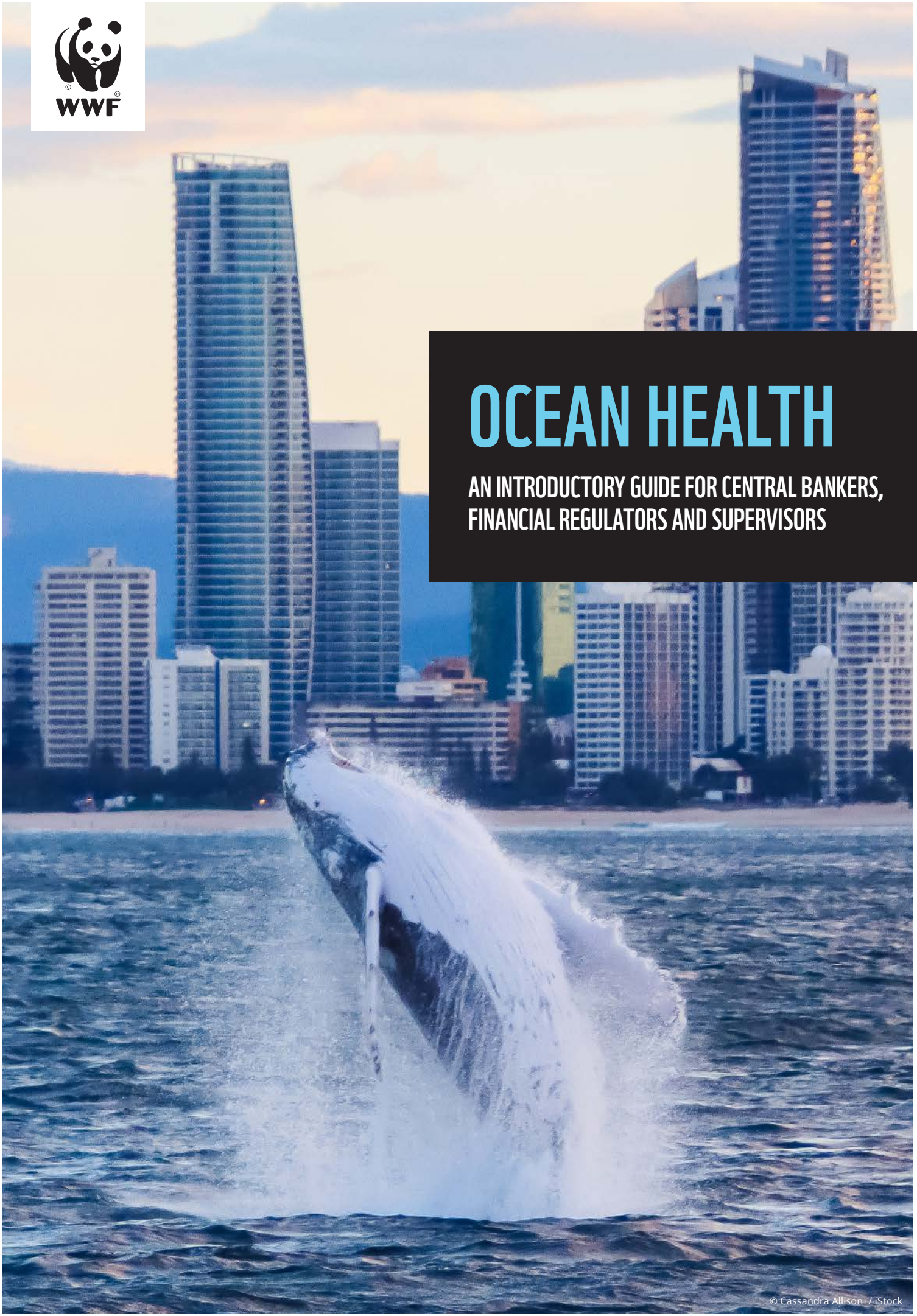

# OCEAN HEALTH

## AN INTRODUCTORY GUIDE FOR CENTRAL BANKERS, FINANCIAL REGULATORS AND SUPERVISORS

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# ACKNOWLEDGEMENTS

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### About WWF, and the Greening Financial Regulation and Blue Futures Initiatives

WWF is one of the world's most respected and experienced conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which people live in harmony with nature.

WWF has worked with the finance sector for more than a decade via innovative collaborations that seek to integrate ESG risks and opportunities into mainstream finance, to redirect financial flows in support of the global sustainable development agenda.

Through its **Greening Financial Regulation Initiative (GFRI)**, WWF engages specifically with central banks and financial supervisors as well as insurance regulators on the need to fully integrate climate and environmental risks into mandates and operations. To that end, WWF is releasing a series of guides on the different realms of nature to break the topic down into more digestible units, guiding central bankers, financial regulators and supervisors to the areas where it matters the most.

Meanwhile, **WWF's Blue Futures Initiative** focuses on addressing the financial risks associated with destructive business-as-usual practices in the ocean and works with mainstream finance actors towards redirecting finance towards Sustainable Blue Economy pathways that have the restoration, protection and sustainable management of coastal and ocean ecosystems as a primary objective. For more information, visit **wwf.panda.org/discover/oceans/ocean_finance/**

This guide is one of a three-part series. The first, on deforestation and conversion, was published in July 2024; the second, on oceans (this guide); and the third, on freshwater, will be published in early 2026.

The aim of this guide is to build bridges between the central banking community and ocean specialists. We invite readers, especially those linked to these communities, to embrace the guide with an open mind in order to appreciate the complex and unique ways in which ocean health and resilience are essential ingredients for world prosperity, which must therefore be managed – for our sake, and for the sake of future generations.

For more information, visit **panda.org/gfr** or contact us at **gfr@wwf.ch**

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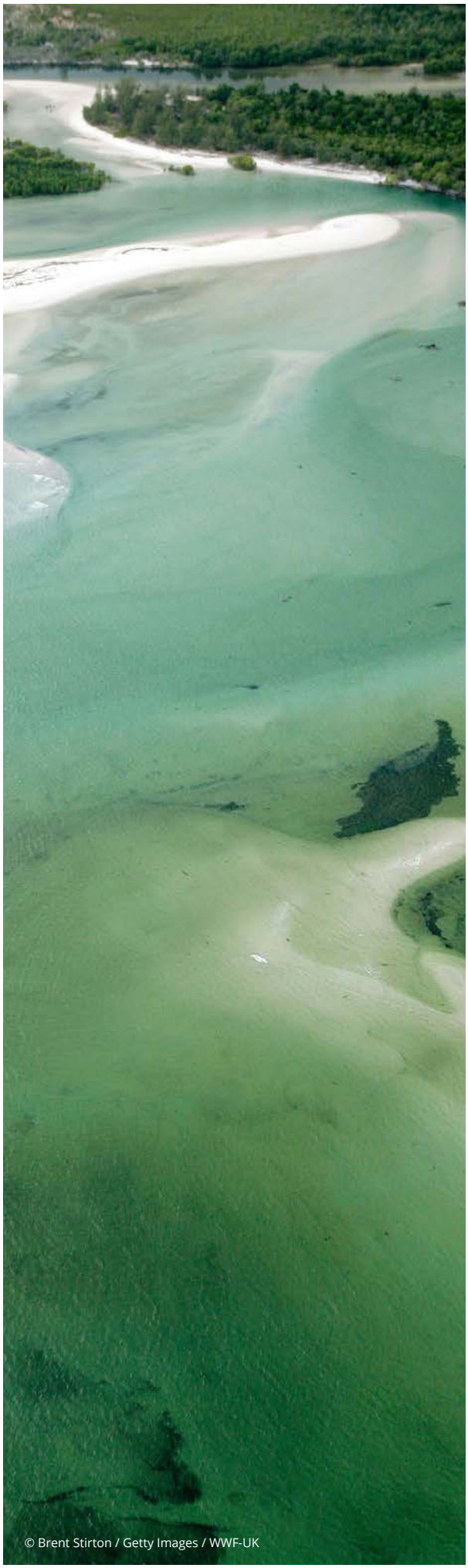

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# EXECUTIVE SUMMARY

**Ocean health:** why it matters for central banks, financial regulators, and supervisors. An introduction to the critical economic and financial stakes tied to the ocean, and what they can do about it.

Central banks and financial regulators, as supervisors at the apex of the banking system, are responsible for more than just the maintenance of price stability in the global economy. They are key actors leading the financial system, with core competencies and mandates in assessing, managing and guiding macro-economic and macro-financial risk. Over the past 20 years, central banks and financial regulators have increasingly made full use of their mandate to include greater consideration of risk factors originating outside the financial system, notably impacts and risks associated with climate change. This remit continues today, with increasing emphasis on accounting for systemic risks presented by nature loss and biodiversity decline. The Network on Greening the Financial System (NGFS) provides tools and resources to build a case for central banks and financial regulators to act on accounting for and managing both climate- and nature-related risks. This marks an encouraging evolution and provides a foundation to extending this work further. This paper outlines systemic exposures to ocean-related nature risks and their ripple effects through the rest of the global economy, and provides clear recommendations for action by central banks and financial regulators.

## WHY THE OCEAN IS MATERIAL FOR CENTRAL BANKS AND FINANCIAL REGULATORS – VALUE IS AT RISK

The economic activity taking place at sea and along coasts (often referred to as "the ocean economy") is substantial: its equivalent estimated value would make it the world's fifth-largest national economy (WWF, 2015). It has been growing faster than the global average since 1995 (UN Trade and Development [UNCTAD], 2025), although this growth has largely been driven by unsustainable 'business-as-usual' (BAU) practices which are degrading ocean health, putting long-term economic value and financial stability at risk.

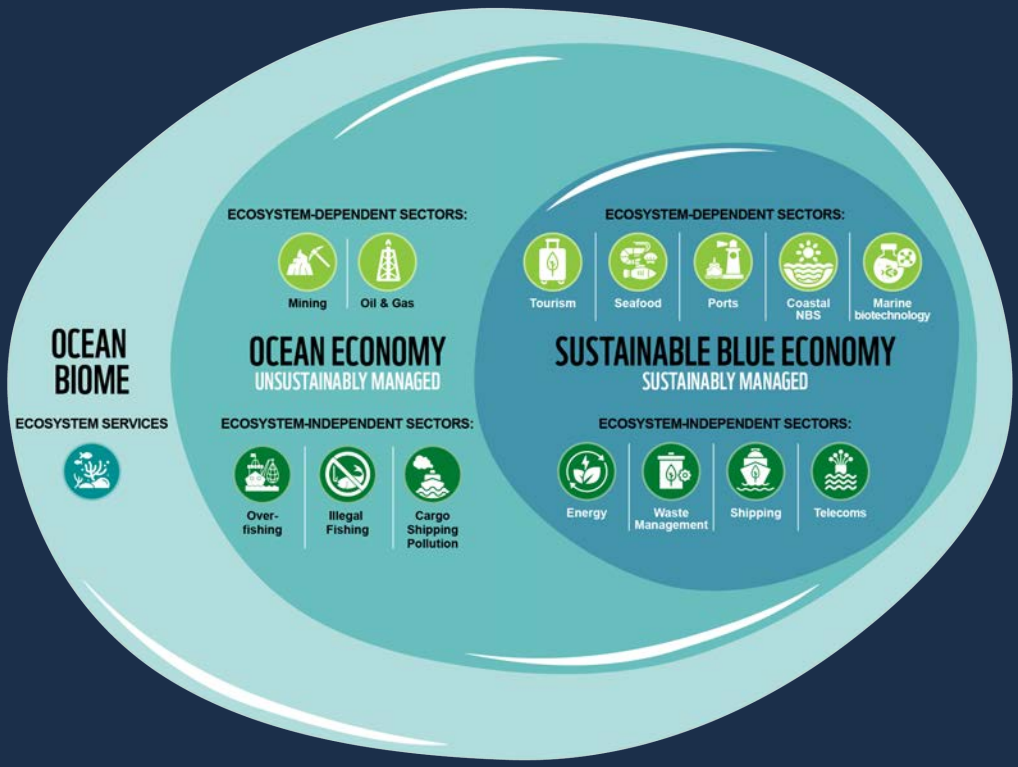
### WHAT IS THE SUSTAINABLE BLUE ECONOMY?

Unlike the broader ocean economy, which includes all ocean- and coastal-based economic activity regardless of its impact, the Sustainable Blue Economy (SBE) refers specifically to economic activities that are inclusive, environmentally sustainable, and support the regeneration of ocean ecosystems. WWF uses this term to highlight development pathways that protect both people and nature. More particularly, WWF (2015) has defined the SBE as one that:

- Provides social and economic benefits for current and future generations, by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity and political stability.
- Restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems – the natural capital upon which its prosperity depends.
- Is based on clean technologies, renewable energy, and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet.

Ocean ecosystems are under threat from direct drivers of biodiversity loss and ecosystem degradation: changes in land and sea use (including coastal reclamation), direct overexploitation of organisms (e.g. overfishing), climate change (including ocean warming and acidification), pollution and invasive species (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019).

These drivers often stem from ocean economic activities that themselves depend on healthy marine and coastal ecosystems. As a result, **up to 66% of publicly listed companies are exposed to risks associated with the decline of these ecosystem services** (WWF, 2021). The global financial system plays a role in this decline by continuing to direct the majority of capital toward BAU activities while flows to more sustainable alternatives are limited. UNEP (2023) estimates that **US$7 trillion of global financial flows currently contribute to nature loss**, with only US$200 billion supporting nature-based solutions. **These environmental impacts and economic dependencies present material climate- and nature-related risks to the wider economy. As such, they fall within the mandates of central banks and financial regulators responsible for financial and price stability.**




SUSTAINABLE DEVELOPMENT GOALS

# A SUSTAINABLE BLUE ECONOMY:

Restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems — the natural capital upon which its prosperity depends.

Is based on clean technologies, renewable energy, and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet.

Provides social and economic benefits for current and future generations by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity, and political stability.


***Figure 1:*** *First figure shows the relationship between the ocean biome and its ecosystem services, the ocean economy, and the Sustainable Blue Economy, while the second shows the Sustainable Blue Economy infinity loop.*

***Table 1:*** *Overview of sector-level risk exposure across ocean economy sectors under a BAU scenario between 2020 and 2035. Source: Navigating Ocean Risk (WWF, 2021).*

| SECTOR | SECTOR-LEVEL VALUE AT RISK (US$ BILLION) | CAUSES (OF BOTH PHYSICAL AND TRANSITION RISK) |
|---|---|---|
| **Ports and shipping** | 874 | Climate impact, storms and sea level rise. |
| **Fisheries and aquaculture** | 2,890 (31 for aquaculture) | Fishing effort: overfishing, habitat degradation from fishing. Nutrient pollution also contributes. Reputational risk from unsustainable fishing and unsustainable feed. |
| **Coastal tourism** | 655 | Degradation of coral reefs and mangroves, storm impact, plastic pollution. |
| **Coastal real estate and infrastructure** | 3,980 | Climate impact, notably coastal flooding and sea level rise affecting urbanized coastal populations. |
| **Marine renewable energy** | 8.6 | Limited climate impact through storm damage and potential nature impacts, including disturbance of marine habitats and species. |

## THE OCEAN-CLIMATE NEXUS

The ocean is inextricably linked to the global climate, acting as the primary regulator of global temperature and driving the transfer of heat from the equator to the poles (IPCC, 2019). A healthy ocean supports a healthy climate, and a changing climate will change the ocean. The combined challenges and interactions between ocean and climate are often described as the ocean-climate nexus, building on the climate-nature nexus (NGFS, 2024). **The nexus is partly physical: heat transfer, temperature regulation, and the water cycle which is shaped by ocean salinity and in turn influences precipitation and cloud cover.** Ocean salinity itself is being altered by warming seas (United Nations, 2021). The physical links between ocean and climate create a compelling case for emphasizing the ocean in the transition to net zero.

The biological component of the ocean-climate nexus is no less important. **Marine life is a globally significant carbon sink and locks in atmospheric carbon through ecological processes.** Ocean action includes conserving and restoring marine ecosystems that act as carbon sinks, such as mangroves, seagrasses and salt marshes (Diz *et al.*, 2021). Preventing their degradation – which can amplify climate change (Andersen *et al.*, 2024) – and strengthening their resilience to climate impacts is also critical. This perspective is reflected in the Ocean Panel's identification of five priority ocean-based climate solutions: scaling up ocean-based renewable energy, decarbonizing shipping, protecting and restoring coastal ecosystems, advancing sustainable ocean-based food, and exploring carbon storage in the seabed (Hoedg-Guldberg, *et al.*, 2019).

## TIPPING POINTS

Sustained or extreme pressure on an ecosystem as a result of the drivers of ocean health decline (for example, due to temperature or weather changes) can push its natural equilibrium to a tipping point – one wherein the functioning of the ecosystem 'tips over' from one regime to an alternate stable state, affecting the makeup of the ecosystem and the services it is able to provide. This can have substantial consequences for the economy and financial system (Marsden *et al.*, 2024). Once the ecosystem is in a new alternate stable state, changing it back to its original state may be difficult or even impossible (IPCC, 2019). In many cases, the conditions needed for recovery are stricter than those that caused the initial change, meaning that simply reducing pressure may not be enough to restore the original balance. This dynamic reflects the broader planetary boundaries framework, which identifies critical thresholds in Earth systems that, once crossed, risk irreversible and unpredictable environmental change (Stockholm Resilience Centre, 2025a).

A significant and noteworthy climatological tipping point exists in the state of the Atlantic Meridional Overturning Circulation (AMOC), a deep-water current that pumps heat across the Atlantic as part of the planetary circulatory system. The slowing-down of the AMOC would likely trigger changed weather patterns and reduced temperatures, affecting water availability and crop production (Jackson *et al.*, 2015; IPCC, 2019), with the impacts of a shutdown more significant. Evidence suggests that a slowing-down of the AMOC is already underway (Ditlevsen & Ditlevsen, 2023). Recent findings indicate that warm-water coral reef systems may have crossed a critical ecological tipping point, with reports of widespread mortality and transition toward a new, less recoverable stable state (Stockholm Resilience Centre, 2025b). Taken together, these findings highlight growing scientific concern that key systems are showing signs of stress, with potential long-term implications that warrant continued monitoring and research.

## MANAGING OCEAN-RELATED RISK

This paper builds on previous narratives on climate- and nature-related risk (NGFS, 2024) and ocean-related risk (Almeida & Reitmeier, 2024), and maps the channels through which these risks feed into macroeconomic and financial systems (see the system map below). Ocean-related risks arise from both environmental and financial sources, often driven by unsustainable economic activities that are enabled and incentivized by the financial system. As on land, the links between environmental degradation in the ocean and its financial consequences are strong. The drivers of marine biodiversity loss create direct physical risks for sectors that strongly rely on marine ecosystem services. In particular, diminished provisioning and regulatory services present notable risk to highly dependent sectors – for example, the risk of collapse in wild-capture fisheries as a result of overexploitation.

The overriding concern with physical risk and transition risk, as well as the high-impact systemic environmental risk that can occur as a result of crossing ecological tipping points, is the systemic risk they pose to the finance sector and broader macroeconomic stability. Each of these risk factors individually and collectively contribute to systemic risk to the economy as well as the financial system. Accumulating physical risks in particular can result in significant country-level changes in productivity, growth, inflation and the cost of capital through sector-wide instances of stranded assets, productivity decline, and disruption to established business models. Where transition risk factors resulting from ocean health decline are not actively managed upfront to reduce shocks to the real economy, these risks further compound macroeconomic impacts. At the level of the financial system, these risks manifest as uncertainty, lower returns, capital destruction and devaluation. Contagion effects further amplify their impact, and regulatory responses, such as fiscal tightening or rate changes, can unintentionally add to instability. Failing to manage physical and transition risks from declining ocean health can trigger cascading, self-reinforcing impacts that cause lasting harm to economic growth, productivity and welfare.

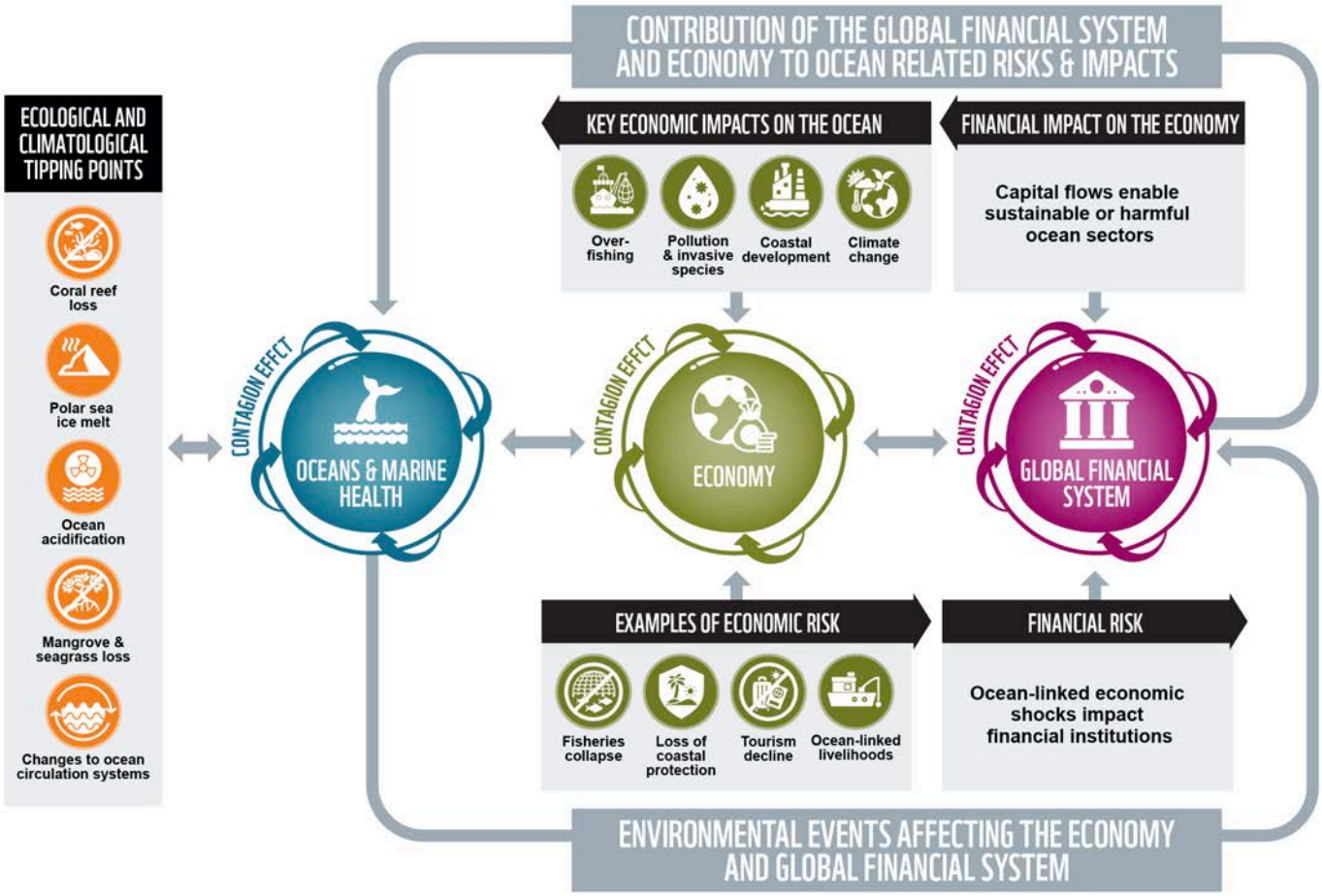



***Figure 2:*** *Transmission channels of ocean-related risks to the financial system. Adapted from NGFS (2023), Almeida & Reitmeier (2024) and WWF (2024).*

# CALL TO ACTION FOR CENTRAL BANKERS, FINANCIAL REGULATORS AND SUPERVISORS

The ocean is a global climate regulator and a foundation of economic prosperity (ECB, 2025) and as such the financial system should do its part in directing more capital into protecting the ocean and marine ecosystems.

In order to account for the UNOC 2025 outcomes and begin taking action on ocean-related issues, central banks and financial regulators are strongly recommended to integrate ocean-related risks into their activities, policies and regulatory frameworks. **Without taking the ocean into account, central banks and financial regulators will not be able to manage and mitigate climate- and nature-related risks.**

Through collective action, central banks and financial regulators can help **mainstream and standardize** the assessment of ocean-related risks and impacts. By engaging in international forums – such as the G20, where ocean sustainability is already on the political agenda through the Ocean20 – **central banks and financial regulators can highlight the importance of recognizing systemic risk linked to ocean health**. This may help leverage the G20's mandate to call on the Financial Stability Board (FSB) to expand its work in this area. The G20 can also engage through other platforms, such as the BRICS.

**Central banks and financial regulators have opportunities to engage with peers and collaborate across the financial system.** This includes linking existing work on climate- and nature-related risk mitigation with ocean-related issues. This collaboration can take place both domestically – through partnerships with other financial supervisors – and internationally – by engaging with other central banks and financial regulators, global initiatives and development finance institutions. Such cooperation can occur through bilateral dialogues, regional platforms, and broader multilateral forums.

The integration of ocean-related risks across ocean economy sectors in central bank monetary policy will help mitigate financial risks linked to ocean health decline and ensure that central bank lending activities do not contribute further to harmful activity in the ocean.

In doing so, central banks and financial regulators can learn lessons from the private sector, looking to commercial financial institutions such as banks and insurers for examples of how to integrate ocean sustainability into financing. While individual policies, risk management interventions and innovative financial transactions are positive steps, some financial institutions have begun to recognize that achieving a net-zero, resilient and nature-positive future requires a fundamental change in the way businesses operate.

This guide provides specific short- and medium-term recommendations for central banks and financial regulators to assess and manage ocean-related risks, address the drivers of ocean health decline from their own financing activities, and help advance the transition to a Sustainable Blue Economy.

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# CONTEXT AND ABOUT THIS GUIDE

The economic activity taking place in and around the ocean is substantial: in aggregate it is equivalent in value to the world's fifth-largest national economy (WWF, 2015). Collectively it is often referred to as 'the ocean economy,' which covers economic activity at sea and in coastal areas. The ocean economy has grown faster than the global average since 1995 (UN Trade and Development [UNCTAD], 2025), and in many cases steeply (Jouffray *et al.*, 2020).

While this growth has been rapid, an unsustainable economy is the major driver of declining ocean health. The ocean is under threat from direct drivers of biodiversity loss and ecosystem change – land and sea overexploitation and direct damage, climate change, pollution and invasive species (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019). Often, these drivers stem from the same ocean sectors that depend on the ecosystems they are degrading, presenting material risk to the whole economy.

The role of finance in contributing to these drivers is beginning to be understood, and frameworks such as the Taskforce on Nature-related Financial Disclosures (TNFD) are emerging to support financial institutions in assessing and acting on their exposure to nature-related risk. Central banks and financial regulators, due to their unique roles in both price stability and banking supervision, have clear exposure to and involvement in financing harmful activities on land (Network for Greening the Financial System [NGFS], 2024; WWF, 2024a). This paper maps out how they are similarly exposed to nature-related risk in the ocean, and provides clear recommendations for action.

Fortunately, opportunities for sustainable development exist. A subset of economic activity in the ocean, referred to here as the 'Sustainable Blue Economy' (SBE), centres around sustainable economic development and a just transition, while safeguarding ocean health and aligning with net-zero and nature-positive goals (WWF, 2015).

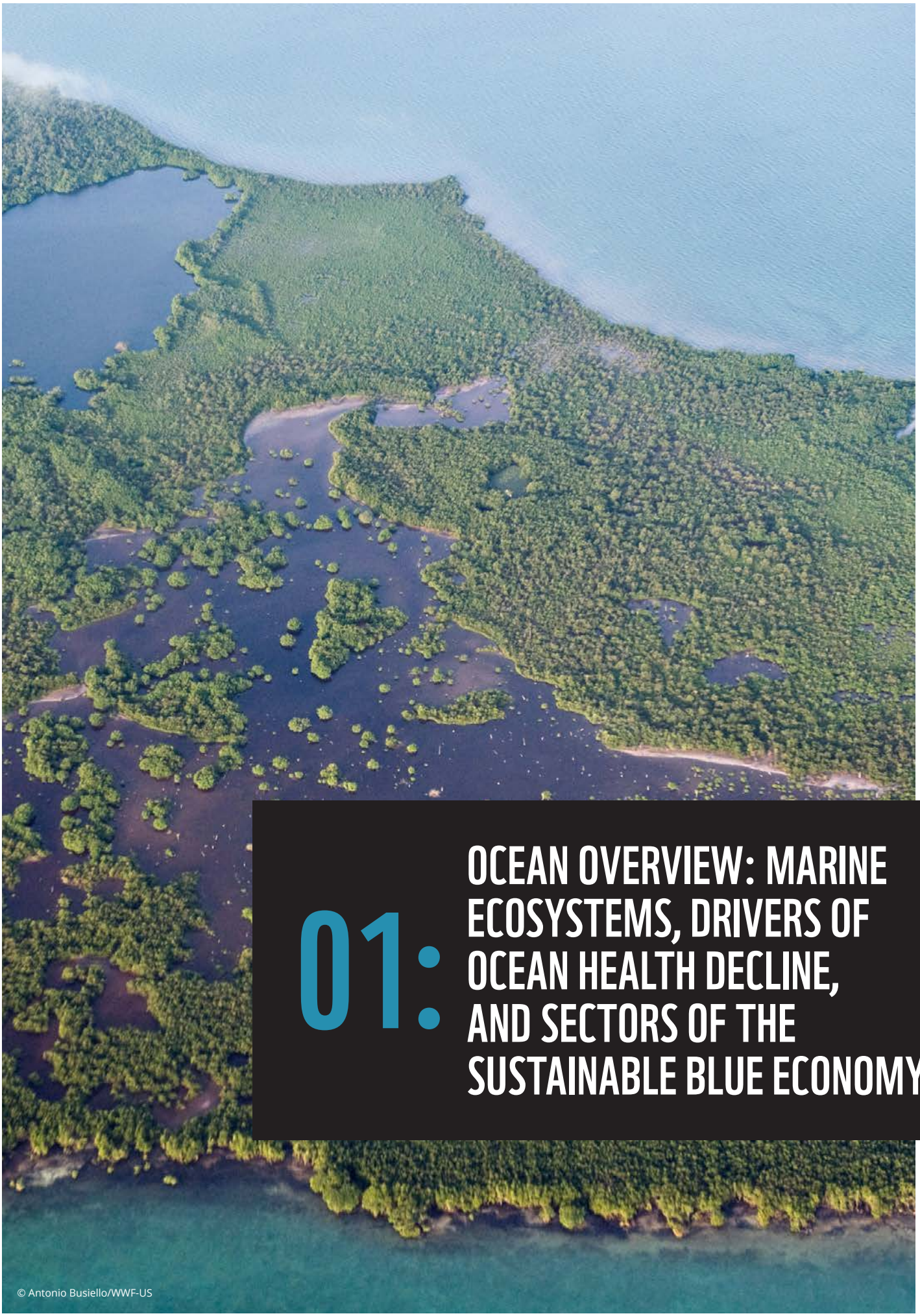
Financial institutions have an important role to play both in managing risk in the transition to a SBE and in capitalizing on the opportunities for sustainable development in the ocean. They also contribute to shaping the enabling conditions for this transition.

