Global Insights | Sustainability

Ocean Degradation

The neglected SDG that could sink them all

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Executive Summary

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This report focuses on ocean degradation and makes the case for (1) increased attention and action from businesses and financial institutions, and (2) a more integrated approach across climate change, biodiversity loss and ocean degradation. It starts by examining the significance of the ocean from environmental, economic and social perspectives and the current state of play. This is followed by a deep dive into the root causes of negative impacts on oceans, which is then mapped to industries – both marine and land-based. Almost all industries contribute to ocean degradation through one or more of three key "stressors": climate change, pollution, and land/sea use change & direct exploitation. We then discuss the risks and opportunities for businesses and financial institutions, as well as relevant regulations and initiatives that are in place and on the horizon. The note concludes with a set of recommendations for the private, public and finance sectors.

"But the sea which no one tends is also a garden" - William Carlos Williams

UN SDG 14: Life below water remains undervalued and underfunded even though ocean health is critically important to the planet, society and the global economy. Human activities – largely through overfishing, pollution, coastal development and climate change – are driving increasing ocean degradation, which in turn is undermining the natural world's productivity and resilience upon which our societies and economies depend. One of the challenges in achieving UN SDG 14 is that there are many ways to dissect ocean issues, and they are often discussed and analysed in siloes. This also applies more broadly when discussing ocean degradation, which is often viewed as a separate threat but is in fact intrinsically connected to climate change and biodiversity loss.

Although businesses and financial communities have important roles to play in driving more sustainable use of ocean resources and in financing a sustainable ocean economy, ocean sustainability largely overlooked. Progress has been made to understand and tackle climate change and biodiversity loss on a terrestrial basis, yet attention to sustainability from a marine perspective remains in its infancy. In this note, we make the case for why businesses and financial institutions should care about a sustainable ocean economy, and why a more holistic view across oceans, climate change and biodiversity loss is needed.

The next decade will be crucial in addressing the twin crises of climate change and biodiversity loss that are driving an "ocean emergency". Businesses and financial institutions should not view ocean issues as distant and separate from these two threats. Governments are taking increasing action on climate change and biodiversity loss, with ocean degradation rising on their agendas – for example, legally binding international treaties on plastic pollution and protection of the high seas are expected to be finalised in the next two years, on top of the Post-2020 Global Biodiversity Framework that includes several ocean-related targets such as protection of 30% of the world's ocean by 2030. Countries are starting to make the Task Force on Climate-related Financial Disclosures (TCFD) climate risk reporting mandatory, and the Taskforce on Nature-related Financial Disclosures (TNFD) is not far behind with the framework expected to launch in 2023. We think there is a real opportunity for businesses and financial institutions to upskill before the incoming waves of regulation and policies on ocean issues.

Although the ocean covers more than 70% of the planet, it is not too big to fail. That is why we must embrace the challenge - open our eyes to the significance of the ocean in our journey to a sustainable future, break down siloes and harness the vast opportunities that lie just beneath the surface.

Contents

Introduction

What is the current state of the ocean?

"With every drop of water you drink, every breath you take, you're connected to the Sea. No matter where on Earth you live". These powerful words from oceanographer and explorer Sylvia Earle elegantly distil humankind's intrinsic connection with the sea. As the planet's largest ecosystem, ocean health is critically important to the planet, society and global economy. A dedicated UN Sustainable Development Goal (UN SDG 14: Life below water) calls to "Conserve and sustainably use the oceans, seas, and marine resources for sustainable development".

Oceans cover >70% of the Earth's surface, are home to 80% of all life, and provide vital ecosystem services – they produce 50% of global oxygen, absorb 30% of CO_2 produced by humans, and capture 90% of the heat generated from those emissions[1]. Billions of people around the world depend on oceans for their food and livelihoods, and ocean industries have been valued by some studies at upwards of US$2.5 trillion. Yet despite the significance of this vital ecosystem, human activities have been driving a decline in ocean health. At the 2022 UN Ocean conference in Lisbon, Portugal earlier this year, UN Secretary-General Antonio Guterres called for urgent action to tackle the current "Ocean emergency".[2]

Some may ask: what is the "emergency"? Part of the challenge is that nature has properties that are difficult to appreciate, assess and value, which the Dasgupta Review on the Economics of Biodiversity (2021) highlights are *silent, mobile and/or invisible*. "Out of sight, out of mind" comes to mind with regards to ocean health. However, data on the current state of oceans paint a sobering picture both in terms of the physical state of the ocean as well as for marine life and ecosystems.

Human activities are driving marine species declines and extinctions: research from WWF found that marine populations declined almost 50% between 1970 and 2012.[3] We are also losing precious marine ecosystems - 50% of the world's corals and almost a third of all seagrass have been lost[4], and the destruction of mangroves has exceeded average global forest loss by a rate of 3 to 5 times[5]. The Second World Ocean Assessment released in 2021 highlighted that 90% of mangrove, seagrass and marsh plant species – all vital carbon sinks – are threatened with extinction. Given the vastness of oceans, it is rather remarkable that researchers have found that no area unaffected by human influence.[6] Coastal environments around the world have been degraded by human activities; a recent study found that only 15% of coastal areas remain in their natural state.[7] Various forms of marine pollution are increasing at alarming rates and harming marine life. Interest in the ocean and its resources is also on the rise and has been coined by some experts as the "Blue

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[1] UN SDGs - Goal 14: Conserve and sustainably use the oceans, seas and marine resources; IPCC (2019) Special Report on the Ocean and Cryosphere in a Changing Climate

[2] UN Ocean Conference opens with call for urgent action to tackle ocean emergency - United Nations Sustainable Development

[3] WWF (2015) Living Blue Planet Report

[4] IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages.

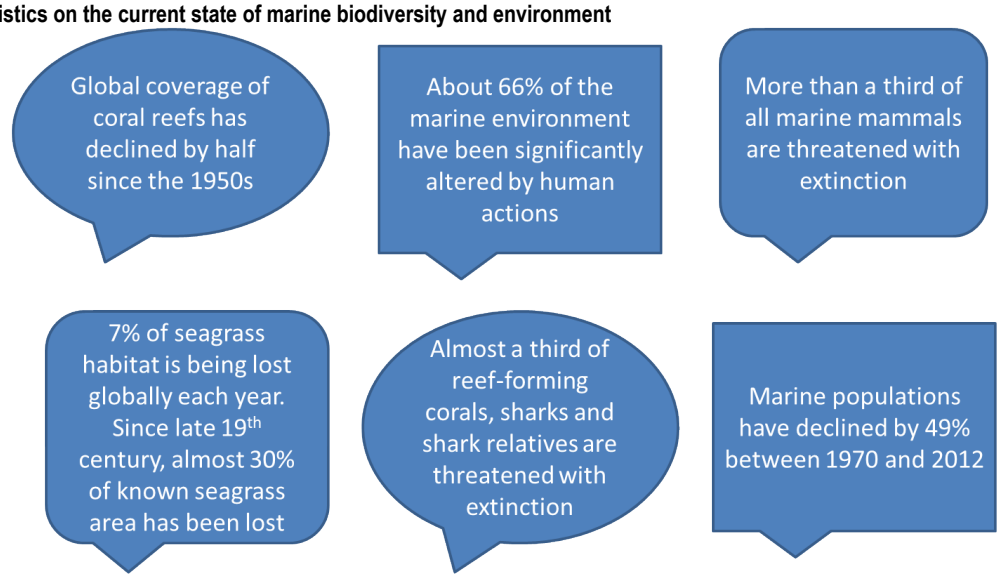
[5] UNEP (2014) The importance of mangroves to people: a call to action.

[6] Halpern, B.S. et al. A global map of human impact on marine ecosystems. Science. 2008 Feb 15;319(5865):948-52. doi: 10.1126/science.1149345. PMID: 18276889.

[7] Williams, B. A., Watson, J. E., Beyer, H. L., Klein, C. J., Montgomery, J., Runting, R. K., ... & Wenger, A. (2022). Global rarity of intact coastal regions. Conservation Biology, e13874.

Acceleration" – a race between diverse and often competing interests in ocean food, material and space.[8]

Figure 1. Key statistics on the current state of marine biodiversity and environment



Source: Citi Global Insights, IPBES, WWF, UNEP, Eddy et al. 2021

The physical properties of oceans are changing: becoming warmer, more acidic, stormier, and less predictable as sea levels rise. According to the World Meteorological Organisation, global mean sea level, ocean temperatures and ocean acidification reached record highs in 2021.[9] Marine heatwaves[10] are also on the rise and can have devastating impacts on marine life and ecosystems with consequences for marine food chains. Research has found that the number of annual marine heatwave days globally increased by more than 50% between 1925 and 2016, and are becoming more intense.[11]

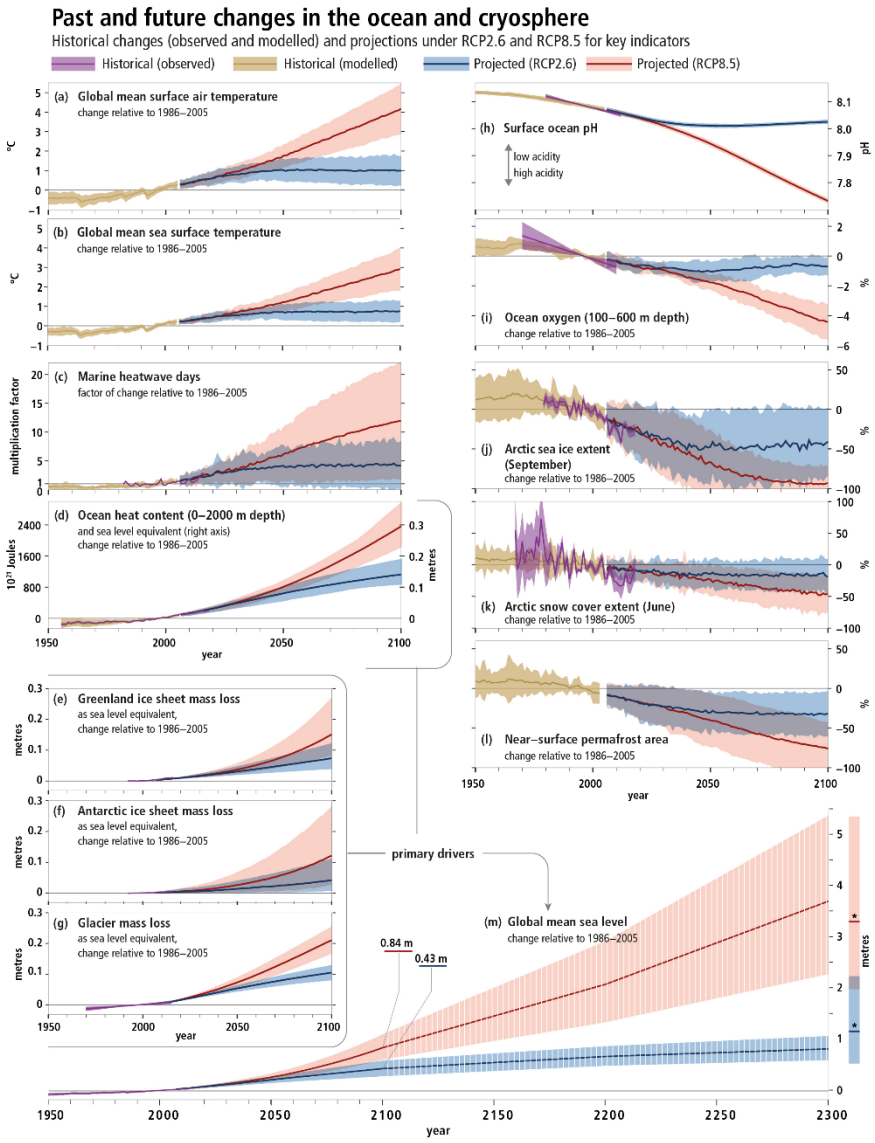
[8] Jouffray, J. B., Blasiak, R., Norström, A. V., Österblom, H., & Nyström, M. (2020). The blue acceleration: the trajectory of human expansion into the ocean. One Earth, 2(1), 43-54.

[9] World Meteorological Organisation (2022) State of the Global Climate 2021

[10] Prolonged periods of anomalously high sea surface temperatures usually lasting at least 5 days.

[11] Viglione, G. (2021) Fevers are plaguing the oceans — and climate change is making them worse.

Figure 2. Past and projected future changes in the ocean for a set of key indicators



Source: Figure SPM.1 from IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [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.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-35. https://doi.org/10.1017/9781009157964.001. (with permission)

The good news is that governments are starting to pay attention: more than 100 countries are now committed to protect at least 30% of land and oceans by 2030 (also known as 30x30), which is a key component of the Post-2020 Global Biodiversity Framework set to be agreed at COP15 taking place in Montreal, Canada in December 2022. The goal has been endorsed by the G7 and received a boost in commitments at the 2022 UN Ocean conference. At the end of the ocean conference, world leaders recognised the past “collective failure to achieve ocean-related targets” and renewed their commitment in a new Lisbon Declaration that calls upon all stakeholders to

"urgently take ambitious and concerted action to accelerate implementation to achieve Goal 14 as soon as possible without undue delay".[12]

The world's oceans can be divided into national waters and international waters (also known as the high seas), which are not under the jurisdiction of any one country. Every coastal nation has the right to control marine resources up to 200 nautical miles from its shoreline, and these areas are called Exclusive Economic Zones (EEZ). Most of the world's oceans are beyond national jurisdiction (61%), and there are various international bodies and treaties that manage human activity within international waters. The UN Convention on the Law of the Sea (UNCLOS) which is an international agreement that provides a legal framework for all marine activities, yet it does not currently include a global framework for international waters. Some experts highlight the patchwork sectoral and regional approaches makes establishing and monitoring protected areas challenging both logistically and legally. They also emphasise the current approach actually leads to degradation of marine environments and resources.[13] Negotiations for a UN Ocean treaty under UNCLOS to protect and manage the high seas have been ongoing for two decades; the fifth round concluded in August 2022 without consensus and will reconvene in 2023. This treaty matters because it aims to create an international legally binding treaty on the conservation and use of marine resources in international waters. According to the latest data on marine protected areas, only 1.44% of the high seas is currently protected, compared to 18.65% of national waters.[14]

The UN also declared 2021-2030 as the decade of Ocean Science for Sustainable Development, which aims to produce "the science we need for the ocean we want".[15] There is still much we don't know about the ocean: according to NOAA, more than 80% of the ocean remains unmapped, unobserved and unexplored.[16] However, much progress has been made in recent years, and technological advancements are allowing for better and faster data collection.. For example, we have gone from 6% of global oceans being mapped in 2014 to 15% in 2019, and more data was collected on the oceans in 2018 than during the entire 20th century.[17] However, this must also be accompanied by insights and action or we risk falling into the trap of John Naisbitt's paradox of "drowning in information, but starved for knowledge".

