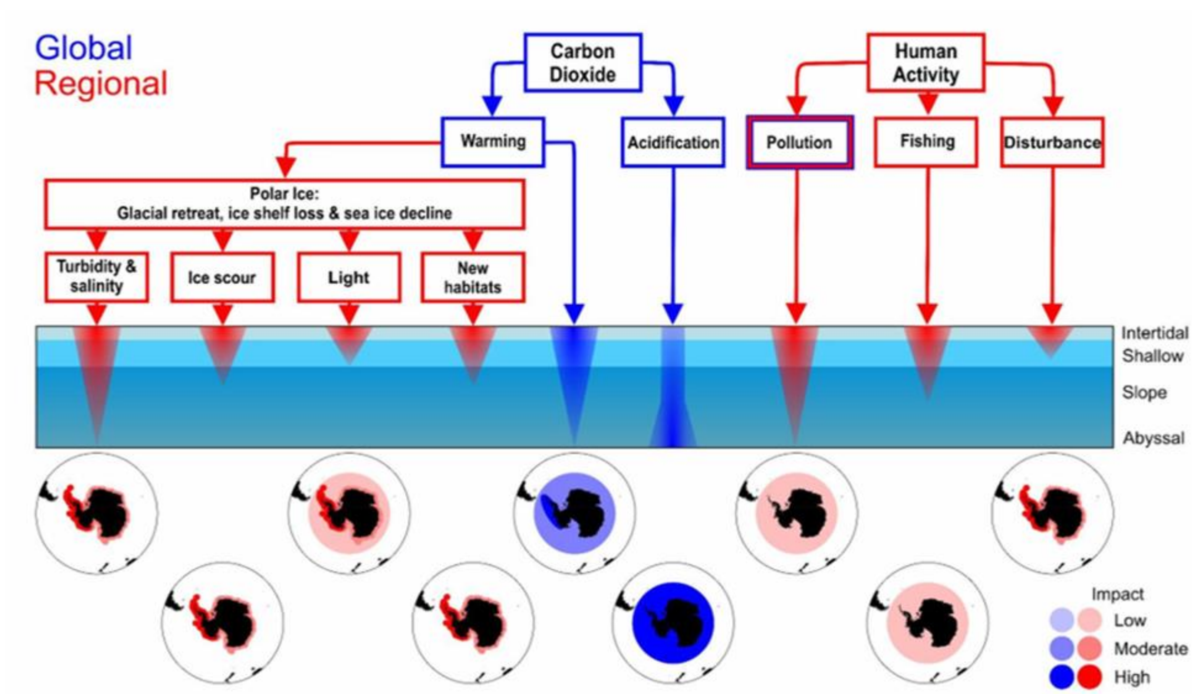
Southern Ocean

The ecosystems of Antarctica host a diverse, highly endemic community shaped by isolation and freezing temperatures. Projected changes (figure XI) will likely reach tipping points in physiological limits, primary productivity, ecosystem function and competition by the end of this century (Griffiths and others, 2024). These changes will affect Antarctic benthic ecosystem health, stability and uniqueness as endemic cold-water species decline and cosmopolitan species move south. Benthic changes remain poorly understood, with research focused mostly on a few shallow water taxa, requiring advanced technologies to address geographic, depth, seasonal and taxonomic gaps (Griffiths and others, 2024).

Cold-adapted species face threats from local and global drivers, including warming, acidification and changes to the cryosphere. The impacts vary by location, depth and community type, with the most significant changes observed in the shallows of the west Antarctic Peninsula (Griffiths and others, 2024). These include the emergence of newly exposed coastline (leading to new habitats), reduced sea ice and increased iceberg scouring and turbidity, leading to higher mortality, lower diversity and reduced primary production, carbon storage and spatial competition (Griffiths and others, 2024).

Figure XI

Southern Ocean: global and local stressors, associated pressures and recently documented consequences for marine benthic invertebrates



Source: Prepared by the writing team.

Note: Arrow width indicates relative importance of stressors at global and local scales.

3. Implications for achieving the targets of the Sustainable Development Goals of the 2030 Agenda for Sustainable Development

The preservation and sustainable management of marine ecosystems, a key focus of the Sustainable Development Goals, is closely tied to benthic fauna, which are crucial for ecosystem health and resilience. This connection is particularly evident in Goal 14, which is aimed at conserving and sustainably using the oceans, seas and marine resources. The conservation of benthic fauna also supports Goal 13 (climate action) and Goal 15 (life on land), as healthy marine ecosystems help to regulate the climate and maintain global ecological balance.

The negative biodiversity and ecosystem trends outlined in the present subchapter hinder progress towards the achievement of relevant Goals. Effective implementation of the Agreement on Marine Biological Diversity of Areas beyond National Jurisdiction to complement existing management measures and strengthened ocean management at the regional and national levels are crucial for advancing Goal 14. Increasing conservation-focused ocean management measures at the regional and national levels can support the achievement of Goal 14, contributing to addressing climate change (Goal 13) and reducing biodiversity loss (Kunming-Montreal Global Biodiversity Framework).

4. Key remaining knowledge and capacity gaps

(a) Marine invertebrates are underdocumented in the deep ocean, developing States and island States, and there are few experts on certain taxa;

(b) Increased digitization and genomic research are needed to identify cryptic species, integrate species information and improve accessibility;

(c) Documenting larval and juvenile settlement in deeper ecosystems remains challenging;

(d) Research on the biological pump and human impacts is needed;

(e) Local research and cooperation need improvement:

   (i) To activate skills and resources to use citizen and community science programmes to fill knowledge gaps;

   (ii) To develop effective succession planning and career development opportunities for early and mid-career marine scientists;

   (iii) To meaningfully and ethically consider Indigenous Peoples and First Nations and local knowledge;

   (iv) To secure consistent funding for long-term biodiversity monitoring;

(f) The recording of benthic invertebrates during assessments of commercial fisheries using bottom trawl should be used as a supplement to small-scale grab or underwater video methods;

(g) Ocean digital twins should be developed that compile available data and allow the development of future scenarios and predictions;

(h) Imaging techniques, possibly combined with artificial intelligence, can be used to monitor infrequently assessed, remote and inaccessible benthic ecosystems;

(i) Improved seabed management in relation to increasing human activities is needed;

(j) Networking across regions and disciplines is vital for understanding marine biodiversity, gathering key information, monitoring changes and conducting research on biodiversity patterns and processes, improving the societal relevance of research (Tolochko and others, 2021).

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