**Financial regulators and supervisors may currently contribute to the decline of ocean and marine ecosystems by not responding to the environmental impacts of the financial flows they oversee.** Harmful subsidies, inadequate disclosure requirements and a lack of integration of ocean-related risks into supervisory frameworks mean that capital continues to support activities that lead to overfishing, marine pollution and coastal habitat destruction, which in turn generate systemic financial risks. To reverse this trend, financial regulators can play a transformative role by incorporating ocean health into risk assessments, requiring transparency on marine impacts, and by incentivizing investment in SBE solutions, which will in turn contribute to the alignment of financial flows with international ocean protection goals.

This report presents this narrative in the context of central banks, financial regulators and supervisors introducing core concepts of ocean ecosystem service provision and the SBE; outlines drivers of ocean health decline; demonstrates the systemic importance of these issues to the financial sector; and highlights the role central banks and financial regulators play in contributing to the current state of affairs. It offers examples, tools and recommendations for improving ocean health, and enabling and implementing the transition to a SBE.

## ACRONYMS

| | | | |
|---|---|---|---|
| **DNB** | De Nederlandsche Bank; Central Bank of the Netherlands | **PBoC** | People's Bank of China |
| **IPBES** | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services | **SBE** | Sustainable Blue Economy |
| **IPCC** | Intergovernmental Panel on Climate Change | **SBTN** | Science-Based Targets Network |
| **IUU** | Illegal, unreported and unregulated | **SUSREG** | Sustainable Financial Regulations and Central Bank Activities |
| **MSP** | Marine Spatial Planning | **TNFD** | Taskforce on Nature-related Financial Disclosures |
| **NGFS** | Network on Greening the Financial System | **UNEP FI** | United Nations Environment Programme Finance Initiative |



# 01: OCEAN OVERVIEW: MARINE ECOSYSTEMS, DRIVERS OF OCEAN HEALTH DECLINE, AND SECTORS OF THE SUSTAINABLE BLUE ECONOMY

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# SECTION 01:

# OCEAN OVERVIEW: MARINE ECOSYSTEMS, DRIVERS OF OCEAN HEALTH DECLINE, AND SECTORS OF THE SUSTAINABLE BLUE ECONOMY

## NATURE IN THE OCEAN

The global ocean is central to planetary health. It regulates the global climate and absorbs the vast majority of atmospheric carbon (Intergovernmental Panel on Climate Change [IPCC], 2019). Every year, more is understood about the diversity of life in the marine environment, and notably about life in the fragile and little-studied deep ocean. The ocean and its surrounding coasts are rich in biodiversity, supporting the livelihoods and prosperity of coastal communities worldwide, with the overall value of key ocean assets estimated to be US$24 trillion[1] (Hoegh-Guldberg *et al.*, 2015). Some of the world's wealthiest nations owe their prosperity to the goods and services derived from the marine environment, including fishing (Angus, 2023). Ocean ecosystems range from coastal dunes to shallow-water reefs and deep trenches. Although the ocean spans 71% of the planet's surface, less is known about the diversity and function of these ecosystems, particularly deep-ocean ecosystems, than their terrestrial counterparts. Salient differences exist between land and ocean that should be understood by central banks and financial regulators (see Box 1).


1. This 'global ocean asset value' is calculated based on ocean-related activities and assets, including direct output from marine fisheries and ecosystems (US$6.9 trillion), trade and transport (US$5.2 trillion), and adjacent assets including productive coastlines (US$7.8 trillion) and carbon absorption (US$4.3 trillion). Given the challenges in assessing ecosystem service values, this figure is likely an underestimate of the true value (Hoegh-Guldberg *et al.*, 2015).

## BOX 1: WHY THE NEED FOR A SPECIAL FOCUS ON THE OCEAN?


The ocean is different in character to the land, and for the purposes of its sustainable development this carries some important consequences. Physically, where land can largely be considered a two-dimensional area, the ocean is a three-dimensional space, with ecosystems existing at different, but overlapping, depths and areas. This makes area-based management more complex, particularly where seabed stakeholders (and ecosystem services) are distinct from those in the water column above. Water is also more opaque than air, becoming even more so at greater depths – as a result, remote imaging of marine habitats is significantly more challenging than for their terrestrial counterparts, and there are only limited technologies available that make it possible to determine habitat health or integrity, for example, to any degree comparable to terrestrial ecosystems. As a result, costly and time-consuming in-situ measurement is often required to build a complete picture of the health of the ocean (Kavanaugh *et al.*, 2021).

Due to the sheer size and scale, as well as the connectivity provided by water and the stability of the marine environment, which undergoes fewer fluctuations than air and land, species and habitat ranges can be considerably larger and interconnected across ecosystems, making it difficult to isolate impacts and dependencies. Existing methods for nature-related DIRO (dependency, impact, opportunity and risk) assessment and locating the interface with nature as outlined by e.g. the TNFD's LEAP Framework, are therefore more challenging to implement in the marine environment. Similarly, management interventions in one area may not be sufficient to achieve conservation or sustainable development objectives without similar interventions elsewhere to fully capture species and habitat ranges or interactions. These physical challenges make understanding and acting on the science of the ocean more complex and costlier, and as a result there is generally less data available on the state of nature in the marine environment than on land. This underscores the need to support more systematic data collection.

At the same time, as humans (largely) don't live in the ocean but use it as a place for work and recreation, it is governed in a fundamentally different way to land, with resultant challenges for both management and finance. Much of the ocean beyond national jurisdictions is a global commons, and its legal status is often compared to outer space rather than to anywhere else on Earth. It falls under the aegis of a set of international maritime laws that apply to specific activities and behaviours (such as transit, resource extraction or pollution) which can be difficult to enforce (Szepes, 2013). Within national jurisdictions, layers of sovereignty extend out to different distances from the coast, and apply differently to the water column and the seabed as well as to extraction and navigation. In many jurisdictions there is no concept of private property or ownership of resources in marine spaces, which are instead held in public trust or as a public good (Campbell *et al.*, 2016), complicating liability, risk transfer and management. Ecosystem-based marine spatial planning (EB MSP) is a vital tool for dealing with the complexities of how the ocean is used and managed within exclusive economic zones (EEZs). These differences that do exist warrant special attention and a precautionary approach. They are factored into the key SBE considerations for central banks and financial regulators that are discussed in this paper.

Ocean ecosystems are typically classified either as continental shelf ecosystems (no more than 200m deep and adjacent to coasts) or as open ocean ecosystems (beyond the continental shelf, with an average depth of ~3.5km) (Table 2).

Coastal environments – featuring several ecosystems that provide vital services, including mangrove forests, coastal dunes, and brackish environments such as lagoons, estuaries and deltas – are all considered to be ocean ecosystems.

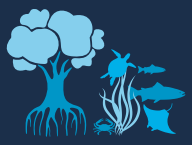
***Table 2:*** *Overview of commonly used ecosystem categorizations for the ocean. Source: NGFS (2024)*

| REALMS | | IUCN GLOBAL ECOSYSTEM TYPOLOGY (V2.1) | TNFD (2023) BASED ON IUCN GET AND UN SEEA | ENCORE (2024 VERSION) |
|---|---|---|---|---|
| **Ocean (including related transitional realms)** | **Marine** | • Marine shelf (M1)<br>• Pelagic ocean waters (M2)<br>• Deep sea floors (M3)<br>• Anthropogenic marine (M4) | • Marine shelf (M1)<br>• Open ocean waters (M2)<br>• Deep sea floors (M3)<br>• Artificial marine systems (M4) | • Marine shelves (M1)<br>• Pelagic ocean waters and sea floors (M2 + M3)<br>• Anthropogenic marine systems (M4) |
| | **Marine – Subterranean** | • Subterranean tidal (SM1) | • Subterranean tidal (SM1) | • Subterranean tidal (SM1) |
| | **Marine – Terrestrial** | • Shorelines (MT1)<br>• Supralittoral coastal (MT2)<br>• Anthropogenic shorelines (MT3) | • Shore systems (MT1)<br>• Maritime vegetation (MT2)<br>• Artificial shorelines (MT3) | • Shoreline systems (including Anthropogenic shorelines) and supralittoral coastal systems (MT1 + MT2 + MT3) |
| | **Marine – Freshwater** | • Semi-confined transitional waters (FM1) | • Coastal inlets and lagoons (FM1) | • Semi-confined transitional waters (FM1) |
| | **Marine – Freshwater – Terrestrial** | • Brackish tidal (MFT1) | • Brackish tidal systems (MFT1) | • Brackish tidal systems (MFT1) |

Each of these ecosystems provides vital goods and services, benefits to humanity that underpin multiple economic activities such as fishing and tourism, and critical societal functions such as coastal protection, food security and cultural priorities (see next section). The collective value of Antarctic and Southern Ocean ecosystem services, for example, is conservatively valued at US$180 billion per year (Stoeckl *et al.*, 2024). Two especially significant flagship ecosystems, which both capture public attention and provide substantial services to society, are coral reefs and mangrove forests. Mangroves provide ecosystem services estimated to be worth up to US$57,000 per hectare per year (Hoegh-Goldberg, 2015).

# SPOTLIGHT ON OCEAN ECOSYSTEMS: MANGROVES

Mangroves are coastal forests that are uniquely well adapted to growing in saltwater environments. Mangroves cover approximately 0.1% of the ocean floor, and although limited in scope, they are among the most effective carbon-sequestering habitats on Earth.

## MANGROVES AND BIODIVERSITY

Mangroves provide habitat for several protected species, and play an important ecological role as comparatively safe spawning and nursery grounds for many others. Their influence on marine life therefore reaches far beyond the extent of their cover.

## MANGROVES AND HUMANS

Mangrove ecosystems play a vital role as a nursery ground for commercially important species, in flood defence and in carbon sequestration. The value of mangroves rises up to over US$850,000 per hectare for critical mangrove habitat in the Caribbean (Beck *et al.*, 2022). Historically, mangroves have acted as a nursery ground for fisheries and as a source of fuel wood for coastal communities. More recently, coastal activity, particularly the rapid growth in aquaculture in Southeast Asia, has resulted in substantial losses in mangrove forest. Globally, mangrove areas declined by about 1.04 million hectares or around 6.6% between 1990 and 2020 (FAO, 2020).

## MANGROVES AND CLIMATE CHANGE

Mangrove forests store high quantities of carbon and are therefore highly effective carbon sinks. Globally, blue carbon ecosystems store an estimated 11.5 billion tonnes of carbon, with mangroves holding the largest share at 6.5 billion tonnes. Mangrove sediments sequester roughly 38.3 teragrams of carbon per year, and may trap carbon more quickly than ecosystems such as grasslands or tropical rainforests (Choudary *et al.*, 2024). The density of mangrove root systems and the extent of mangrove habitat also serve as defensive infrastructure for coastlines – breaking wave action, minimizing storm surges, preventing flooding, and mitigating the impact of storms.

# SPOTLIGHT ON OCEAN ECOSYSTEMS: CORAL REEFS

Coral reefs are biogenic habitats, built by the animals that inhabit them. They cover approximately 0.1% of the ocean floor. While corals are typically considered tropical, cold-water corals exist in higher latitudes. Corals are slow-growing and sensitive to environmental changes.


## CORAL REEFS AND BIODIVERSITY

Coral reefs are biodiversity hotspots, rivalling the diversity and complexity of tropical rainforests. Southeast Asia's Coral Triangle is particularly diverse, containing 76% of the world's coral species and 37% of the world's coral reef fish species.

## CORAL REEFS AND HUMANS

Humanity interacts with coral reefs primarily for fishing and tourism, with smaller industries in e.g. the trade in saltwater aquarium fish. Coral reefs also serve as natural storm breaks, attenuating wave impact during tropical cyclones. The world's largest reef, the Great Barrier Reef in Australia, is estimated to contribute around US$4 billion annually to the Australian economy (Deloitte Access Economics, 2017). Coral reefs are harmed by overfishing, nutrient runoff and pollution from land-based activities such as agriculture, and are particularly sensitive to climate change.

## CORAL REEFS AND CLIMATE CHANGE

Almost all warm-water coral reefs are projected to suffer significant losses even under a 1.5°C climate scenario (IPCC, 2019). Similarly, a recent study on global tipping points reports that widespread mortality of warm-water coral reefs is already occurring (Stockholm Resilience Centre, 2025b). Significant efforts are underway to strengthen their climate resilience and to prioritize the most resilient reef systems, for example through the Coral Reef Rescue Initiative.

# OCEAN ECOSYSTEM SERVICES

Aside from their functions in the natural world, ecosystem services can broadly be organized in terms of their utility to humanity. As such, they are grouped by how humans engage with or perceive them – whether they provide specific goods, services or amenity value. While their value to society is usually difficult to quantify, particularly in the case of regulating and supporting ecosystem services that provide non-market value (see figure below), ocean ecosystem services have clear intrinsic value in the support they provide for global society and the global economy.

In general, this value is not reflected in market prices for ocean goods, nor does it factor in governmental and corporate decision-making – as such, the true value of ocean services to humanity and the planet is mostly invisible to the economy. While clearly marine in focus, ocean ecosystem services include coastal ecosystems and their processes, and can begin as far as 100km inland (Barbier, 2017).

The four broad categories of ecosystem services are provisioning, regulating, cultural and supporting; these are briefly described in this section. Ecosystem services interact, and supporting services are particularly important in sustaining and enabling the remaining categories of service.

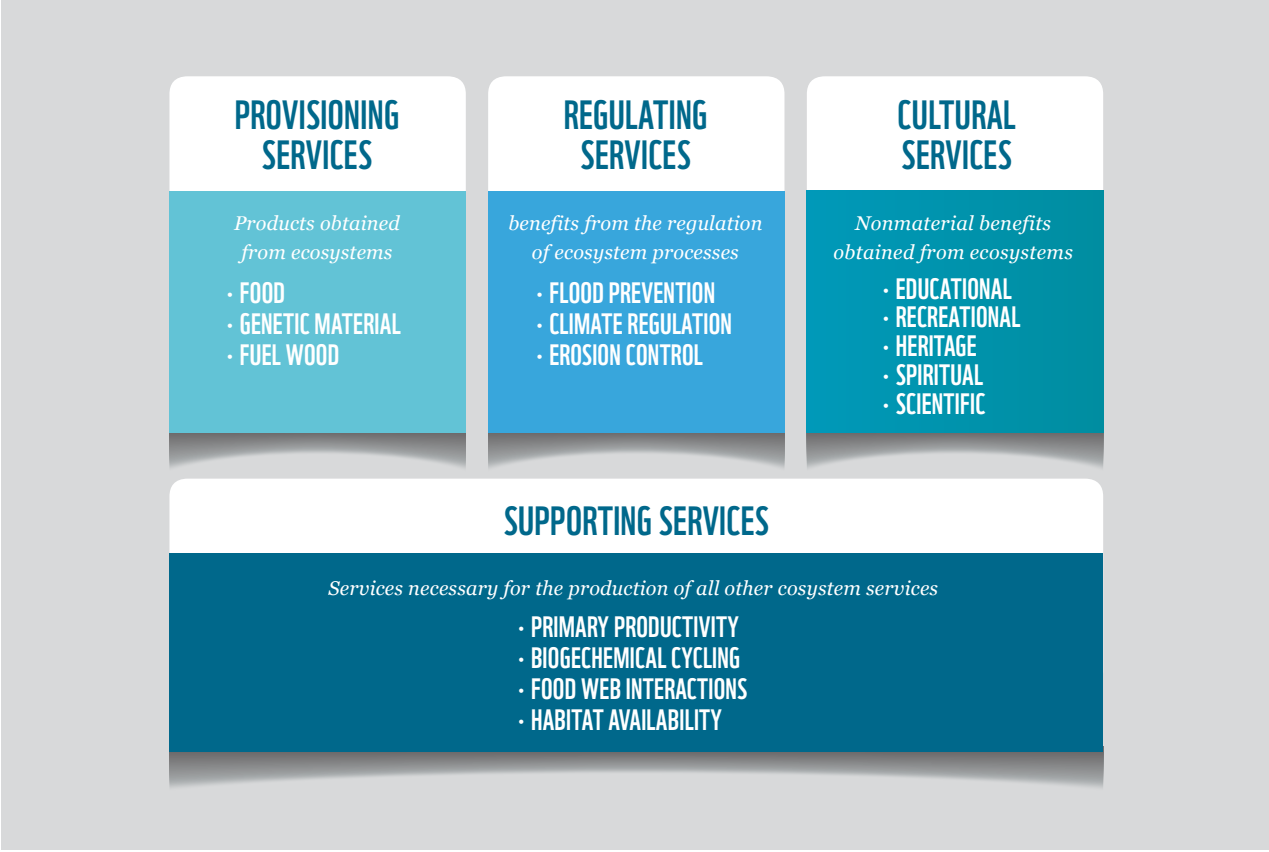



***Figure 3:*** *Overview of ecosystem services provided by the ocean, with examples per category. Adapted from source: Final Recommendations of the Interagency Ocean Policy Taskforce (2010).*

## PROVISIONING SERVICES

Provisioning services are those that produce products from the environment that humans use – in the case of the ocean, this primarily concerns seafood and materials derived from marine flora and fauna such as algal supplements, genetic resources for medicines, or fuel wood from coastal forests such as mangroves.

## REGULATING SERVICES

Regulating services are those that maintain the stability of the environment for humans. These include, for example, the ocean's role in climate mitigation as a carbon sink, as well as thermal transfer, moving heat from the equator to the poles and making higher latitudes habitable. Regulating services also act at more localized scales, for example through the flood and storm surge control provided by coral and mangrove habitats, and the stabilizing effect of dunes on coastlines. Regulating services are especially important cross-cutting services on which most blue economy sectors rely either directly or indirectly.

## CULTURAL SERVICES

Cultural services are those that provide recreational, spiritual or historic meaning to societies and communities. In the ocean, cultural services are typically found in coastal regions, and can include recreational environments in tourist areas, or the spiritual value of charismatic megafauna to coastal communities. While clearly significant in the tourism industry, cultural services are also important to consider in the context of fishing as well as in the siting of any installation or infrastructure, which can conflict with spaces considered historically or spiritually significant, disrupt historic access rights, or contribute to visual pollution and degrade the amenity value of a given space. The aesthetic value of coastal and marine environments also supports higher real estate prices.

## SUPPORTING SERVICES

Supporting services are those that support all other ecosystem services in their function. In the ocean they include primary production (conversion of solar energy to biomass), food web dynamics (nutrient transfer from one organism to another, for example to support populations of commercially significant fish), the maintenance of genetic diversity within species, biogeochemical cycles (pathways by which chemical elements move through abiotic and biotic compartments, such as the nitrogen cycle), and habitat availability and resilience. While less immediate in their benefits to humanity, they are fundamental to the functioning of nature and are therefore of great significance to the governance and management of marine spaces, and the industries that depend on them.

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# OCEAN HEALTH DECLINE – DRIVERS AND TIPPING POINTS

As on land, the health of the ocean is threatened by human activity. The general state of nature in the ocean is declining and undermining the ecosystem services on which society depends.

Since 1970, populations of different marine species have declined by 56%, undermining the resilience of entire marine ecosystems (WWF, 2024b). This decline, coupled with the ecological tipping points that it can trigger, places enormous value at risk – estimated by WWF (2021) to be US$8.4 trillion in the next 15 years, to which two-thirds of globally listed companies are exposed (see box 'Value at risk in the ocean' in the Environmental materiality section, below).

## DRIVERS OF OCEAN HEALTH DECLINE

Broadly speaking, there are five direct drivers of decline in biodiversity and ecosystem services in the ocean that are recognized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).[2] As on land, these drivers are the result of human activity on nature and in turn exert pressures that affect the state of nature in the ocean. While specific assessments of impacts on marine biodiversity and details on drivers of biodiversity loss in a marine setting are to date limited (Nordic Council of Ministers for the Environment and Climate 2023), the broad ramifications of these drivers for the ocean are outlined below. It is worth noting that these drivers interact with and compound one another, such that addressing ocean health decline and biodiversity loss requires a holistic perspective that goes beyond addressing individual drivers. For example, where overexploitation and climate change interact in a fishery, these collectively create a non-linear response in a fish population that reduces resilience (Vasilakopoulos & Marshall, 2015). Similarly, coral reefs that are already stressed by rising temperatures become more vulnerable to additional pressures, such as pollution or nutrient runoff, which can accelerate bleaching and reduce their capacity to recover (Donovan *et al.*, 2020).

### NATURAL RESOURCE USE AND EXPLOITATION

The most significant driver of marine biodiversity loss globally is the exploitation of marine living resources through overfishing (IPBES, 2020), which reduces populations of fish and affects ecosystem functionality due to disruption to the food web. Fishing pressure and fisheries management differ significantly from country to country (Food and Agriculture Organization of the United Nations [FAO], 2024a), with fishing being both a subsistence activity in dependent artisanal communities (Virdin *et al.*, 2023) and a highly industrialized sector producing US$195 billion in trade value in 2024 (FAO, 2024a). Directly tied to consumption as well as indirect socioeconomic drivers, exploitation is driven by per capita consumption of resources, considered a more significant driver of biodiversity and ecosystem change than population growth (IPBES, 2020). The emergence of the middle class in developing countries and the associated increase in demand for seafood – including both for direct human consumption and the roughly 20% of the marine catch used for fishmeal and feedstock for aquaculture and livestock (Issifu *et al.*, 2022; FAO, 2024a) – continues to drive a trend of overexploitation of marine resources. In addition, proposals for deep seabed mining represent a looming threat, raising serious concerns over widespread and possibly irreversible impacts on deep-sea ecosystems.

2. The direct drivers are complemented by indirect drivers of change that are 'underlying causes', including e.g. economic growth, demographic change, consumption patterns, technological innovation and public policy (IPBES, 2020).


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## POLLUTION

Pollution in the marine environment takes many forms, including the familiar chemical sources of pollution from industrial activity and vessels, alongside noise, light and electromagnetic pollution associated with construction activity (including for sectors broadly considered beneficial for the climate transition, such as offshore wind). Marine pollution originates both from activities at sea and from land-based sources such as agricultural runoff and untreated wastewater. Nutrient loading from agriculture can cause oxygen depletion in coastal waters (Diaz & Rosenberg 2008), leading to marine 'dead zones' that are no longer able to support complex life. Pollution of different types reduces the health of marine organisms to a greater or lesser extent (Mearns *et al.*, 2017), affecting growth and reproduction and thereby reducing the integrity and resilience of ecosystems.

Ocean acidification is a pollution effect of climate change and alters marine biogeochemistry. This in turn reduces the fitness of calcium-building phytoplankton that sit at the base of the food web (Dutkiewicz *et al.*, 2015), impacting entire ecosystems and reducing their functionality (Zunino *et al.*, 2021). Ocean acidification is also recognized as one of the nine planetary boundaries (Rockström *et al.*, 2024), underscoring its significance as a global systemic risk.

Plastic pollution is an additional driver of ocean health decline. It has physical consequences such as injuring or killing animals through ingestion (Wilcox *et al.*, 2015). Both acute change, for example as a result of the construction of a new offshore installation on an oyster reef, as well as chronic use change, for example due to continuous scouring of the seabed from fishing activity or anchoring of merchant vessels, can contribute to the destruction and degradation of marine habitats. This reduces ecosystem functionality and can result in the immediate loss of regulating and cultural ecosystem services, such as when the natural flood defences provided by a mangrove forest are erased as a result of land conversion.

## CLIMATE CHANGE

The ocean is the world's largest carbon sink (Gruber *et al.*, 2023) and, like land, is directly impacted by a warming planet. Unlike air, water has a higher specific heat capacity and can absorb substantial amounts of energy before changing temperature. This means that the ocean acts as a planetary heat sink, with comparatively stable temperatures over time. As a result, marine life is significantly more sensitive to temperature change than life on land (Pinsky *et al.*, 2019), and even small temperature changes in the marine environment can result in biodiversity loss.

Due to the 'lock in' of historic emissions and their long-term impact on the atmosphere and ocean, even if emissions are reduced to net zero by 2050, the impacts of climate change on the ocean will still be felt. As a result, climate change is a major driver of marine biodiversity loss, with the majority of the world's coral reefs expected not to survive warmer ocean waters, even under a 1.5°C scenario (IPCC, 2019). Polar and equatorial regions are expected to be most severely impacted by a warming ocean. Nature does not respect man-made boundaries, and climate change is already driving changes in the distribution of marine life, with commercially significant fish species crossing jurisdictional boundaries and affecting commercial catch opportunities, international relations and local livelihoods (Morley *et al.*, 2018).

The ocean's role as a planetary heat sink also affects global weather patterns, and warmer ocean water appears to be driving stronger El Niño cycles (Cai *et al.*, 2014). It also produces stronger weather events, including more intense tropical cyclones (Gilford *et al.*, 2024), leading to additional impacts on marine species and habitats.

## BOX 2: THE OCEAN-CLIMATE NEXUS


The ocean is inextricably linked to the global climate, acting as the primary regulator of global temperature and the transfer of heat from the equator to the poles (IPCC, 2019). A healthy ocean supports a healthy climate, and a changing climate will change the ocean. As a result, it is helpful to think of the combined challenges and interactions between ocean and climate as the ocean-climate nexus, building on the concept of the climate-nature nexus (NGFS, 2024) coined to describe similar dynamics between climate and nature.

Part of the ocean-climate nexus is physical, affecting abiotic parameters that impact on life but are not influenced by it. This includes heat transfer and temperature regulation as well as the water cycle, which is affected by ocean salinity and affects precipitation and cloud cover. Ocean salinity, in turn, is being affected by ocean warming (United Nations, 2021). The physical links between ocean and climate create a compelling case for emphasizing the importance of the ocean in the transition to net zero. They also translate directly into economic risks, particularly through damage to coastal infrastructure and the displacement of communities in vulnerable coastal zones.

The biological component to the ocean-climate nexus is no less important. Marine life is a globally significant carbon sink and locks atmospheric carbon within ecological processes. Ocean action includes conserving and restoring marine habitats that store carbon, such as mangroves, seagrasses and salt marshes (Diz *et al.*, 2021), and preventing degradation that amplifies climate change (Andersen *et al.*, 2024). Addressing climate impacts that affect the health and resilience of these ecosystems is also ocean action. This perspective aligns with the Ocean Panel's identification of five priority ocean-based climate solutions: scaling up ocean-based renewable energy, decarbonizing shipping, protecting and restoring coastal ecosystems, advancing sustainable ocean-based food, and exploring carbon storage in the seabed (Ocean Panel, 2020).

## INVASIVE SPECIES

Much as on land, invasive species in the marine environment can outcompete native populations, alter ecosystem functioning, and affect output from fishing and aquaculture (Gallardo *et al.*, 2015), although the extent of their impact varies by species and their role in the ecosystem (Anton *et al.*, 2019). While the exact economic cost of invasive species is difficult to quantify, known economic costs associated with invasive marine species are estimated at US$3.6 billion since 1971 (Cuthbert *et al.*, 2021) – this is likely an underestimate due to limited knowledge (Haubrock *et al.*, 2022).

Many ocean economy sectors can act as vectors for invasive species, particularly the global shipping fleet which crosses ecosystems and habitats and is known to transport invasive species in its ballast water and on ship hulls (Molnar, 2008). Artificial channels that link ecologically distinct biomes, such as the Panama and Suez Canals, are also significant vectors for invasive species transmission (Galil *et al.*, 2016). Any substrates introduced into the marine environment, such as offshore wind turbines or oil and gas platforms, can become habitats for invasive species (Watson *et al.*, 2024) and contribute to the loss of marine biodiversity.

# TIPPING POINTS IN OCEAN ECOSYSTEMS

Ecosystems, when healthy, are generally more resilient to external shocks in their structure and function. Like many natural systems, they operate in a state of 'dynamic equilibrium', where fluctuations in climate conditions, resource availability and population dynamics exist, but are absorbed within the bounds of an ecosystem's functioning.

However, sustained pressure or extreme alteration to the parameters of an ecosystem (for example, due to temperature or weather changes, or the collapse in the population of a particular species) can push the state of equilibrium to a tipping point, where the functioning of the ecosystem 'tips over' from one regime to an alternate stable state, affecting the services the ecosystem is able to provide. Once in a new stable state, the ecosystem is in a new dynamic equilibrium. In these cases, changing the ecosystem back to its original state may be difficult or impossible (IPCC, 2019), particularly where the threshold to return to the original condition is not in the same place as the threshold that was initially crossed. The diagram below, while a substantial oversimplification of the functioning of ecosystems and factors involved, illustrates the change in regime that an ecosystem can adopt as a result of human pressure.

The drivers of ocean health decline outlined in this section are pressures that move ecosystems towards these tipping points, which can have substantial economic consequences (Marsden *et al.*, 2024). There are real-world examples of the impacts of a marine ecosystem crossing over into an alternate state: for example, recent evidence shows that the Western Baltic cod population has crossed a tipping point, resulting in the collapse of the fishery and the emergence of a stable low-productivity regime due to a combination of overexploitation, eutrophication and climate change (Möllmann *et al.*, 2021; Moll *et al.*, 2024). According to Möllmann *et al.* (2021), ignorance of productivity changes in the stock was a major reason for the collapse. The authors add that while the fishery "has only a comparatively low direct economic importance… its indirect economic value through local employment and tourism is assumed to be huge".

A significant and noteworthy climatological tipping point exists in the state of the Atlantic Meridional Overturning Circulation (AMOC), a deep-water current that pumps heat across the Atlantic as part of a planetary thermohaline circulation. The slowing-down of the AMOC would likely trigger changed weather patterns and reduced temperatures in Europe, affecting water availability and crop production (Jackson *et al.*, 2015; IPCC, 2019), with the impacts of a shutdown more significant; evidence suggests a slowing-down is currently underway (Ditlevsen & Ditlevsen, 2023).