The business and financial communities also have important roles to play in tackling ocean health decline. In the Citi GPS report on Biodiversity, we explored why corporates and investors should care about biodiversity loss, not to ignore this systemic threat, and tackle the issue with the same urgency as the climate crisis. Enormous progress has been made by the business and finance communities on climate change, and now biodiversity loss on a terrestrial basis is quickly rising up the agenda. However, despite its extraordinary significance, a focus on sustainability from a marine perspective remains largely in its infancy:

[12] UN (2022) UN Ocean Conference final draft of the political declaration

[13] The Pew Charitable trusts (2020) A path to creating the first generation of high seas protected areas

[14] https://www.protectedplanet.net/en/thematic-areas/marine-protected-areas [Accessed 26 Sept 2022]

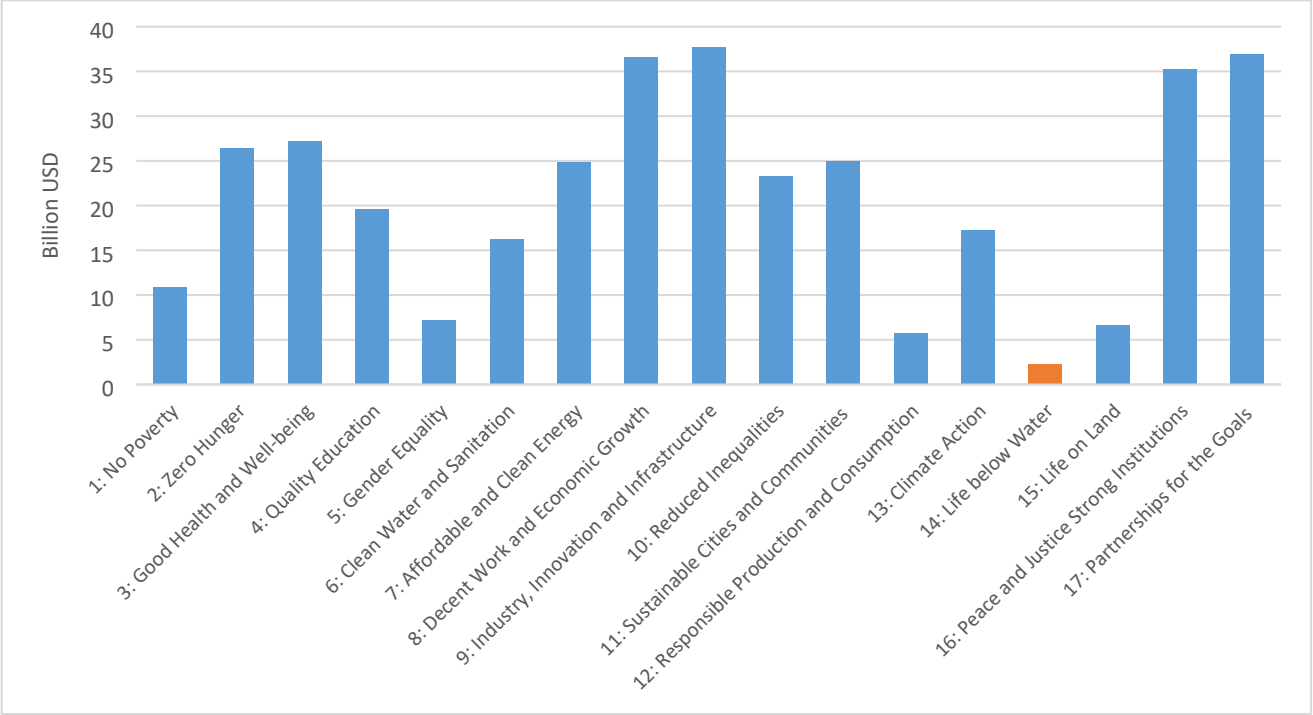
[15] https://www.oceandecade.org/

[16] NOAA (2022) How much of the ocean have we explored?

[17] Brett, A., Leape, J., Abbott, M., Sakaguchi, H., Cao, L., Chand, K., ... & Myksvoll, M. S. (2020). Ocean data need a sea change to help navigate the warming world.

- SDG 14: Life Below Water receives the lowest level of blended and impact finance, as well as aid out of all the SDGs.[18] SDG 14 received 0.01% of all SDG funding from ODA up to 2019.[19]
- SDG 14 is one of the least prioritised goals in corporate sustainability programmes and targets.[20]
- Less than 2% of support from the Green Climate Fund (GCF) and less than 1% of Global Environmental Facility (GEF) funding for climate change go towards ocean-based solutions.[21]
- Only 3.29% of use of proceeds sustainable bonds went to UN SDG 14 in 2021.[22]
- Only 7% of global marine conservation funding in 2019 came from private finance.

Figure 3. Financing for the UN SDGs (considering ODA, OOF, Other private flows, private grants)



Source: The SDG Financing Lab, Citi Global Insights

A 2020 survey of 74 financial institutions by the UNEP Finance Initiative found that 62% of respondents have not integrated the sustainable ocean economy into their

[18] OECD (2018) Blended finance funds and facilities: 2018 survey results; World Economic Forum and Friends of Ocean Action (2022) SDG14 Financing Landscape Scan: Tracking Funds to Realize Sustainable Outcomes for the Ocean; The SDG financing lab

[19] World Economic Forum and Friends of Ocean Action (2022) SDG14 Financing Landscape Scan: Tracking Funds to Realize Sustainable Outcomes for the Ocean

[20] KPMG (2020) The time has come – the KPMG Survey of Sustainability Reporting 2020; MSCI (2020) Who cares about the UN Sustainable Development Goals?

[21] The Commonwealth (2022) Blog: Why we need to tackle the ocean funding crisis

[22] Environmental Finance (2022) Environmental Finance Sustainable Bonds Insight 2022

institution's sustainability considerations, and 23% have just started the integration. However, the topic of oceans is rising up the investor agendas, a study by Responsible Investor reported high investor interest in ocean-related investments is high among investors, and that it is ready for an which could increase in importance over the coming decade. While interest is high, action remains limited and three in four investors surveyed have not assessed their portfolios for their impact on oceans. Key barriers for investors were found to include low industry expertise and a lack of investment grade projects.[23] However, there are some investors who are taking the lead: for example, Norges Bank Investment Management recognises the importance of ocean sustainability and has set out a lists of expectations for its investee companies on the matter: which includes 1) integrate ocean sustainability considerations into policies and strategy, 2) integrate material ocean-related risks into risk management, 3) disclose material ocean sustainability information, and 4) engage transparently and responsibly on ocean-related matters.[24]

Capital is being directed at ocean issues around the world, but much more needs to be mobilised. Estimates vary as to how much goes to supporting a sustainable ocean economy from various sources, but some aspects are widely recognised – 1) there is a significant financing gap, and 2) there is very little private sector investment. A study on SDG 14 funding estimates $175 billion per year is needed for better conservation and sustainable use of our oceans, and that there is a funding gap of $149 billion per annum.[25] Put into context, this is about a third of the average $555 billion spent each year on global fossil fuel subsidies between 2017-2019.[26]

There is still much we do not know about the ocean, but data clearly show that: 1) ocean health is in decline; and 2) ocean sustainability is largely overlooked by governments, businesses and the financial community. Too long have we taken the ocean for granted, with the assumption that it will continue to supply us with resources and ecosystem services. We can no longer ignore ocean issues and must recognise the importance of a healthy ocean as well as the risks of continuing "business as usual" for the planet, for society, and for the global economy.

Definitions

Various terms are used to discuss the ocean and sustainability such as "sustainable ocean economy", "blue economy", and "sustainable blue economy", none of which are used universally. "Blue economy" is often used interchangeably with "sustainable ocean economy" and, according to the World Bank, is the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem." The High Level Panel for A Sustainable Ocean Economy adopts a similar definition but also adds "… the health of ocean ecosystems and associated services". There is also no universally agreed categorisation of the industries within the ocean economy, but, broadly speaking, this pertains to economic activity that takes place in and around the ocean. As well, there are debates around whether extractives such as oil and gas, and sea bed mining should be included in a sustainable ocean/blue economy. However, the need for clear definitions and taxonomies is being increasingly recognised by a variety of stakeholders including policymakers, business and financiers. In this report, we use the terms "ocean economy" and "sustainable ocean economy" and consider the High Panel definition for the latter.

[23] RI/Credit Suisse (2021) Investors and the Blue Economy

[24] Norges Bank Investment Management (2022) Ocean sustainability

[25] Johansen, D. F., & Vestvik, R. A. (2020). The cost of saving our ocean-estimating the funding gap of sustainable development goal 14. *Marine Policy*, *112*, 103783.

[26] Timperley, J. (2021). Why fossil fuel subsidies are so hard to kill. *Nature*, 598(7881), 403-405.

Why does the ocean matter?

It is difficult to overstate the importance of a healthy ocean for our planet, society and global economy. It plays a fundamental role in regulating the climate, the air we breathe and the water we drink and use. At least 50% of oxygen production comes from the ocean, and it is also the world's largest carbon sink. Oceans provide vital food, energy resources and materials, as well as livelihoods to billions of people around the world. They support biodiversity, which in turn maintains ocean health and ecosystem services; for example, whales and other marine life sequester CO_2 and pump nutrients across oceans that promote primary production. Conservative estimates from the IMF place the economic value of a great whale at more than $2 million, and over $1 trillion for the current stock. They also emphasise that whales play a significant role in capturing CO_2 and protecting them can help tackle climate change.[27] Oceans also play important roles in human health and well-being as well as culture and heritage. The link of ocean health to public health may be surprising and offers a treasure trove of resources for biomedical research and pharmaceuticals. According to UNESCO, bacteria found in the ocean has been used in the detection of COVID-19, as well as AIDS and SARS.[28] Though it is difficult to assign a monetary value to such a vital ecosystem, one study valued ocean assets at more than $24 trillion and stressed the actual value is likely much higher given the difficulties in quantifying ecosystem services.[29] The ocean is vital to the global economy as ocean-based industries employ millions of people around the world, and some studies have valued ocean-based economic sectors to be worth up to $6 trillion every year. For Small Island Developing States (SIDS), ocean-based sectors provide a substantial contribution to national GDP: for example, coastal tourism alone contributes more than 40% of GDP in Fiji, Maldives, Antigua and Barbuda, Cabo Verde, Grenada and Saint Lucia and 65% in the Seychelles.[30]

Ocean health is closely connected to climate change. In fact, a growing number of studies demonstrate the environmental and economic case for ocean-based climate action. The ocean has absorbed 20-30% of anthropogenic CO_2 emissions and >90% of the excess heat helping to buffer the impacts of global warming.[31] If we simply consider the carbon sequestration abilities of marine habitats, we can see they are important carbon sinks with some ecosystems able to capture more carbon than tropical forests. However, vast amounts of these precious stores of "blue carbon" are being destroyed. Studies have found that mangroves can sequester 2-5 times more carbon than tropical forests.

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[27] Chami, R., Cosimano, T. F., Fullenkamp, C., & Oztosun, S. (2019). Nature's Solution to Climate Change: A strategy to protect whales can limit greenhouse gases and global warming. Finance & Development, 56(004).

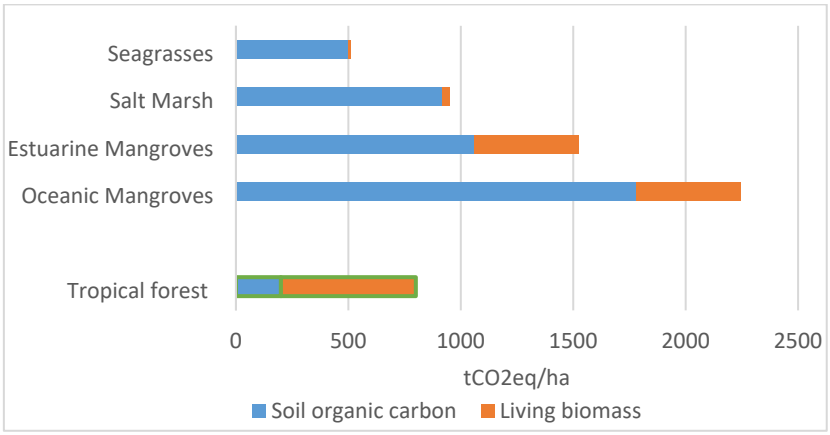
[28] UNESCO (2022) COVID-19: the ocean, an ally against the virus

[29] WWF (2015) Reviving the Ocean Economy – the case for action

[30] OECD (2021) COVID-19 pandemic:Towards a blue recovery in small island developing states

[31] IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [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.)]. In press.

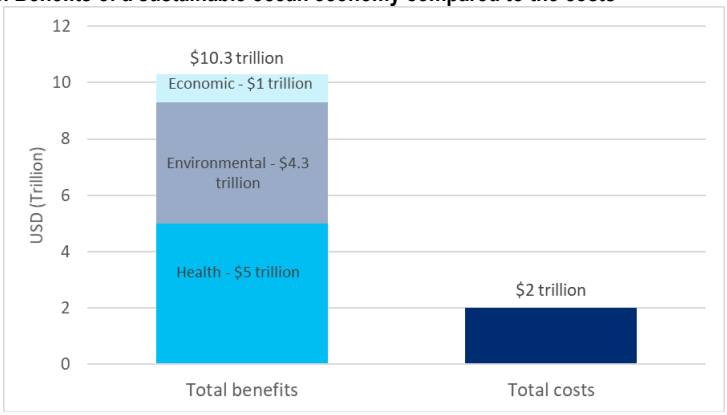
Figure 4. Global averages for carbon sinks of key coastal habitats compared with tropical forests



Source: IUCN, Citi Global Insights

Research has found that ocean-based climate solutions[32] can deliver up to 1/5 of annual GHG emission reductions needed by 2050.[33] More recent work commissioned by the Ocean Panel report that investing $1 in key ocean actions can deliver at least $5 in benefits over the next 30 years, delivering a whole host of economic, environmental, social and health benefits.[34] Some studies have tried to quantify the costs of inaction: for example, WWF analysis found that investors risk losing $8.4 trillion in assets and revenue due to ocean health decline and climate change if business as usual continues.[35] Key sectors that are most at risk include Coastal real estate and infrastructure, Commercial fisheries, and Ports and shipping.

Figure 5. Benefits of a sustainable ocean economy compared to the costs



Source: Citi Global Insights, High Level Panel for a Sustainable Ocean Economy

[32] There is no universally agreed definition and categorisation of ocean-based climate solutions, this study considered ocean-based renewable energy, ocean-based transport, coastal and marine ecosystems, ocean-based food systems, and carbon storage

[33] Hoegh-Guldberg. O., et al. 2019. "The Ocean as a Solution to Climate Change: Five Opportunities for Action." Report. Washington, DC: World Resources Institute. Available online at http://www.oceanpanel.org/climate

[34] Konar, M., & Ding, H. (2020). A Sustainable Ocean Economy for 2050 Approximating Its Benefits and Costs Secretariat of the High Level Panel for a Sustainable Ocean Economy, World Resources Institute.

[35] WWF and Metabolic (2021) Navigating Ocean Risk: Value at Risk in the Global Blue Economy

The ocean connects many critical global challenges including climate change, biodiversity loss, food security, global health threats, social inequalities as well as peace and security. Social inequalities might seem surprising at first, but they are interwoven with the industries and activities that the ocean supports. For example, many of the small-scale fishers in developing economies face high levels of poverty and lack social and economic opportunities. The UN's recent 2022 SDG progress report found that Covid-19 has had disproportionate impacts on small-scale fishers where many have been unable to catch, process or sell fish for long periods of time.[36] Gender inequality is also not uncommon across sectors as women are often more present in the low skilled, low paid, seasonal, informal and least stable jobs. For example, the UN reports that women earn on average 64% of men's wages for the same work in aquaculture.[37] Note that the seafood industry goes beyond just catching and farming fish as women make up 90% of onshore fish workers, which include cleaning, processing, packaging, marketing and selling products. A recent paper shone a light on the hardships women in the industry endure, including long hours, poor working conditions, low pay, lack of representation at the management level and systemic discrimination.[38] There is also a growing body of research that shows there are gendered effects of marine pollution as well as maritime disasters: pregnant women and children are most sensitive to the toxic materials in fish, and women and children are 14 times more likely than men to die during a natural disaster.[39]

A more holistic way to consider the importance of oceans is to use the blueprint of the UN Sustainable Development Goals – poor ocean health (SDG 14: Life Below Water) threatens other SDGs, whereas a sustainable ocean economy can help to support and meet other goals. The IPCC Special Report on the Ocean and Cryosphere in a Changing Climate emphasises that the UN SDGs are all connected to varying extents with the ocean and provide some examples of how a decline in ocean health can impact other goals[40]:

- Ocean health decline is increasingly driving migration and loss of biodiversity, which impacts marine food supply chains and threatens SDG 1 (No poverty) and SDG 2 (No hunger).

- Physical ocean changes […] could have serious impacts for coastal communities and small island states, with risks for SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 8 (Decent Work and Economic Growth). A recent report on impacts, adaptation and vulnerability from the IPCC sixth assessment cycle (AR6) note that by 2050, more than a billion people living in low-lying coastal communities and cities are at risk of coastal climate hazards.[41]

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[36] UN DESA (2022) The Sustainable Development Goals Report 2022

[37] UN Women (2020) Empowering Women through Oceans Conservation.

[38] Finkbeiner, E. M., Fitzpatrick, J., & Yadao-Evans, W. (2021). A call for protection of women's rights and economic, social, cultural (ESC) rights in seafood value chains. Marine Policy, 128, 104482.

[39] OECD (2021) Gender and the Environment: Building evidence and policies to achieve the SDGs.

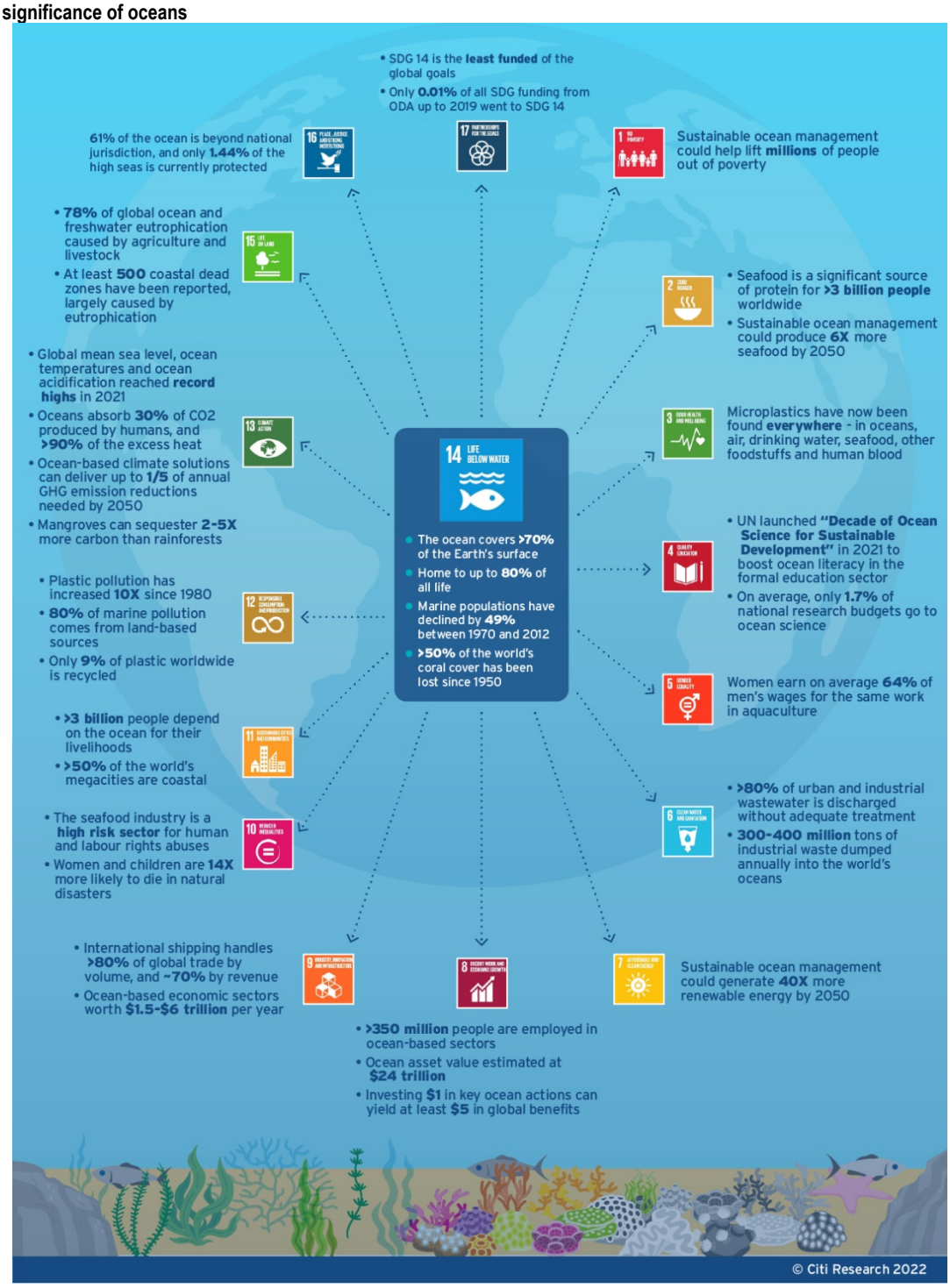
[40] IPCC, 2019: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

[41] IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3–33, doi:10.1017/9781009325844.001.

- Melting glaciers may lead to an eventual increase in water, but it also means a decrease in vital water supplies to millions of people around the world who depend on water from mountains for a host of uses such as drinking and sanitation (SDG 6), clean energy (SDG 7), and irrigation (SDG 2).

The following figure summarises the significance of oceans and SDG 14 across the global goals.

Figure 6. The significance of oceans



Source: Citi Research and Global Insights

However, the ocean emergency is not a recent revelation as, similar to climate change, academics have been warning for years that ocean health has been declining and action is needed. Oceanographer and explorer Sylvia Earle has been warning that the oceans are “not too big to fail” and that “No ocean; no life, no blue; no green”. We can no longer continue business as usual – the next decade will be crucial in addressing the twin crises of climate change and biodiversity loss, and we must not lose sight of the critical role oceans can play in addressing both. The global environmental challenges we face are deeply interconnected and cannot be tackled in siloes but require an integrated approach. Building and supporting a sustainable ocean economy offers a unique opportunity to address multiple crises, drive progress across the UN Sustainable Development Goals, and potentially generate billions of dollars of economic value.

To make this happen, we need to acknowledge the significance of oceans to a sustainable future, building capacity and fostering collaboration within and across sectors to address this truly systemic challenge and opportunity. The business and finance communities have a crucial role to play. Even though oceans remain largely overlooked, we think three key trends are converging to finally deliver the awareness, tools and capital needed to kickstart a sustainable ocean economy: 1) growing awareness and action by governments and private sector on climate change and biodiversity loss; 2) the rise of ESG and sustainable finance; and 3) technology and innovations enabling better and faster data collection and insights on oceans to support decision making.

What are the main causes of ocean degradation?

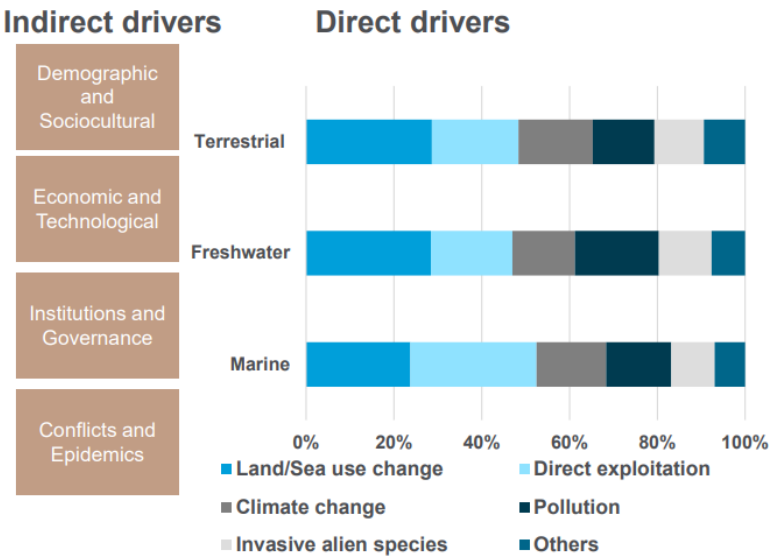
"The ocean is large and resilient, but it is not too big to fail. What we are taking out of the sea, what we are putting into the sea are actions that are undermining the most important thing the ocean delivers to humankind – our very existence" - **Sylvia Earle**

The chapter above has demonstrated the many reasons we should care about the ocean – it is the life support of our planet and sustains societies and economies around the world. However, human activities are putting increasing pressure on oceans and impacting their productivity and capacity to regulate climate and other vital ecosystem services. Scientists have estimated that just 13% of the world's oceans remain untouched by the negative impacts of human activity.[42]

So what are the main causes of ocean health decline? According to the second UN World Ocean Assessment in 2021, the most significant drivers of change in oceans are overfishing, pollution and climate change. IPBES, which is the IPCC equivalent for climate, carried out a landmark assessment in 2019 on the drivers of nature loss, and found that direct exploitation (mainly fishing) has had the largest relative impact (29%) on marine ecosystems. Sea use change comes second, mainly through habitat loss and degradation, followed by pollution and climate change at 16% and 15%, respectively. Invasive alien species and other drivers make up the rest.

Figure 7. Five key drivers of nature loss across terrestrial, freshwater and marine ecosystems

These five drivers have caused more than 90% of nature loss in the past 50 years, with land and sea use change and direct exploitation accounting for more than 50%



Source: IPBES, Citi GPS

These human-driven pressures should not be viewed in isolation as they exacerbate each other and have a cumulative effect on the marine environment. Studies by Halpern *et al*.[43] have found that no area of marine ecosystem is unaffected by human

[42] Jones, K. R., Klein, C. J., Halpern, B. S., Venter, O., Grantham, H., Kuempel, C. D., ... & Watson, J. E. (2018). The location and protection status of Earth's diminishing marine wilderness. Current Biology, 28(15), 2506-2512.

[43] Halpern B. et al. (2019) Recent pace of change in human impact on the world's ocean; Halpern et al. (2015) Spatial and temporal changes in cumulative human impacts on the world's ocean

influences, and now most of the ocean (59%) is experiencing increasing cumulative impacts from human activities. This is due in particular to climate change stressors – sea surface temperature, ocean acidification and sea level rise – which are increasing rapidly.

For this report, we focus on three main set of drivers: 1) Land/sea use change & over-exploitation, 2) Pollution, and 3) Climate change. The climate change stressors amplify and exacerbate many of the other stressors – for example, ocean warming, acidification and de-oxygenation create favourable conditions for larger and more frequent toxic algae blooms caused by nutrient runoff. Climate change will also exacerbate the spread of plastic pollution in marine environments[44]. Let's not forget the life cycle of plastic from extraction and refining of oil to manufacture and end of life is carbon-intensive and contributes to climate change. According to OECD, plastics generated 1.8 billion tonnes of GHG emissions in 2019, accounting for 3.4% of global GHG emissions; it expects this to more than double to 4.3 billion tonnes of GHG emissions by 2060.[45]

The climate stressors also have a two-way relationship with fishing & aquaculture: they directly impact the distribution, quantity and health of ocean biodiversity, and can impact the viability and productivity of fisheries and aquaculture. Studies have found that overfishing makes wild capture production more vulnerable to ocean warming, and continued warming will hinder efforts to rebuild overfished populations.[46] Overfishing also impacts marine ecosystem services, which can lead to increased production of CO_2 in oceans. As well, it has been found that both climate change and overfishing influence pollution sensitivity, further weakening the resilience of ocean biodiversity and marine ecosystems.[47]

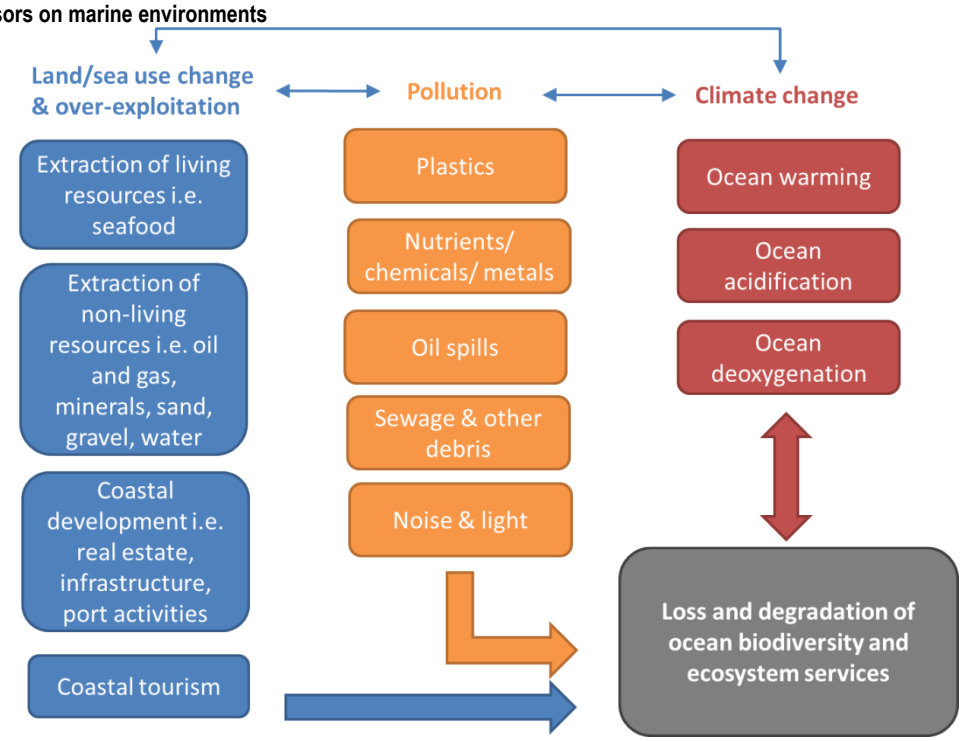
[44] Ford, H. V., Jones, N. H., Davis, A. J., Godley, B. J.,...& Koldewey, H.J. (2022) The fundamental links between climate change and marine plastic pollution. *Science of the Total Environment*, 806, 150392

[45] OECD (2022) OECD Global Plastics Outlook

[46] Free, C. M., Thorson, J. T., Pinsky, M. L., Oken, K. L., Wiedenmann, J., and Jensen, O. P. (2019). Impacts of historical warming on marine fisheries production. Science 363, 979–983.

[47] Issifu, I., Alava, J. J., Lam, V. W., & Sumaila, U. R. (2022). Impact of Ocean Warming, Overfishing and Mercury on European Fisheries: A Risk Assessment and Policy Solution Framework. Frontiers in Marine Science.

Figure 8. Key stressors on marine environments



Source: Citi Global Insights

Climate change

As we discussed in earlier, oceans play a vital role in regulating global climate and help to buffer the worse impacts of global warming. However, climate change is causing ocean acidification, warming as well as de-oxygenation, which is harming and accelerating loss of ocean biodiversity and habitats. This, in turn, is creating a negative feedback loop and impacting the oceans' ability to provide critical ecosystems services (such as absorbing carbon and heat and supplying oxygen) and leading to broader economic and social impacts which include food security, livelihoods, disaster risk management, disease control and biomedical research.[48]

[48] Talukder, B., Ganguli, N., Matthew, R., Hipel, K. W., & Orbinski, J. (2022). Climate Change-Accelerated Ocean Biodiversity Loss & Associated Planetary Health Impacts. The Journal of Climate Change and Health, 100114.

Figure 9. Inter-dependencies across climate change, oceans, biodiversity loss and societal health

Source: Talukder et al. (2022), IPCC, Citi Research and Global Insights

Ocean warming, acidification and deoxygenation have been referred to by some experts as “the deadly trio” or “triple threat” of climate change stressors on marine environments. Oceans and the atmosphere interact constantly, and as surface waters absorb the excess atmospheric heat caused by rising greenhouse gas emissions, sea surface temperature (SST) has increased and is changing ocean circulation patterns around the world. According to NOAA, SST has been consistently higher over the past three decades than at any other time since 1880, and in 2021, annual global SST was 0.65°C above the 20th century average.[49] Scientists have also recently found that global warming is speeding up ocean currents, by ~15% per

[49] NOAA (2021) Annual 2021 Global Climate Report

decade from 1990 to 2013, warning that this could have serious global implications for weather patterns, jet streams and the ocean's ability to store heat.[50]

Oceans' absorption of excess atmospheric CO_2 may be buffering the impacts of climate change, but it is changing the chemistry of ocean waters and making it more acidic. Ocean acidity is increasing at an unprecedented rate: over the past 200 years, it has increased by approximately 30%.[51] It poses a serious threat to marine ecosystems, especially organisms like corals and mollusks, as ocean acidification is causing their calcium carbonate shells and skeletons to dissolve.

There are two main drivers of ocean de-oxygenation: 1) ocean warming as warmer waters retains less oxygen, and 2) nutrient pollution from agricultural run-off and waste is causing eutrophication and excessive algae growth, leading to less oxygen. The latter primarily takes place in coastal areas. Research shows that the oxygen content of global oceans has decreased by around 2% over the past 50 years,[52] and ocean "dead zones" with zero oxygen have quadrupled in size since 1950.[53] Scientists warn that these conditions are not sustainable in the long run as low and declining oxygen levels in the oceans could have serious consequences for marine life and the ecosystem services we derive from them.