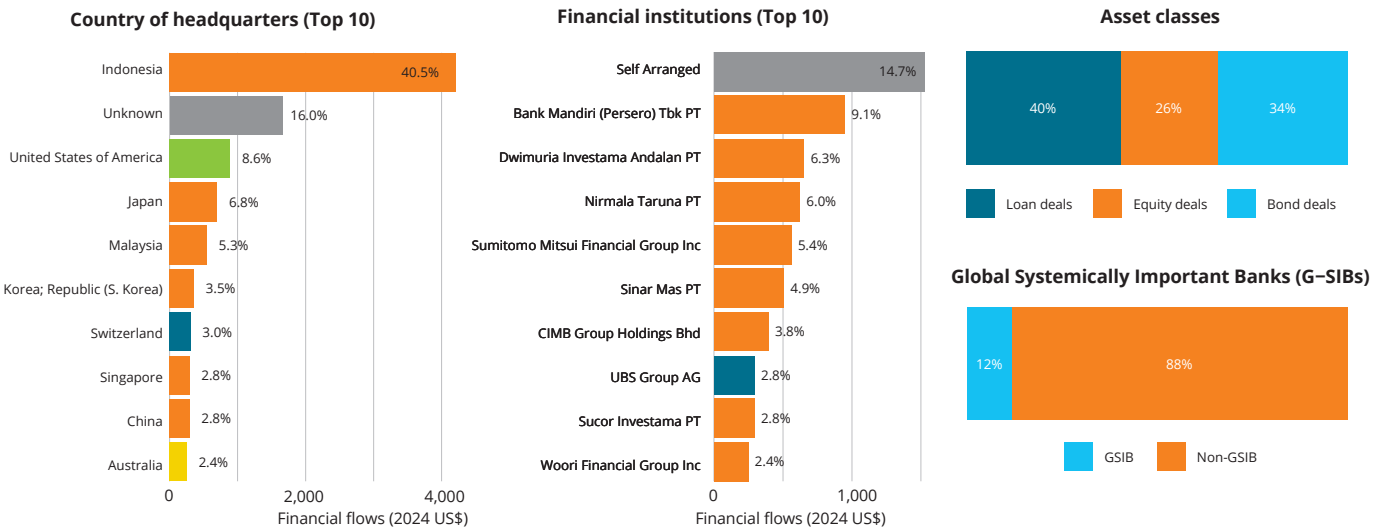
As society continues to exceed planetary boundaries (Caesar *et al.*, 2024), a number of tipping points across different ecosystems and entire biomes are possible and indeed likely (IPCC, 2019). In the case of the ocean, due to the complexity of the ecosystems involved and the limited data available, it is unclear exactly where tipping points lie. Nevertheless, the significance of the impacts of crossing these tipping points provides a compelling case for urgent action to address ocean health decline.

# CASE STUDY

## FINANCIAL FLOWS AND MANGROVE LOSS IN INDONESIA
### (UCL IIPP AND WWF, 2025)

**Mangroves are critical ecosystems facing tipping points under interacting pressures, notably land-use change and climate change. Over 20% of the world's mangrove cover is in Indonesia (more than double that of any other country), yet extensive losses have occurred since 2000 due to conversion for shrimp aquaculture and palm oil plantations.**

Between 2014 and 2024, financial flows totalling US$10.3 billion went to companies potentially linked to mangrove degradation from these sectors. Most of these flows originated from Indonesian financial institutions, including state-owned banks, alongside significant "self-arranged" financing by companies themselves. Financial institutions in the US were also notable contributors.


These findings underscore the systemic financial risks tied to ecosystem tipping points and the role of financial flows in accelerating nature loss. For central banks and financial regulators in ecosystem-financing countries, the implications are clear:

- **Policy tools should influence the price and availability of finance to companies driving ecosystem degradation**, including through collateral, disclosure, and supervisory frameworks.
- Action **must address multiple asset classes beyond bank lending**, incorporate corporate group structures, and consider global justice dimensions given the international nature of capital flows.
- Focusing on ecosystems at risk of tipping points, such as mangroves, offers an **entry point for an ecosystem-based approach to managing nature-related financial risk**, while ensuring risks are not simply displaced elsewhere.

# THE SECTORS OF THE SUSTAINABLE BLUE ECONOMY

Ocean economy sectors are directly and indirectly at risk of loss in value if the drivers of ocean health decline – many of which are endogenous, stemming from the ocean economy itself – continue to threaten vital ecosystem services.

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At the same time, some sectors of the ocean economy can be made compatible with notions of sustainability, reducing their harmful impact on the marine environment and supporting principles of sustainable development. It is therefore helpful to characterize the differences between the sectors of the ocean economy that are directly at risk because of natural capital losses (ecosystem-dependent, such as commercial fisheries), those that are indirectly at risk (ecosystem-independent, such as marine renewables), those that can transition to become part of the SBE, and those that are inherently unsustainable (harmful sectors such as seabed mining and oil and gas extraction that are not discussed further in this report) (figure 3, page 16). It is crucial to note that different sectors depend on the health of the ocean to different degrees: some, such as seafood and tourism, are directly reliant on ecosystem services, while others, such as shipping or offshore energy, are less directly dependent but may still face material risks through climate impacts, regulation, or reputational pressures. Inherently unsustainable activities lie outside the scope of a SBE.

It is important to differentiate the ocean economy – which encompasses all economic activity on the ocean and coasts regardless of its social and environmental impact – from a SBE that focuses on inclusive, sustainable and regenerative development pathways. WWF has defined a Sustainable Blue Economy[3] as one that:

- Provides social and economic benefits for current and future generations, by contributing to food security, poverty eradication, livelihoods, income, employment, health, safety, equity and political stability.
- Restores, protects and maintains the diversity, productivity, resilience, core functions, and intrinsic value of marine ecosystems – the natural capital upon which its prosperity depends.
- Is based on clean technologies, renewable energy and circular material flows to secure economic and social stability over time, while keeping within the limits of one planet (WWF, 2015).

3. This definition is shared by UNEP FI's Sustainable Blue Economy Finance Initiative.

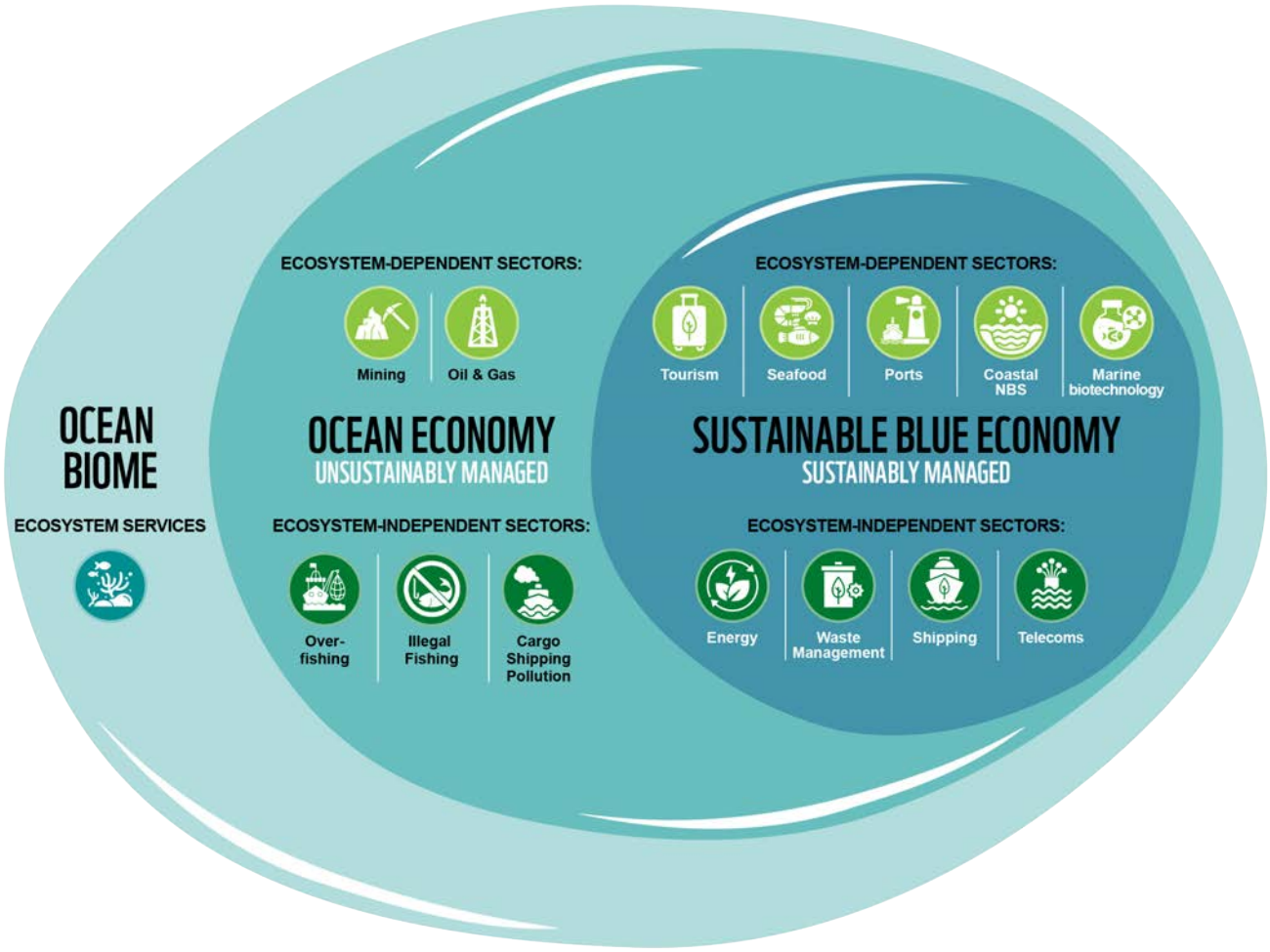


***Figure 4:*** *Venn diagram outlining the relationship between the ocean biome and its ecosystem services, the ocean economy, and the Susainable Blue Economy.*

This paper focuses on a selection of ocean economy sectors with the potential to transition to a SBE, and does not cover harmful, non-renewable extractive sectors.

This section provides a brief overview of the most significant ocean economy sectors that have the opportunity to transition to being part of the SBE, and their direct dependencies and impacts on the state of nature and ecosystem services. This includes established activities such as fisheries, aquaculture, tourism, ports and shipping, as well as emerging areas like marine biotechnology (see Blasiak *et al.*, 2023). For clarity, this document uses the term 'ocean economy' to describe current and general economic activity in the ocean, whether it is sustainable or not, and 'Sustainable Blue Economy' (or SBE) to discuss activity or the need for transition in line with the definition above. The United Nations Environment Programme Finance Initiative (UNEP FI) publications Turning the Tide (UNEP FI, 2021a) and Diving Deep (UNEP FI, 2022a) provide further information on these sectors, their social and environmental impacts, and the material social and environmental risks facing financial institutions as a result.

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# SEAFOOD (FISHING AND AQUACULTURE)

Seafood, comprising both wild-caught and farmed fish (aquaculture), is a globally significant source of food security[4] and livelihoods[5], with the majority of production taking place in Asia (FAO, 2024a). Production from seafood is expected to increase by 10% by 2032, driven by growth in aquaculture and the recovery of overfished capture fisheries (ibid). Seafood activities also include downstream processing and trade, which carry additional risks and opportunities, particularly around transparency and traceability in global supply chains.

As one of the world's oldest economic activities, fishing (understood here as the commercial capture of wild fish and other seafood from marine sources) is a firmly established sector of the ocean economy. However, commercial fishing relies directly on nature for its productivity and is wholly dependent on provisioning and supporting ecosystem services for its viability. At the same time, unsustainable fishing activities can be some of the most environmentally harmful in the ocean, with overfishing, bycatch and destructive fishing practices contributing to the endangerment of multiple species (Dulvy *et al.*, 2021) as well as habitat destruction (IPBES, 2020). Due to a substantial increase in fishing effort over the last 50 years, as well as current and historic overfishing in many parts of the world, some fish populations have continued to decline and fisheries productivity worldwide has plateaued at approximately 86-94 million tonnes per year since the late 1980s (FAO, 2024). Illegal, unreported and unregulated (IUU) fishing is another major source of loss, with global annual losses estimated at US$10-23 billion (Agnew *et al.*, 2009). Regional assessments reflect similar challenges; for instance WWF (2023) also estimated significant foregone revenue from IUU shrimp and tuna fishing in the Southwest Indian Ocean. The financial sector is beginning to respond; for instance, some insurers have introduced exclusions for vessels engaged in IUU fishing (WWF & Deloitte, 2023).

As a result, opportunities to transition fishing towards sustainability are tied clearly and directly to a combination of measures, including rebuilding wild fish stocks, addressing IUU fishing, reducing overcapacity and harmful subsidies, managing impacts on ecosystems and non-target species, improving supply chain transparency and traceability, and reducing loss and waste. Multiple efforts in this regard are already underway, and certification of fisheries (for example by the Marine Stewardship Council [MSC] – a useful and recognized global benchmark for assessing the environmental performance of wild-capture fisheries) has increased the availability and incentives for sourcing and retail of fish products certified by the MSC.

Activity in sustainable finance has focused on financing fisheries recovery and sustainability since the 2009 publication of a joint FAO and World Bank study (Kelleher & Arnason, 2009) which suggested that US$50 billion of revenue per year was lost due to unsustainable management. It was later updated to suggest that over US$80 billion of revenue was lost in 2017 (World Bank, 2017). Interventions in fisheries management practices have been a focus of prominent debt conversion deals (also known as debt-for-nature swaps) in recent years, notably in Seychelles and Belize, where savings generated through debt conversion have been allocated towards conservation activity and supporting sustainable fisheries management (The Nature Conservancy [TNC], 2023).

Aquaculture, the farming of fish and other seafood, though practised in certain forms since antiquity, has undergone rapid expansion since the second half of the 20th century (FAO, 2024a). It has been one of the drivers of the growth in the ocean economy, with a 24% increase in the European Union since 2020 (European Commission, 2024). As a rapidly growing and increasingly dominant sector, aquaculture overtook wild-capture fishing as the primary source of global seafood for the first time in 2022-2023


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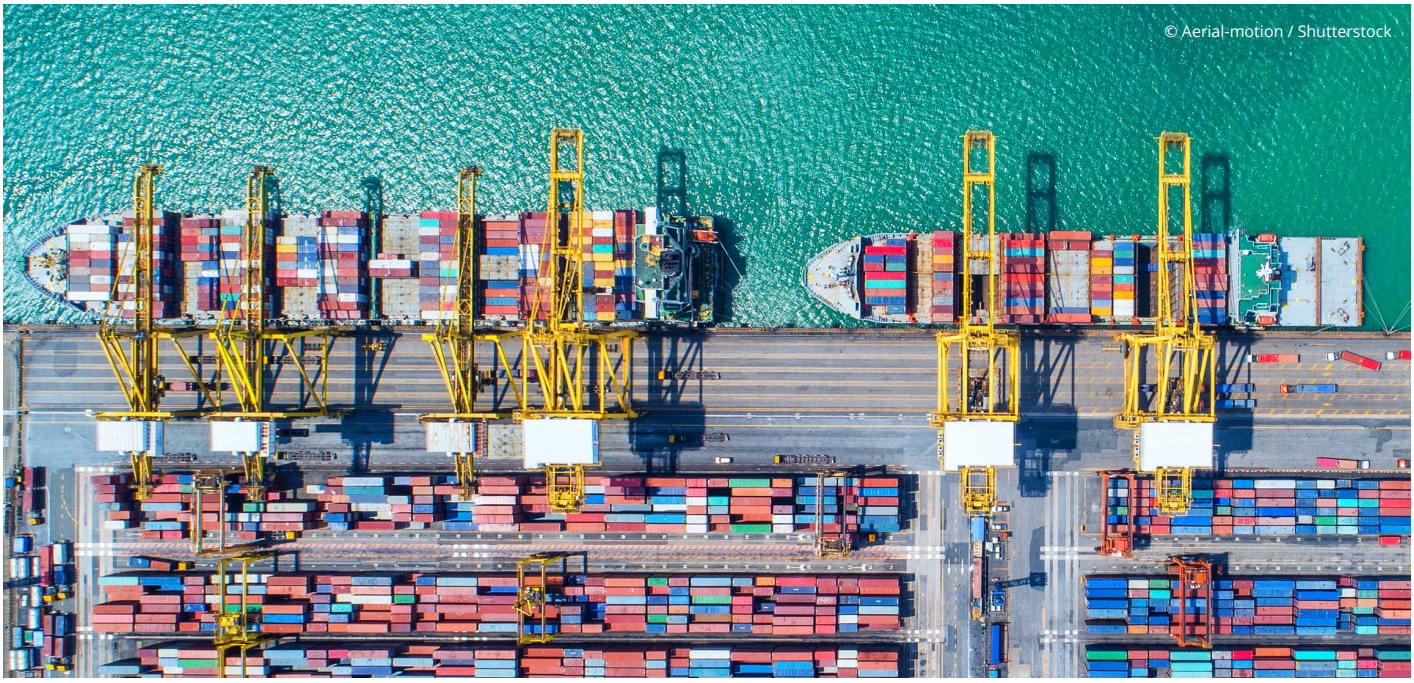
(FAO 2024a). Growth in demand for seafood, particularly from emergent middle classes in Asia and Africa, is predicted to drive continued development of both extensive and intensive aquaculture production worldwide (ibid). As a result, investor confidence in aquaculture growth is significantly higher than in wild-caught fisheries (UNEP FI, 2021b).

While aquaculture is less reliant on ecosystem services than wild-capture fisheries, it is still dependent on the state of nature and provisioning ecosystem services. One example is its reliance on small pelagic species that are reduced to fishmeal and fish oil for rearing carnivorous farmed species such as salmon. This links aquaculture growth directly to wild-capture fisheries (WWF, 2025a; Roberts *et al*., 2024). Recent studies estimate that about 11% of wild-caught fish are used in aquaculture feed, with an additional 5% going to land-based livestock production (Roberts *et al*., 2024). This reliance raises concerns about unintended consequences of aquaculture expansion for fisheries conservation (Longo & York, 2024). It also depends on suitable environmental conditions, including water quality, temperature, circulation and nutrient dynamics, as well as ecosystem services such as waste assimilation, disease control, habitat provision, and primary production.

Due to its rapid growth, the environmental impacts of aquaculture are becoming increasingly important to consider and manage in its transition to a sustainable model. Extensive land conversion for aquaculture ponds, particularly in Southeast Asia, has directly resulted in 28% of total mangrove loss, or 544,000 ha lost between 1971 and 2013 (Hamilton 2013), contributing to the loss of coastal resilience and important spawning, breeding and nursery grounds for vulnerable, endangered, threatened and protected [ETP] species (Sandilyan & Kathiresan, 2012). Pollution, notably nitrogen runoff from feed and waste, has similarly impacted habitats adjacent to existing aquaculture ponds (Luo, Hu & Chen, 2018), while inadequate biosecurity measures in aquaculture operations have facilitated the transmission of diseases to surrounding wild populations (Bouwmeester *et al*., 2020). Further impacts include competition with traditional fisheries over space and resources, welfare concerns for both farmed and wild animals, transfer of disease from escapees and antibiotic use, and the diversion of nutritious forage fish (e.g. anchovies, sardines) into fishmeal and oil rather than them being used for direct human consumption (Sumaila, 2024).

Nevertheless, abundant opportunities for sustainable aquaculture development exist, including innovation in alternative feeds that reduce reliance on wild-caught fish, the development of low-impact farmed sources including low-trophic-level species that protect habitats and reduce dependency on wild-capture fisheries (WWF, 2024h). Other opportunities include the development of closed-loop recirculating aquaculture systems, and the implementation of sustainability best practices as prescribed by certifiers such as the Aquaculture Stewardship Council (ASC). Financing for sustainable aquaculture practices has included both investment at the venture scale (e.g. through impact funds such as Aqua-spark, Mirova's Sustainable Ocean Fund and the Global Fund for Coral Reefs [GFCR]), as well as engagement through mainstream financing for listed seafood companies undergoing a transition to sustainable production and sourcing of farmed seafood, for example through Rockefeller Asset Management's Ocean Fund or DWS' ESG Concept Blue Economy Fund.

4. Aquatic foods provide 15% of globally consumed animal protein (FAO, 2024a).
5. Primary production alone provides more than 60 million jobs worldwide (FAO, 2024a)




## ROBECO'S SEAFOOD TRANSITION PATHWAY

Robeco, a Dutch asset manager, together with WWF-Netherlands, has recently developed the first iteration of a 'nature transition pathway' for the seafood sector, to halt and reverse biodiversity loss in line with the Global Biodiversity Framework (Robeco, 2024).

This framework, developed with technical expertise and advice from WWF, aligns with the AR3T hierarchy (Avoid and Reduce harm, Restore and Regenerate nature and Transform economy and society) actions for biodiversity used by the SBTN, and also builds on approaches and guidance developed by the TNFD, the World Benchmarking Alliance, UNEP FI and others. The framework defines 'must haves', 'should haves' and 'could haves' for seafood practices, including prohibitions on highly damaging behaviour such as shark finning and investing in landscape restoration, and underpins Robeco's investment decisions in seafood as well as their engagement efforts as part of their active ownership strategy.

# SHIPPING

Shipping acts as the global economy's circulatory system, moving over 80% of the world's goods (United Nations Conference on Trade and Development [UNCTAD], 2023) and connecting national economies to international markets. While shipping is not dependent on marine ecosystem services in the way that seafood is, the world's merchant fleet of more than 105,000 vessels (ibid) interacts continuously with the marine environment. Environmental impacts from the shipping industry include harm to wildlife through the introduction of invasive species in ballast water (Molnar, 2008); collisions with fauna (Silber *et al.*, 2012); pollution from wastewater, particulates, nitrous oxides and sulphur dioxide (Jaegerbrand *et al.*, 2019); and approximately 3% of global greenhouse gas (GHG) emissions that contribute to climate change (UNCTAD 2023). It is also a source of underwater noise, and is responsible for pollution from shipbreaking activities and the use of toxic antifoulants.

Discussion and action on the shipping sector's transition to sustainability has been growing since 2018, though with an overriding focus on addressing the sector's climate impact, which has resulted in the adoption of a revised Strategy on Reduction of GHG Emissions from Ships (International Maritime Organization [IMO], 2023) to align the sector with the Paris Agreement. Frameworks like the Poseidon Principles provide a narrative for financial institutions to assess and disclose the climate alignment of their shipping portfolios. Sustainable financing activity, such as the Green Shipping Fund, is focused on the climate performance of the sector, for example through enhancing energy efficiency, emissions reduction, and new technologies for decarbonization.

While several regulations exist, for example, to manage ballast water and reduce pollution, impacts on nature have been less of a focus for the sector than climate, though due to the nature-climate and ocean-climate nexuses discussed previously, financing efforts that focus on decarbonization or waste reduction directly support ocean health.

## WASTE MANAGEMENT

Waste management has a significant but indirect relationship with ocean health, largely due to its role in addressing pollution in the marine environment. Rather than the presence of waste management generating harmful impact, in this context the more significant consideration is absence or failure of waste management and circular economy[6] systems to prevent waste from ending up in the ocean. Particularly in emerging markets, the lack of closed landfill and waste collection systems that can keep up with growth rates in rapidly expanding urban centres is a source of substantial pollution (Hoornweg, Bhada-Tata & Kennedy, 2013). Inevitably, uncaptured waste finds its way into the ocean, and effective waste management is therefore a vital activity of the SBE.

In addition to its role in containing waste, capturing material value at end of life is an equally important role of the waste management industry in reducing impacts of the material economy on nature. The development and implementation of strategies and infrastructure (such as mixed-use recycling facilities) that enables the transition to the circular economy is vital to securing ocean health.

Financing for waste management infrastructure has been specifically linked to ocean health improvement and is eligible for blue bond financing, as outlined by the ICMA blue bond guidance (2023). Impact funds such as Circulate Capital are emerging with the intent to finance circular economy improvements in coastal areas, particularly in Small Island Developing States (SIDS) and rapidly urbanizing markets.

## PORTS

Like merchant vessels, ports are essential to the global economy. They also share responsibility with shipping for many similar impacts on nature, through pollution and their contribution to climate change. Port impacts are however more localized, due to their fixed locations. These fixed locations expose ports to place-based impacts, especially in the development of new port infrastructure that may result in the degradation of surrounding ecosystems, as well as dependencies on marine ecosystem services such as protection from storm surges. These impacts and dependencies are especially material for ports when they come into conflict, for example where construction activity degrades habitat that would otherwise provide flood protection from nature-based infrastructure (see section on Coastal nature-based solutions).

Because of these place-based impacts, nature-positive opportunities do exist for ports, and guidance[7] on aligning port activity with nature-positive has been developed. Due to the scale of investment typically required, financing for port development is particularly well suited to, for example, use-of-proceeds bonds that earmark specific sustainability interventions.[8] Prominent examples include the Port of Los Angeles' first green bond issuance in 2016 (Port of Los Angeles, 2016), the Port of Rotterdam's green revolving credit facility in 2019 (Clifford Chance, 2019) and DP World's 2024 blue bond issuance for marine transport, port infrastructure and nature-positive initiatives (DP World, 2024). Additional examples of port sector initiatives and financing mechanisms for nature-positive development are provided in the World Economic Forum's 2024 report on the role of ports in supporting a nature-positive future (WEF, 2024).

## COASTAL INFRASTRUCTURE

Defensive coastal infrastructure plays an important supporting role in the global economy, particularly for defence against storm surges, saltwater intrusion, subsidence, erosion and sea level rise (Barnier, 2017). Traditional man-made defensive infrastructure ('grey' infrastructure) has direct impacts on coastal and marine environments, especially where its installation leads to the destruction or degradation of natural habitat (for example degrading intertidal habitat through the construction of sea walls and groynes) and its presence disrupts ecosystem processes (such as nutrient cycling).

Nature-based solutions (NbS), also referred to in various forms as green, nature-based, and natural infrastructure (UNEP FI, 2022a), act in this context as coastal infrastructure that uses the natural environment as part of its role in defending human activity along the coast without disrupting nature to the same extent. While their impacts on nature are less significant than those of grey infrastructure, NbS are inherently more dependent on the state of nature for their effective functioning, and are therefore sensitive to impacts on nature from adjacent economic activities.

Finance for coastal defence is urgently needed – Nichols *et al.* (2019) estimate that by 2100 between US$40 billion and USD$170 billion will be needed for coastal defence annually, compared with approximately US$1 billion per year in 2014 (Bisaro & Hinkel, 2018). Financing for NbS should be considered primarily as an addition to other sectoral activity on the coast, for example the development of port or waste management infrastructure that may capture co-benefits through the retention or restoration of ecosystem services (although these will vary from location to location) (Raymond *et al.*, 2017). Capturing these co-benefits through, for example, carbon sequestration, can make NbS more attractive for private actors to co-finance alongside public entities (Kok *et al.*, 2021).

6. WWF defines a sustainable circular economy as a regenerative system, driven by renewable energy, that replaces the current linear 'take-make-dispose' industrial model. Materials are instead maintained in the economy and resources are shared, while waste and negative impacts are designed out. A sustainable circular economy creates positive environmental and society-wide benefits and functions within planetary boundaries, supported by an alternative growth and consumption narrative.
7. For example the World Economic Forum (WEF)'s Insight Report on the role of the port sector in nature positive (WEF, 2025).
8. As outlined by the International Capital Market Association (ICMA) blue bond guidance (ICMA, 2023).

## TOURISM

The coastal tourism industry is a significant driver of economic development, particularly in lower-income economies in tropical SIDS and emerging markets (Cardenas-Garcia, Brida & Segarra, 2024). Tourism in this context comprises both land-based coastal tourism (including accommodation and attractions), marine attractions (e.g. coral reefs and wrecks), and cruise ships.

Many coastal and marine tourism value propositions are based on outstanding natural beauty, and in this regard tourism is heavily dependent on cultural ecosystem services provided by the ocean (Church, Coles & Fish, 2017). Land-based tourism, particularly where adjacent to ecosystems that provide flood protection services such as mangroves or coral reefs (Menendez *et al.*, 2020), is further dependent on these services.

Due to its diversity in form, tourism has multiple impacts on the state of nature in the ocean, and its rapid development has affected the marine environment, particularly through pollution and harm to wildlife (Matias, Leonel & Imperador, 2022). Tourism can be highly damaging to coastal and marine environments and cause a resultant risk to ETP species, including through habitat destruction from construction on land and anchoring at sea, and habitat degradation from excess tourism (UNEP FI, 2021).

Fortunately there are several initiatives focusing on managing nature-related risk in the tourism industry by reducing harm and working with nature, for example through accreditation to tourism eco-labels recognized by the Global Sustainable Tourism Council (GSTC). Financing for sustainable tourism strategies and specific products, such as parametric insurance for coastal hotels to regenerate coral reefs, have been successfully implemented (InsuResilience Global Partnership, 2020).

## MARINE RENEWABLES

Marine renewable energy, most prominently offshore wind (OSW), is one of the key emerging sectors of the ocean economy, particularly in Europe where installed capacity has increased to 35GW in recent years, with another 13.2GW of offshore capacity awarded for development in the first half of 2024 (WindEurope, 2024). Nevertheless, while central to the climate transition, marine renewables generate harmful impacts on the marine environment, notably during construction, which can result in habitat degradation and noise pollution (UNEP FI, 2021). Due to the relatively low maturity of the sector, these impacts are only recently beginning to be assessed and understood. Examples of sector initiatives, biodiversity integration and innovative financing approaches are provided in the WEF's 2024 report on the role of the offshore wind sector in supporting a nature-positive transition (WEF, 2024).

Like shipping, marine renewables have limited dependencies on ecosystem services provided by the ocean, with the exception of regulating services for climate resilience from, for example, reefs, dunes and mangroves that can protect coastal infrastructure, such as land-based transformers, from extreme weather events.

Financing for marine renewables has scaled up commensurate with the growth of the industry's prominence worldwide in supporting the climate transition, and both sustainability-linked and use-of-proceeds instruments have been deployed to incentivize the development of OSW farms in key markets, including the first blue bond issued in 2023 by an energy company, Orsted (Orsted, 2023), that includes a focus on financing biodiversity initiatives.