The latest UNEP Emissions Gap report found that a current policy scenario puts the world on track for a global temperature rise of 2.7°C by end of the century.[54] This is well above the goal of the Paris Agreement to keep global warming well below 2°C, and preferably to 1.5°C. Our current trajectory would have devastating impacts on ocean biodiversity and coastal environments, leading to knock-on effects across societies and economies. According to WWF, climate change stressors could reduce fish biomass by 30-40% in some tropical regions by 2100 under a Business-As-Usual Scenario.[55] IPCC estimates that climate-induced declines in ocean health could cost the global economy $428 billion annually by 2050, and $1.98 trillion by 2100.[56] Even though a 1.5°C world would still have consequences for oceans, the differences between a 2°C and 1.5°C world are substantial and worth striving for.

Figure 10. Table on the impacts of climate change on oceans at 1.5°C, 2°C and 3°C

	1.5°C	2°C	3°C
Sea level rise (by 2100)	48cm	56cm	7+ meters Near-complete melting of the Greenland ice sheet
Increase in global marine heatwave days per year (by 2100)	X16	X23	X41
Marine life (by 2100)	- Coral reefs decline by 70-90%	- Virtually all coral reef lost	- Marine ecosystems may collapse
Global population flooded in coastal areas	- 28 million/year (by 2045) - 60 million/year (by 2095)	- 30 million/year (by 2045) - 72 million/year (by 2095)	

Source: UNEP, Carbonbrief, Citi Global Insights

[50] Hu, S., Sprintall, J., Guan, C., McPhaden, M. J., Wang, F., Hu, D., & Cai, W. (2020). Deep-reaching acceleration of global mean ocean circulation over the past two decades. Science advances, 6(6), eaax7727.

[51] NOAA (2022) Resources – Ocean and Coasts – Ocean acidification

[52] Oschlies, A. et al. (2018) Drivers and mechanisms of ocean deoxygenation, Nature Geoscience

[53] Breitburg D. et al. (2018) Declining oxygen in the global ocean and coastal waters

[54] UNEP (2021) Emissions Gap Report 2021

[55] Monnier, L., Gascuel, D., Alava, J.J., Barragán, M.J., Gaibor, N., Hollander, F.A., Kanstinger, P., Niedermueller, S., Ramírez, J., & Cheung, W.W.L. 2020. Small-scale fisheries in a warming ocean: exploring adaptation to climate change. Executive summary. WWF Germany

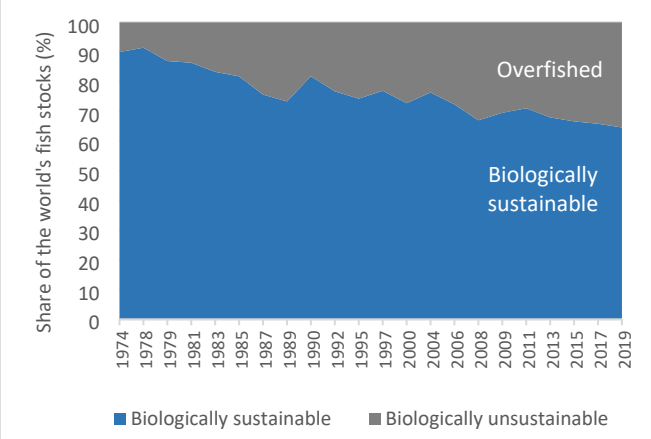
[56] IPCC (2019) Special Report on the Ocean and Cryosphere in a Changing Climate

Some experts say climate change *is* ocean change, and we have described above how global warming poses a serious threat to ocean biodiversity and ecosystems as well as broader planetary, human and economic health. Tackling climate change is vital to protecting the oceans, but the opposite also applies where ocean-based climate solutions can make significant contributions to addressing climate change. A more holistic view of climate change and ocean health is needed to better understand their inter-dependencies and help turn a vicious circle of harm into a more virtuous circle of productivity, resilience and prosperity.

Land/sea use change and over-exploitation

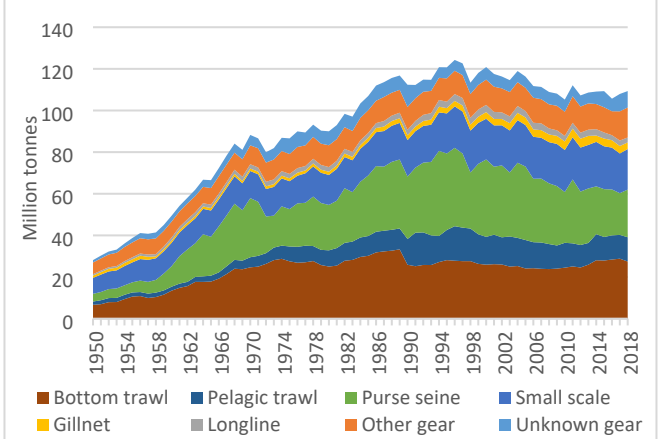
Fishing has had the largest impact on marine biodiversity over the past 50 years, and the footprint of industrial fishing is now 4 times that of agriculture and covers over 50% of the world's oceans.[57] In 2020, global fisheries and aquaculture production reached 178 million tonnes, with capture fisheries making up 51% (90 million tonnes) and aquaculture 49% (88 million tonnes). The FAO expects fisheries and aquaculture production to increase to 202 million tonnes in 2030 (14% increase from 2020), with most of the increase to come from fish farming. Research has found that decreased catch in traditional fishing grounds is leading to commercial fishing companies targeting new species and expanding their fishing to wider coverage and deeper depths.[58] The latest FAO review on global fisheries and aquaculture reported that 35.4% of the world's fish stocks were over-fished in 2019, and 57.3% were maximally sustainably fished.[59] Additional insights from the Minderoo Foundation, which has developed a global fishing index, find that out of the 1,439 assessed fish stocks, nearly 1 in 10 have been driven to collapse.[60]

Figure 11. The world's fish stocks



Source: FAO, Citi Global Insights

Figure 12. Global fish catch by gear type



Source: UN FishStat Database, Our World in Data, Citi Global Insights

Various fishing methods have different impacts on the marine environment. Subsistence and more small-scale fishing, which are more common in developing countries, often use pole and line and longline methods, whereas trawling methods are more common with industrial fishing practices. Figure 12 shows that bottom

[57] Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. A., Boerder, K., Ferretti, F., ... & Worm, B. (2018). Tracking the global footprint of fisheries. Science, 359(6378), 904-908.

[58] Tickler, D. et al., (2018) Far from Home: Distance Patterns of Global Fishing fleets, Science Advances, 4, (8)

[59] UN FAO (2022) The State of World Fisheries and Aquaculture

[60] https://www.minderoo.org/global-fishing-index/

trawling, also called dredging, is the most common method globally and accounts for a quarter of wild fish catch.

Bottom trawling involves large weighted nets being dragged across the sea floor and has the largest negative impact on the marine environment as it often results in high bycatch and damage to the seabed and marine life. Research has found that every year, around 5 million km^2 of seabed is trawled, releasing between 0.6 and 1.5 Gigaton of aqueous CO_2, which the authors highlight is comparable to estimates of carbon loss in soils by farming.[61] Bottom trawling is most intense within the territorial seas of coastal nations. It has been reported that China, Vietnam, Indonesia, India and Morocco are the top-five bottom-trawling countries, and the practice is growing quickly in Asia.[62]

The establishment of Marine Protected Areas (MPAs) may not be enough to stop harmful activities if they are not monitored and enforced. For example, recent data from Global Fishing Watch has revealed that more than 90% of Britain's offshore MPAs are still being bottom trawled, even after the 2020 Fisheries Act – which gave the UK powers to ban bottom trawling. Monitoring fishing activity is challenging, especially when it takes place far away from the shore. However, emerging technology such as satellite imaging and advanced analytics increasingly allows us to monitor and track fishing activity. Global Fishing Watch[63] research assesses the global footprint of fishing. A seminal study published in 2018 found that whilst more than half of the world's oceans are being fished by industrial vessels, it is also highly concentrated with half of the fishing activity occurring in just 0.5% of the ocean.[64]

Since 1990, global fish consumption has increased by 122%, and more year-on-year than any other animal-based protein sources (e.g. meat, milk, eggs). For over 3 billion people in lower income countries, it is the main source of protein.[65] Global demand does not show signs of slowing, and total production, trade and consumption reached all-time highs in 2018. Over the past few decades, most of the increase in production has come from aquaculture. While some argue that it is a more ecologically friendly alternative to fishing, others say its expansion is having mixed impacts on coastal and ocean ecosystems. The creation of reservoirs and ponds for aquaculture can lead to negative impacts on coastal and marine environments through habitat modification and clearing. The practice of aquaculture can also lead to pollution via waste as well as the introduction of chemicals, nutrients, pathogens and invasive alien species. For certain species, there are also reports that aquaculture contributes to overfishing due to the demand for fish feed, which comes from wild catch species. It has been reported that globally, 11% of wild fish catch is used as feed for fish farms.[66] However, many organisations including the FAO have stated that aquaculture can contribute to many global sustainability goals if managed well, as they can provide employment and livelihoods, support food security, and help tackle overfishing.

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[61] Sala, E., Mayorga, J., Bradley, D., Cabral, R. B., Atwood, T. B., Auber, A., ... & Lubchenco, J. (2021). Protecting the global ocean for biodiversity, food and climate. Nature, 592(7854), 397-402.

[62] Steadman, D., Thomas, J. B., Villanueva, V. R., Lewis, F., Pauly, D. W., Deng Palomares, M. L., ... & Rocliffe, S. (2021). New perspectives on an old fishing practice: Scale, context and impacts of bottom trawling. Our Shared Seas, Report, 44.

[63] https://globalfishingwatch.org/

[64] Kroodsma, D. A., Mayorga, J., Hochberg, T., Miller, N. A., Boerder, K., Ferretti, F., ... & Worm, B. (2018). Tracking the global footprint of fisheries. Science, 359(6378), 904-908.

[65] UN FAO (2020) The State of World Fisheries and Aquaculture

[66] Naylor, R. L., Hardy, R. W., Buschmann, A. H., Bush, S. R., Cao, L., Klinger, D. H., ... & Troell, M. (2021). A 20-year retrospective review of global aquaculture. Nature, 591(7851), 551-563.

It is also important to note that the fishing and aquaculture industries support billions of people around the world, especially in lower-income countries. The FAO reports that in 2020, an estimated 58.5 million people worked in fisheries and aquaculture; of these, 65% were employed in fisheries, and 35% in aquaculture.[67] But the number of people who depend on the ocean for their livelihoods more broadly is over 3 billion.[68] The welfare of workers is of growing concern, with some experts noting that human rights violations are widespread in fisheries around the world.[69] Illegal, unreported and unregulated (IUU) fishing is also a major issue for governments and the industry, remaining an obstacle to achieving sustainable fishing, as well as threatening livelihoods and exacerbating poverty. According to WWF, IUU fishing equates to approximately 11-19% of global fisheries production and results in losses of $10-23.5 billion per year.[70]

Other examples of sea use change that can lead to habitat modification and destruction include coastal development, coastal tourism, marine dredging and mining, port activities, and oil and gas production. These activities also often contribute to various forms of marine pollution (see below).

Human beings have long settled in coastal areas, which provides access to food, materials and resources, as well as trade and travel. About 11% of the world's population live in low-lying coastal areas (ie, less than 10m above sea level), and 55% of the global urban population live in coastal settlements.[71] More than half of the world's megacities (>10 million inhabitants) are coastal.[72] Research also shows that for some countries, coastal population growth has been increasing at around twice the rate of the national average, driven by demographic changes as well as urbanisation.[73] It has also been reported that 80% of all tourism is based near oceans.[74]

This proliferation and growth of coastal infrastructure and economic activities benefit economies and societies but also often alter and destroy natural marine habitats and ecosystems. The irony is that coastal vegetation and marine ecosystems (such as mangroves, seagrasses, saltmarshes, as well as corals reefs) provide important ecosystem services such as coastal protection from wind, waves and erosion, as well as flood protection that is increasingly necessary given the impacts of climate change. As discussed earlier in the report, these important marine habitats also have immense carbon storage capabilities. Studies have found that mangroves and reefs provide annual storm and flood protection benefits that exceed $65 billion and $4 billion, respectively. These precious ecosystems are very much under threat and need urgent protection: globally, less than 45% of mangroves, saltmarshes, tropical coral reefs and less than 30% of seagrasses are in Marine Protected Areas.[75]

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[67] UN FAO (2022) The State of World Fisheries and Aquaculture

[68] https://www.un.org/sustainabledevelopment/oceans/

[69] Teh, L. C., Caddell, R., Allison, E. H., Finkbeiner, E. M., Kittinger, J. N., Nakamura, K., & Ota, Y. (2019). The role of human rights in implementing socially responsible seafood. PloS one, 14(1), e0210241.

[70] WWF (2022) Illegal, Unreported and Unregulated Fishing

[71] Steven, A.D.L., Appeaning Addo, K., Llewellyn, G., Vu, T.C. et al. 2020. Coastal Development:

Resilience, Restoration and Infrastructure Requirements. Washington, DC: World Resources Institute.

[72] Blackburn, S., Pelling, M., & Marques, C. (2019). Megacities and the coast: global context and scope for transformation. In Coasts and Estuaries (pp. 661-669). Elsevier.

[73] Steven, A.D.L., Appeaning Addo, K., Llewellyn, G., Vu, T.C. et al. 2020. Coastal Development:

Resilience, Restoration and Infrastructure Requirements. Washington, DC: World Resources Institute.

[74] Honey, M., & Krantz, D. (2007). Global trends in coastal tourism. Center on Ecotourism and Sustainable Development.

[75] Steven, A.D.L., Appeaning Addo, K., Llewellyn, G., Vu, T.C. et al. 2020. Coastal Development:

Pollution

The imagery of a mother albatross unwittingly feeding her chicks plastic gripped audiences of millions in the UK and abroad since the final episode of *Blue Planet II* aired in 2017. Scientists have been warning about plastic waste and pollution for years without much palpable change, but the powerful visuals and storytelling from the incomparable Sir David Attenborough seemed to have had a real impact. We discussed this tipping point in our inaugural Sustainable Tipping Points report. "The Blue Planet Effect" has been credited with raising global awareness of plastic pollution and galvanising action from individuals, governments and businesses around the world. Plastic pollution has increased ten-fold since 1980[76], so tackling it is absolutely critical; we do focus our efforts on this key issue, though it is not the only form of pollution impacting marine environments. We consider five sub-categories: "Noise and light", "Oil spills", "Plastics", "Sewage and other debris", and "Nutrients/Chemicals/Metals". Research has found that 80% of marine pollution comes from land-based sources[77], which means traceability is important and coordinated effects are required to tackle the issue.

Much attention has been given to plastic pollution, which accounts for the majority of marine litter. Most marine plastic comes from land-based sources: studies have found that 70-80% by weight is transported into oceans by rivers or from coastlines, with the other 20-30% coming directly from marine sources such as fishing nets, lines and other equipment.[78] Tourism and other commercial activities on coastal and marine environments also contribute to direct plastic pollution. On land, plastics pollution come from various sources that include inadequate waste and recycling management, littering, sewage, transport, industrial activities, construction and engineering. Recent research has found that just 10 products make up 75% of marine litter with single-use bags, plastic bottles, food containers and food wrappers the most widespread items (see Figure 13).[79] Scientists estimate that 75 to 199 million tonnes of plastic waste is currently circulating in our oceans, with 9-14 million tonnes being added every year.[80]

Resilience, Restoration and Infrastructure Requirements. Washington, DC: World Resources Institute.

[76] Scholes, R. J., Montanarella, L., Brainich, E., Barger, N., Ten Brink, B., Cantele, M., ... & Willemen, L. (2018). IPBES (2018): Summary for policymakers of the assessment report on land degradation and restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

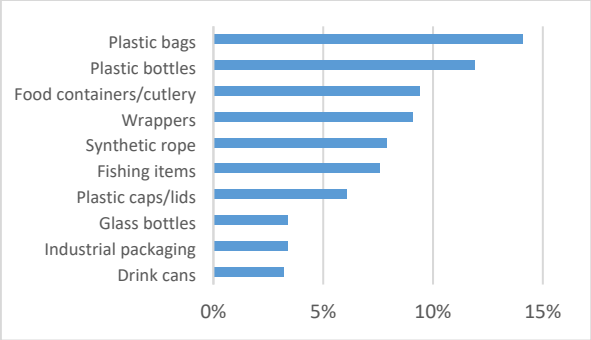
[77] https://www.un.org/sustainabledevelopment/oceans/

[78] Li, W. C., Tse, H. F., & Fok, L. (2016). Plastic waste in the marine environment: A review of sources, occurrence and effects. Science of the Total Environment, 566, 333-349.