## WWF NATURE POSITIVE OCEANS FRAMEWORK (2025)

The Nature Positive Oceans Framework (WWF, 2025b) provides general and sector-specific recommendations for companies operating in the ocean and on its coasts – specifically those in the offshore wind, coastal and marine tourism, shipping, and seafood sectors – for how they can contribute to the nature-positive global societal goal through their direct operations and their supply chains. Specifically, it outlines key considerations and proposes credible, evidence-based activities, organized across the AR3T action framework, that companies can take to support the 2030 mission of the Kunming-Montreal Global Biodiversity Framework.

# KEY MESSAGES TO CENTRAL BANKS, FINANCIAL REGULATORS AND SUPERVISORS


## THE OCEAN UNDERPINS PLANETARY AND ECONOMIC STABILITY.

It regulates climate, absorbs carbon, and sustains biodiversity, yet remains less understood and monitored than terrestrial systems.


## MARINE ECOSYSTEMS PROVIDE CRITICAL SERVICES THAT ARE RARELY VALUED WITHIN THE ECONOMY.

From food provision and coastal protection to climate regulation and cultural values, these services support trillions in economic value but are rarely priced or reflected in financial decisions.


## OCEAN ECOSYSTEM SERVICES ARE INTERCONNECTED AND CROSS-CUTTING.

Supporting services like nutrient cycling and primary production sustain provisioning, regulating, and cultural benefits that economies and societies depend on.


## MARINE BIODIVERSITY AND ECOSYSTEM HEALTH ARE IN STEEP DECLINE.

Since 1970, marine species populations have dropped by more than half, weakening resilience and exposing economies to systemic risks.


## FIVE MAJOR DRIVERS ACCELERATE OCEAN HEALTH DECLINE.

Overextraction (including overfishing), pollution, land/sea use change, climate change, and invasive species interact and compound, creating non-linear risks that are difficult to model or manage.


## TIPPING POINTS IN OCEAN SYSTEMS CAN POSE IRREVERSIBLE RISKS.

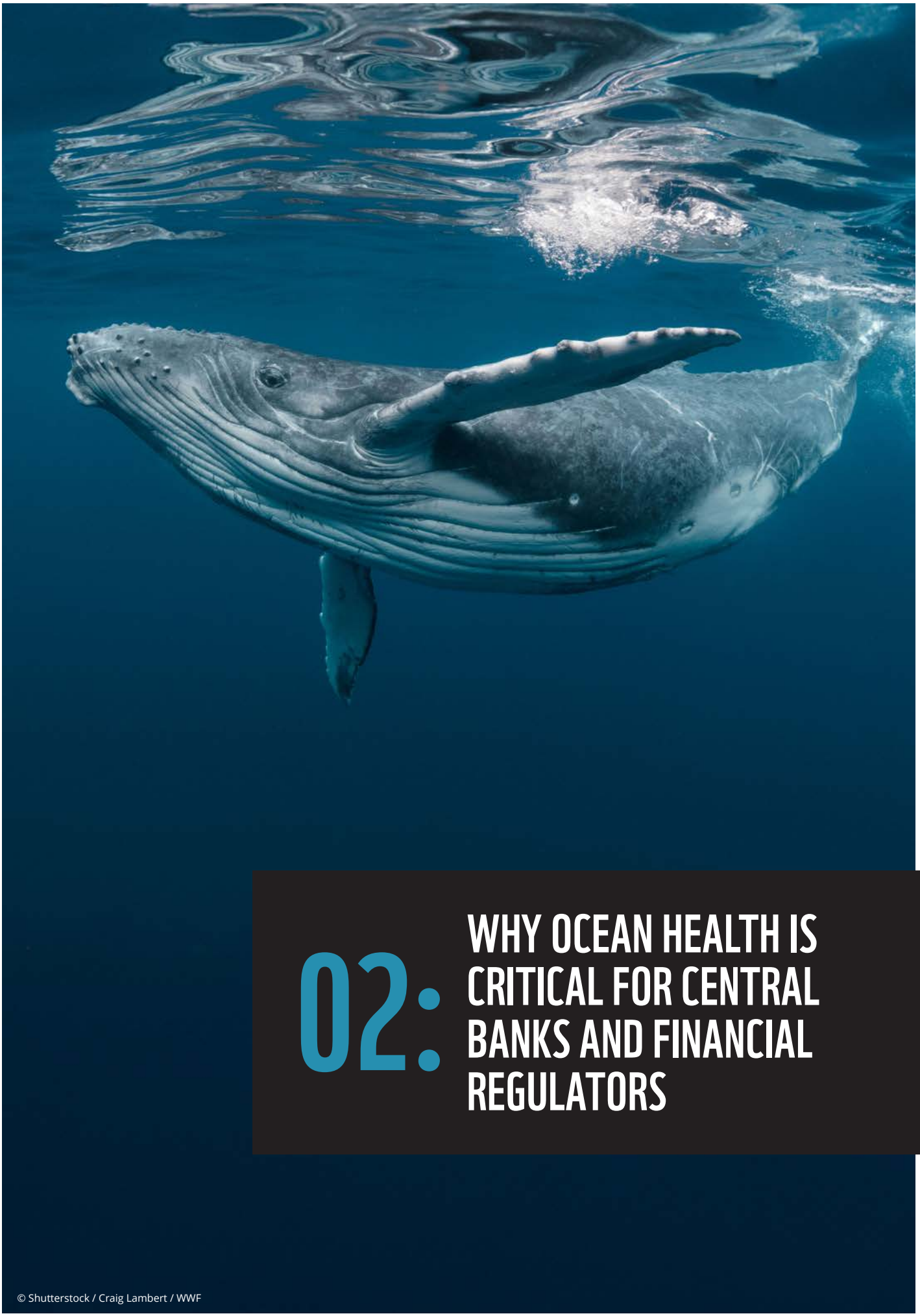
Examples include permanent loss of coral reefs through bleaching events, and potential disruption of the Atlantic circulation, with far-reaching macroeconomic consequences.


## OCEAN ECONOMY SECTORS ARE UNEVENLY EXPOSED.

Seafood and tourism are highly dependent on healthy ecosystems, while shipping, ports, and marine renewables face indirect risks via regulation, climate impacts, and reputational pressures.


## NOT ALL OCEAN ACTIVITIES ARE PART OF A SUSTAINABLE BLUE ECONOMY.

Harmful sectors like offshore oil and gas or deep-sea mining fall outside sustainability pathways, while others (seafood, aquaculture, ports, waste management, tourism, renewable energy) can transition toward sustainable models.



# 02: WHY OCEAN HEALTH IS CRITICAL FOR CENTRAL BANKS AND FINANCIAL REGULATORS

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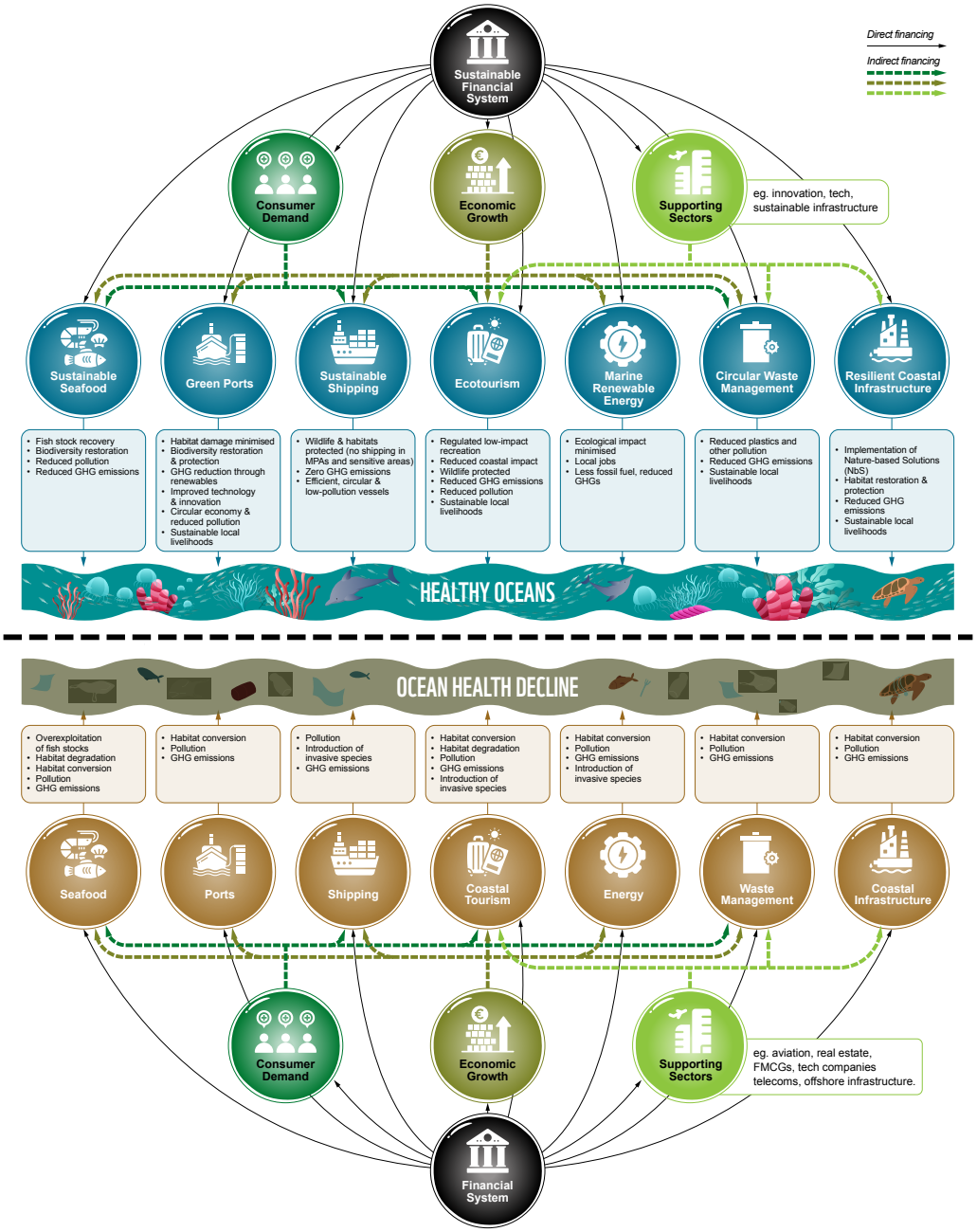
# SECTION 02:

# WHY OCEAN HEALTH IS CRITICAL FOR CENTRAL BANKS AND FINANCIAL REGULATORS

Today's environmental impacts are tomorrow's financial risks (WWF, 2022), and it is clear that many of these impacts are negatively affecting the health of the ocean. It is also clear that the ocean economy are significant contributors to societal benefits, economic development and food security, and that ocean-related sectors have significant dependencies and impacts on nature in the ocean. As a result, the opportunities and risks associated with their development and their contribution to the economy and society are relevant to the responsibilities and activities of central banks and financial regulators.

## SYSTEM MAP

### SUSTAINABLE FINANCE CONTRIBUTING TO HEALTHY OCEANS




### UNSUSTAINABLE FINANCE CONTRIBUTING TO OCEAN HEALTH DECLINE

This section examines the hazard narrative of the ocean economy in terms of transmission channels for environmental and financial materiality, and unpacks a selection of examples of physical and transition risks in key ocean economy sectors to build awareness of the significance of the ocean within nature-related risk management. To effectively manage these risks, central banks and financial regulators should work to identify their specific country-level exposure to physical and transition risk in the ocean economy (Figure 4) before assessing the resulting economic and financial risks and taking action to safeguard price stability.

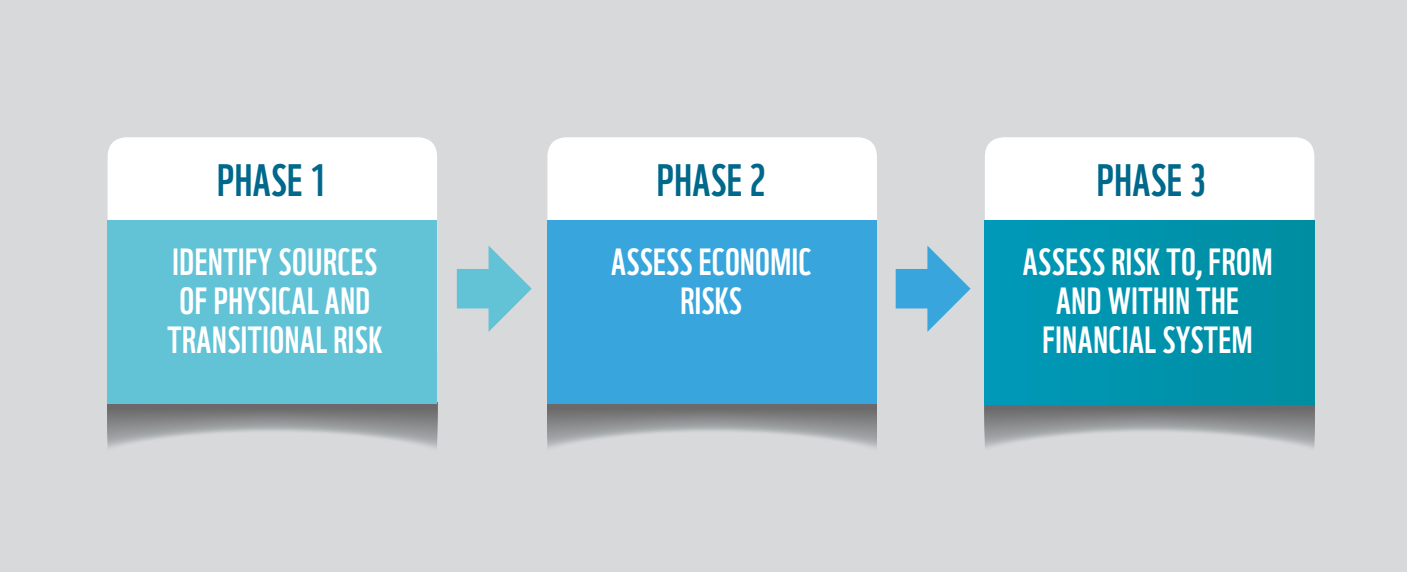



***Figure 5:*** *Steps in understanding and assessing nature-related financial risk. Source: NGFS (2024).*

The interactions between financial and environmental materiality across sectors of the ocean economy are not static. They take time to materialize, and should be considered to be dynamic. Material environmental risks interact across sectors and may present financially material risks elsewhere – for example, increased fishing pressure on a coral reef may depress its value to dive tourism. The 2010 Deepwater Horizon oil spill, the largest such spill in history, resulted in a significant and permanent devaluation of oil company BP, while its environmental impacts resulted in US$22.7 billion in lost tourism revenue by 2013 and US$8.7 billion in lost fishing revenue by 2020 (WWF, 2019). A holistic view in assessing ocean-related risks is therefore of paramount importance. It is also important to recognize the multidimensionality of these risks, as well as how interconnected they are. Risk assessment in the ocean is made ever more complex as the baseline of stressors and hazards is rapidly shifting (ORRAA, 2022).

Transition risks are similarly complex – the introduction of a marine spatial planning regime, for example, may increase short-term costs for key sectors in adjusting to a more equitable distribution of marine spaces in the long term. While it is important for the transition to a SBE to take place, it needs to be carefully managed in order to capture the greatest benefits and deal with any transition-related risks. It is therefore clear that understanding both environmental and financial materiality in the ocean is necessary to managing ocean-related risks.

# ENVIRONMENTAL MATERIALITY: HOW THE FINANCIAL SYSTEM ENABLES AND DRIVES OCEAN HEALTH DECLINE

The financial system supports and incentivizes economic activity that directly harms ocean health, notably through extractive industries, although significant impacts are also generated when the sectors covered in this paper are not sustainably managed (figure 4, page 24).

Much as on land, the linkages between environmental and financial materiality are strong (Table 3), and drivers of nature and biodiversity loss present direct physical risks to those sectors dependent on marine ecosystem services.

The reduction in provisioning and regulatory services presents notable risk to highly dependent sectors – for example the risk of collapse in wild-capture fisheries as a result of overexploitation.

***Table 3:*** *Overview of relative weighting of financial and environmental materiality across blue economy sectors. Based on ENCORE mapping of dependencies and impacts across ISIC sectors.*

| SECTOR | ENVIRONMENTAL MATERIALITY | FINANCIAL MATERIALITY |
|---|---|---|
| Seafood | ↑↑↑ | ↑↑↑ |
| Shipping | ↑↑ | ↑↑ |
| Ports | ↑↑ | ↑ |
| Tourism | ↑↑ | ↑↑ |
| Marine renewable energy | ↑ | ↑ |
| Waste management | ↑↑ | ↑↑ |
| Coastal infrastructure | ↑↑ | ↑↑ |

Direct financing of ocean economy sectors therefore generates environmentally material impacts on ocean health, creating an endogenous source of risk to the financial system (Figure 6). In addition, the compounding effect of financing related activities (for example, financing secondary markets for seafood, or scaling coastal tourism through financing the global aviation industry) further impacts on ocean health. Note that in addition to the ocean economy sectors outlined in the previous chapter, the environmental materiality of finance for the ocean also includes several terrestrial activities, in sectors such as agriculture, where the runoff of fertilizers and other chemicals is a significant non-point source of marine pollution with negative consequences for ocean sectors such as seafood and tourism.9 Another example is the oil and gas sector, where financing onshore as well as offshore fields contributes to ocean-related risks.

In addition, financing that supports the indirect drivers of nature and biodiversity loss (IPBES, 2020), notably in relation to ongoing economic growth and changes in consumer appetite, drives increased demand for – and therefore productivity in – maritime trade, tourism and seafood consumption, among others. Consequently, current financing should be viewed as a major driver of ocean health decline and as highly exposed to ocean environmental materiality, regardless of whether it is directly financing ocean economy sectors or not.

9. For simplicity, this terrestrial connection is not included in the system map of environmental materiality provided in Figure 4.

# FINANCIAL MATERIALITY: HOW OCEAN-RELATED RISK TRANSMITS TO THE ECONOMY AND THE FINANCIAL SYSTEM

In line with the conclusions of the Network on Greening the Financial System (NGFS) on nature-related risks and the transmission channels they present regarding financial risk, Almeida & Reitmeier (2024) put forward similar transmission channels for ocean-related risks to the financial system. While Almeida & Reitmeier suggest a number of physical and transition risks in the ocean economy, this paper builds out the narrative on the nature of physical risks stemming from impacts and dependencies on the ocean outlined in the previous chapter, as well as the risks inherent to the transition to a SBE. Figure 7 illustrates these relationships, alongside feedback loops and the impacts of ocean health decline on the financial system. Note that this diagram provides a high-level overview of material risk, and is an oversimplification of the relationship between the ocean and the economy. It does not dig into sector-specific transmission channels of physical and transition risk.

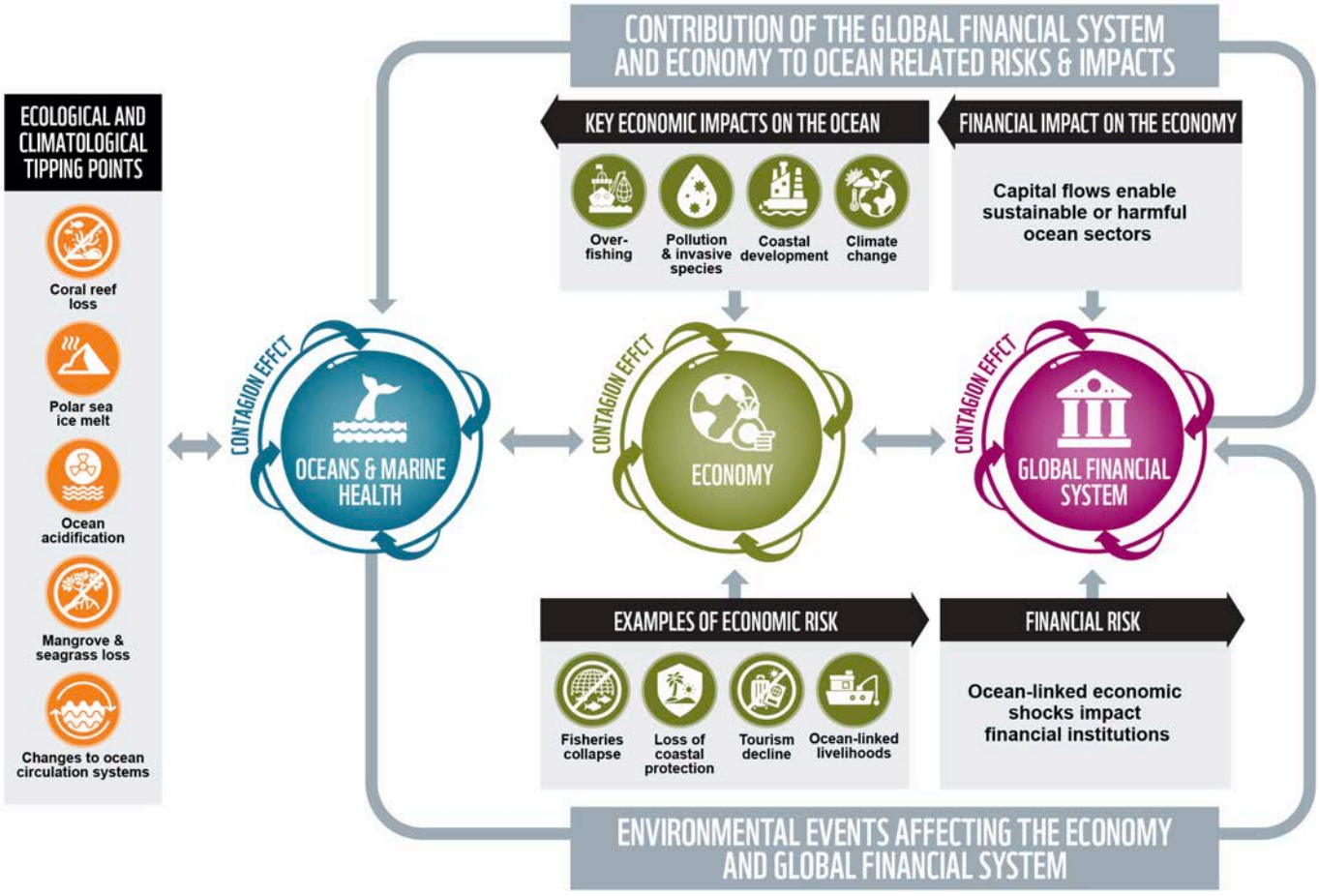



***Figure 7:*** *Transmission channels of ocean-related risks to the financial system. Adapted from NGFS (2023), Almeida & Reitmeier (2024) and WWF (2024).*

# PHYSICAL RISK

Previous sections have outlined the significance of ocean ecosystem services for society at large as well as the sectors of the ocean economy. Zooming out to a macroeconomic landscape, the health of the ocean (and the ecosystem services it provides) therefore underpins many economic functions that are central to a stable economic environment and are thus relevant to the mandate of central banks and financial regulators. For example, tourism, the second-most economically significant sector of the ocean economy (OECD, 2025), is directly linked to the health and beauty of the natural environment; where this is undermined by habitat loss and reduced resilience to climate impact, the value of the industry and its assets, including invested capital, earning potential and employment opportunities, are all at risk.

There are varied degrees of exposure to physical risk across different blue economy sectors, with those with the greatest dependencies on ecosystem services such as fishing and coastal tourism bearing the most financially material risk. The 2021 WWF report Navigating Ocean Risk (WWF, 2021) provides a detailed assessment of environmental risks across key sectors of the ocean economy under a business-as-usual scenario over the next decade (see box below).

## VALUE AT RISK IN THE OCEAN

Boston Consulting Group, together with WWF, has developed a body of work outlining the value of, and dependency on, ecosystem services and economic productivity in the ocean at a global level (Hoegh-Guldberg *et al.*, 2015) as well as regional analyses across different ocean basins. Building on this work, in 2021 WWF released Navigating Ocean Risk, a study aiming to provide investors with an understanding of the financial consequences of the risks and impacts facing the ocean. The study presents a method for valuing financial risks arising from ongoing loss of ocean health by examining a selection of listed companies to understand their exposure to environmental risks associated with ocean health decline (WWF, 2021).

The study found that 66% of publicly listed companies are exposed to – and to a greater or lesser extent dependent on – the services provided by a healthy ocean. While this is relevant for sectors with clear linkages to the ocean such as seafood and tourism, many other sectors such as airlines and retailers also derive revenues from the blue economy (recall Figure 4 above). The model found that US$8.4 trillion of assets and revenues are at risk between 2020 and 2035. The sectoral costs of these risks are captured in the box below. While the study did not differentiate between physical and transition risks, the vast majority of risk factors captured in Navigating Ocean Risk are interpreted as physical risks to the sectors due to exposure to climate impact and nature loss.

Failing to integrate adequate risk management could affect business profitability where operations are particularly vulnerable to declining ocean health and climate resilience – in Table 2 above, this is clearly illustrated by the order of magnitude of high value at risk in seafood and coastal real estate sectors, where, under a business-as-usual scenario, US$2.89 trillion and US$3.98 trillion in revenues and assets, respectively, are at risk from pollution, overfishing, and the health of supporting ecosystems (WWF, 2021).

Although designed for equity investors, the model is nevertheless relevant for a broad audience in illustrating economic exposure to ocean health decline, and its findings act as a foundation for this paper's focus on communicating ocean-related risk to a central bank and regulatory audience.

Natural resource extraction, climate change and land/sea use change are key drivers of physical risk in the ocean economy, and therefore are most notable in the context of fisheries, coastal and marine tourism, and marine renewables. Here, depletion in natural assets – as in the case of fisheries – undermines the resource base on which the industry depends and can (and indeed has) lead to the collapse of fishing-based economies. Elsewhere, development activity, notably infrastructure and property construction, can bring about further biodiversity loss through habitat degradation reducing ecosystem service provision. Degradation in the state of nature can be a particularly concerning source of physical risk for the tourism sector, especially for coastal and cruise-based tourism where natural beauty is a key driver of revenue. For asset-heavy sectors like ports, exposure to climate impact from storms and sea level rise are significant sources of physical risk (WWF, 2021). Adjacency effects, for example where construction activity reduces the fitness of commercial fish stocks (e.g. as a result of loss of nursery grounds when mangrove forests are destroyed), are a compounding source of physical risk in the ocean economy.

## SYSTEMIC ECOSYSTEM STABILITY RISK

As outlined in this section, physical risks directly affect businesses reliant on ecosystem services and therefore present economic and financial risks that are important for financial supervisors to assess and manage. However, the linear transmission channels through which these risks accrue do not adequately capture the broader systemic risk presented by the deterioration in the state of nature that results from ocean health decline. These risks, captured in Figure 4 as 'systemic ecosystem stability risk' in line with language used by the TNFD, are non-linear consequences of physical risk where these risk factors cross tipping points and result in permanent loss of nature and essential ecosystem services.

The consequences can be dramatic, and could destabilize the financial system as a result of e.g. breakdown in climate regulation (for example through a slowing or shutdown in thermohaline circulation in the deep ocean) resulting in rapid and irreversible climate change, or catastrophic asset destruction and reduced food security in the event of e.g. ecosystem collapse. These risks are existential, and despite uncertainty concerning their likelihood over the medium to long term, they require urgent attention by policymakers and financial regulators to assess and mitigate, over and above the 'ordinary' transmission channels for physical and transition risk.

The cost of loss in resilience to climate change due to, for example, construction work degrading ocean health is a significant driver of increased physical risk to the economy and hence the financial system. Here ocean-based physical risk becomes part of the existing understanding of climate-related risk (recall the ocean-climate nexus, above) and should be viewed in this context, for example for its knock-on effects on insurance pricing and, in severe cases, contagion effects across financial institutions that are indirectly exposed.

Indirect risk transmission also exists for the blue economy – for example, stock depletion in fisheries can disrupt business models in the seafood industry and drive up prices for consumers, a form of 'ecoflation'[10] that can reduce demand for seafood as stocks collapse. At the same time, reduced availability of wild fish may increase demand for farmed fish, which can drive pressure to expand aquaculture in ways that risk unsustainable practices, disease outbreaks, pollution, monoculture and invasive species. While this may incentivize catch reduction over time, as highlighted previously where stock collapse is considered a tipping point, it may not result in ecosystem recovery. Meanwhile, as seafood consumption is increasing due to growth in the middle class, notably in Asia, this form of inflationary pressure can drive consumers towards alternate sources of animal protein with higher carbon intensity and/or reduce household budgets, with knock-on effects on spending and saving, as well as broader economic and societal consequences for food security and balance of trade. Further indirect risk transmission channels resulting from ocean health decline can result in trade imbalance, reduce growth and productivity, and affect demand.


10. Inflation related to environmental factors.

# TRANSITION RISK

Ocean economy transition risks are diverse, and relate to the interventions made in markets and society to support the transition to sustainability. While some of these transition risks are directly linked back to the physical risks and environmental materiality illustrated above, others are a result of changes in values and public awareness regarding the state of the ocean. These can influence markets and affect reputations, and can result in stranded assets and large changes in the cost of capital.

The TNFD risk register has standardized the types of transition risk that exist for nature, and while other resources such as the UNEP FI guidance Turning the Tide (2021) outline slightly different risk categories, this document uses the TNFD risk categories for consistency. Each of these transition risks can increase costs and curtail opportunities unless proactively managed, with a need for clarity from the regulatory system on expectations of financial institutions and the provision of guidance on what activities can reduce or mitigate these transition risks. Note that transition risks interact and can compound one another (UNEP FI, 2021a), which is especially important to consider for those sectors subject to high adjacency effects from other users of the marine environment and with high dependency on ecosystem services, such as seafood (WWF, 2021).

## REPUTATIONAL RISK

Reputational risk in the ocean economy is prominent across all sectors, and is a notable concern where non-compliance with new regulations compounds existing regulatory risk. For both reputational and regulatory risk, limits to transparency, monitoring, control and surveillance, as well as traceability across supply chains inherent to the ocean, can mask these risks until revealed – as has been the case in relation to human rights violations in the seafood industry in recent years, and among seafarers more broadly (Seafarers International Union, 2023) as evidenced by the Outlaw Ocean project (Urbina, 2019). Changes in public sentiment are a source of reputational risk, for example in the context of deep-sea mining, which has quickly evolved from being presented as an opportunity for economic development in the energy transition into a call by 40 governments and 570 civil society organizations, as well as 69 companies and 37 financial institutions (as of October 2025), for a moratorium on deep-sea mining and a transition to a circular economy for critical minerals due to the potential for permanent harm to deep-sea ecosystems (WWF, 2024e; Deep Sea Conservation Coalition, 2025.; Finance for Biodiversity, 2025; Stop Deep Sea Mining, 2025).