[79] Morales-Caselles, C. et al. (2021) Humanity's fast-food habit is filling the ocean with plastic

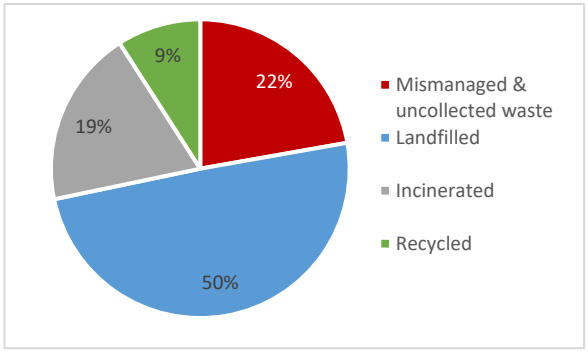
[80] United Nations Environment Programme (2021). From Pollution to Solution: A global assessment of marine litter and plastic pollution. Nairobi.

Figure 13. Breakdown of global ocean litter by product



Source: Morales-Caselles et al. (2021) , Citi Global Insights

Figure 14. Global plastic waste management in 2019



Source: OECD , Citi Global Insights

Current use of plastics is far from circular. There is plenty of room for improvement globally with only 9% of plastic waste being recycled and 22% being mismanaged and leaking into the environment.[81] Plastic waste is growing rapidly, but waste management and recycling efforts are falling short. If we continue business as usual, UNEP estimates that by 2040, volumes of plastic pollution going into marine ecosystems will nearly triple to 23-37 million metric tons per year. The study estimated economic costs of marine plastic pollution to be at least $6-19 billion globally in 2018, which could increase to $100 billion per year by 2040.[82]

Plastics are widely considered the most harmful portion of marine litter to ocean biodiversity and ecosystems and can now be found everywhere in the ocean.[83] These have even been found in the Mariana Trench, which is the deepest point on Earth at more than 10 km below the surface. The main impacts on marine life include physical interactions (such as entanglement, ingestion, and smothering), as well as chemical pollutants that can impact growth and reproduction.[84] It is hard to forget the visual of a dead sea turtle or other marine animal entangled in a fishing net or plastic packaging. Researchers have already found evidence of ingestion and/or entanglement from plastic pollution in *all* marine turtle species.[85] Many of the whales and dolphins that end up beached have been found with stomachs filled with plastic products.[86]

In addition to macroplastics, microplastics (less than 5mm long) can directly leak into oceans via tyre abrasion, textiles, personal care products, wastewater and plastic pellets used in the manufacturing process. Also, once plastic enters oceans, they breakdown to micro and nanoplastics that make recovery and clean-ups near impossible and ingestion by marine life easier. Microplastic can now be found in all

[81] OECD (2022) Global Plastics Outlook: Economic drivers, Environmental impacts and Policy options

[82] United Nations Environment Programme (2021). From Pollution to Solution: A global assessment of marine litter and plastic pollution. Nairobi.

[83] Ibid

[84] Tekman, M. B. , Walther, B. A. , Peter, C. , Gutow, L. and Bergmann, M. (2022): Impacts of plastic pollution in the oceans on marine species, biodiversity and ecosystems, 1–221, WWF Germany, Berlin. Doi: 10.5281/zenodo.5898684

[85] M.B. Tekman, L. Gutow, C. Peter, M. Bergmann, 2021. LITTERBASE: Online Portal for Marine Litter, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, litterbase.org

[86] Kühn, S., Bravo Rebolledo, E. L., & Franeker, J. A. V. (2015). Deleterious effects of litter on marine life. Marine anthropogenic litter, 75-116.

samples collected from the world's oceans, including from the Arctic, as well as in tap water. It has also made it into marine food chains and human diets.

Plastic pollution is also severely impacting precious marine ecosystems such as coral reefs and mangroves. For example, researchers have found that the likelihood of disease increases from 4% to 80% when coral reefs are entangled in plastic.[87] This is on top of the threats from ocean warming and acidification. In summary, plastic pollution is a widespread problem that threatens many aspects of ocean health and has broader social and economic implications – including food safety and security, human health, coastal tourism, as well as livelihoods.

We summarise the other forms of pollution that negatively impact marine environments below.

Figure 15. Other types of pollutants that impact marine environments

	Description	Impact on marine ecosystems
Noise and light	- Underwater and surface noise and light pollution from ship engines, port activity, propellers, seismic blasts, oil drilling, construction, sonar	- Can cause disturbance to animals and birds inhabiting marine ecosystems - Underwater noise is now recognised as a world-wide problem affecting many species (Williams et al. 2015)
Oil spills	- Oil spills can come from drilling rigs, tankers, pipelines, refineries, ships and boats, marinas - Land-based activities can also lead to oil input into oceans incl. land vehicles	- Kills animals by suffocation or poisoning - Can also impact breeding, and food sources - Destruction and degradation of marine and coastal habitats
Sewage and other debris	- Over 80% of urban and industrial wastewater is discharged into the environment without adequate treatment (IPBES, 2019) - 300-400 million tons of industrial waste (incl. heavy metals, solvents, toxic sludge, and other wastes) dumped annually into the world's waters (IUCN, 2020) - Sewage waste may also come directly from vessels i.e. cruise lines, cargo ships, passenger vessels	- Sewage discharge carries pathogens, nutrients, contaminants and other pollutants that could lead to toxic algae blooms, disease and death for marine species - Could in turn affect food supply chains, and human health
Nutrients/ chemicals/ metals	- Nutrient pollutants come primarily from agricultural runoff, but also from urban and industrial wastewater - Chemicals and metals enter the marine environment either directly or from water systems, and come mainly from mines and quarries, manufacturing/industrial operations and wastewater discharge - Chemical pollution can come from plastic, HPC products such as sunscreen, pesticides, antibiotics - Research has found that both chemical pollution and excessive nitrogen and phosphorus pollution have passed the safe operating space of their "planetary boundary" (Persson et al. 2022; Steffen et al. 2015)	- Nutrients pollution leads to an increase in the frequency and severity of algae blooms, which can turn into "dead zones" impacting fisheries and marine ecosystems, as well as result in toxic seafood (Chen et al., 2021) - At least 500 coastal dead zones have been reported, up from fewer than 50 in 1950 (Breitburg et al. 2018) - Chemical and metal pollutants impact coastal habitats such as coral reefs, and can enter marine food chains, and affect human health via seafood consumption

Source: Citi Global Insights

Economic activities are driving most of the pressures on the marine environment. In the following section, we map the three main causes discussed above to industries to help us assess which sectors are "responsible" for what stressors and therefore which might be best placed to tackle the issues.

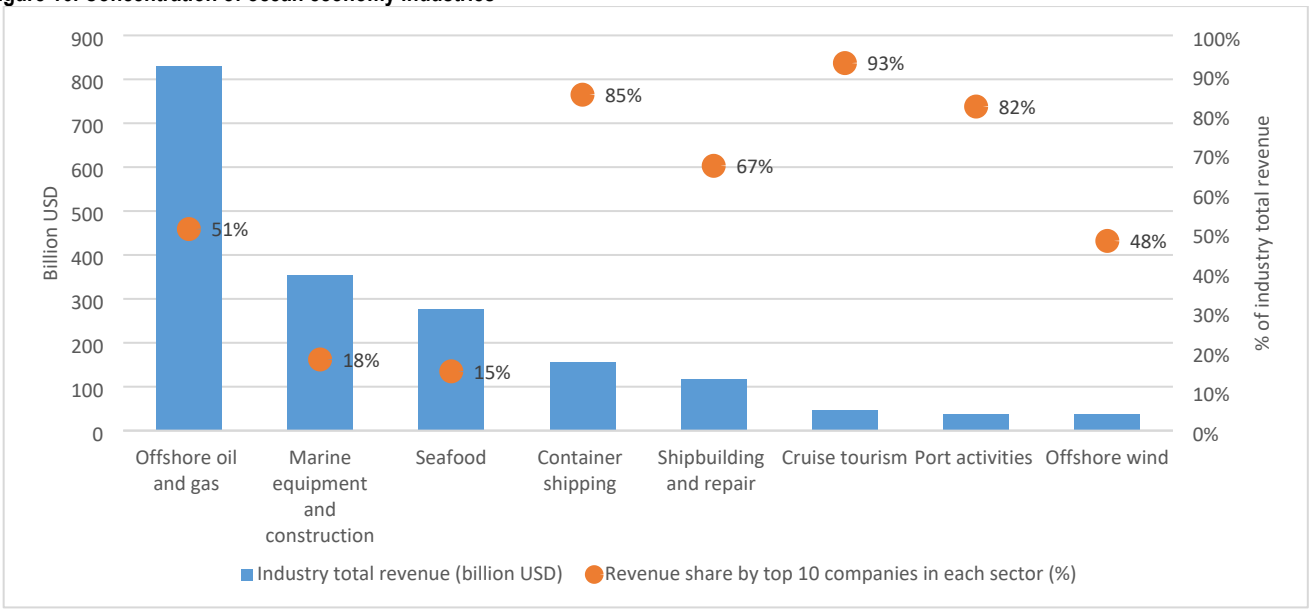
[87] Lamb, J. B., Willis, B. L., Fiorenza, E. A., Couch, C. S., Howard, R., Rader, D. N., True, J. D., Kelly, L. A., Ahmad, A., Jompa, J., Harvell, C. D., 2018. Plastic waste associated with disease on coral reefs. Science 359 (6374), 460–462

How do these causes intersect with industries?

Marine-based industries broadly encompass fishing and aquaculture, marine energy (oil and gas as well as renewables), ports and shipping, coastal tourism, as well as coastal real estate and infrastructure. Together, they contribute substantially to the global economy: estimates on the value of ocean-based economic sectors vary from $1.5 to $6 trillion per year.[88] The international shipping industry is often called the backbone of global trade as it is responsible for the bulk of trade activities, handling more than 80% by volume and ~70% by revenue.[89] Global trends show an acceleration of activity across marine-based industries since 2000.[90]

An analysis by Virdin et al. (2021) found there is high industry concentration amongst ocean-based industries: the 10 largest companies in eight core sectors generate on average 45% of each industry's total revenues; aggregating across all eight industries, the 100 largest corporations account for 60% of total revenues.[91] The sectoral concentration within the blue economy is also noted by other authors: for example, 13 seafood corporations control 40% of the world's largest commercial fisheries.[92] Regional concentration also exists as almost 50% of the shipbuilding market is concentrated in China, and nine of the 10 largest ports worldwide are in Asia.[93]

Figure 16. Concentration of ocean economy industries



Source: Virdin et al. (2021), Citi Global Insights

Two key considerations that most existing studies overlook are 1) pressures/impacts on the marine environment, and 2) land-based industries, which we highlight above

[88] OECD, WWF, UNCTAD

[89] UNCTAD (2019) Review of maritime transport 2019. United Nations publications. Sales, No. E.19 IID.20. New York and Geneva

[90] Jouffray J-B et al. (2021) Blue Acceleration: an ocean of risks and opportunities.

[91] Virdin, J., Vegh, T., Jouffray, J. B., Blasiak, R., Mason, S., Österblom, H., ... & Werner, N. (2021). The Ocean 100: Transnational corporations in the ocean economy. Science advances, 7(3), eabc8041.

[92] Österblom, H., Jouffray, J. B., Folke, C., Crona, B., Troell, M., Merrie, A., & Rockström, J. (2015). Transnational corporations as 'keystone actors' in marine ecosystems. PloS one, 10(5), e0127533.

[93] Statista (2022) Global market share of China's shipbuilding industry 2014-2021; Largest container ports worldwide based on throughput 2021

account for 80% of marine litter. These two aspects matter, in our opinion, as they can help to provide a more holistic view of who is best placed to tackle which issue(s).

In our Citi GPS report Biodiversity: the ecosystem at the heart of business, we stressed that most businesses have a two-way relationship with nature: on the one hand, they depend on the goods and services that it provides; on the other hand, their operations and supply chains may have direct and indirect impacts on biodiversity and natural ecosystems. Fisheries, for example, depend entirely on fish stocks, but operations can lead to over-exploitation, habitat destruction, and pollution. The tourism industry is another example where dependencies and impacts on nature are closely linked – coastal tourism can lead to increased pollution and waste, as well as habitat degradation/destruction, but coastal ecosystems are often key tourist attractions. Both fisheries and coastal tourism depend highly on a healthy ocean, but these activities erode the natural capital that their profitability relies on.

To understand how the main stressors described above intersect with industries, and who might be best placed to "tackle" them, we mapped out the impacts of industries across eight metrics. It is difficult to produce a directly comparable scale metric of impact across the different stressors for different industries given the use of different metrics and availability of data across all industries. We used the ENCORE database[94] and its sector impact materiality mapping which considers a rating system of Low, Medium, High, Very High, as a starting point and supplemented it with industry- and issue- specific deep dives. Further research is still needed to better understand industry impacts on the marine environment, though there is already a rich source of evidence, mostly across academic literature and in siloes by industry and stressor. For this assessment, we have tried to bring together relevant research across industries and issues to gain a more holistic view. More details on the impacts by industry and stressor can be found in the appendix.

Each materiality rating was allocated a number (Low-1, Medium-2, High-3, Very High-4), and these were added to give a total Marine Impact Score to help give a sense of the relative scale of total impact across the industries. We recognise that this is a subjective exercise, but it allows a degree of comparison across industries and marine stressors. There are plenty of studies that have taken deep dives on individual issues, but we think a more holistic approach allows for a better overview of marine-related issues that industries should be tackling, of which there may be several.

Also, it should be noted that location matters when it comes to impact on natural ecosystems, making it even more difficult to quantify industry impact across the stressors. This analysis aims to serve as a primer and guide for corporates, investors and other financial actors, but more detailed assessments are required to assess a company's dependencies and impacts that also takes into consideration supply chain and location.

[94] https://encore.naturalcapital.finance/en

Figure 17. Impact mapping of industries across eight drivers of ocean degradation

	Land/sea use change & over-exploitation		Pollution					Climate change	Marine Impact Score
	Direct exploitation	Land/sea use change	Noise and light	Oil spills	Plastic	Sewage and other debris	Nutrients/ chemicals /metals	GHG emissions	
Marine - Oil and gas	L	VH	VH	VH	M	VH	VH	VH	27
Marine - Commercial fishing	VH	VH	H	H	VH	H	M	M	25
Marine - Coastal tourism	M	VH	H	M	VH	VH	H	M	24
Marine - Shipping	L	H	VH	VH	H	VH	H	M	24
Marine - Port infrastructure & services	L	VH	VH	H	H	VH	H	M	24
Marine - Seabed mining	L	VH	VH	M	M	VH	VH	L	22
Marine - Aquaculture	M	VH	H	L	H	H	VH	L	21
Marine - Renewables	L	H	VH	M	M	M	VH	L	19
Land - Urban development	L	VH	L	L	VH	VH	VH	VH	23
Land - Agriculture & livestock	M	M	L	L	H	H	VH	VH	20
Land - Waste management	L	L	L	L	VH	VH	VH	H	19
Land - Industry/manufacturing - plastics	L	L	L	M	VH	M	VH	H	18
Land - Industry/manufacturing - chemicals	L	L	L	M	VH	M	VH	H	18
Land - Transportation	L	L	L	M	VH	L	M	VH	16
Land - Energy extraction	L	L	L	H	L	L	H	VH	15
Land - Thermal power generation	L	L	L	H	L	L	H	VH	15
Land - Industry/manufacturing - textiles	L	L	L	L	VH	M	M	M	14
Land - Industry/manufacturing - HPC	L	L	L	L	VH	M	M	M	14
Land - Industry/manufacturing - food & drink	L	L	L	L	VH	M	M	M	14
Land - Industry/manufacturing - other	L	L	L	L	H	M	M	M	13
Financial services	H	H	H	H	H	H	H	H	24

Industries that are marine/coastal are direct drivers of biodiversity and ecosystem loss, as well as various forms of pollution. They can also contribute to ocean degradation indirectly via climate change.