## REGULATORY RISK

Regulatory risk is prominent in those cases where regulatory adjustments on sustainability may result in costs including stranded assets, which are particularly relevant in the context of commodities and sectors with high capital costs. Shipping, recognized as a sector that is challenging to decarbonize (WWF, 2021), may be especially exposed to regulatory risk on net zero and SO2 emissions reductions. Soft commodities, notably seafood, are also exposed to regulatory risk, for example through changes in sustainability requirements for seafood imports into the European Union, which can affect the profitability of seafood companies for that export to EU markets. Regulatory risk also includes responses to emerging legislation on sustainability reporting and due diligence, such as the European Union's Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CS3D).

## MARKET RISK

Market risk can include changes in pricing and demand for specific products or services in the ocean economy, and in this context can interplay strongly with reputational risk. Macroeconomic trends that impact on, for example, the price of energy can in turn affect development prospects, as has been the case in the offshore wind market following changes in the price of raw materials and logistics and growing competition from China, have led to a slowdown in project development and financial losses among Western-listed energy companies (Rabobank, 2023).

## TECHNOLOGY RISK

Technology risk refers to risk associated with the changes or substitutions in products and services that result from a transition to a reduced impact or dependency on nature, for example the shift from plastics to biodegradable materials (TNFD, 2023). This risk category shares similarities with the Turning the Tide 'operational risk' category, and can also include, for example, changes needed in business methods to fall in line with sustainable fishing practices and certification requirements.

## LIABILITY RISK

Liability risk refers to potential financial losses stemming directly or indirectly from legal claims, and can follow from other transition risks or from the consequences of physical risk. As laws, regulations and cases related to how an organization responds to nature-related risk evolve, the probability of contingent liabilities arising for an organization may increase (Task Force on Climate-related Financial Disclosures [TCFD], 2021). High-profile cases include liability claims arising from major oil spills and ship groundings, such as the 1989 Exxon Valdez and the 2010 Deepwater Horizon cases.

## TRANSLATION TO SYSTEMIC MACROECONOMIC RISK AND FINANCIAL RISK

The overriding concern with physical risk, transition risk and the high-impact systemic environmental risk as a result of crossing ecological tipping points relates to systemic risk to macroeconomic stability and financial risk. Each of these risk factors individually and collectively contribute to systemic risk to the economy as well as the financial system. Accumulating physical risks in particular can result in significant country-level changes in productivity, growth, inflation and cost of capital as a result of sector-wide instances of stranded assets, productivity decline and disruption of established business models. Where transition risk factors resulting from ocean health decline are not proactively managed to reduce shocks to industry, they further compound macroeconomic impact.

These risks accrue to the financial system where they increase uncertainty, reduce returns, destroy capital and devalue economies. Contagion effects across the financial system resulting from these risk factors further compound their impact, and responses to one manifestation of risk by regulators and financial supervisors through fiscal tightening and rate changes may further compound other sources of macroeconomic risk if not carefully managed. These cascading and runaway consequences of inadequate management of physical and transition risk may cause lasting damage to growth, productivity and welfare.

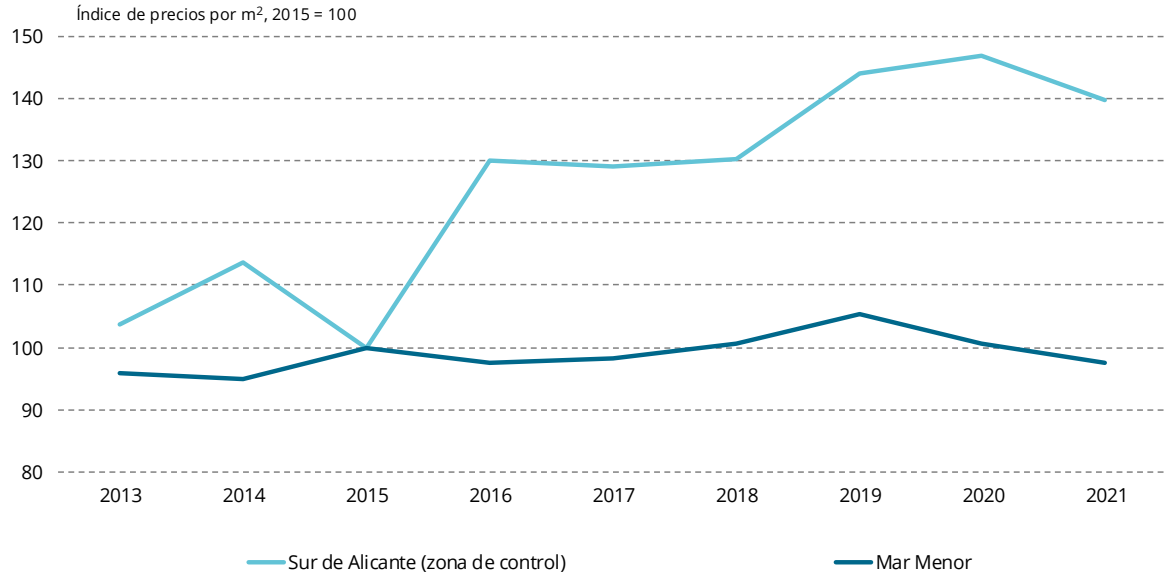
## ENVIRONMENTAL DETERIORATION CAN HAVE A SIGNIFICANT NEGATIVE ECONOMIC IMPACT: THE CASE OF THE MAR MENOR (BANCO DE ESPAÑA, 2024)

El Mar Menor, located in Murcia (southeast Spain), is the largest saltwater lagoon in Europe and covers an area of about 135km². It has long been an important tourist destination, surrounded by more than 7,500 villages and historically attracting more than 200,000 visitors each year.

However, rapid urban and tourism development, combined with the conversion of agricultural land for intensive farming, has led to severe environmental degradation. Extremely frequent flooding and extreme temperatures have further worsened the situation. The disruption of nitrogen and phosphorus cycles has triggered eutrophication, causing massive algal blooms (the so-called green soup) and large scale die-offs of aquatic species.

Since 2015, property values in the Mar Menor area have dropped by 43% compared to similar nearby coastal zones. The estimated loss in real estate value exceeds EUR4 billion, a price that has already exceeded the yields generated by the change in agricultural crops.

The impact on house prices of severe environmental degradation in the Mar Menor region




***Source:*** *Rodriguez, et al. 2023. Impact of climate risk materialization and ecological deterioration on house prices in Mar Menor, Spain. Sci Rep 13, 11772.*

# KEY MESSAGES TO CENTRAL BANKS, FINANCIAL REGULATORS AND SUPERVISORS


## OCEAN HEALTH IS DIRECTLY LINKED TO FINANCIAL AND ECONOMIC STABILITY.

Decline in marine ecosystems erodes the natural capital base that underpins productivity, growth, trade and employment.


## FINANCE IS A DRIVER OF OCEAN DECLINE.

Lending, investment and subsidies continue to flow into sectors that overexploit, pollute or degrade marine ecosystems, locking in systemic risk.


## ENVIRONMENTAL MATERIALITY IN THE OCEAN IS HIGH.

Sectors like seafood, tourism and coastal infrastructure depend directly on ocean ecosystem services, while ports, shipping and renewables exert strong impacts.


## FINANCIAL MATERIALITY ARISES THROUGH CLEAR TRANSMISSION CHANNELS.

Ocean risks manifest as credit, market, liquidity and operational risks across financial institutions and the wider economy.


## PHYSICAL RISKS ARE ALREADY VISIBLE.

Overfishing, coral bleaching, coastal erosion and extreme weather undermine economic sectors and assets, with cascading macroeconomic impacts.


## TRANSITION RISKS ARE ACCELERATING.

Emerging regulation, trade measures, reputational pressures and liability claims linked to unsustainable ocean use can rapidly reprice assets and disrupt business models.


## PHYSICAL AND TRANSITION RISKS COMPOUND INTO SYSTEMIC MACROECONOMIC RISK.

Declining ocean health can drive stranded assets, lower productivity, disrupt trade, and create cascading shocks to growth, inflation and capital costs.


## SYSTEMIC ECOSYSTEM STABILITY RISK REQUIRES URGENT ATTENTION.

Crossing tipping points — such as disruption of thermohaline circulation—can trigger non-linear, irreversible losses of ecosystem services.


## RISKS ARE DYNAMIC AND INTERCONNECTED.

Multiple drivers interact, tipping points can trigger sudden and irreversible losses, and contagion can spread across portfolios and borders.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# 03: CENTRAL BANKS, FINANCIAL REGULATORS AND OCEAN HEALTH: CURRENT STATE OF PLAY

# SECTION 03:

# CENTRAL BANKS, FINANCIAL REGULATORS AND OCEAN HEALTH: CURRENT STATE OF PLAY

## CONTRIBUTION TO OCEAN HEALTH DECLINE

Financial regulators and supervisors currently contribute to the decline of ocean and marine ecosystems by not responding to the environmental impacts of the financial flows they oversee. Harmful subsidies, inadequate disclosure requirements and a lack of integration of ocean-related risks into supervisory frameworks mean that capital continues to support activities like overfishing, marine pollution and coastal habitat destruction, which in turn generate systemic financial risks. To reverse this trend, financial regulators can play a transformative role by incorporating ocean health into risk assessments, requiring transparency on marine impacts and incentivizing investment in SBE solutions, which will in turn contribute to the alignment of financial flows with international ocean protection goals.

International efforts to strengthen global ocean governance have continued to advance. In international trade, the WTO Agreement on Fisheries Subsidies entered into force in September 2025 after reaching the required number of member ratifications. It prohibits subsidies for IUU fishing, for fishing overfished stocks, and for fishing on the unregulated high seas. This milestone marks the world's first binding multilateral agreement focused on ocean sustainability and highlights the importance of aligning financial oversight with global policy reform (WTO, 2025). Similarly, the High Seas Treaty, formally known as the Agreement on Biodiversity Beyond National Jurisdiction (BBNJ), was ratified in September 2025, establishing a legally binding framework to designate marine protected areas in international waters and advance the Global Biodiversity Framework target to protect 30% of the ocean by 2030.

WWF has previously outlined the importance of central bank collateral frameworks in driving demand towards financial assets that may be associated with climate- and nature-related risk (WWF, 2024a). This is also true for the ocean economy. Mispricing of these risks and the principle of market neutrality adhered to by central banks and financial regulators may then result in inadequate allocation of resources and amplify climate- and nature-related risk. The same is true for the ocean economy.

Given the breadth of the ocean economy and the importance of its sectors to global trade and economic development, it is highly likely that these sectors feature prominently in central bank collateral baskets. While collateral frameworks are beginning to take account of climate- and nature-related risk (as outlined in the next section), there is no clear action yet that suggests that ocean-related risks are being assessed and managed for inclusion in collateral baskets. As a result, central banks are both exposed to ocean-related risk and contributing to ocean health decline through driving demand towards assets that reduce ocean health, thereby increasing the risk exposure of the wider financial system. A helpful first step to further clarify this exposure would be a comprehensive collateral basket assessment of core sectors of the ocean economy against specific issuers and ultimate parent companies. For this assessment, WWF suggests using the UNEP FI Recommended Exclusions for Financing a Sustainable Blue Economy (UNEP FI, 2021c) as the set of indicators for harmful and unsustainable activities in the ocean economy.

Central banks and financial regulators are therefore strongly recommended to go beyond their existing measures to incorporate climate- and nature-related risk in their financial supervision, collateral frameworks, bond purchasing, risk management and disclosure, and incorporate ocean-related risks. In doing so, central banks and financial regulators can look to private sector approaches taken and lessons learnt on sector policies and sustainable financing strategies for the ocean, as outlined in the next section.

# CENTRAL BANKS AND FINANCIAL REGULATORS' ACTION ON OCEAN HEALTH

Ocean risks are increasingly acknowledged as a subset of climate and environmental risks in the supervisory expectations set by financial supervisors and regulators. However, there has not been any detailed framework to date that provides comprehensive guidelines detailing the tools and strategies that financial institutions can use to effectively assess, manage and mitigate ocean risk. This paper seeks to fill this gap.

WWF's 2024 Sustainable Financial Regulations and Central Bank Activities (SUSREG) assessment highlighted a substantial deficiency in the integration of ocean-related risks in central banks' and central banks´, financial regulators´s and supervisors´regulatory frameworkss. In both the banking and insurance sectors, only **38% of the assessed jurisdictions partially met the SUSREG criteria**. This means that while ocean and marine risks are acknowledged in several supervisory frameworks, they are often only briefly mentioned under the definition of environmental risks and are otherwise not expanded upon. This means that ocean risk exposure has not been adequately known or captured by central banks to date.

Supervisors have yet to incorporate more detailed requirements to specifically address and mitigate ocean risks in greater detail and focus. For instance, the Bank of Thailand (BOT) defines 'environmental risks' as the potential for business losses arising from environmental and climate change issues.[11] Pollution of the ocean was included among the negative externalities caused by clients or counterparties, which were listed under environmental issues along with deforestation and biodiversity destruction.

However, BOT does not go into detail on the specific types of ocean-related risks, nor does it outline how financial institutions should manage and mitigate ocean risks, or provide a framework for activities that avoid these risks. **Without detailed and binding guidelines in place, financial institutions and economies will remain exposed to unmitigated ocean and marine-related shocks.**

Central banks, financial regulators and financial supervisors are strongly encouraged to develop supervisory guidelines that specifically address the assessment and mitigation of ocean-related risks, similar to the Guidelines on Mitigating Deforestation Risks provided by the Sustainable Finance Platform in the Netherlands, led by De Nederlandsche Bank (DNB).

As discussed above, each ocean economy sector possesses unique characteristics in operating its businesses, which results in different environmental impacts and risks for the financial sector. Given these, the development of tailored guidelines is important to address the unique risk exposure posed by each sector.

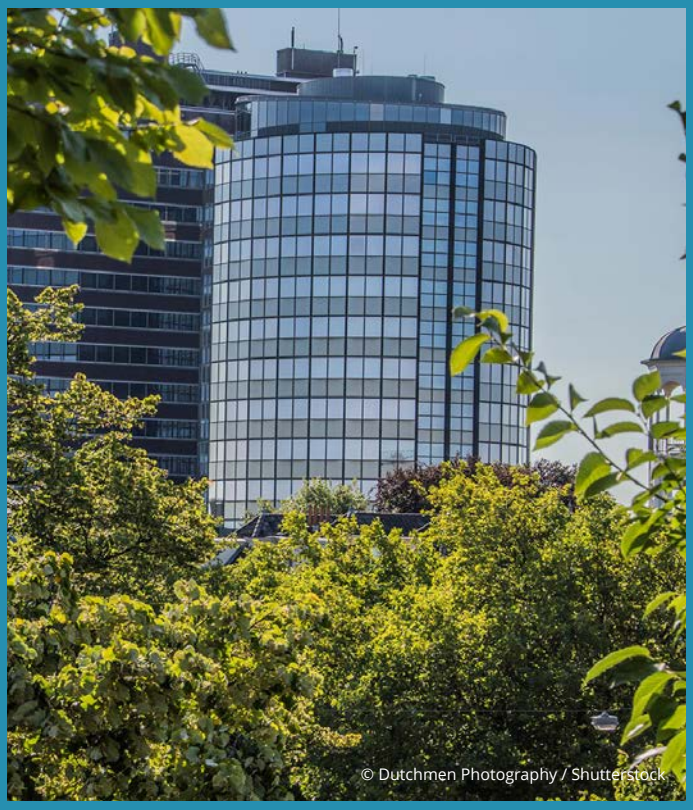

11. https://www.bot.or.th/content/dam/bot/fipcs/documents/FPG/2566/EngPDF/25660028.pdf

# CASE STUDY

## CENTRAL BANK GUIDANCE ON CLIMATE AND ENVIRONMENT

De Nederlandsche Bank (DNB) is the central bank of the Netherlands, and is part of the Eurosystem, the national competent authority under the system of European banking supervision, where it participates in the implementation of monetary policy and price stability alongside its peers within the European Union. It also supervises those Dutch banks not under the direct supervision of the European Central Bank. It has been a frontrunner in building narratives and implementing new policy for both climate- and nature-related risk in the past decade, and co-founded the Network on Greening the Financial System (NGFS) where it co-chairs the task force on nature-related risks with the Bank of France.

As such, expectations are high that DNB will understand the effect of nature-related risk on price stability, and implement policy to assess and manage this risk. Unsurprisingly, DNB outperforms EU-wide scoring on SUSREG indicators for environment and nature-related risk (Figure 8 below), although there is still a long way to go before it receives a full score.



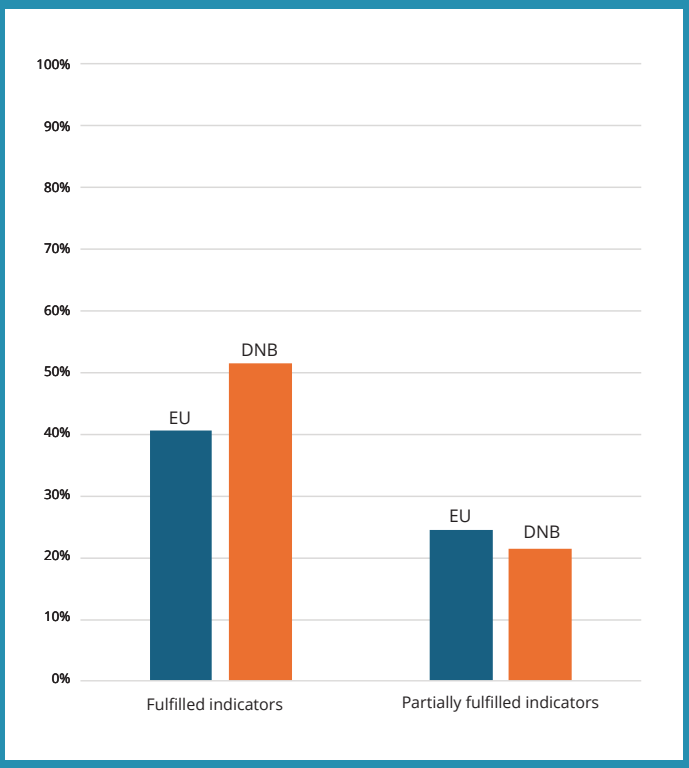




***Figure 8:*** *Relative performance of DNB and EU27 central banks and financial regulators on selected nature-related indicators from WWF's 2024 SUSREG assessment (WWF, 2024f). For more information on indicator scoring, see the WWF SUSREG methodology here.*

A new indicator in the 2024 SUSREG assessment evaluates how financial supervisors integrate oceans and marine life into decision-making, risk management and policies. None of the central banks assessed, including DNB, scored above partial fulfilment, showing that central banks and regulators still have a considerable amount to do in addressing the ocean and blue economy in their work on nature- and sustainability-related risk. DNB has since issued new guidance on climate- and environment-related risk (DNB, 2025). While not ocean-specific, its recommendations on materiality assessment, business models, governance, risk management and reporting are directly relevant to financing the ocean economy.

**To effectively integrate ocean health considerations into its existing recommendations, DNB should expand on its drivers of ocean-related risk, building on important existing references to sea level rise and biodiversity loss.** Its recommendations on governance and business models are broadly applicable but should more explicitly recognize dependencies on marine and coastal ecosystem services. On risk management, DNB's approach already aligns with UNEP FI's framing of material risks in the SBE and could be strengthened by encouraging use of the TNFD LEAP approach. Finally, on reporting, DNB could address persistent marine data gaps by encouraging use of complementary tools such as ENCORE or ESGAP, alongside emerging standards like the ESRS, to more accurately capture ocean-related risk.

# OPPORTUNITIES FOR CENTRAL BANKS AND FINANCIAL REGULATORS TO TAKE ACTION

Central banks can strengthen systemic resilience through the way in which they manage their own portfolios. As major investors, central banks are uniquely positioned to incentivize and foster more sustainable finance. A key approach is to mitigate systemic risk and reinforce market confidence by integrating sustainability considerations into investment decisions and strategies, including on sector-specific sustainability criteria and the conservation of coastal and marine ecosystems.

Central banks can act as leaders in capturing these opportunities for sustainable finance. A notable example is Norges Bank, the central bank of Norway, which also manages one of the biggest sovereign wealth funds in the world. The bank has published an ocean sustainability policy in its responsible investment framework (Norges Bank Investment Management, 2018). This states that companies invested in by Norges Bank should meet certain expectations, such as integrating ocean sustainability considerations into policies, strategies and risk management. Furthermore, the central bank also emphasizes the need for companies to provide credible disclosure on material ocean sustainability information and engage proactively to support the development of standards, certifications and best practices in ocean-related risk management.

Similarly, the People's Bank of China (PBoC) provides evolving instructions and guidance on green finance, which includes ocean-related financing, for China's financial institutions. In 2021, PBoC issued a Green Bond Endorsed Projects Catalogue, together with the National Development and Reform Commission (NDRC) and the China Securities Regulatory Commission (CSRC). This catalogue lists more than 200 green programmes broken down by industry, with clear descriptions and conditions of eligibility for green bond financing. The catalogue includes the production and operation of marine energy, as well as the management and protection of marine ranching, a type of aquaculture. In the 2025 version, the catalogue explicitly excludes IUU fishing or harvest of endangered species in its fishery item. Other ocean-related items eligible for green bonds include initiatives towards the decarbonization of the shipbuilding and energy industries (including commodities like green methanol and green ammonia); and marine biologic resources like pharmaceutics and fermentation products based on marine microbes. In 2024, facilitated by the NDRC, PBoC issued an additional Catalogue for Guiding the Transition of Industries to Green and Low-Carbon Energy. This represents an iterative step towards sustainable financing for ocean health, further including renewable energy, wastewater management and other blue economy sectors. PBoC has collaborated with the European Union to build interoperability across these catalogues and the Multi-Jurisdiction Common Ground Taxonomy for sustainable activities, initiating a common taxonomy across the two markets in 2020 which was updated in 2024.

## ENGAGEMENT AND COLLECTIVE ACTION WITHIN THE SUPERVISORY SYSTEM

Central banks and financial regulators have opportunities to engage with their peers and collaborate across the financial supervisory system on ocean health and linkages between existing work on nature-related risk and ocean-related issues. This collective action exists to bring forward an ocean health narrative both domestically with other financial supervisors and internationally with other central banks and financial regulators, global initiatives and development finance institutions. This includes bilateral dialogue as well as participation in broader groups and regional initiatives such as the Central Bank of West African States (BCEAO) in West Africa or the ASEAN Central Bank Forum in Asia.

Through collective action, central banks and financial regulators can work to mainstream and standardize consideration of ocean-related risks and impacts within the supervisory system, particularly in the context of encouraging the Financial Stability Board (FSB), to expand its mandate to include ocean-specific issues. By engaging with the G20, where the topic of ocean sustainability is already on the political agenda through the Ocean 20, central banks and financial regulators should consider engaging in the finance track on strategic macroeconomic issues. This would aim to leverage the mandate of the G20 to call on the FSB to expand its work in this area. Similarly, central banks and financial regulators can collaborate in the context of the Basel and IAIS Framework to amplify existing calls to incorporate nature-related risk into these standards (Planet Tracker, 2023), particularly in elevating nature and ocean considerations alongside climate.

The perspective of central banks and financial regulators on ocean-related issues is amplified when linked to similar efforts across the financial system, private sector and civil society. Whether in relation to access to data, development of new assessment models and tools, or frameworks to guide sustainable action, participating in broader frameworks such as the UNGC – UNEP FI Ocean Investment Protocol, can scale up the required collective action and ensure actions across stakeholder groups remain coordinated.

Further, central banks and financial regulators, especially in the context of emerging markets, can look to collaborate with major development banks, many of whom are actively engaged on ocean sustainability, to ensure harmonized and consistent approaches to accounting for ocean-related risk and opportunity. In so doing, they can also coordinate with development banks in facilitating public-private partnerships.

Domestically, central banks and financial regulators are strongly encouraged to work with their counterparty financial supervisors to ensure the financial system as a whole works to better understand and support the effective management of ocean-related issues. As evidenced by DNB's latest guidance on nature-related risk (see case study, page 49), aligning and coordinating across supervisory bodies can help ensure the effective integration of these sustainability considerations into the supervisory system.

## LESSONS LEARNED FROM THE PRIVATE SECTOR

Central banks and financial regulators can look to a number of commercial financial institutions, including banks, investors and insurers, for examples of how to integrate ocean sustainability considerations into financing. While individual policies, risk management interventions or innovative financial transactions offer a step in the right direction, some financial institutions have started to acknowledge that responding and contributing to a net-zero, resilient, nature-positive future requires a fundamental change in how businesses operate. Such organizations are adopting climate and nature transition planning, which is an emerging concept that can help unlock transformative action and avoid the risks associated with the continued degradation of nature and climate change. It does so by identifying a consistent set of actions, strategies and accountability mechanisms, embedded within and across the organization.

Every year, WWF publishes the Sustainable Banking Assessment (SUSBA) and the Resilient and Sustainable Portfolios that Protect Nature and Drive Decarbonization (RESPOND) benchmarking tools for a selection of leading global banks and asset managers, respectively, to assess progress on nature- and climate-related focus areas. Since 2022, these benchmarks have included progress on ocean- and seafood-specific policies and expectations, and provide a useful time series on how financial institutions are integrating material environmental risks into their practices.

# REGIONAL TRENDS

*In general, European banks continued to have the most robust policies and processes, while both North American and Asian banks lagged behind. That said, Asian banks made the most progress year-on-year.*

## BANKS' SCORES BY REGION

*Box and whisker plot*

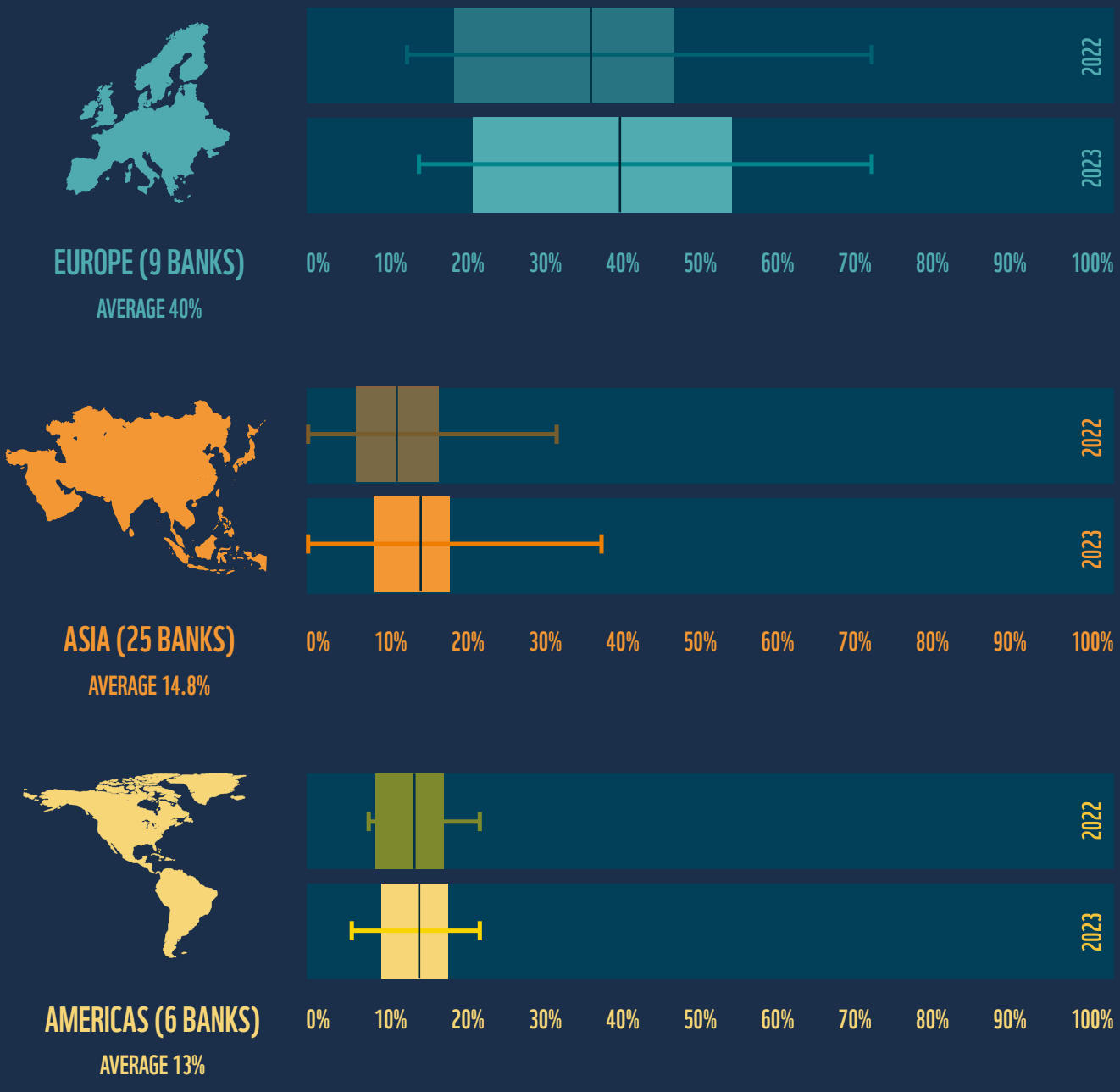
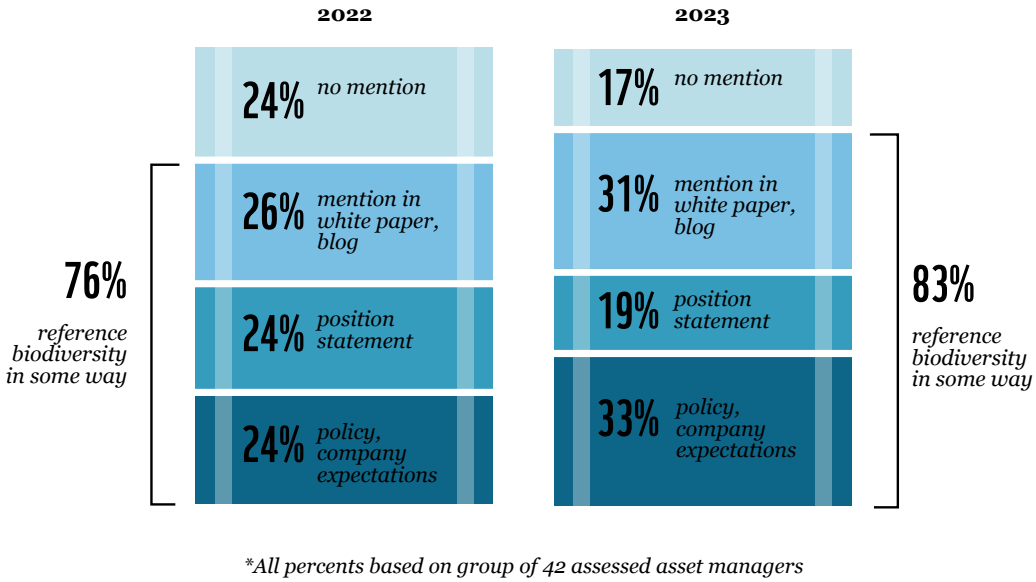



***Figure 9:*** *Incremental progress in bank seafood policies 2022–2023. Source: WWF (2024c)*




*All percents based on group of 42 assessed asset managers

***Figure 10:*** *Incremental improvement in asset manager references to biodiversity in institutional documents as a proxy for greater recognition of seafood- and ocean-specific factors. Source: WWF (2024d)*

As outlined in Figures 10 and 11, a number of financial institutions have looked to update their policies and risk management frameworks to incorporate sustainability considerations into their approach to financing the ocean economy, specifically in seafood. These sector-specific standards provide clarity on what activities are encouraged, expected, tolerated or excluded from financing, and can apply to divisions of a financial institution or the institution as a whole. Good examples here include Standard Chartered's updated agribusiness position statement, which includes clear guidance on sustainable performance for both aquaculture and wild-capture fisheries, and Deutsche Bank's environmental and social due diligence framework which includes financing provisions for maritime activities within World Heritage sites or development within Ramsar sites, UNESCO biosphere reserves and IUCN Type 1 protected areas. More examples can be found in the Ocean Risk and Resilience Action Alliance (ORAA) product pipeline.

A separate strategy is to look more closely at the opportunity landscape for sustainable transactions based on existing standards and principles, for example green/blue bonds and sustainability-linked loans. Here, different institutions have incorporated ocean-specific considerations into their sustainable finance frameworks and have executed on deals that promote sustainability in the market. For example, HSBC, alongside The Nature Conservancy (TNC) and the Australian government, have developed a blue environmental impact bond framework to identify investable NbS with revenue streams from increased ecosystem services in New South Wales (UNEP FI, 2022b).

Incentivizing these behavioural changes is an important aspect of institutionalizing sustainability considerations within financial institutions that may be relevant for central banks and financial regulators. Important factors to consider include how sustainable financing is incentivized and how performance is rewarded within institutions, as well as how corporate governance monitors and supports decision-making for sustainability.

Private-sector-led collaborations, particularly in the context of overcoming financing challenges related to, for example, ocean data availability and impact measurement, are important examples of collective action that central banks and financial regulators may also contribute to and leverage. As no single organization can address ocean health decline on its own, coordinated and integrated approaches across stakeholders are essential. Fortunately, several initiatives exist that support this collective action, including: (1) the recently released Ocean Investment Protocol (United Nations Global Compact (UNGC) and UNEP FI, 2025) that outlines key requirements across stakeholder groups to scale up finance for a SBE; (2) the Ocean Impact Navigator, developed by 1000 Ocean Startups, a tool designed to *"simplify, harmonize and strengthen impact measurement and reporting"* (1000 Ocean Startups, 2022); and (3) the Fisheries Improvement Fund, a new funding solution for Fishery Improvement Projects (Finance Earth, 2025). Lastly, some private sector actors such as Oslo-based VC fund Katapult Ocean, have been advocating for a systemic and highly collaborative approach to building ocean impact investment portfolios (www.oceanreturns.com) in order to achieve a holistic

transformation of the ocean economy. These platforms bring together a coalition of venture capitalists, incubators, accelerators and matchmakers looking to scale innovations and transformative startups for ocean health restoration.

Remaining aware of and proactively participating in both existing and emerging initiatives in the SBE through participation in dialogue on ocean health with the private sector is an important action for central banks and financial regulators. **In this particular context, due to their responsibility for system stability, central banks and financial regulators can also play an important role in ensuring a level playing field for sustainable investment strategies, policies and behaviours set by the private sector.**

## FINANCIAL INSTRUMENTS FOR A SUSTAINABLE BLUE ECONOMY

Several instruments are already in use to channel capital towards ocean sustainability. They can help reduce systemic risk by supporting conservation, restructuring debt, or de-risking investment in ocean-related sectors.

- **Blue Bonds:** Used by sovereigns, development banks and corporates to finance marine conservation and sustainable ocean sectors. Investor demand has been high but depends on credible standards and measurable impacts. Blue bonds have emerged as a recent financial innovation to mobilize capital for ocean conservation, beginning with the Seychelles' 2018 sovereign blue bond (US$15 million), followed by multilateral development bank issues such as the Nordic Investment Bank's €2 billion SEK Baltic Sea bond in 2019 and the Asian Development Bank's A$208 million double issuance in 2021, and more recently by commercial banks and corporates, including Ørsted and DP World in 2024.
- **Debt-for-Nature Swaps:** Allow sovereign debt restructuring in exchange for commitments to conservation, with recent large-scale examples of swaps in Belize (2021) and Ecuador (2023).
- **Blended Finance Facilities:** Mix concessional finance, guarantees, and loans to address capital gaps in ocean sectors and support SMEs and community projects.
- **Impact Funds and Accelerators:** Provide targeted capital and technical assistance to early-stage enterprises in sustainable seafood, plastics alternatives, reef protection and other marine solutions.

For central banks and financial regulators, these instruments illustrate how financial flows can be steered toward sustainable outcomes. Understanding their mechanics helps in assessing risk, encouraging market credibility, and identifying where supervisory or portfolio policies can reinforce systemic resilience.

# KEY MESSAGES TO CENTRAL BANKS, FINANCIAL REGULATORS AND SUPERVISORS

01

## FINANCIAL FLOWS ARE STILL CONTRIBUTING TO OCEAN HEALTH DECLINE.

Harmful subsidies, weak disclosure requirements, and a lack of supervisory integration mean that capital continues to support overfishing, marine pollution, and coastal habitat destruction. This exposes financial systems to systemic risk while undermining international ocean protection goals.

02

## COLLATERAL FRAMEWORKS ARE A CRITICAL BLIND SPOT FOR OCEAN-RELATED RISK.

Ocean economy sectors likely feature prominently in central bank collateral baskets, but mispricing and the principle of market neutrality risk locking in harmful activities. Assessing collateral exposures against harmful and sustainable activities is a practical first step to close this gap.

03

## SUPERVISORY FRAMEWORKS ONLY PARTIALLY ADDRESS OCEAN-RELATED RISK.

WWF's 2024 SUSREG shows that fewer than 40% of jurisdictions partially integrate ocean considerations in banking and insurance supervision, typically under broad "environmental risk" categories. Without explicit supervisory guidance, exposure to unmitigated ocean-related shocks persists.

04

## OCEAN-SPECIFIC SUPERVISORY GUIDELINES ARE URGENTLY NEEDED.

Current practices lack detail on how financial institutions should assess, mitigate, and avoid ocean risks. Tailored guidelines, similar to those developed for deforestation risk, would ensure that ocean-related vulnerabilities are systematically identified and managed.

05

## INTEGRATING OCEAN HEALTH INTO CENTRAL BANK OPERATIONS STRENGTHENS SYSTEMIC RESILIENCE.

Central banks, as major investors, can reduce systemic vulnerabilities and foster market confidence by embedding ocean sustainability criteria in portfolio management, governance, and risk practices. This also sends a strong signal to the wider financial system.

06

## EMERGING PRACTICES IN OTHER JURISDICTIONS PROVIDE PATHWAYS FORWARD.

Norges Bank has set ocean sustainability expectations in its sovereign wealth fund, and the People's Bank of China has included ocean-related activities in its green bond catalogues while excluding harmful fisheries. Such examples demonstrate that central banks can integrate ocean considerations without overstepping mandates.

07

## OPPORTUNITIES EXIST TO PROACTIVELY EMBED OCEAN CONSIDERATIONS IN MONETARY AND SUPERVISORY POLICY.

By incorporating ocean-related risks into supervision, collateral frameworks, bond purchasing and disclosure requirements, central banks can align financial flows with sustainable blue economy outcomes. This not only mitigates systemic risk but also creates pathways to finance solutions that strengthen resilience.

08

## ENGAGEMENT AND COLLECTIVE ACTION AMPLIFY INFLUENCE AND CONSISTENCY.

Central banks and regulators can use their voice in international platforms, such as the G20, FSB, Basel framework, and regional supervisory forums, to ensure ocean risks are systematically integrated. Collaborating with private financial institutions and development banks also helps close data gaps, set standards, and create a level playing field for sustainable ocean finance.


# 04: TOOLS FOR OCEAN ECONOMY FINANCIAL RISK ASSESSMENT

# SECTION 04:
# TOOLS FOR OCEAN ECONOMY FINANCIAL RISK ASSESSMENT

This section describes tools available for use by central banks and financial regulators in assessing their exposure to nature-related financial risk in the ocean economy. These tools also enable central banks and financial regulators to eliminate unsustainable activities from their monetary and non-monetary policy portfolios. Lastly, these tools may also support risk identification and assessment across the phases suggested by the NGFS and the steps of the TNFD LEAP framework.

Given the breadth of sectors and biomes comprising the ocean economy, the tools provided here are an illustration of the types of tools available for central bank consideration and have been categorized by function and use case. Resources that provide further details on tools according to their specific use can be found in the ORRAA *Risk and Vulnerabilities Mapping paper* (Tokunaga *et al.*, 2022) as well as in the TNFD Tools Catalogue, which links available tools (both open source and proprietary, ocean-linked and general) to the steps of the LEAP framework. The tools highlighted in this paper should not be considered an exhaustive list, and their inclusion does not represent endorsement of their use: they are here simply to provide an overview of available resources.

In terms of mapping against the NGFS phases for risk assessment, several tools are suited to Phase 1, as most of the scientific literature on which tools are based focuses on parameterizing or quantifying nature-related physical and transition risks. Fewer resources exist to translate this information into Phase 2, and while those included in the table below are valuable resources that central banks and financial regulators are strongly encouraged to explore, they often don't explicitly cover ocean sectors or marine ecosystem services. Nevertheless, the UNEP FI sector guidance, Global Ocean Accounts Partnership, Biodiversity Risk Filter and ESGAP and INCAF tools warrant incorporation into central bank assessments of linkages to ocean health despite their constraints.

Fewer resources still make linkages from Phase 1 through to Phase 3 on risk to financial systems. Of these, ESGAP and INCAF are specifically designed to support central banks and financial regulators in understanding exposure to nature-related risk and macroeconomic consequences, though at the time of writing these are not ocean-specific.[12] Central banks and financial regulators may wish to explore the UNEP FI guidance, although it is written for a commercial finance audience, to consider linkages to e.g. understand what sectoral activities to exclude from policy portfolios and eligibility criteria for collateral baskets.[13]


12. A 'blue' ESGAP covering the ocean is however in development at the time of writing.
13. See the Appendix for more information on UNEP FI and its ocean-specific resources.

# GAPS AND CHALLENGES IN OCEAN ECONOMY TOOLS

Despite an abundance of tools and datasets that can support central bank understanding of ocean health, gaps and challenges remain, particularly with respect to tools that are both granular enough at asset level while being broad enough to cover the range of ocean sectors and ecosystem services outlined in this paper. To date, most tools with linked databases focus on geospatial data and climate-related risk, while nature-related risk, quantification of ecosystem services, value at risk, and sector-specific exposure assessment remain limited. These challenges, and suggested ways in which central banks and financial regulators may support their resolution, are highlighted here.

As is clear from the table, gaps remain in the toolset for risks associated with ocean health, and these are briefly discussed below.

1. Global tools to understand nature-related risk that are already well suited to central bank use, like INCAF and ESGAP, do not explicitly cover ocean health, limiting their application to understanding risk exposure in the ocean economy. Central banks and financial regulators, by emphasizing the significance of understanding ocean-related risks, can signal the importance of developing these tools to the market.

2. Some sectors and biomes are better represented in the existing toolset than others – coastal areas are easier to assess and more information is available on which to, for example, model different scenarios. Similarly, the seafood industry, due to its maturity and direct interface with nature, has more data and tools available for risk assessment and management.

3. Given the different physical nature of the ocean, the 'Locate' phase of the LEAP framework against which available tools can be mapped is particularly challenging to address in the marine environment.

4. Few macroeconomic models fully account for systemic risks associated with ecosystem collapse or sea level rise. INCAF, a helpful tool in this regard, does not explicitly cover the marine environment. Further work in this area is urgently needed.

5. While standardization is emerging, several different approaches continue to exist, particularly with respect to risk exposure analysis. Despite the challenges in applying the LEAP framework to the marine environment, the structured approach adopted by the TNFD to build standardization should be further encouraged.

6. Much more information is needed linking ocean physical and transition risk to Phase 3 of the NGFS risk assessment framework. Proprietary tools (not included in this analysis) are beginning to fill this gap, many of which are being provided by ESG data providers. These institutions now have a crucial role to play in building capacity and expertise in assessing ocean risk at the corporate level. Central banks and financial regulators should, however, encourage the availability of as much open source information as possible, also to support understanding of the translation to macroeconomic risk.

While challenges remain and no one tool is able to provide a complete picture of ocean-related risk for the purposes of central bank activities and remits, utilizing a combination of tools can provide sufficient information to get underway. Recent research also highlights major gaps in corporate disclosure of ocean impacts, underscoring the importance of improving transparency and harmonizing reporting standards to support effective risk assessment (Jouffray *et al.*, 2025). However, significant efforts are underway to build data sets, develop more sophisticated tools and clarify linkages between the drivers of ocean health decline, physical and transition risk, and financial risk and macroeconomic stability. Central banks and financial regulators are encouraged to maintain a close interest in this rapidly developing space.

| | | ENCORE (OPEN SOURCE) | UNEP FI GUIDANCE (OPEN SOURCE) | ESGAP |
|---|---|---|---|---|
| **Description** | | An online tool that helps organizations explore their exposure to nature-related risk across different sectors. Impact analysis includes sectoral exposure to marine ecosystem use. | A risk-based set of sector-specific sustainability criteria for behaviour to avoid, challenge and seek out in financing for the ocean. | A method for determining nature-related risk in the context of planetary boundaries, scaled down to a country level. An ocean-specific ESGAP assessment is in development. |
| **Central bank use case** | | Classifies sectoral impacts and dependencies on nature with materiality of exposure to build picture of exposure across economies. | Provides clear recommendations for action to financial institutions on exclusions, engagement and opportunities that central banks and financial regulators can align against their own portfolios. | Overall assessment of the environmental sustainability of a given territory against key indicators of planetary health, enabling target-setting at country level. |
| **Category** | | Risk exposure analysis | Risk exposure analysis<br>Framework for standardization | Risk exposure analysis |
| **Sustainable Blue Economy focus** | | ✓ | ✓ | ✗ |
| **Sectors covered** | | Seafood, ports, shipping, marine renewables, tourism, waste management, infrastructure | Seafood, ports, shipping, marine renewables, tourism, waste management, infrastructure | N/A |
| **NGFS phases for risk assessment framework** | **Identification of sources of physical and transition risk** | ✓ | ✓ | ✓ |
| | **Assessment of economic risks** | | | ✓ |
| | **Assess risk to, from and within the financial systems** | | ✓ | ✓ |
| **TNFD LEAP approach step (L, E, A, P)** | | E | E, A | L, E |

| | | INCAF | OCEAN DATA PLATFORM (OPEN SOURCE) | SEAFOOD STEWARDSHIP INDEX (OPEN SOURCE) |
|---|---|---|---|---|
| Description | | A method for determining macroeconomic nature-related risk at a country level, with specific assessments of value at risk for water and agriculture. | Cloud-based geospatial platform for ocean-nature datasets. | Benchmarking tool for corporate performance on seafood sustainability. |
| Central bank use case | | Builds on the NGFS climate scenario framework and examines potential for linking nature-climate risk scenarios for stress testing. | Compilation of data sets on ocean-related health indicators, aims to be a one-stop-shop for integrated ocean data for decision-making. Data and modelling tool for developing nature scenarios. | At-a-glance overview of sustainability performance of listed seafood companies that can be aligned with eligibility for collateral baskets. |
| Category | | Risk exposure analysis<br>Stress testing (precursor) | ESG profiling<br>Data portal | ESG profiling<br>Assessment and ranking service<br>Framework for standardization |
| Sustainable Blue Economy focus | | ✗ | ✓ | ✓ |
| Sectors covered | | N/A | Seafood, ports | Seafood |
| NGFS phases for risk assessment framework | Identification of sources of physical and transition risk | ✓ | ✓ | ✓ |
| | Assessment of economic risks | ✓ | | ✓ |
| | Assess risk to, from and within the financial systems | ✓ | | |
| TNFD LEAP approach step (L, E, A, P) | | L, E | L | E |

| | | WWF NAVIGATING OCEAN RISK | WWF BIODIVERSITY RISK FILTER AS PART OF THE RISK FILTER SUITE (OPEN SOURCE) | MSC STANDARD (OPEN SOURCE) |
|---|---|---|---|---|
| Description | | Study of BAU and sustainable trajectories for ocean development and economic consequences for ocean economy sectors. | Screening and prioritization of biodiversity risk exposure as a whole. | Sector-specific sustainability standard and certification scheme for fisheries. Assessed fisheries are publicly available. |
| Central bank use case | | Quantification of sectoral, ocean-specific risk to complement global value-at-risk studies and understand macro risk exposure. | Screening tool for priority action on risk exposure across portfolios, supports understanding of exposure to risk within collateral baskets and reasons for updated sector policies. | Attaining MSC certification indicates fisheries that are taking responsible measures towards sustainability. |
| Category | | Risk exposure analysis | Risk exposure analysis | Assessment and ranking service |
| Sustainable Blue Economy focus | | ✓ | ✗ | ✓ |
| Sectors covered | | Coastal infrastructure, fisheries, aquaculture, ports and shipping, coastal tourism, marine renewable energy | N/A | Seafood |
| NGFS phases for risk assessment framework | Identification of sources of physical and transition risk | ✓ | ✓ | ✓ |
| | Assessment of economic risks | ✓ | ✓ | |
| | Assess risk to, from and within the financial systems | ✓ | | |
| TNFD LEAP approach step (L, E, A, P) | | N/A | L, E, A, P | L, E, A, P |

| | | ASC STANDARD (OPEN SOURCE) | SBTN OCEAN HUB (OPEN SOURCE) | COASTAL RISK INDEX (OPEN SOURCE) |
|---|---|---|---|---|
| Description | | Sector-specific sustainability standard and certification scheme for aquaculture. Assessed farms are publicly available. | SBTN target-setting methodology for ocean sectors, beginning with seafood. Fits into LEAP-aligned 5-step SBTN guidance. | Global platform of flood maps to understand current and future coastal flood risk and risk reduction benefits from natural habitats. |
| Central bank use case | | Benchmark for sustainability in seafood and sectoral sustainability certification, key reference point for sector policy. | Biome-specific guidance on science-based target setting and action for ocean sectors, with methods for assessing exposure, measuring impact and setting targets. | Exposure mapping for coastal climate-related risk, supports decision-making in relation to vulnerability and resilience of coastal areas. |
| Category | | Assessment and ranking service | Risk exposure analysis<br>Impact measurement and analysis<br>Target-setting | Risk exposure analysis |
| Sustainable Blue Economy focus | | ✓ | ✓ | ✓ |
| Sectors covered | | Seafood | Seafood (with plans for additional sectors) | Infrastructure |
| NGFS phases for risk assessment framework | Identification of sources of physical and transition risk | ✓ | ✓ | ✓ |
| | Assessment of economic risks | | | |
| | Assess risk to, from and within the financial systems | | | |
| TNFD LEAP approach step (L, E, A, P) | | L, E, A, P | L, E, A, P | L, E, A, P |

| | | OCEAN HEALTH INDEX | OCEAN IMPACT NAVIGATOR (OPEN SOURCE) | MARXAN | GLOBAL OCEAN ACCOUNTS PARTNERSHIP |
|---|---|---|---|---|---|
| Description | | A country-level framework for assessing ocean health based on the sustainable provisioning of benefits and services from a healthy ocean. | Impact KPI framework aiming to simplify impact measurement across ocean startups and venture capital. | Decision-support tool for structuring, designing and evaluating spatial planning projects, including for the marine environment. | An initiative enabling countries and other stakeholders to measure and manage progress toward ocean-based sustainable development and climate action. |
| Central bank use case | | Country assessment tool against a range of indicators for ocean health to support prioritization of action at national scales. | Standardization of ocean-related performance indicators supports measurement and aggregation of key data points for ocean health. | Toolset for spatial planning at national level to support decision-making and social and environmental risk management. Data and modelling tool for developing nature scenarios. | Building a standard approach to tracking ocean economic flows and public finances. |
| Category | | Assessment and ranking service | Impact measurement and analysis<br>Data portal<br>Framework for standardization | Data portal<br>Modelling tool | Data portal<br>Framework for standardization |
| Sustainable Blue Economy focus | | ✓ | ✓ | ✓ | ✓ |
| Sectors covered | | N/A (indirectly covers KPIs on ocean resources) | N/A (indirectly covers KPIs on ocean resources) | N/A (spatial planning tool; indirectly covers multiple ocean uses) | N/A |
| NGFS phases for risk assessment framework | Identification of sources of physical and transition risk | ✓ | ✓ | ✓ | ✓ |
| | Assessment of economic risks | | | | ✓ |
| | Assess risk to, from and within the financial systems | | | | |
| TNFD LEAP approach step (L, E, A, P) | | L, E | E, A | L, E | P |

| | | GLOBIO | IUU FISHING RISK INDEX (OPEN SOURCE) | GLOBAL FISHING WATCH (OPEN SOURCE) |
|---|---|---|---|---|
| Description | | Integrated assessment modelling framework to inform and support policymakers by quantifying global human impacts on biodiversity and ecosystems. | A global assessment measuring countries' vulnerability, exposure, and response to illegal, unreported and unregulated (IUU) fishing. The index combines qualitative and quantitative indicators across 152 coastal states. | A satellite-based monitoring platform that uses Automatic Identification System (AIS) data and machine learning to track global fishing vessel activity and trans-shipment patterns. Provides near-real-time insights into fishing pressure, potential illegal activity, and fleet behaviour. |
| Central bank use case | | Data and modelling tool for developing nature scenarios. | Provides country-level indicators of governance, enforcement, and resource sustainability, serving as a proxy for sovereign and macro-sector exposure to nature-related and illicit-economy risks. Useful for identifying countries with potentially weak ocean governance and high dependence on fisheries exports. | Offers geospatial and activity-level data to support sectoral risk screening, particularly for institutions financing fisheries, ports, or logistics. Helps supervisory bodies understand spatial concentration of activity and potential links between environmental degradation and financial exposure. |
| Category | | Modelling tool | Assessment and ranking service | Data portal |
| Sustainable Blue Economy focus | | ✗ | ✓ | ✓ |
| Sectors covered | | N/A | Seafood, Ports, Shipping | Seafood, Shipping, Ports, Marine renewables |
| NGFS phases for risk assessment framework | Identification of sources of physical and transition risk | ✓ | ✓ | ✓ |
| | Assessment of economic risks | | ✓ | ✓ |
| | Assess risk to, from and within the financial systems | | | |
| TNFD LEAP approach step (L, E, A, P) | | P | L, E | L, E, A |

# KEY MESSAGES TO CENTRAL BANKS, FINANCIAL REGULATORS AND SUPERVISORS


## A GROWING SET OF TOOLS IS AVAILABLE TO HELP ASSESS OCEAN-RELATED FINANCIAL RISKS.

These include risk exposure analysis (ENCORE, ESGAP, INCAF), ESG profiling (Seafood Stewardship Index, WWF Risk Filter Suite), data portals (Ocean Data Platform), and sector standards (MSC, ASC).


## MOST TOOLS ARE CONCENTRATED IN EARLY-STAGE RISK IDENTIFICATION (NGFS PHASE 1).

They can classify dependencies and impacts but are less effective in translating results into macroeconomic and financial system risk (Phases 2-3).


## COVERAGE ACROSS BLUE ECONOMY SECTORS IS UNEVEN.

Seafood and coastal ecosystems are relatively well covered, but shipping, offshore energy, and deep-sea ecosystems lack robust assessment tools.


## MARINE ENVIRONMENTS PRESENT UNIQUE TECHNICAL CHALLENGES FOR ASSESSMENT.

For example, the TNFD “Locate” step is harder to implement in the ocean due to limited visibility, data scarcity, and the complexity of overlapping ecosystems.


## MACROECONOMIC MODELLING OF SYSTEMIC RISKS LIKE ECOSYSTEM COLLAPSE OR SEA-LEVEL RISE IS STILL LIMITED.

Tools such as INCAF and ESGAP move in this direction, but marine-specific extensions are needed to capture systemic stability risks.


## CORPORATE DISCLOSURE OF OCEAN IMPACTS REMAINS WEAK AND FRAGMENTED.

Fewer than 25% of firms report targets or metrics for ocean-specific impacts, highlighting the need for supervisors to push for harmonized standards.


## NO SINGLE TOOL PROVIDES A COMPLETE PICTURE.

Central banks and regulators should use a portfolio of tools while encouraging more open-source, marine-specific methodologies to close critical gaps.

# 05: RECOMMENDATIONS FOR CENTRAL BANKS AND FINANCIAL REGULATORS TO ADDRESS OCEAN-RELATED RISK

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# SECTION 05:

# RECOMMENDATIONS FOR CENTRAL BANKS AND FINANCIAL REGULATORS TO ADDRESS OCEAN-RELATED RISK

On the basis of the dependencies, impacts, risks and opportunities associated with key ocean economy sectors and their significance to central banks and financial regulators, this paper makes the following recommendations. These recommendations are aligned with those published in relation to the ocean economy by the Ocean Investment Protocol (UNGC and UNEP FI, 2025), WWF's report *Assessing financial flows within the Southwest Indian Ocean blue economy* (WWF, 2024g) and the 2024 SUSREG report (WWF, 2024f), as well as broader recommendations for central banks and financial regulators produced by the NGFS.

Given the systemic, endogenous and uncertain nature of ocean-related risks, a precautionary policy approach is needed for central banks and financial regulators. As highlighted by Kedward *et al.* (2020), nature-related financial risks cannot be fully quantified or managed through disclosure and market-based measures alone. Instead, financial supervisors and central banks should act early and decisively to prevent the buildup of systemic vulnerabilities, for example by identifying and discouraging clearly unsustainable activities, integrating qualitative assessments into prudential and monetary frameworks, and steering capital towards nature-positive outcomes.

The recommendations presented here are therefore structured as urgent actions, shorten measures and medium term priorities to help financial authorities respond effectively to these systemic risks.

## URGENT ACTIONS

- Central banks and financial regulators are encouraged to undertake urgent research to **assess their own exposure and the exposure of their financial system to the ocean-related risks** highlighted in this paper using the tools suggested.

## SHORT-TERM ACTIONS

- Central banks and financial regulators should further suggest and support the **development of tools that can clarify the extent and magnitude of ocean-related risk and support more effective risk management practices by financial institutions.** This should include a call for greater focus on ocean-related dependencies and impacts by financial institutions and data providers through greater data collection and analysis as well as sector-specific scenario analysis.

- Central banks and financial regulators need to **send signals and set expectations for commercial banks and insurers to integrate ocean-related risk into their existing environmental and social risk frameworks and policies and risk appetites.** Key to this is the creation of a level playing field for financial institutions to incorporate ocean-related issues into their strategies, policies and practice. As part of this, nature-related risk considerations should include and address ocean-related risk, covering all aspects of ocean-related risk and reflecting environmental, societal and financial materiality across banking activity. Similarly, expectations should be set regarding board-level supervision of ocean-related risk, and institutional knowledge of ocean health and its linkages to systemic risk. This also includes supporting the development and use of ocean health outcome metrics (see WWF's Ocean Positive Framework), and ongoing international efforts to foster consensus on how such outcomes are measured (e.g. through UNOC).

- Central banks and financial regulators are encouraged to **lead by example and build an understanding of the exposure to ocean-related risk within their monetary policy portfolio (including their collateral baskets)** within their respective jurisdictions. This should be done from a double materiality perspective, including both environmental and financial materiality.

- To that effect, central banks and financial regulators need to allocate resources to **develop internal capacity to understand and assess ocean-specific dependencies and impacts,** and translate these to risks and opportunities. As part of this, central banks and financial regulators should engage with academic and scientific research institutions, as well as civil society organizations, to support the development of their own expertise. The materiality of ocean-related risks and the findings from these assessments should be highlighted and shared, similarly to the sharing of information on nature-related risk, to raise awareness and call for action on risk management.

- Central banks and financial regulators should call for existing tools and models, such as ESGAP, INCAF and GLOBIO (see tools section, above), to explicitly include ocean-related indicators of dependency and impact and support any new research that may be required to build out necessary knowledge and understanding. While the ocean data landscape is not currently comprehensive, **building out available tools and resources should ultimately serve the development of stress-testing capacity against ocean-linked systemic risks to the financial system.**

- Central banks and financial regulators should urge international regulatory bodies like the Financial Stability Board (FSB) and international financial standards-setters (such as the Basel Committee on Banking Supervision, the International Association of Insurance Supervisors and the IOSCO) as well as national regulatory and supervisory authorities to integrate ocean-related issues into the regulatory frameworks governing global and domestic systemically important banks (G-SIBs and D-SIBs) and strengthen major banks' resilience to environmental shocks. **Through the G20 finance track on strategic macroeconomic issues, central banks and financial regulators should call on the FSB to expand its work to integrate ocean-related issues.**

- As part of these expectations, **central banks and financial regulators should make clear the importance of estimating the environmental materiality of ocean health decline, based on robust, quantifiable and asset-specific assessments, taking into account the most adverse scenarios and including qualitative and expert judgement when good quality data are lacking.** Similarly, central banks and financial regulators should stress the need to include assessment of exposure to, and materiality of, financial risks. Expectations should be set that these assessments are disclosed publicly alongside financial reporting in line with regulatory requirements where jurisdictionally applicable.