Land-based industries are largely impacting oceans via pollution and climate change which are indirectly harming ocean health, biodiversity and ecosystems.

Source: ENCORE, Citi Global Insights

Offshore oil & gas and Commercial fishing top the marine impact score as their activities contribute substantially across all three stressor groups. By value, offshore oil and gas is the largest ocean-based industry accounting for 45% of total revenues in the ocean economy according to the Ocean100 study we mentioned above (Virdin et al., 2021). Seafood production is the third-largest, accounting for 15%. These two industries are also some of the biggest beneficiaries of government support in subsidies. Globally, $35 billion is paid to marine fisheries every year; of this, $22 billion (60%) is considered "harmful" subsidies under WTO definition and lead to overfishing, overcapacity and pollution.[95] The World Bank considers fisheries to be underperforming assets. Studies have found that much of international fishing may only be profitable as a result of large subsides and low labour costs, without which more than half of fishing activity would be unprofitable at current exploitation rates.[96] Financial services score highly given exposure to high-impact industries and their key roles in helping companies transition. Other marine industries – eg, Coastal tourism, Shipping, Port infrastructure & services, Aquaculture, Seabed mining, Offshore renewables – also score highly as they can be direct drivers of biodiversity and ecosystem loss and degradation, as well as direct polluters into marine environments. Many also contribute to climate change through the production of GHG emissions from operations.

However, a spotlight on "ocean-based industries" alone is not enough to tackle ocean degradation, as much of the pollution that ends up in marine environments originates from land-based activities. For land-based sectors, Urban development and Agriculture & livestock scored highly because of their impacts across all three pressure groups, especially pollution and GHG emissions. As we discussed in detail

[95] Sumaila, U. R., Walsh, M., Hoareau, K., Cox, A., Teh, L., Abdallah, P., ... & Zhang, J. (2021). Financing a sustainable ocean economy. Nature communications, 12(1), 1-11.

[96] Sala, E., Mayorga, J., Costello, C., Kroodsma, D., Palomares, M. L., Pauly, D., ... & Zeller, D. (2018). The economics of fishing the high seas. Science advances, 4(6), eaat2504.

in our recent Citi GPS report on Food and Climate Change, Agriculture and food is responsible for almost 1/3 of global GHG emissions, and we cannot get to net zero without tackling food-related GHG emissions. It might be a bit surprising to see Agriculture connected to direct exploitation of marine life, but it has been found that 5% of wild fish catch goes to making feed for livestock.[97] Coastal ecosystems are not only being destroyed for aquaculture, but also for farming for example mangroves have been deforested for rice cultivation and oil palm plantations across South East Asia.[98] With more than 50% of the world's urban population living in coastal areas, the pressures exerted by coastal urban areas on marine environments are intense due to GHG emissions from energy use to plastics pollution and waste.

Waste management is a key sector as mismanagement leads to more pollution reaching marine environments. For example, research has found that more than 80% of sewage is discharged into the environment untreated, and that sewage discharge happens in the waters of at least 104 of 112 major coral reef systems around the world.[99] The waste sector is also a major source of microplastic leakage into the environment. The main source of GHG emissions from the industry comes from landfills that release methane and account for approximately 5% of global GHG emissions.[100]

For Manufacturing industries, tackling plastics pollution is critical. The most obvious sub-industries are Plastic production, Packaged Foods & Drinks and HPC, but Textiles is also a significant polluter, especially microplastic from textiles. For example, it is estimated that 16-35% of microplastics released to oceans globally are from the washing of synthetic textiles,[101] which are forms are plastic and now make up 60% of clothing material globally.[102]

The manufacturing of Chemicals and chemical products and Agriculture lead to substantial nutrient and chemical pollutants entering marine environments. Pesticides and herbicides used in farming also find their way into marine environments through leaching. Industrial chemicals used across manufacturing sub-industries can reach oceans from direct dumping or indirectly through streams and rivers. These chemicals can eventually enter food chains with potentially harmful implications for human health. It has also been found that agricultural practices use 8-10 million tons of plastic every year and contribute to plastic pollution via use of plastic-covered seeds, fertilisers and pesticides, plastic film and mulch, coverage for greenhouses, and wastewater.[103]

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[97] Naylor, R. L., Hardy, R. W., Buschmann, A. H., Bush, S. R., Cao, L., Klinger, D. H., ... & Troell, M. (2021). A 20-year retrospective review of global aquaculture. Nature, 591(7851), 551-563.

[98] Richards, D. R., & Friess, D. A. (2016). Rates and drivers of mangrove deforestation in Southeast Asia, 2000–2012. Proceedings of the National Academy of Sciences, 113(2), 344-349.

[99] Wear, S. L., & Thurber, R. V. (2015). Sewage pollution: mitigation is key for coral reef stewardship. Annals of the New York Academy of Sciences, 1355(1), 15-30.

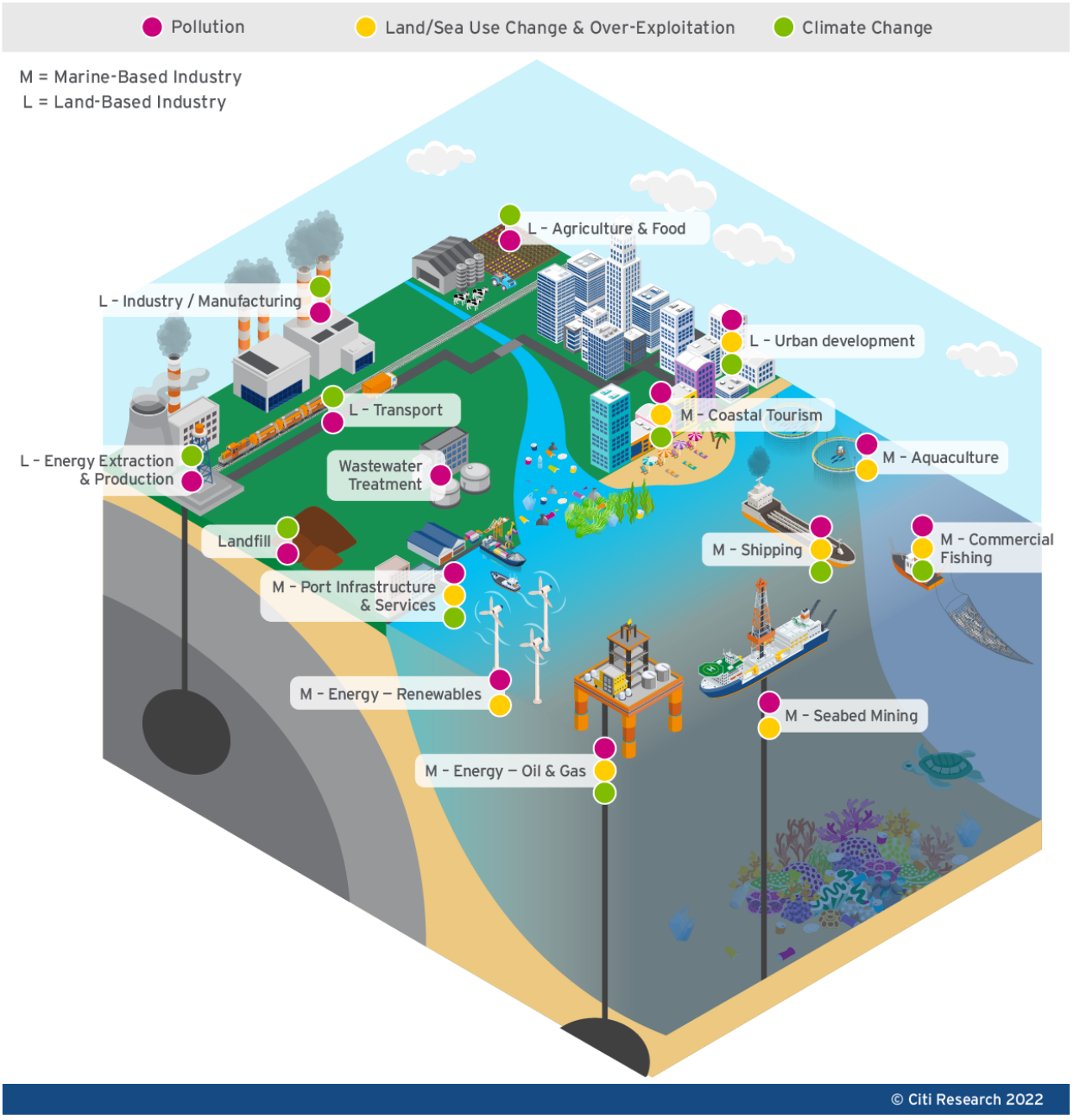
[100] Stocker, T. IPCC, 2013: Technical Summary. In Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change; IPCC: Geneva, Switzerland, 2013; pp. 159–254.

[101] UNEP (2018) Mapping of global plastics value chain and plastics losses to the environment: with a particular focus on marine environment; Boucher, J. and Friot, D. (2017) Primary microplastics in the oceans, International Union for the Conservation of Nature

[102] UNEP (2019) Fashion's tiny hidden secret

[103] UNEP (2022) From pollution to solution – a global assessment of marine litter and plastic pollution

Figure 18. Summary of industry drivers of ocean degradation



Source: Citi Research and Global Insights

The operation of one industry can also impact and/or conflict with another. However, not all interactions are negative as there are also opportunities for industries to collaborate in a positive way. For example, infrastructure used for marine renewables could perhaps be used as substrate for aquaculture farms. The following table provides some examples of relationships across industries.

Figure 19. Examples of relationships across industries

The table should be read left to right, taking the industry on the left-hand side and examining how it affects each of the industries along the top of the matrix

	Commercial fishing	Aquaculture	Oil and gas	Marine Renewables	Coastal tourism	Shipping	Port infrastructure & services	Agri-culture	Industry	Waste management
Commercial fishing		Decline in wild catch and demand in seafood could drive increase in aquaculture activity			Overfishing and habitat destruction can impact tourism that depends on healthy coastal environments for their income Opportunities for sustainable fishing tourism					
Aquaculture	Introduction of invasive species, feed, chemicals, pesticides, antimicrobials, equipment and gear can harm wild species. Some aquaculture also indirectly contribute to decline in wild species because the fishmeal used for feed relies on wild capture fish.				Habitat destruction for aquaculture can impact tourism and reduce natural coastal protection					
Oil and gas	Oil spills and leaks can negatively impact fish stocks	Oil spills and leaks can negatively impact farmed stock			Oil spills and leaks can contaminate /harm ecosystems i.e. coral reefs					
Marine renewables	Marine renewables could infringe on fishing grounds	New offshore wind farms could provide substrate for aquaculture farms				Installation of offshore renewables may disrupt shipping routes	Clean marine energy could support low carbon ports			
Coastal tourism	Seafood sourcing policies could impact fishing practices					Cruising governed by many of the same regulations as shipping				
Shipping	Shipping may disrupt fishing grounds (e.g. noise, emissions, waste discharge, invasive species, stranding, oil spills)			Shipping routes may impede installation of offshore renewables	Coastal environments may be negatively impacted by vessels (e.g. waste, emissions, noise, oil spills, stranding)					
Port infrastructure & services	Ports serve all other marine-based sectors – for example, shipping and fishing vessels depend on port infrastructure and services to load and unload cargo, equipment, catch, and passengers. For fishing and aquaculture, cold storage facilities are often located in or around ports.							Ports also serve land-based sectors indirectly through trade of products		
Agriculture	Agricultural run-offs can harm seafood populations (e.g. algal blooms caused by nutrient run-off)	Agricultural runoff can harm seafood farms								
Industry	Industrial run-offs can harm seafood populations (e.g chemicals, nutrients, waste)	Industrial run-offs can harm seafood harms (e.g chemicals, nutrients, waste)								
Waste management	Poor waste management could negatively impact fish populations	Poor waste management could negatively impact fish populations			Poor waste management could negatively impact coastal environments					

Source: UNEP FI, WWF, IUCN, Citi Global Insights

The mapping across industries and stressors allows us to take a more holistic view of all the different ways industries could be contributing to declining ocean health as well as how they impact each other. While most literature tends to focus on key issues for certain sectors to address (eg, biodiversity loss due to overfishing or plastics pollution from single-use plastics) We think a more integrated approach can allow for smarter, more effective action from stakeholders and help to maximise impact.

Such an approach can also help companies identify synergies across key issues that are on/rising up the business agenda – climate change, nature loss and pollution. For example, land-based industries taking action on climate change and reducing their environmental impact on land (such as regenerative farming practices in the agriculture sector) are also contributing to a more sustainable ocean economy as result of climate action and reduced use of fertilisers, pesticides and other chemicals. Industries that take action to address climate change are also helping to reduce the climate stressors on marine ecosystems. However, there is a risk that this could lead to greenwashing, which we are certainly not encouraging. corporates and investors will be increasingly pressured to address multiple environmental threats, there is an opportunity to embrace the inter-dependencies to assess risk and identify potential win-win solutions.

Risk and opportunities for businesses and financial institutions

As we have stated clearly, companies have a societal and environmental imperative to take action on ocean issues. However, there is also a business case as climate and nature-related risks are increasingly becoming business risks. If we continue down a business-as-usual trajectory, WWF report a potential value at risk of up to $8.4 trillion over the next 15 years due to declining ocean health and climate change. The table below provides some examples of nature-related business risks for marine-based industries and some key land-based industries.

Figure 20. Examples of ocean-related risks for marine-based industries

	Physical/ operational risks	Market risks	Regulatory risks	Reputational/liability risks
Commercial fishing	- Unsustainable and IUU fishing practices are eroding the very natural capital on which the industry depends – putting production and supply chains at risk - Operations are exposed to extreme weather events driven by climate change - Loss of coastal habitats such as mangroves and coral reefs can impact fish stock as they are home to a large share of commercial fisheries - Seafood waste along the supply chain leads to economic losses	- Buyers are starting to demand higher levels of traceability and certification around environmental and social concerns - Markets are increasingly wanting seafood to be sourced sustainably, and destructive fishing practices are unlikely to meet market-leading standards - Seafood companies will have to address emissions in production and supply chains as markets demand scope 3 disclosure and targets	- Regulations being introduced in key seafood markets including US, EU and Japan to combat IUU fishing. Companies in the UK and EU have legal obligations to ensure they are not supporting IUU fishing - Regulation measures could be introduced to tackle overfishing, bycatch, destructive fishing practices and abandoned gear, companies who don't comply could face fines, penalties and moratoria.	- Industry and companies reputation could be impacted by: 1) IUU fishing and associated human rights issues and environmental impact, 2) Destructive fishing practices that lead to habitat destruction and pollution, 3) Social and labour abuses and violations, 4) Marginalisation of small-scale fishers
Aquaculture	- Destruction of coastal habitats such as mangroves and seagrasses for site location can lead to increased risk of storms and flooding to farms - Lost harvest due to escaped fish and spread of disease can lead to significant economic losses - Disease prevention and control is a major problem and can be costly - Seafood waste along the supply chain leads to economic losses	- Growing awareness about connection between seafood production and habitat destruction. Market actors under growing pressure to tackle deforestation along supply chains and introducing measures such as certifications - Importing markets with high food standards may reject farmed fish which are more exposed to chemicals, pesticides, antimicrobials	- Increasing regulation on use of chemicals, pesticides and feed, companies who don't comply face growing risk of fines and penalties - Regulation and policy on location and siting could impact operations	- Reputation of the industry and companies could be negatively impacted by: 1) Eutrophication and contamination caused by farming practices, 2) Escape events, 3) Spread of disease and impact on wild species, 4) Deforestation linked to soy production for fish feed, 5) Killing of wild predators
Port infrastructure & services	- Operations are exposed to sea level rise, extreme weather events driven by climate change - Increased risk of infrastructure damage	- Risk of customers who avoid ports with poor environmental records - Risk of accidents that cause environmental damage	- Regulatory risks from violation of environmental codes during construction and operation i.e. fines for damaging coastal ecosystems, release of air/water pollutants, oil spills - Regulation and policy on siting could impact location of ports	- Reputation of the industry and companies could be negatively impacted by: 1) Habitat destruction and ecosystem damage caused by operations and accidents, 2) Disturbance to local communities from pollution
Shipping	- Operations are exposed to sea level rise, extreme weather events caused by climate change - Increased risk of vessel and cargo damage, and passenger injury due to stormier seas - Increased risk of re-routing - Increased risk of vessel damage due to marine pollution i.e. fishing gear stuck in propellers	- Shipping routes and activities could impede on other marine activities that result to fines to vessels and companies	- Heavily regulated by IMO - Regulation measures on emissions and other pollutants pose a risk to vessels and companies who don't comply - Conservation measures pose a risk to vessels and companies that cause disruption and destruction of marine habitats and life	- Reputation of the industry and companies could be negatively impacted by: 1) Growing awareness around oil spills, plastic pollution, ballast water, waste, hull coatings, and heavy fuel oil emissions, 2) Habitat destruction caused by operations
Marine renewables	- Operations are exposed to extreme weather events caused by climate change - Increased risk of equipment damage and lower productivity	- Public opinion on the potential disruption of offshore renewables on biodiversity could impact attractiveness in the market	- Conservation measures could pose a risk to 1) location and siting of offshore renewables, 2) Operations e.g. restrictions during migratory periods for birds	- Reputation of the industry and companies could be negatively impacted by: 1) Siting of renewables in/near areas of high biodiversity, 2) Potential disruption to marine life, 3) User conflict with fisheries
Coastal tourism	- Siting and operations exposed to sea level rise, flooding and extreme weather events caused by climate change - Ocean warming and acidification pose a risk to coastal habitats such as coral reefs which attracts tourism	- Growing consumer awareness around sustainable seafood and plastic pollution could impact the attractiveness of a provider if they are not taking action	- Regulatory risks apply to potential habitat damage caused by coastal developments and activities - Growing measures on waste and pollution such as plastics pose a risk to companies if they don't comply	- Reputation of the industry and companies could be negatively impacted by: 1) Destruction of marine habitats, 2) Pollution and waste 3) Accidents

Source: UNEP FI, The Minderoo Foundation, TNFD, Citi Global Insights

Figure 21. Examples of ocean-related risks for land-based industries

	Physical/ operational risks	Market risks	Regulatory risks	Reputational/liability risks
Agriculture	- Increased risk of resource scarcity i.e. water, fertile land - Increased risk of lower crop production and livestock productivity as a result of extreme weather events and conditions - Increased risk of new pests and disease - Increased risk of disruption to supply chains	- Markets are demanding increased supply of certified products i.e. deforestation and conversion free	- Growing regulatory measures tackling commodity driven deforestation and other habitat conversions - Increasing regulation on use of chemicals, pesticides, companies who don't comply face growing risk of fines and penalties - The Global Post 2020 Biodiversity Framework has proposed a global target of reducing pesticide use by 2/3 by 2030	- Reputation of the industry and companies could be negatively impacted by: 1) Deforestation linked to agricultural commodity 2) Disruption/harm to wildlife caused by operations
Industry/ manufacturing	- Operations are exposed to extreme weather events caused by climate change - Increased risk of infrastructure damage - Increased risk of resource scarcity i.e. water - Increased risk of disruption to supply chain	- Growing consumer awareness around plastic pollution and other pollutants could impact the attractiveness of a product	- Tightening and increasing measures on waste and pollution poses a risk to companies who don't comply - Growing number of countries banning single use plastics - Negotiations have started on a legally binding global agreement on plastic pollution which is expected to be agreed by 2024	- Reputation of the industry and companies could be negatively impacted by: 1) Branded/unbranded plastic pollution and marine debris 2) Harm to marine life caused by product - Research has found that corporate liabilities related to plastic pollution could reach $20 billion per year in the US alone by 2030, with chemical additive manufacturers and polymer manufacturers most at risk
Waste management	- Operations are exposed to extreme weather events caused by climate change - Increased risk to waste infrastructure	- GHG emissions from the waste sector could become a material issue for waste management companies	- Tightening and increasing measures on waste and pollution poses a risk to companies who don't comply - Regulatory risks could potentially apply to emissions from the waste sector	- Growing public awareness and campaigns on marine plastics and other pollutants likely to shine a spotlight on all stakeholders

Source: TNFD, UNEP, Citi Global Insights

Companies that don't take action could be increasingly exposed to these risks, which could decrease company value and increase their cost of capital as a result of negative impacts or dependencies on climate and the marine environment. We also highlighted in the Biodiversity Citi GPS report that there is a growing consensus that materiality is double, and it is not just sustainability-related impacts on the company that can be financially material, but also the impacts of their business activity on the environment, economy and society. This very much applies to the marine and coastal environments: in 2021, UNEP FI released a report on recommended exclusions for sustainable blue economy financing. The following table provides an example for each industry the report covers and illustrates how a company's access and cost of capital could be affected if they don't tackle ocean-related issues.

Figure 22. Examples of recommended exclusions for sustainable blue economy financing from UNEP FI

Industry	Criterion	Scenario	Recommendation
Seafood	Location and siting of farms	Evidence that owned and operated farms or farms in supply chain are not located in a legally designated aquaculture zone or do not have the required legal permit or licence, including within legally protected areas that do not allow multiple uses, such as High Conservation Value Areas or RAMSAR or UNESCO World Heritage Sites	Do not finance
Ports	Protecting marine life and ecosystems from pollution and destruction	Loss of critical IUCN red-listed habitats and species in the development and implementation of the port.	Do not finance. Require Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) transparency and verification.
Maritime transportation	Water pollution: from waste, fuel waste, ballast water, noise	Improper waste disposal—including garbage, chemicals, sewage and fuel waste — has a quantifiable significant impact on marine life.	Do not finance companies that are not in compliance with IMO and Marpol regulations relating to waste disposal at sea, or that are disposing of toxic and quantifiably high levels of any waste into the sea.
Marine renewable energy	Planning new developments and project lifecycle	Siting of wind farms in protected areas for birds, bats, fish and marine mammals negatively impacted by wind farm construction, operation and decommissioning, including resultant bird strikes. This is particularly urgent in the context of multiple wind farm developments and the potential for cumulative impacts.	Do not finance wind farms designated for development in areas of high ecological value, high biodiversity and critical habitat for Endangered, Threatened and Protected Species (ETP) species
Coastal and marine tourism	Physical impact on habitat	Destination development within protected areas, critical habitat for ETP species, or areas providing vital ecosystem services such as coastal flood defence.	Do not finance any development within IUCN Type I protected areas, critical habitat, or areas providing vital ecosystem services.
Infrastructure	Infrastructure planning and location	Evidence of planned construction of grey infrastructure in protected areas or areas of high conservation value by project developer.	Do not finance grey infrastructure in protected areas or areas of high conservation value due to associated biodiversity losses.
Waste management	Waste disposal	Lack of due consideration for locating disposal sites where there is a high risk of negative environmental or social impacts arising from leaked waste.	Do not finance or insure disposal facilities that pose a high risk of negative environmental or social impacts

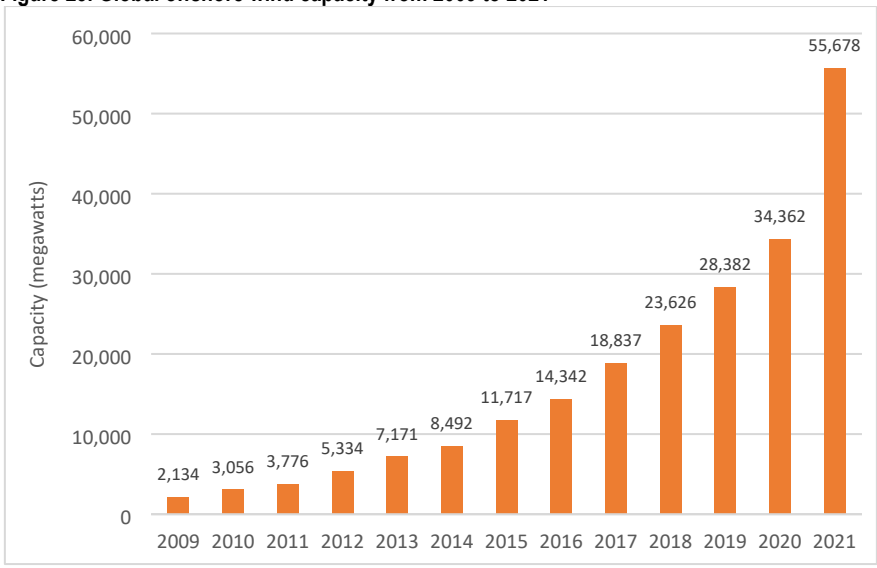
Source: UNEP FI, Citi Global Insights

Also, just as companies are now being increasingly held to account for their scope 3 (supply chain) emissions, we could see that expand to include other environmental impacts, which means land-based industries should be considering the impact of their supply chains on marine environments. For example, who is responsible for the plastics pollution that ends up in the ocean – it is the petrochemicals industry, plastics manufacturers, consumer goods companies, retail companies, waste management, or all the above? Well, if we apply the same logic of scope 3 emissions, then it would be all players involved in the supply chain.

However, it is not all about risk as there are also plenty of opportunities in the ocean economy. Earlier we mentioned the growing interest and activity in marine environments for food, resources and space, which has been called the "Blue acceleration". Balancing ocean sustainability and this growth in ocean activity is an important and pressing challenge. Some emerging industries are related to solutions for climate change, for example offshore renewables, carbon storage and seabed mining. Offshore wind capacity has been growing steadily over the past decade from 3 GW in 2010 to 34 GW in 2020. IRENA predicts massive growth in the coming

decades: its 1.5C scenario foresees offshore wind reaching 380 GW by 2030 and more than 2,000 GW by 2050.[104]

Figure 23. Global offshore wind capacity from 2009 to 2021



Source: Statista, Citi Global Insights

Other emerging ocean energy technologies include floating solar PV as well as tidal, ocean wave, thermal and salinity gradient technologies. However, clean ocean energy technologies could lead to unintended consequences for marine environments, and it is vital that project-specific assessments are carried out to understand the potential implications of the development location and operations on marine ecosystems.

According to the IPCC and IEA, it is virtually impossible to reach net zero without Carbon Capture Utilisation and Storage (CCUS). One way CCUS can be used is to store captured CO_2 underground, which could be deep saline formations, unmineable coal beds or depleted oil and gas fields. Research has found that refitting oil and gas rigs to store CO_2 could be 10 times cheaper than decommissioning the platforms.[105] Norway is a leader in the CCS space and has geologically stored more than 20 $MtCO_2$ in the past 20 years. Its government launched a full-scale CCS project in 2020 called "Longship" that includes capture, transport and storage beneath the seabed, with the hope that it can catalyse wider development of CCS in Europe. For a deep dive into CCUS, please see our tipping points note "Capturing the problem: CCUS – the next big thing?" Research is ongoing to better understand the potential impacts of CO_2 storage on marine life and ecosystems. Since potential harm could come from operations and/or potential leaks, the long-term monitoring of CO_2 reservoirs will be important. Nature-based solutions are also being explored to capture and store CO_2: for example, mass seaweed cultivation has the potential to absorb substantial

[104] IRENA (2021), Offshore renewables: An action agenda for deployment, International Renewable Energy Agency, Abu Dhabi.

[105] Scafidi, J., & Gilfillan, S. M. (2019). Offsetting Carbon Capture and Storage costs with methane and geothermal energy production through reuse of a depleted hydrocarbon field coupled with a saline aquifer. International Journal of Greenhouse Gas Control, 90, 102788.

amounts of CO_2, improve water quality by removing harmful nutrients, as well as provide a sustainable source of food, feed, energy and raw material.

Another climate-related emerging sector that is proving more controversial is deep sea mining. Growing interest and activity come largely from increasing demand for the rare metals used for building batteries that can be found in the deep sea such as cobalt, manganese, copper and nickel. The recent UN Ocean conference saw many calls to end deep sea mining, including from French President Emmanuel Macron who called for a legal framework to stop deep sea mining. At the time of writing, the International Seabed Authority (ISA) is developing regulations and rules for the exploitation of mineral resources in the deep sea, and the activity is not currently permitted. The ISA has, however, granted exploration licenses to 22 mining companies as of September 2022.[106]

The emerging field of marine biotechnology is gathering attention and interest as unexplored marine environments offer undiscovered sources of biomolecules and biomass. Potential use cases are diverse and include food and feed, energy, agronomy, cosmeceuticals, bio-inspired materials, healthcare and wellbeing as well as climate change and bioremediation.[107] However, industry development faces two key barriers – lack of investment and a need for human capital and infrastructure.[108] Another sector worth highlighting is desalination: after starting in the 1960s, the average year-on-year growth in global desalination capacity since 2000 has been about 7.5% and reached about 115Mm3/d.[109] The use of desalination is very location specific, with the majority of plants located in the MENA region. However, water scarcity is a growing issue globally due to population and economic growth coupled with declining water supplies as a result of climate change. Conventional desalination processes are also expensive, energy-intensive, and produce substantial wastewater that pollutes marine environments. Opportunities exist to deliver more affordable and sustainable desalination solutions; renewable desalination technologies such as solar thermal systems are currently being developed with potential applications for both low-income and high-income countries.

Technological advancements are enabling many of the emerging sectors we discussed above and is developing into an industry on its own. A seminal paper by the OECD in 2016 reported the ocean economy could more than double its contribution to global value added by 2030, and it listed “Hi-tech marine products and services” as an emerging sector. It is truly an exciting time for ocean data – satellites, underwater drones, floating sensors, wave gliders and other technologies are helping better and faster data collection, as well as derive insights that can be leveraged to support a more sustainable ocean economy. We highlight some key application areas below.

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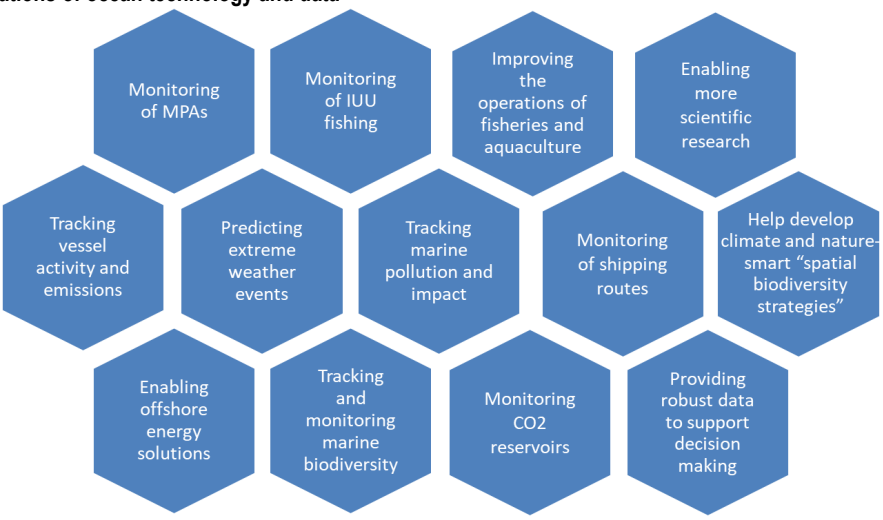
[106] https://isa.org.jm/exploration-contracts

[107] Rotter, A., Barbier, M., Bertoni, F., Bones, A. M., Cancela, M. L., Carlsson, J., ... & Vasquez, M. I. (2021). The essentials of marine biotechnology. Frontiers in Marine Science, 158.

[108] ibid

[109] Dhakal, N., Salinas-Rodriguez, S. G., Hamdani, J., Abushaban, A., Sawalha, H., Schippers, J. C., & Kennedy, M. D. (2022). Is Desalination a Solution to Freshwater Scarcity in Developing Countries? Membranes, 12(4), 381.