- Further, central banks and financial regulators, especially in the context of emerging markets, can look to **collaborate with major development banks, many of whom are actively engaged on ocean sustainability, to ensure harmonized and consistent approaches to accounting for ocean-related risk and opportunity.** In so doing, central banks and financial regulators can also coordinate with development banks in the context of facilitating public-private partnerships.

- Domestically, **central banks and financial regulators are strongly encouraged to work with their counterpart financial supervisors to ensure the financial system as a whole is equipped to better understand and support the effective management of ocean-related issues and their consequences for financial stability.** Similarly, central banks and financial regulators are encouraged **to work with their governments to support, for example through policy interventions and incentives, the transition to a SBE,** in order to capture long-term benefits and reduce systemic risks from unsustainable economic development and ocean health decline.

- Central banks and financial regulators are encouraged to adopt existing sustainability frameworks for ocean health to support further alignment and action from financial institutions. The UN Sustainable Blue Economy Finance Principles provide a high-level framework for financing sustainability. While written for commercial finance, the concepts and practices outlined by the Principles codify best practice approaches for all financing for a SBE. **Central banks and financial regulators are recommended to align their own policy and practice for sustainable financing with the UN Sustainable Blue Economy Finance Principles,** and engage with broader frameworks such as the UNGC–UNEP FI Ocean Investment Protocol to scale up collective action for addressing ocean health decline.


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# MEDIUM- AND LONG-TERM RECOMMENDATIONS

- Over time, central banks and financial regulators should work to **integrate ocean-related risks into scenario analysis and stress-tests on resilience to risks associated with climate change, nature loss and ocean health decline**, and include ocean-related risk across a broad range of models and scenarios.

**Going forward, central banks and financial regulators should:**

### 1 Develop expectations for ocean health and SBE-related policies with clear objectives and timebound targets for financial institutions.

Central banks and regulators should establish supervisory expectations that require and guide financial institutions to adopt policies addressing ocean health and the SBE. These should include measurable, timebound targets – such as reducing exposure to ocean-degrading sectors, or increasing lending to sustainable fisheries and coastal resilience projects – to ensure accountability and progress.

### 2 Account for ocean risk in refinancing and reserves tiering

Refinancing operations and the tiering of reserve requirements can be powerful levers for influence. By adjusting access to favourable refinancing terms or reserve remuneration based on banks' exposure to ocean-related risks, central banks can incentivize financial institutions to shift capital away from harmful marine activities and toward sustainable ocean sectors.

### 3 Account for ocean risk within tools such as prudential requirements (including capital requirements) and credit guidance

Regulatory tools like capital adequacy rules or sectoral credit guidance can be adapted to reflect the financial risks stemming from ocean degradation. For instance, higher risk weights can be applied to loans supporting unsustainable marine industries, while favourable conditions can be extended to those funding blue economy solutions, encouraging a reallocation of capital.

### 4 Account for ocean risk in monetary policy portfolios

Central banks can assess and disclose the exposure of their own monetary policy portfolios – including sovereign bonds and corporate assets – to ocean-related risks. Incorporating ocean health criteria into portfolio management practices would not only reduce financial risk but also set a strong market signal aligned with global biodiversity and climate commitments.

### 5 Set up dedicated teams or departments to monitor and supervise sustainability disclosures and transition plans by financial institutions

To ensure effective oversight, central banks and regulators should create specialized units with the expertise to evaluate banks' sustainability disclosures and transition plans, including those related to ocean impacts. These teams can help improve data quality, identify greenwashing, and guide institutions through the transition to nature-positive business models.

### 6 Support sustainable financing through the development of interoperable SBE taxonomies

Central banks can play a key role in promoting credible blue finance by supporting the development and harmonization of SBE taxonomies. These frameworks help define what qualifies as sustainable ocean investment, enabling consistency across markets and reducing the risk of mislabelling or greenwashing.

### 7 Collaborate with governments and other financial regulators and central banks on measures to account for ocean-related issues

Addressing ocean risks requires coordinated action. Central banks should work closely with finance ministries, environmental agencies and international regulatory bodies to align policies, share data and develop joint strategies. This cross-sectoral cooperation is essential for building resilient financial systems that account for the health of marine ecosystems.

# GLOSSARY OF TERMS

| TERM | DEFINITION |
|---|---|
| **Aquaculture** | The cultivation of farmed fish and seafood. |
| **Collateral** | A pledged security for certain types of financing. |
| **Collateral basket** | A collection of eligible assets (including marketable assets as well as non-marketable assets such as private state loans) set by central banks and financial regulators which they will accept as collateral from commercial banks in exchange for lending capital. |
| **Dependency** | Aspects of ecosystem services that an organization or other actor relies on to function (TNFD). |
| **Driver** | Non-product outputs of a business activity that affect nature (TNFD). |
| **Ecosystem services** | The benefits, both goods and services, that people obtain from ecosystems. |
| - Provisioning services | Products obtained from ecosystems, such as seafood, wood and energy. |
| - Regulating services | Benefits obtained from the regulation of ecosystem processes, such as flood protection. |
| - Cultural services | Non-material benefits from ecosystems including spiritual, scientific and recreational benefits. |
| - Supporting services | Underpinning services that allow for the provision of all other ecosystem services, such as nutrient cycling or primary productivity. |
| **Fishery** | An area, typically managed, where fish are caught for commercial or recreational purposes. |
| **Fishing** | The capture of wild fish from the marine environment. |
| **Impact** | A change in the state (quality or quantity) of natural capital, which may result in changes to the capacity of nature to provide ecosystem services (TNFD). |
| **Issuer** | An entity that creates and offers for purchase securities such as stocks and bonds. |
| **Materialities** | Facts or topics that matter most to a business and its stakeholders, those that would affect the judgement of an informed stakeholder like an investor. |
| - Environmental | The actual and potential impacts of a business on the environment, 'inside-out'. Equates to 'impact' in the DIRO typology of the TNFD. |
| - Financial | Environmental consequences and dependencies that have a real-world impact relevant to a business' financial performance, 'outside-in'. Equates to 'dependency' in the DIRO typology of the TNFD. |
| - Double | The notion of accounting for both inside-out (environmental) and outside-in (financial) materiality |
| **Ocean economy** | Economic activity on or around the ocean, including coastal activity. A catch-all term for any such economic activity, regardless of its sustainability performance (compare with Sustainable Blue Economy). |
| **Prudential risk** | Risk that affects confidence in the financial system, on the basis of a reduction in the financial health of its actors. |
| **Sustainable Blue Economy** | A subset of the ocean economy in line with the notions of sustainable development and the Principles of the Sustainable Blue Economy (compare with ocean economy). |

# APPENDIX I:
# FURTHER RESOURCES FOR SUSTAINABLE OCEAN FINANCING OPPORTUNITIES AND RISK MANAGEMENT

A number of resources exist that can support financial institutions, including central banks and financial regulators, in implementing sustainable ocean finance alongside ocean-climate and nature-related risk management. While many of these have been developed for private finance or focus on sustainability more broadly, they are nevertheless helpful for central banks and financial regulators to explore in order to implement ocean-specific considerations into their frameworks. This section briefly outlines some of the most significant resources and publications on this topic; subsequent sections offer further detail on specific tools.

## TASKFORCE ON NATURE-RELATED FINANCIAL DISCLOSURES (TNFD)

The TNFD is a voluntary framework for corporations to report on their nature-related dependencies, impacts, risks and opportunities (DIRO), building on the disclosure framework developed for climate-related risk that now sits with the International Sustainability Standards Board. The TNFD's guidance centres on the LEAP (Locate, Evaluate, Assess, Prepare) framework to support institutions in understanding their interface with nature and core metrics on which to disclose. In relation to the blue economy, while the guidance of the TNFD is broadly applicable across sectors, the taskforce offers additional sector-specific guidance for disclosure on seafood and marine transportation.

## EUROPEAN UNION DIRECTIVES AND STANDARDS

The European Union (EU) is among the actors mandating corporate disclosure for marine ecosystems through the Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS), the Corporate Sustainability Due Diligence Directive, the Sustainable Finance Disclosure Regulation, and the EU taxonomy.[14]

- The CSRD[15] outlines ways in which corporations are obliged to disclose on their impacts on dependencies on nature, while the ESRS underpins what corporations are expected to disclose on – ESRS standard E3 on water and marine resources is particularly relevant for the SBE, and requires companies to make detailed disclosures on policies, actions and targets related to marine resources, as well as their potential financial effects from marine-related impacts, risks and opportunities. Additionally, where companies are required to report on standard E4 on biodiversity depending on their materiality assessments, there is an additional requirement to report on their transition plan on biodiversity and ecosystems. This may include ocean-related targets on biodiversity conservation.

- The Corporate Sustainability Due Diligence Directive (CSDDD)[16] focuses on corporate due diligence and the ways in which corporations should follow the AR3T mitigation hierarchy (avoid, reduce, restore, regenerate and transform as a cross-cutting action) in assessing and managing their impacts and dependencies on nature. It complements the CSRD in outlining what elements should be acted on as well as disclosed on.

- The EU taxonomy for sustainable activities[17] provides a normative framework for what can be considered 'sustainable' in an EU financing context. It is a classification system that defines criteria for economic activities that are aligned with a net-zero trajectory to 2050 and broader environmental goals.

14. At the time of writing these regulations and directives are subject to change through the streamlining and bundling of sustainability requirements under a new 'Omnibus' proposal.
15. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
16. https://commission.europa.eu/business-economy-euro/doing-business-eu/sustainability-due-diligence-responsible-business/corporate-sustainability-due-diligence_en
17. https://finance.ec.europa.eu/sustainable-finance/tools-and-standards/eu-taxonomy-sustainable-activities_en

Alongside climate change mitigation and adaptation, these include sustainable use and protection of water and marine resources, the transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems. Each of these are directly relevant to the ocean, and for an activity to be taxonomy-aligned it must actively contribute to one of these six goals while 'doing no significant harm' to any.

- The Sustainable Finance Disclosure Regulation (SFDR)[18] is a regulatory framework for financial institutions operating within the European market to disclose material sustainability information to investors; it enables investors to assess how sustainability risks are integrated into financial decision-making. Similarly to the taxonomy, it outlines for financial institutions whether an investment can be considered sustainable by contributing to social and/or environmental outcomes and doing no significant harm.

## THE SUSTAINABLE BLUE ECONOMY FINANCE PRINCIPLES, INITIATIVE, AND SECTOR GUIDANCE

In 2018, WWF, the European Commission, European Investment Bank and The Prince of Wales's International Sustainability Unit (now part of the World Resources Institute) developed the Sustainable Blue Economy Finance Principles, a set of 14 principles to guide financial institutions in financing the transition to sustainability in the blue economy. These high-level guidelines outline core principles of sustainable finance, including on risk awareness, systemic impacts, transparency, a grounding in science, and following a precautionary approach. Upon their publication the Principles were handed to UNEP FI, who host them within the Sustainable Blue Economy Finance Initiative.

As part of UNEP FI's fostering of the membership-based Sustainable Blue Economy Finance Initiative, sector-specific guidance for financing the SBE has been developed and released alongside ancillary materials. This guidance, published in Turning the Tide (UNEP FI, 2021a) and *Diving Deep* (UNEP FI, 2022a) outlines financially material risks to core sectors of the SBE, covering seafood, ports, maritime transportation (shipping), marine renewable energy, coastal tourism, waste prevention and management, and nature-based coastal infrastructure. Additional briefing papers on unsustainable and harmful sectors were published alongside *Diving Deep*, outlining key risks associated with offshore oil and gas, dredging, and deep-sea mining. Lastly, the Initiative has also published a target-setting manual for implementing *Turning the Tide* and *Diving Deep*, with a focus on the seafood sector (UNEP FI, 2024). This target-setting manual is aligned with the sectoral disclosure and target-setting guidance produced by the TNFD and SBTN. Most recently, UNEP FI and the UN Global Compact released the Ocean Investment Protocol (2025), which provides a united framework for stakeholders to scale finance and accelerate the transition to a SBE.

While directed towards commercial finance institutions (banks, investors and insurers), the underlying narrative of assessing and managing material physical and transition risks, as well as the specific recommendations for action on different social and environmental pressures, is nevertheless of significant value to central banks and financial regulators as guidance on how to set policy and provide recommendations on ocean health and the SBE.

## BLUE BOND GUIDANCE

A number of multilateral institutions have developed and maintained distinct eligibility criteria and sustainable finance frameworks for blue bonds, so labelled as a marine or oceanic counterpart to the established 'green' use-of-proceeds bond, the purpose and scope of which are codified by the International Capital Market Association (ICMA) green bond principles.

To build confidence in ocean financing and harmonize the market, leading institutions (the Asian Development Bank (ADB), International Finance Corporation (IFC), UNEP FI, United Nations Global Compact, and ICMA) brought together their respective frameworks on blue financing to develop market guidance on blue bonds (ADB, ICMA, IFC, UNEP FI & UNGC, 2023). This practitioner's guide, published by the ADB and IFC on behalf of its institutional co-authors, categorizes blue bonds clearly as a subset of green bonds, to which the same ICMA principles apply but with extended context and eligibility criteria specific to the SBE. In addition to outlining the issuance process for blue bonds, this guidance provides recommendations on incorporating ocean-specific considerations into issuer strategies for sustainability-linked bonds and considers social co-benefits alongside the environmental objectives of a blue bond. It also offers example performance measurement outputs and indicators across sectors. The guidance is applicable to both corporate and sovereign issuers.

In May 2023 the Indonesian government launched the first publicly offered sovereign blue bond worldwide, aligned with the blue bond guidance and with UN Development Programme support (UNDP, 2023). The bond raised approximately JPY20.7 billion (US$150 million) in the Japanese debt capital market. The proceeds from the blue bond are allocated to finance projects that protect Indonesia's extensive marine ecosystems, addressing critical issues such as plastic waste, and supporting sectors like fisheries and coastal tourism. In the same year, Indonesia also developed a blue economy roadmap (Ministry of National Development Planning/ National Development Planning Agency [BAPPENAS], 2023), which aims to enhance the management of marine and coastal ecosystems while promoting sustainable livelihoods and equitable economic opportunities.

18. https://finance.ec.europa.eu/sustainable-finance/disclosures/sustainability-related-disclosure-financial-services-sector_en

This coordination between large-scale sustainable financing instruments and strategic policy frameworks for the development of a SBE can be similarly incentivized or established through the use of existing guidance to inform central bank policy and strategy.

## VALUE-BASED INTERMEDIATION FINANCING AND INVESTMENT IMPACT ASSESSMENT FRAMEWORK

A notable example of voluntary sectoral guides is the Value-based Intermediation Financing and Investment Impact Assessment Framework (VBIAF, Bank Negara Malaysia, 2019), a sectoral guide issued by the banking association working group in Malaysia, coordinated by Bank Negara Malaysia. The framework provides guidance on how to assess and mitigate climate and environmental risks, including ocean-related issues, across various industries. For instance, in the guide for the construction and infrastructure sector (Association of Islamic Banking and Financial Institutions Malaysia [AIBIM], 2022), financial institutions are encouraged to assess the possible risk transmission related to marine biodiversity during infrastructure design, construction, operations and decommissioning processes. An example of this is aquatic pollution from the use of anti-fouling paints during ship repair. After identifying the risks, financial institutions should review mitigation strategies accordingly. In addition, marine parks are also specifically categorized as environmentally sensitive areas (ESAs), resulting in the need for minimal development in these regions to safeguard marine life.

Although the guide is a voluntary initiative, this is a good first step for supervisors to consider monitoring how financial institutions are managing their sector-specific lending and risks, including the ocean-related risks and impacts within their clients' and counterparts' activities.

## OTHER INITIATIVES

There are multiple initiatives for the development of a SBE, for individual sectors as well as for broader marine conservation or sustainable development outcomes. The table below provides a brief overview of some of the most significant initiatives and platforms in this space.

***Table 4:*** *Overview of selected initiatives for the Sustainable Blue Economy.*

| FOCUS | INITIATIVE | DESCRIPTION |
|---|---|---|
| Finance | BlueInvest | European technical assistance and matchmaking platform driven by the European Investment Fund for startups and venture capitalists in the blue economy. |
| Finance | 1000 Ocean Startups | Member-based initiative of donors, project developers, venture capitalists and impact funds to build finance network for the SBE. Hosts the Ocean Impact Navigator. |
| Finance | Sustainable Blue Economy Finance Initiative | Initiative hosted by UNEP FI that provides principles and guidance on financing the SBE, with sector-specific recommendations and recommended exclusions on financing material social and environmental sustainability topics. |
| Finance | Back Blue | Ocean finance commitment developed by the Ocean Risk and Resilience Action Alliance (ORRAA) and the World Economic Forum to deliver on the UN Race to Resilience and drive nature-positive investment for the ocean. |
| Finance | Poseidon Principles | Industry framework for shipping finance aligned with net zero. Provides a set of principles for integrating climate considerations into lending decisions for international shipping. |
| Finance | Seafood Investor Action Group | Investor initiative to engage seafood companies on impacts and risks related to nature and biodiversity. |

| | | |
|---|---|---|
| **Finance** | **One Ocean Finance Facility** | A planned public-private development finance mechanism aimed at mobilizing billions in funding for the SBE. This initiative seeks to unlock underutilized capital from ocean-dependent industries through a global platform designed to be agile, scalable and targeted. |
| **Finance** | **Clean Oceans Initiative** | European Investment Bank, KfW and AFD initiative to provide EUR4 billion by the end of 2025 for projects that reduce the discharge of plastics into the ocean. |
| **Finance** | **InvestEU Blue Economy** | European combination of existing funds and initiatives to mobilize an additional EUR500 million of EU funds for financial intermediaries investing in the blue economy. |
| **Finance** | **ADB Action Plan for Healthy Oceans and Sustainable Blue Economies** | Asian Development Bank plan to mobilize US$5 billion for ocean conservation and sustainable blue economies for ADB member countries. US$3.7 billion has been allocated to date. |
| **Finance** | **ProBlue** | World Bank multi-donor trust fund to support sustainable development in a healthy ocean, focusing on seafood, pollution and plastics; key sectors including tourism, energy and transport; and capacity-building for governments. |
| **Finance** | **Blue Mediterranean Partnership** | Multi-donor trust fund of European entities aiming to invest EUR1 billion to develop a SBE in the southern Mediterranean. |
| **General sustainable development** | **Sustainable Development Goals** | Global goals for sustainable development. Goal 14 is specific to life below water and relevant for seafood and marine conservation, though the blue economy touches on multiple goals including on sustainable cities and communities, affordable and clean energy, zero hunger, action to combat climate change, industry, responsible consumption and production, innovation and infrastructure. |
| **General sustainable development** | **Global Biodiversity Framework** | Set of global targets for achieving nature positive with a mission to 2030 to halt and reverse biodiversity loss. All 23 targets are relevant to the ocean, with targets 1-3 focusing on reduced biodiversity loss, restoration and conservation outcomes. |
| **General sustainable development** | **Apia Commonwealth Ocean Declaration** | Declaration by Commonwealth nations to mobilize action for ocean health. A Working Group on Sustainable Ocean Finance aims to mobilize finance towards SDG 14. |
| **General sustainable development** | **Ocean Action Agenda** | World Economic Forum platform to convene stakeholders for a regenerative and equitable ocean economy. Focuses on building partnerships between business and science/policy. |
| **Marine conservation** | **Global Ocean Alliance (30by30)** | Coalition of countries advocating for legally protecting 30% of the ocean through marine protected areas (MPAs) and other conservation tools. |
| **Marine conservation** | **UNESCO Marine World Heritage Programme** | Supports conservation of marine sites with outstanding natural or cultural value. |

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| **Marine conservation** | **High Seas Treaty or BBNJ Agreement (Agreement on Marine Biological Diversity of Areas beyond National Jurisdiction)** | Legally binding instrument, adopted in 2023 and ratified September 2025, for the conservation and sustainable use of marine biodiversity in areas beyond national jurisdictions. |
| **Sectoral – coastal tourism** | **Blue Flag Programme** | Gives awards to beaches and marinas meeting environmental and educational criteria, promoting eco-conscious tourism. |
| **Sectoral – coastal tourism** | **Global Sustainable Tourism Council (GSTC)** | Provides global standards for sustainable tourism against which different operators provide sustainable tourism certification schemes. Covers hotels and destinations. |
| **Sectoral – marine renewable energy** | **Ocean Energy Systems (OES)** | Led by the International Energy Agency. Facilitates international R&D collaboration for wave, tidal, and other ocean energy technologies. |
| **Sectoral – marine renewable energy** | **Ocean Renewable Energy Action Coalition** | Led by the Global Wind Energy Council, aims to accelerate and scale up offshore wind generating capacity to 1,400GW by 2050. |
| **Sectoral – ports and shipping** | **EcoPorts** | Voluntary initiative of the European Sea Ports Organisation offering environmental reviews and best practices to reduce ports' environmental footprint. |
| **Sectoral – ports and shipping** | **Getting to Zero Coalition** | A cross-industry alliance aiming to deploy commercially viable zero-emission ships by 2030, aligned with the IMO's decarbonization goals. |
| **Sectoral – ports and shipping** | **IMO's Initial GHG Strategy** | Strategy by International Maritime Organization to cut emissions by 50% by 2050 (from 2008 levels). |
| **Sectoral – seafood** | **Aquaculture Stewardship Council (ASC)** | Market-leading certifier of aquaculture operations that meet environmental and social standards, including on water quality, feed sustainability, and worker welfare. |
| **Sectoral – seafood** | **Marine Stewardship Council (MSC)** | Certifier of fisheries that meet the MSC's certification standards, encouraging market-based incentives for responsible fishing. |
| **Sectoral – seafood** | **Seafood Stewardship Index** | Index ranking the sustainability performance of the world's 30 most influential seafood companies, enabling benchmarking and performance assessment of the seafood industry for finance and other parties. |
| **Sectoral – seafood** | **WTO Agreement on Fisheries Subsidies** | Adopted in June 2022 and entering into force in September 2025, this is the first WTO agreement to focus on the environment. It prohibits harmful fisheries subsidies that contribute to overfishing and IUU fishing, marking a major milestone for ocean sustainability. Further negotiations on additional provisions are ongoing. |
| **Sectoral – waste management** | **Global Plastics Treaty** | A global treaty to end plastic pollution, most of which ends up in the ocean. Currently under negotiation, with talks stalled after the August 2025 session failed to reach agreement. |

# REFERENCES


Agnew, D.J., Pearce, J., Pramod, G., Peatman, T., Watson, R., Beddington, J.R. & Pitcher, T.J. 2009. Estimating the worldwide extent of illegal fishing. *PLoS ONE*, 4 (2). https://doi.org/10.1371/journal.pone.0004570

Almeida, E. & Reitmeier, L. 2024. *The blue imperative: understanding interactions between the ocean, climate and economy*. London: CETEx and Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. https://cetex.org/publications/the-blue-imperative-understanding-interactions-between-the-ocean-climate-and-economy/

Andersen, N.F., Cavan, E.L., Cheung, W.W.L., Martin, A.H., Saba, G.K. & Sumaila, U.R. 2024. Good fisheries management is good carbon management. n*pj Ocean Sustainability*, 3 (17). https://doi.org/10.1038/s44183-024-00053-x

Angus, I. 2023. The fishing revolution and the origins of capitalism. *Monthly Review*, 74 (10). https://doi.org/10.14452/MR-074-10-2023-03_1

Anton, A., Geraldi, N.R., Lovelock, C.E., Apostolaki, E.T., Bennett, S., Cebrian, J., Krause-Jensen, D., Marba, N., Martinetto, P., Pandolfi, J.M., Santana-Garcon, J. & Duarte, C.M. 2019. Global ecological impacts of marine exotic species. *Nature Ecology and Evolution*, 3, 787–800. https://doi.org/10.1038/s41559-019-0851-0

Asian Development Bank (ADB), International Capital Market Association (ICMA), International Finance Corporation (IFC), United Nations Environment Programme Finance Initiative (UNEP FI) & United Nations Global Compact (UNGC). 2023. *Bonds to Finance the Sustainable Blue Economy: A Practitioner's Guide*. Asian Development Bank/ International Finance Corporation. https://dx.doi.org/10.22617/TCS230328-2

Association of Islamic Banking and Financial Institutions Malaysia [AIBIM]. 2022/. VBIAF *Sectoral Guide: Construction & Infrastructure* (C&I). https://aibim.com/vbiaf-sectoral-guide/Vbiaf-Sectoral-Guide-on-Construction-and-Infrastructure.pdf Accessed 15/04/2025.

Banco de España. 2024. *Implicaciones económicas y financieras del cambio climático. Banco de España*. https://clubgestionriesgos.org/wp-content/uploads/IIPP-2024-02-16-hdc-es-or2.pdf Accessed 09/09/2025.

Bank Negara Malaysia. 2019. *Value-based Intermediation Financing and Investment Impact Assessment Framework: Guidance Document*. https://www.bnm.gov.my/documents/20124/761679/VBIAF_Final+guidance+1.11.2019.pdf Accessed 15/04/2025.

Ministry of National Development Planning/National Development Planning Agency (BAPPENAS). 2023. *Indonesia Blue Economy roadmap*. BAPPENAS. https://aipalync.org/storage/documents/main/eng-indonesia-blue-economy-roadmap-ebook-1714456651_1723718648.pdf Accessed 15/04/2025.

Barbier, E.B. 2017. Marine ecosystem services. *Current Biology*, 27 (11): 507–510. https://doi.org/10.1016/j.cub.2017.03.020

Beck, M.W., Heck, N., Narayan, S., Menendez, P., Reguero, B.G., Bitterwolf, S., Torres-Ortega, S., Lange, G., Pfliegner, K., Pietsch McNulty, V. & Losada, I.J. 2022. Return on investment for mangrove and reef flood protection. *Ecosystem Services*, 56: 101440. https://doi.org/10.1016/j.ecoser.2022.101440

Blasiak, R., Jouffray, JB., Amon, D.J. *et al*. Making marine biotechnology work for people and nature. *Nat Ecol Evol* 7, 482–485 (2023). https://doi.org/10.1038/s41559-022-01976-9

Bisaro, A. & Hinkel, J. 2018. Mobilizing private finance for coastal adaptation: A literature review. *WIREs Climate Change*, 9(3): e514. doi.org/10.1002/wcc.514

Bouwmeester, M.M., Goedknegt, M.A., Poulin, R. & Thieltges, D.W. 2020. Collateral diseases: Aquaculture impacts on wildlife infections. *Journal of Applied Ecology*, 58: 453-464. https://doi.org/10.1111/1365-2664.13775

Cai, W., Borlace, S., Langaigne, M., Van Rensch, P., Collins, M., Vecchi, G., Timmermann, A., Santoso, A., McPhaden, M.J., Wu, L., England, M.H., Wang, G., Guilyardi, E. & Jin, F. 2014 Increasing frequency of extreme El Nino events due to greenhouse warming. *Nature Climate Change*, 4: 111–116. https://doi.org/10.1038/NCLIMATE2100

Cai, J.N., Huang, H. & Leung, P.S. 2019. *Understanding and measuring the contribution of aquaculture and fisheries to gross domestic product (GDP)*. FAO Fisheries and Aquaculture Technical Paper No. 606. Rome, FAO. https://openknowledge.fao.org/handle/20.500.14283/ca3200en

Campbell, L.M., Gray, N.J., Fairbanks, L., Silver, J.J., Gruby, R.L., Dubik, B.A. & Basurto, X. 2016. Global Oceans Governance: New and Emerging Issues. *Annual Review of Environment and Resources*, 41: 2.1-2.27. https://doi.org/10.1146/annurev-environ-102014-021121

Cárdenas-García, P.J., Brida, J.G. & Segarra, V. 2024. *Modeling the link between tourism and economic development: evidence from homogeneous panels of countries*. Humanities and Social Sciences Communications, 11: 308. https://doi.org/10.1057/s41599-024-02826-8

Choudhary, B., Dhar, V. & Pawase, A.S. 2024. Blue carbon and the role of mangroves in carbon sequestration: its mechanisms, estimation, human impacts and conservation strategies for economic incentives. *Journal of Sea Research*, 199: 102504. https://doi.org/10.1016/j.seares.2024.102504

Church, A., Coles, T. & Fish, R. 2017. Tourism in sub-global assessments of ecosystem services. *Journal of Sustainable Tourism*, 25 (11): 1529–1546. https://doi.org/10.1080/09669582.2017.1291649

Clifford Chance. 2019. *Clifford Chance acts for lenders on Port of Rotterdam's sustainability-linked facility*. Clifford Chance. https://www.cliffordchance.com/news/news/2019/04/clifford-chance-acts-for-lenders-on-port-of-rotterdam-s-sustaina.html Accessed 07/03/2025.

D'Angelo, S. & Maccariello, R. 2021. Microplastics: A threat for male fertility. *International Journal of Environmental Research and Public Health*, 18: 2392. https://doi.org/10.3390/ijerph18052392

Deep Sea Conservation Coalition (DSCC). 2025. *Voices calling for a moratorium: governments and parliamentarians*. https://deep-sea-conservation.org/solutions/no-deep-sea-mining/momentum-for-a-moratorium/governments-and-parliamentarians/ Accessed 09/09/2025.

Deloitte Access Economics. 2017. *At what price? The economic, social and icon value of the Great Barrier Reef*. Deloitte. https://www.deloitte.com/au/en/services/economics/perspectives/great-barrier-reef.html Accessed 12/03/2025.

De Nederlandsche Bank (DNB). 2025. *Guide to managing climate and environmental risks*. De Nederlandsche Bank. https://www.dnb.nl/media/ep1p04h5/klimaat-en-milieurisico-s-sectoren-uk.pdf Accessed 02/06/2025.

Diaz, R.J. & Rosenberg, R. 2008. Spreading dead zones and consequences for marine ecosystems. *Science*, 321: 926–929. https://doi.org/10.3390/ijerph18052392

Ditlevsen, P. & Ditlevsen, S. 2023. Warning of a forthcoming collapse of the Atlantic meridional overturning circulation. *Nature Communications*, 14: 4254. https://doi.org/10.1038/s41467-023-39810-w

Diz, D., Merriman, P., De Vos, K., Sommerkorn, M. & Walmsley, S. 2021. *Blueprint for a Living Planet: Four Principles for Integrated Ocean-Climate Strategies*. WWF International, Gland, Switzerland. https://wwfint.awsassets.panda.org/downloads/blueprint_for_a_living_planet_final_june_2021_spreads.pdf

Donovan, M.K., Adam, T.C., Shantz, A.A., Speare, K.E., Munsterman, K.S., Rice, M.M., Schmitt, R.J., Holbrook, S.J. & Burkepile, D.E. 2020. Nitrogen pollution interacts with heat stress to increase coral bleaching across the seascape. *PNAS*, 117 (10): 5351–5357. https://doi.org/10.1073/pnas.1915395117

DP World. 2024. *DP World becomes the first company in the middle east to issue a blue bond*. DP World. https://www.dpworld.com/news/releases/dp-world-becomes-the-first-company-in-the-middle-east-to-issue-a-blue-bond/ Accessed 07/03/2025.

Dulvy, N.K., Pacoureau, N., Rigby, *et al*. 2021. Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*, 31 (21): 4773–4787. https://doi.org/10.1016/j.cub.2021.08.062

Dutkiewicz, S., Morris, J.J., Follows, M.J., Scott, J., Levitan, O., Dyhrman, S.T. & Berman-Frank, I. 2015. Impact of ocean acidification on the structure of future phytoplankton communities. *Nature Climate Change*, 5 (11): 1002–1006. https://doi:10.1038/nclimate2722

European Central Bank (ECB). 2025. *Stemming the tide: safeguarding our ocean and economy*. https://www.ecb.europa.eu/press/key/date/2025/html/ecb.sp250607~e6ed4778bc.en.html Accessed 09/09/2025.

European Commission. 2024. *The EU Blue Economy Report 2024*. Publications Office of the European Union. https://data.europa.eu/doi/10.2771/186064 Accessed 07/03/2025.

Food and Agriculture Organization of the United Nations (FAO). 2020. *Global forest resources assessment 2020*. FAO Knowledge Repository. https://openknowledge.fao.org/items/d6f0df61-cb5d-4030-8814-0e466176d9a1 Accessed 09/09/2025.

FAO. 2024a. *The State of World Fisheries and Aquaculture 2024*. Rome. http://openknowledge.fao.org/items/06690fd0-d133-424c-9673-1849e414543d

FAO. 2024b. *World Fish trade fall in 2024*. FAO GLOBEFISH. https://www.fao.org/in-action/globefish/news-events/news/news-detail/world-fish-trade-fall-in-2024/en Accessed 05/03/2025.

Finance Earth. 2025. Fisheries improvement fund. https://finance.earth/fif/ Accessed 09/09/2025.

Finance for Biodiversity (FfB). 2025. *Statement on deep-seabed mining* (DSM). https://www.financeforbiodiversity.org/statement-on-deep-seabed-mining-dsm/ Accessed 09/09/2025.

Galil, B., Marchini, A., Occhipinti-Ambrogi, A. & Ojaveer, H. 2017. The enlargement of the Suez Canal – Erythraean introductions and management challenges. *Management of Biological Invasions,* 8 (2): 141–152. https://doi.org/10.3391/mbi.2017.8.2.02

Gallardo, B., Clavero, M., Sanchez, M.I. & Vila, M. 2015. Global ecological impacts of invasive species in aquatic ecosystems. *Global Change Biology*, 22 (1): 151–163. https://doi.org/10.1111/gcb.13004

Gilford, D.M., Giguere, J., Pershing, A.J. 2024. Human-caused ocean warming has intensified recent hurricanes. *Environmental Research: Climate*, 3 (4). https://doi.org/10.1088/2752-5295/ad8d02

Gruber, N., Bakker, D.C.E., DeVries, T., Gregor, L., Hauck, J., Landschuetzer, P., McKinley, G.A. & Mueller, J.D. 2023. Trends and variability in the ocean carbon sink. *Nature Reviews Earth & Environment,* 4: 119–134. https://doi.org/10.3929/ethz-b-000595538

Hamilton, S. 2013. Assessing the role of commercial aquaculture in displacing mangrove forest. *Bulletin of Marine Science*, 89 (2): 585–601. https://doi.org/10.5343/bms.2012.1069

Haubrock, P.J., Bernery, C., Cuthbert, R.N., Liu, C., Kourantidou, M., Leroy, B., Turbelin, A.J., Kramer, A.M., Verbrugge, L.N.H., Diagne, C., Courchamp, F. & Gozlan, R.E. 2022. Knowledge gaps in economic costs of invasive alien fish worldwide. *Science of the Total Environment*, 803. https://doi.org/10.1016/j.scitotenv.2021.149875

Hoegh-Guldberg, O. *et al*. 2015. *Reviving the Ocean Economy: the case for action – 2015*. WWF International, Gland, Switzerland. https://wwfint.awsassets.panda.org/downloads/revivingoceaneconomy_summary_high_res.pdf

Hoegh-Guldberg. O., *et al*. 2019. *The Ocean as a Solution to Climate Change: Five Opportunities for Action*". https://doi.org/10.69902/332b8e08 Accessed 09/09/2025.

Hoornweg, D., Bhada-Tata, P. & Kennedy, C. 2013. Environment: Waste production must peak this century. *Nature*, 502: 615–617. https://doi.org/10.1038/502615a

InsuResilience Global Partnership. 2020. Global Parametrics – *Mexican Reef Protection Program Blending Parametric Insurance and Nature-based Solutions*. InsuResilience Global Partnership. https://annualreport.insuresilience.org/global-parametrics-mexican-reef-protection-program/ Accessed 10/03/2025.

International Capital Market Association (ICMA), International Finance Corporation, UNEP FI, UN Global Compact & Asian Development Bank. 2023. *Bonds to finance the Sustainable Blue Economy: A practitioner's guide*. ICMA, London. https://www.icmagroup.org/assets/documents/Sustainable-finance/Bonds-to-Finance-the-Sustainable-Blue-Economy-a-Practitioners-Guide-September-2023.pdf Accessed 07/03/2025.

International Maritime Organization (IMO). 2023. Resolution MEPC.377(80) 2023 *IMO Strategy on Reduction of GHG Emissions from Ships*. Adopted 7 July 2023. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf Accessed 07/03/2025.

Intergovernmental Panel on Climate Change (IPCC). 2019. Summary for Policymakers. In: H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría,

M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.) IPCC *Special Report on the Ocean and Cryosphere in a Changing Climate*. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–35. https://doi.org/10.1017/9781009157964.001

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019. *Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES Secretariat, Bonn, Germany. https://doi.org/10.1111/padr.12283

IPBES. 2020. *Models of drivers of biodiversity and ecosystem change*. IPBES. https://www.ipbes.net/models-drivers-biodiversity-ecosystem-change Accessed 05/02/205

Issifu, I., Deffor, E.W., Ravindra Deshappriya, N.P., Dahmouni, I. & Sumaila, U.R. 2022. Drivers of seafood consumption at different geographical scales. *Journal of Sustainability Research*, 4(3): e220012. https://doi.org/10.20900/jsr20220012

Jaegerbrand, A.K., Brutemark, A., Sveden, J.B. & Gren, I. 2019. A review on the environmental impacts of shipping on aquatic and nearshore ecosystems. *Science of the Total Environment*, 695. https://doi.org/10.1016/j.scitotenv.2019.133637

Jouffray, J.-B., Blasiak, R., Norström, A.V., Österblom, H. & Nyström, M. 2020. The blue acceleration: the trajectory of human expansion into the ocean. *One Earth*, 2 (1): 43–54. https://doi.org/10.1016/j.oneear.2019.12.016

Jouffray, J.-B., Blasiak, R., Nash, K.L., Österblom, H. & Sumaila, U.R. 2025. Identifying and closing gaps in corporate reporting of ocean impacts. *Nature Sustainability* https://doi.org/10.1038/s41893-025-01631-8

Kavanaugh, M.T., Bell, T., Catlett, D., Cimino, M.A., Doney, S.C., Klajbor, W., Messié, M., Montes, E., Muller-Karger, F.E., Otis, D., Santora, J.A., Schroeder, I.D., Triñanes, J. & Siegel, D.A. 2021. Satellite remote sensing and the marine biodiversity observation network. *Oceanography*, 34 (2): 62–79. https://doi.org/10.5670/oceanog.2021.215

Kedward, K., Ryan-Collins, J., & Chenet, H. 2020. Managing nature-related financial risks: a precautionary policy approach for central banks and financial supervisors. *UCL Institute of Innovation and Public Purpose Working Paper Series* (IIPP WPP 2020-09). Available at: https://www.ucl.ac.uk/bartlett/sites/bartlett/files/final_kedward_et_al_nature-related_finance_18_aug.pdf

Kelleher, K. & Arnason, R. (2009) *The Sunken Billions*. World Bank, Washington D.C. https://doi.org/10.1596/978-0-8213-7790-1

Kok, S., Bisaro, A., De Bel, M., Hinkel, J. & Bouwer, L. M. 2021. The potential of nature based flood defences to leverage public investment in coastal adaptation: Cases from the Netherlands, Indonesia and Georgia. *Ecological Economics*, 179. https://doi.org/10.1016/j.ecolecon.2020.106828

Longo, S.B. & York, R. 2024. Why aquaculture may not conserve wild fish. *Science Advances*, 10 (42). https://doi.org/10.1126/sciadv.ado3269

Luo, Z., Hu, S. & Chen, D. 2018. The trends of aquacultural nitrogen budget and its environmental implications in China. *Scientific Reports*, 9: 10877. https://doi.org/10.1038/s41598-018-29214-y

Marsden, L., Ryan-Collins, J., Abrams, J. & Lenton, T. 2024. *Ecosystem tipping points: Understanding risks to the economy and financial system*. UCL Institute for Innovation and Public Purpose, Policy Report 2024/03. https://www.ucl.ac.uk/bartlett/public-purpose/publications/2024/apr/ecosystem-tipping-points-understanding-risks-economy-and-financial-system Accessed 12/03/2025.

Matias, T.P., Leonel, J. & Imperador, A.M. 2022. A systemic environmental impact assessment on tourism in island and coastal ecosystems. *Environmental Development*, 44: 100765. https://doi.org/10.1016/j.envdev.2022.100765

Mearns, A.J., Reish, D.J., Oshida, P.S., Morrison, A.M., Rempel-Hester, M.A., Arthur, C., Rutherford, N. & Pryor, R. 2017. Effects of Pollution on Marine Organisms. *Water Environment Research*, 89 (10): 1704–1798. https://doi.org/10.2175/106143016x14696400495695

Menendez, P., Losada, I.J., Torres-Ortega, S., Narayan, S. & Beck, M.W. 2020. The global flood protection benefits of mangroves. *Scientific Reports*, 10: 4404. https://doi.org/10.1038/s41598-020-61136-6

Molnar, J.L., Gamboa, R.L., Revenga, C. & Spalding, M.D. 2008. Assessing the global threat of invasive species to marine biodiversity. *Frontiers in Ecology and the Environment*, 6 (9): 485–492. https://doi.org/10.1890/070064

Morley, J.W., Selden, R.L., Latour, R.J., Froelicher, T.L., Seagraves, R.J. & Pinsky, M.L. 2018. Projecting shifts in thermal habitat for 686 species on the North American continental shelf. *PLoS ONE*, 13(5): e0196127. https://doi.org/10.1371/journal.pone.0196127

Moll, D., Asmus, H., Blöcker, A., Böttcher, U., Conradt, J., Färber, L., Funk, N., Funk, S., Gutte, H., Hinrichsen, H.H. and Kotterba, P. 2024. A climate vulnerability assessment of the fish community in the Western Baltic Sea. *Scientific Reports*, 14(1), 16184. https://doi.org/10.1038/s41598-024-67029-2

Möllmann, C., Cormon, X., Funk, S., Otto, S.A., Schmidt, J.O., Schwermer, H., Sguotti, C., Voss, R. & Quaas, M. 2021. Tipping point realized in cod fishery. *Scientific Reports*, 11: 14259. https://doi.org/10.1038/s41598-021-93843-z

Network for Greening the Financial System (NGFS). 2024. *Nature-related Financial Risks: A Conceptual Framework to guide Action by Central banks and financial regulators and Supervisors*. NGFS. https://www.ngfs.net/en/publications-and-statistics/publications/nature-related-financial-risks-conceptual-framework-guide-action-central-banks-and-supervisors

Taskforce on Nature-related Financial Disclosures (TNFD). 2023. *Recommendations of the Taskforce on Nature-related Financial Disclosures*. TNFD. https://tnfd.global/wp-content/uploads/2023/08/Recommendations_of_the_Taskforce_on_Nature-related_Financial_Disclosures_September_2023.pdf

Nicholls, R.J., Hinkel, J., Lincke, C., Van der Pol, T. 2019. *Global Investment Costs for Coastal Defence through the 21st Century*. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/31308 Accessed 10/03/2025.

Nordic Council of Ministers for the Environment and Climate. 2023. *Joint Nordic request to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES): assessment of marine ecosystems. Nordic Co-operation. https://www.norden.org/en/declaration/nordic-ministers-reply-ipbes-notification-em202238 Accessed 05/03/2025.

Norges Bank Investment Management. 2018. *Ocean sustainability: Expectations of companies*. Norges Bank Investment Management. https://www.nbim.no/contentassets/7a4dda85e6094f7b84cc3a3a10be628f/ocean_sustainability.pdf Accessed 15/04/2025.

Ocean Risk and Resilience Action Alliance (ORRAA). 2021. *Blue acceleration: an ocean of risks and opportunities* https://oceanrisk.earth/wp-content/uploads/2022/12/ORRAA-Blue-acceleration.pdf Accessed 09/09/2025.

OECD. 2025. *The Ocean Economy to 2050*. https://doi.org/10.1787/a9096fb1-en

Orsted. 2023. *Orsted becomes world's first energy company to issue blue bonds*. Orsted. https://orsted.com/en/media/news/2023/06/20230608684811 Accessed 10/03/2025.

Pinsky, M.L., Eikeset, A.M., McCauley, D.J., Payne, J.L. & Sunday, J.M. 2019. Greater vulnerability to warming of marine versus terrestrial ecotherms. *Nature*, 569 (7754): 108–111. https://doi.org/10.1038/s41586-019-1132-4

Planet Tracker. 2023. *We Need Basel IV for Climate and Nature*. Planet Tracker. https://planet-tracker.org/we-need-basel-iv-for-climate-and-nature/ Accessed 16/05/2025.

Port of Los Angeles. 2016. *Environmental Program and Green Bonds*. Port of Los Angeles Investor Relations. https://www.portoflabonds.org/port-of-los-angeles-bonds-ca/about/esg-program/i1683 Accessed 07/03/2025.

Rabobank. 2023. *The bottlenecks challenging growth in the EU offshore wind supply chain*. Rabobank Research. https://www.rabobank.com/knowledge/d011354306-the-bottlenecks-challenging-growth-in-the-eu-offshore-wind-supply-chain Accessed 22/04/2025.

Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Nita, M.R., Geneletti, D. & Calfaprieta, C. 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy*, 77: 15–24. https://doi.org/10.1016/j.envsci.2017.07.008

Robeco. 2024. *Active ownership report 01.10.2024-31.12.2024*. Robeco. https://assets.ctfassets.net/tl4x668xzide/36bbPTdviFmAReQ1rThWEr/7e49ccdb60fe3e5cca59d7e398a1c105/docu-ocean-health-engagement-leads-q4-robeco-active-ownership-report.pdf Accessed 27/03/2025.

Roberts, S., Naylor, R., Goldstein, J. & Koehn, J. 2024. Feeding global aquaculture. *Science Advances*, 10 (42). https://doi.org/10.1126/sciadv.adn9698

Rodriguez, *et al*. 2023. Impact of climate risk materialization and ecological deterioration on house prices in Mar Menor, Spain. *Sci Rep 13*, 11772. https://doi.org/10.1038/s41598-023-39022-8

Sandilyan, S. & Kathiresan, K. 2012. Mangrove conservation: A global perspective. *Biodiversity and Conservation*, 21: 3523–3542. https://doi.org/10.1007/s10531-012-0388-x

Seafarers International Union. 2024. *ITF demands fair treatment of seafarers*. https://www.seafarers.org/itf-demands-fair-treatment-of-seafarers/ Accessed 09/09/2025.

Silber, G.K., Vanderlaan, A.S.M., Arceredillo, A.T., Johnson, L., Taggart, C.T., Brown, M.W., Bettridge, S. & Sagarminaga, R. 2012. The role of the International Maritime Organization in reducing vessel threat to whales: Process, options, action and effectiveness. *Marine Policy*, 36 (6): 1221–1233. https://doi.org/10.1016/j.marpol.2012.03.008

Stockholm Resilience Centre. 2025a. *Planetary Boundaries*. https://www.stockholmresilience.org/research/planetary-boundaries.html Accessed 09/09/2025.

Stockholm Resilience Centre. 2025b. World reaches first climate tipping point – widespread mortality of coral reefs. https://www.stockholmresilience.org/research/research-stories/2025-10-13-world-reaches-first-climate-tipping-point---widespread-mortality-of-coral-reefs.html Accessed 09/09/2025.

Stoeckl, N., Adams, V., Baird, R., Boothroyd, A., Costanza, R., Hatton MacDonald, D., Finau, G., Fulton, E.A., King, M.A., Kubiszwecki, I., Lannuzel, D., Leane, E., Melbourne-Thomas, J., Neilsen, H., Ooi, C., Raghavan, M., Senigaglia, V., Tian, J. & Yamazaki, S. 2024. The value of Antarctic and Southern Ocean ecosystems. *Nature Reviews Earth & Environment,* 5: 153–155. https://doi.org/10.1038/s43017-024-00523-3

Stop Deep Sea Mining. 2025. *Endorsers* https://www.stopdeepseabedmining.org/endorsers/ Accessed 09/09/2025.

Sumaila, U.R. 2024. Transparency in aquaculture subsidy reporting urgently needed. *Science Advances*, 10 (42). https://doi.org/10.1126/sciadv.adt5484

Szepes, M. 2013. MARPOL 73/78: The challenges of regulating vessel-source oil pollution. *Manchester Student Law Review*, 2 (73).

Taskforce on Climate-related Financial Disclosures (TCFD). 2021. *Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures*. Appendix Table A1.3. https://www.fsb-tcfd.org/publications/ Accessed 07/05/2025.

Taskforce on Nature-related Financial Disclosures (TNFD). 2023. *Guidance on the identification and assessment of nature-related issues: The LEAP approach. V1.1*. TNFD. https://tnfd.global/wp-content/uploads/2023/08/Guidance_on_the_identification_and_assessment_of_nature-related_Issues_The_TNFD_LEAP_approach_V1.1_October2023.pdf?v=1698403116 Accessed 07/05/2025.

The Nature Conservancy (TNC). 2023. *Belize Blue Bonds for Ocean Conservation: First annual impact report November 4 2021 –* March 31 2023. The Nature Conservancy. https://www.nature.org/content/dam/tnc/nature/en/documents/Belize-Blue-Bonds-2023-Impact-Report.pdf Accessed 07/03/2025.

Tokunaga, K, Blasiak, R, Wabnitz, C, Jouffray, J-B, & Norström, A. 2022. *Indicator-based Tools for Assessing Ocean Risks and Vulnerabilities*. Ocean Risk and Resilience Action Alliance (ORRAA) Report. https://oceanrisk.earth/wp-content/uploads/2023/05/ORRAA_Ocean_Risks_and_Vulnerabilities.pdf Accessed 14/05/2025.

UCL IIPP and WWF (2025) *Policy options for financial flows contributing to ecosystem tipping* points.https://wwfint.awsassets.panda.org/downloads/wwf_gfri_ucl-iipp-tipping-point-2025.pdf Accessed 09/09/2025.

United Nations. 2021. *The Second World Ocean Assessment*. Volume 1. United Nations, New York. https://www.un.org/regularprocess/sites/www.un.org.regularprocess/files/2011859-e-woa-ii-vol-i.pdf

United Nations Conference on Trade & Development. UNCTAD. 2023. *Review of Maritime Transport 2023*. United Nations, New York. https://unctad.org/system/files/official-document/rmt2023_en.pdf Accessed 07/03/2025.

UNCTAD. 2025. *The ocean economy is booming. But for how long?* UN Trade and Development. https://unctad.org/news/ocean-economy-booming-how-long. Accessed 05/03/2025.

United Nations Development Programme (UNDP). 2023. *Indonesia launches the world's first publicly offered sovereign blue bond – with UNDP's support*. https://www.undp.org/indonesia/blog/indonesia-launches-worlds-first-publicly-offered-sovereign-blue-bond-undps-support#:~:text=UNDP%20%2D%20AIS%20Forum-,In%20May%202023%2C%20Indonesia%20issued%20a%20first%2Dof%2Dits,Market%20Association%20(ICMA)%20principles. Accessed 15/04/2025.

United Nations Environment Programme Finance Initiative (UNEP FI). 2021a. *Turning the Tide: How to finance a sustainable ocean recovery. A practical guide for financial institutions*. UNEP FI, Geneva. https://www.unepfi.org/publications/turning-the-tide/ Accessed 07/03/2025.

UNEP FI. 2021b. *The Rising tide: Mapping Ocean finance for a new decade*. UNEP FI, Geneva. https://www.unepfi.org/publications/rising-tide/ Accessed 07/03/2025.

UNEP FI. 2021c. *Recommended Exclusions for Financing a Sustainable Blue Economy*. UNEP FI, Geneva. https://www.unepfi.org/publications/turning-the-tide-recommended-exclusions/ Accessed 15/04/2025.

UNEP FI. 2022a. *Diving Deep: Finance, Ocean pollution and coastal resilience*. UNEP FI. Geneva. https://www.unepfi.org/publications/diving-deep/ Accessed 07/03/2025.

UNEP FI. 2022b. *Blue impact bonds for nature*. UNEP FI, Geneva. https://www.unepfi.org/wordpress/wp-content/uploads/2022/02/HSBC-1.pdf Accessed 22/04/2025.

UNEP FI. 2022c. *Harmful marine extractives: Understanding the risks & impacts of financing non-renewable extractive industries*. UNEP FI, Geneva. https://www.unepfi.org/publications/harmful-marine-extractives-deep-sea-mining/ Accessed 22/04/2025.

United Nations Environment Programme (UNEP). 2023. *State of Finance for Nature*. https://www.unep.org/resources/state-finance-nature-2023. Accessed 09/09/2025

UNEP FI. 2024. *Setting Sail: Target Setting in the Sustainable Blue Economy. A manual for the implementation of the Turning the Tide and Diving Deep guidance*. UNEP FI, Geneva. https://www.unepfi.org/publications/setting-sail-target-setting-in-the-sustainable-blue-economy/ Accessed 14/04/2025.

United Nations Global Compact (UNGC) & UNEP FI. 2025. Ocean Investment Protocol – 2025. *A multi-stakeholder plan to enable funding for the Sustainable Ocean Economy*. UNGC and UNEP FI. https://www.unepfi.org/wordpress/wp-content/uploads/2025/05/2025-Ocean-Investment-Protocol.pdf Accessed 02/06/2025.

Urbina, I. 2019. *Lawless ocean: the link between human rights abuses and overfishing*. Outlaw Ocean Project. https://www.theoutlawocean.com/reporting/the-link-between-human-rights-abuses-and-overfishing/ Accessed 28/04/2025.

Vasilakopoulos, P. & Marshall, C.T. 2015. Resilience and tipping points of an exploited fish population over six decades. *Global Change Biology*, 21 (5): 1834–1847. https://doi.org/10.1111/gcb.12845

Virdin, J., Basurto, X., Nico, G., *et al.* 2023. Fishing for subsistence constitutes a livelihood safety net for populations dependent on aquatic foods around the world. *Nature Food*, (4): 874–885. https://doi.org/10.1038/s43016-023-00844-4

Watson, S.C.L., Somerfield, P.J., Lemasson, A.J., Knights, A.M., *et al.* 2024. The global impact of offshore wind farms on ecosystem services. *Ocean & Coastal Management*, 249. https://doi.org/10.1016/j.ocecoaman.2024.107023

Whelan, T., Atz, U., Clark, C. 2021. *ESG and financial performance: Uncovering the Relationship by Aggregating Evidence from 1,000 Plus Studies Published between 2015 – 2020*. NYU Stern. https://www.stern.nyu.edu/sites/default/files/assets/documents/NYU-RAM_ESG-Paper_2021.pdf Accessed 15/04/2025.

Wilcox, C., Van Sebille, E. & Hardesty, B.D. 2015. Threat of plastic pollution to seabirds is global, pervasive, and increasing. *PNAS*, 112 (38): 11899-11904. https://doi.org/10.1073/pnas.1502108112

WindEurope. 2024. *Latest wind energy data for Europe: Autumn 2024*. WindEurope. https://windeurope.org/intelligence-platform/product/latest-wind-energy-data-for-europe-autumn-2024/ Accessed 10/03/2025.

World Bank. 2017. *The Sunken Billions Revisited: Progress and challenges in global marine fisheries*. International Bank for Reconstruction and Development / The World Bank, Washington, D.C. https://openknowledge.worldbank.org/server/api/core/bitstreams/d6ac5090-673e-5d7b-a4ba-92e05c7f830b/content Accessed 07/03/2025.

World Economic Forum (WEF). 2025. *Nature Positive: Role of the Port Sector*. WEF, Geneva. https://reports.weforum.org/docs/WEF_Nature_Positive_Role_of_the_Ports_Sector.pdf Accessed 07/03/2025.

WEF. 2025. *Nature positive: role of the offshore wind sector*. https://reports.weforum.org/docs/WEF_Nature_Positive_Role_of_the_Offshore_Wind_Sector.pdf Accessed 09/09/2025

World Trade Organisation (WTO). 2025. Agreement on Fisheries Subsidies. https://www.wto.org/english/tratop_e/rulesneg_e/fish_e/fish_e.htm Accessed 09/09/2025.

WWF. 2015. *Principles for a Sustainable Blue Economy*. WWF. https://wwfint.awsassets.panda.org/downloads/15_1471_blue_economy_6_pages_final.pdf Accessed 07/03/2025.

WWF. 2019. *The nature of risk: A framework for understanding nature-related risk to business*. WWF. https://wwfint.awsassets.panda.org/downloads/wwf_nature_of_risk_final2.pdf Accessed 28/04/2025.

WWF. 2021. *Navigating ocean risk: Value at risk in the global blue economy*. WWF. https://wwfafrica.awsassets.panda.org/downloads/navigating-ocean-risk-2021.pdf Accessed 12/03/2025.

WWF. 2022. *Central banking and financial supervision roadmap. Transitioning to a Net Zero and Nature Positive economy*. https://business.wwf.nl/globalassets/pdf/nieuws/routekaart-centrale-banken-2022.pdf Accessed 24/03/2025.

WWF. 2023. *The missing millions from shrimp and tuna fisheries in the South*. https://wwfeu.awsassets.panda.org/downloads/wwf___iuu_fishing_of_shrimp_and_tuna_in_the_south_west_indian_ocean___may_2023.pdf Accessed 09/09/2025.

WWF. 2024a. *Deforestation and Conversion: An introductory guide for central bankers, financial regulators and supervisors*. WWF, Gland, Switzerland. https://wwfint.awsassets.panda.org/downloads/wwf-deforestation-guide-central-banking.pdf

WWF. 2024b. *Living Planet Report 2024* – A System in Peril. WWF, Gland, Switzerland. https://www.worldwildlife.org/publications/2024-living-planet-report

WWF. 2024c. *Sustainable Banking Assessment 2024*. WWF-Singapore. https://www.wwf.sg/susba/wp-content/uploads/sites/5/2024/12/SUSTAINABLE-BANKING-ASSESSMENT-2024.pdf Accessed 16/04/2025.

WWF. 2024d. *Getting Underway: Asset managers' seafood sector policy analysis*. https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/7gjie6zfb1_Getting_Underway_2024_1406_FINAL.pdf Accessed 16/04/2025.

WWF. 2024e. *WWF Position: Deep Seabed mining*. WWF. https://wwfint.awsassets.panda.org/downloads/wwf-position-deep-seabed-mining_2024.pdf Accessed 28/04/2025.

WWF. 2024f. 2024 *SUSREG annual report: An assessment of sustainable financial regulations and central bank activities*. WWF. https://wwfint.awsassets.panda.org/downloads/wwf_susreg-2024_full-report_1.pdf Accessed 07/05/2025.

WWF. 2024g. *Assessing the financial flows within the South West Indian Ocean Blue Economy*. Produced by Profundo Research and Advice. https://wwfafrica.awsassets.panda.org/downloads/assessing-financial-flows-within-the-south-west-indian-ocean-blue-economy_1.pdf?48743/Assessing-Financial-Flows-within-the-South-West-Indian-Ocean-Blue-Economy Accessed 03/06/2025.

WWF. 2024d. *Getting Underway: Asset managers' seafood sector policy analysis*. https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/7gjie6zfb1_Getting_Underway_2024_1406_FINAL.pdf Accessed 16/04/2025.

WWF. 2024e. *WWF Position: Deep Seabed mining*. WWF. https://wwfint.awsassets.panda.org/downloads/wwf-position-deep-seabed-mining_2024.pdf Accessed 28/04/2025.

WWF. 2024f. *2024 SUSREG annual report: An assessment of sustainable financial regulations and central bank activities*. WWF. https://wwfint.awsassets.panda.org/downloads/wwf_susreg-2024_full-report_1.pdf Accessed 07/05/2025.

WWF. 2024g. *Assessing the financial flows within the South West Indian Ocean Blue Economy*. Produced by Profundo Research and Advice. https://wwfafrica.awsassets.panda.org/downloads/assessing-financial-flows-within-the-south-west-indian-ocean-blue-economy_1.pdf?48743/Assessing-Financial-Flows-within-the-South-West-Indian-Ocean-Blue-Economy Accessed 03/06/2025.

WWF. 2024h. *Securing biodiversity is essential to achieving food security*. https://wwf.panda.org/wwf_news/?11618966%2FSecuring-Biodiversity-is-Essential-to-Achieving-Food-Security Accessed 09/09/2025

WWF. 2025a. *Eating up the ocean: a call to shift our seafood consumption towards sustainability*. https://www.wwf.ch/sites/default/files/doc-2025-01/2024_WWF-CH_SeafoodFeedprint_1.pdf Accessed 09/09/2025.

WWF. 2025b. *Towards nature positive for the ocean: pathways for corporate contributions*. https://www.worldwildlife.org/projects/towards-nature-positive-for-the-ocean-pathways-for-corporate-contributions Accessed 09/09/2025.

Zunino, S., Libralato, S., Canu, D.M., Prato, G. & Solidoro, C. 2021. Impact of ocean acidification on ecosystem functioning and services in habitat-forming species and marine ecosystems. *Ecosystems*, 24: 1561–1575. https://doi.org/10.1007/s10021-021-00601-3


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