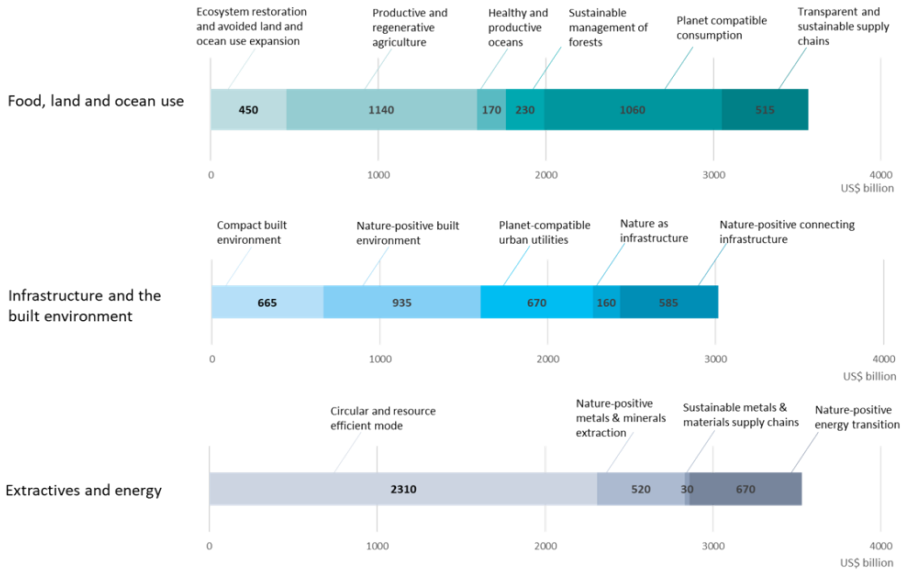
Figure 24. Potential applications of ocean technology and data



Source: Citi Global Insights

There are also plenty of business opportunities for companies that take action on ocean health decline and explore new and sustainable uses of ocean resources. According to WEF, nature-positive solutions can create $10 trillion in business opportunities and 395 million new jobs by 2030. These opportunities – which span across Food, land and ocean use; Infrastructure and the built environment; and Extractives and energy – can help to improve ocean health. For example, scaling circular and resource efficient models for materials will reduce pollutants that end up in marine environments, while nature-positive built environments and utilities can help to reduce emissions, pollution and waste. Planet-compatible consumption is important to reduce pressure on marine resources and the global food system's impact on the planet, especially given the need to sustainably feed a growing population.

Figure 25. Nature-positive business opportunities



Source: WEF, Citi GPS

Even if we only consider the opportunities that relate directly to oceans shown in Figure 25 – healthy and productive oceans, ecosystem restoration and avoided land and ocean use expansion – they add up to a substantial $620 billion. Opportunities include conservation and restoration of marine ecosystems, sustainable management of wild fisheries, and sustainable marine aquaculture (e.g. unfed species such as seaweed and bivalves that do not depend on wild catch for nutrition). It is also an opportunity for businesses to innovate towards ocean-friendly products, services and business models. Restoration and commercial opportunities can also go hand-in hand – for example, the restoration of mangroves alongside integrated aquaculture in Vietnam led to improved farming yields and income rises between 200% and 800%.[110] [111] Let's also not forget mangrove forests play a vital role in climate change mitigation and adaptation.

Overall studies have found that ocean-based climate solutions can deliver up to 1/5 of annual GHG emission reductions needed by 2050 to limit global warming to 1.5°C, as well as deliver trillions of dollars in global benefits.[112] Key action areas include: 1) ocean-based renewable energy; 2) decarbonising international shipping; 3) sustainable fisheries and aquaculture; 4) restoring and conserving coastal and marine ecosystems; and 5) carbon storage in seabed.

In the figure below, we highlight a set of key business opportunities along with the co-benefits that they can deliver.

[110] Browder, G., Ozment, S., Rehberger Bescos, I., Gartner, T., & Lange, G. M. (2019). Integrating green and gray. Washington, DC: World Bank and World Resources Institute.

[111] WEF (2020) The Future of Nature and Business

[112] Konar, M. and H. Ding. (2020) A Sustainable Ocean Economy for 2050: Approximating its Benefits and Costs. Washington, DC: World Resources Institute

Figure 26. Selected commercial opportunities and their co-benefits

	Climate change	Nature loss	Pollution	Food insecurity	Examples
Zero carbon shipping	✓		✓		- Zero/low carbon technologies and alternative fuels e.g. electric engines, biofuels, ammonia and methanol - Improvements in fleet management and voyage plans, ship design and full and propulsion efficiency - Ocean friendly modifications e.g. ballast water treatment, bilge water treatment, retrofits that reduce noise pollution
Offshore renewables	✓				- Offshore wind, floating solar PV, ocean wave, thermal and salinity gradient technologies - Need to ensure installation and operation do not harm marine ecosystems - Can consider integrated sea use with aquaculture, infrastructure could help serve as artificial reefs
Conservation and restoration of coastal habitats i.e. mangroves	✓	✓		✓	- Development of innovative ecosystem insurance products - Technology solutions that can help measure, track, report and protect protected areas and areas of high biodiversity - Innovations in restoration techniques e.g. artificial habitat structures, coral reef implantation
Sustainable fisheries & aquaculture	✓	✓	✓	✓	- Sustainable land-based aquaculture of high-value products e.g. crustaceans, sea urchin - Sustainable production of kelp and other seaweed can produce food, feed, raw materials for pharmaceuticals and other products as well as absorb CO2 and improve water quality - Innovations that help improve cold chain and storage of seafood to reduce waste - Technologies that improve traceability and transparency of seafood value chains - Improvements and innovations in fishing vessels, equipment and gear, as well as aquaculture equipment and gear that reduces impact on marine life and ecosystems - Cellular aquaculture
Alternatives to plastic	✓	✓	✓		- For example – bioplastics, eco-friendly natural alternatives for packaging, textiles, building materials, plastic free packaging, reusable products, plastic-free fishing equipment and gear
Innovations in eco-friendly HPC products		✓	✓		- For example - microbead free products, non-plastic packaging and plastic free products, biodegradable and phosphate-free soaps, shampoos, detergents, cleansers
Innovations in waste management	✓	✓	✓	✓	- Innovations that improve the recycling of plastics and its re-use in a more circular approach - Drainage systems that prevent plastics and other waste and pollutants from entering aquatic environments - Innovations that help to clean up and remove marine pollution - Innovations that improve the effectiveness and efficiency of wastewater treatment plants
Regenerative agriculture and Agtech	✓	✓	✓	✓	- Faming practices that restore soil biodiversity and enhance ecosystem function - Innovations that can make farming more efficient, use less resources and reduce emissions e.g. digital ag, automation, food waste tech, alternative protein, animal agtech, supply chain tech, indoor farming
Sustainable blue infrastructure	✓	✓	✓		- Integration of nature-based solutions (NBS) into coastal planning and development that supports coastal habitats such as mangroves, coral reefs, seagrasses which offer coastal protection, tourist attractions, carbon sequestration, income opportunities - Co-design of coastal industries e.g. offshore renewables and fisheries/aquaculture; fisheries and ecotourism; renewables and waste management - Smart design and planning that prevents/limits waste and pollution from entering marine environments
Ecotourism		✓	✓		- Sustainable ecotourism activities, business models, ventures, that can create opportunities or incentives for reduced biodiversity and ecosystem threat, and enhanced coastal/marine protection
Ocean tech and data products & services	✓	✓	✓		- Use of innovative technologies (i.e. satellite imaging, AI, blockchain, drones, underwater vehicles, sensors, big data) to support research, business and governance - Technology that enables and supports the identification, monitoring and verification of business and marine environment impacts

Source: Citi Global Insights

As we discussed earlier, very little sustainable private investment flows go to the ocean. We believe there are opportunities for increased engagement and capital on two fronts. 1) financing the protection and remediation of coastal and marine environments; and 2) by understanding industrial impacts on the ocean, targeting the root causes of ocean degradation offers potentially greater opportunities for private capital given material levels of financial interaction with corporates within these industries and an existing presence on international financial markets.

As we highlighted in our Citi GPS UN Sustainable Development Goals report, the challenge is not a lack of capital, but rather trillions of dollars of capital aimed at sustainable investment yet frustrated by the lack of appropriate investment and financing vehicles. In particular, the marine environment faces multiple roadblocks that preventing the flow of capital towards a sustainable ocean economy. However, innovative financial instruments and partnerships supported by enabling frameworks and robust data can help to unleash waves of sustainable ocean finance. Also, the connections of SDG 14 across the 17 goals mean that ocean financing impacts other global goals as well. A recent white paper on SDG 14 Financing from WEF reported

that because of the inter-dependencies, "deficits in SDG 14 funding jeopardise the realisation of the entire 2030 Agenda".[113]

This is an opportunity for the finance community to innovate, develop and scale investable finance and insurance products, which could include blue bonds, debt swaps, blue carbon credits, blended finance structures. Public private partnerships will be key to mobilise more private capital: public or philanthropic funding that does not seek market-rate returns can help to de-risk or enhance returns, as well as catalyse private investment into sustainable ocean economy projects that are often novel, untested and, thus, perceived to be high-risk. We include a few case studies below of innovative financial approaches that are being used to support sustainable ocean economy projects.

Case study 1 – Belize nature debt swap

In 2021, Belize signed a debt-for-nature swap with The Nature Conservancy – a $364 million debt conversion for ocean conservation that reduced the country's external debt by 12% of GDP, creating long-term sustainable financing for ocean protection as well as locking in a commitment to protect 30% of Belize's ocean. Belize was able to repurchase a $553 million "superbond" – the government's entire stock of external commercial debt (equivalent to 30% of GDP) – at a 45% discount and agree to spend $4.2 million a year on marine conservation until 2041.[114] The transaction was recognised at the 2022 Environmental Finance Awards, winning Sustainability bond of the year – Sovereign, as well as an award for sustainability bond structure innovation. According to The Nature Conservancy, this is the world's largest debt refinancing for ocean conservation to date.[115] We believe there is a growing potential for more debt-for-nature swaps that offer a potential win-win financing structure.

Case study 2 – Blended Finance – $132 million Althelia Sustainable Ocean Fund

Mirova's Sustainable Ocean Fund is an impact fund that invests predominantly in emerging markets and in three key areas – Sustainable seafood, Circular Economy, and Marine Conversation. The fund reached its final close in May 2020 securing $132 million of public and private investor commitments, exceeding its target. It invests in "initiatives that harness the ocean's natural capital and aims to build resilience in coastal ecosystems and create sustainable economic growth and livelihoods in the blue economy".[116] The fund has a blended finance structure and a $50 million Development Credit Authority facility with USAID that guarantees up to 50% of the principal on eligible loans that the fund extends. The fund's private equity investors include DFIs and institutional investors who benefit from this protection.[117]

Encouragingly, Convergence, the global network for blended finance, reports increasing momentum in the market for blended finance transactions that support ocean action.[118]

Whilst it's not directly related to the ocean, the World Bank Wildlife Conservation Bond has a structure that can be applied to ocean conservation. In March 2022, the

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[113] World Economic Forum and Friends of Ocean Action (2022) SDG14 Financing Landscape Scan: Tracking Funds to Realize Sustainable Outcomes for the Ocean

[114] The Nature Conservancy (2022) Case Study: Belize Debt Conversion for Marine Conservation

[115] ibid

[116] Mirova (2021) Althelia Sustainable Ocean Fund Impact Report 2021

[117] Green Finance Institute (2021) Case studies – Althelia Sustainable Ocean Fund

[118] Economist Impact (2020) Can blended finance stimulate a sustainable ocean economy?

World Bank issued the inaugural Wildlife Conservation Bond, also known as the “Rhino bond”, which was a first-of-its-kind, outcome-based instrument that mobilised private investments to contribute to protecting and increasing the black rhino population in two wildlife parks. It is a five-year $150 million Sustainable Development Bond that will not make coupon payments to investors, but the issuer will make payments to finance conservation activities. If successful, as measured by Conservation Alpha and Zoological Society of London, investors will receive a success payment at maturity, funded by a grant from the Global Environment Facility (GEF). This new approach in conservation financing – which mobilises investment capital wanting to support nature conservation and restoration – could also be applied to the marine environment (e.g. in support of mangrove and coral reef restoration).

In summary, we don’t think ocean issues should be ignored or viewed in isolation by businesses and financial institutions. They are intrinsically connected to other key environmental issues – climate change, biodiversity loss and pollution. Ocean issues are also relevant not just to marine-based industries but to most land-based industries as well, which contribute to ocean degradation through one or more key stressor. We encourage businesses and financial actors to apply an “ocean lens” across strategies, goals and actions, thereby managing climate, nature and ocean issues and risks more holistically. As well, this can incentivize more effective action and capture increased market opportunities.

Regulation, policies and initiatives

Corporate and investor actions on climate change and terrestrial-based nature loss are gathering pace, much of which has been catalysed by regulation. Several marine-based industries have been regulated for many years – for example by conventions administered by the International Maritime Organisation (IMO). However, the growing awareness of sustainability and the rise of ESG are driving a host of sustainability-related disclosure regulations and initiatives on a broader level. There are several initiatives in place or on the horizon that will require corporates and the finance community to assess, reduce, and likely report on their marine environment impacts and dependencies as well as associated risks. As we have shown above, the ocean lies at the centre of several key issues that businesses and finance actors will be expected to address in the coming years – climate change, nature loss and pollution – and we also expect increased targeted action for the marine environment as awareness and evidence grows. In this section, we highlight key regulations, policies, and initiatives for corporates and investors that are in place or expected to mature in the next few years.

1. UN Global Compact Sustainable Ocean Principles

More than 150 companies have now signed onto the UN Global Compact Sustainable Ocean Principles, which received a boost at this year's UN Ocean Conference. According to the UN Global Compact, signatories now cover 30 industries, 35 countries and six continents, with a combined market capitalisation of 1 trillion euros.[119] Companies that have signed up commit to assessing their impact on the ocean and to build ocean sustainability into their strategy. Signatories include shipping giants that account for approximately 50% of global market share, as well as leaders in the renewables and seafood industry. The nine Sustainable Ocean principles build on the UN Global Compact's 10 principles regarding human rights, labour, environment and anti-corruption and provides a framework for responsible business practices across ocean sectors and geographies.

Figure 27. UN Global Compact Sustainable Ocean Principles

Ocean heath and productivity	Governance and engagement	Data and transparency
Principle 1: Assess the short- and long-term impacts of their activities on ocean health and incorporate such impacts into their strategy and policies.	**Principle 5**: Engage responsibly with relevant regulatory or enforcement bodies on ocean-related laws, regulations and other frameworks.	**Principle 8**: Where appropriate, share relevant scientific data to support research on and mapping of relevance to the ocean.
Principle 2: Consider sustainable business opportunities that promote or contribute to restoring, protecting or maintaining ocean health and productivity and livelihoods dependent on the ocean.	**Principle 6**: Follow and support the development of standards and best practices that are recognized in the relevant sector or market contributing to a healthy and productive ocean and secure livelihoods	**Principle 9**: Be transparent about their ocean-related activities, impacts and dependencies in line with relevant reporting frameworks.
Principle 3: Take action to prevent pollution affecting the ocean, reduce greenhouse gas emissions in their operations to prevent ocean warming and acidification, and work towards a circular economy.	**Principle 7**: Respect human, labour, and indigenous peoples' rights in the company's ocean-related activities, including exercise appropriate due diligence in their supply chain, consult and engage with relevant stakeholders and communities in a timely, transparent and inclusive manner, and address identified impacts.	
Principle 4: Plan and manage their use of and impact on marine resources and space in a manner that ensures long-term sustainability and take precautionary measures where their activities may impact vulnerable marine and coastal areas and the communities that are dependent upon them.		

Source: UN Global Compact

[119] https://www.globalcompactusa.org/news/more-than-150-companies-take-principled-stand-at-un-ocean-conference

2. Blue finance initiatives

UN SDG 14: Life Below Water is underfunded and has one of the lowest, if not the lowest, levels of financial investment flows out of the 17 global goals. More financing is needed from public, private and other sources to build and support a sustainable ocean economy. Over the past few years, several organisations have published guidance and frameworks on blue financing including UNEP, UN Global Compact, IFC and IFC. For example, in 2018, the UNEP Finance Initiative launched the Sustainable Blue Economy Finance Principles. Organisations can join as members or signatories; the latter are expected to publicly report annually on progress and can participate in decision-making on work programmes.

Earlier this year, the IFC published guidelines for blue financing, which build on the Green Bond Principles and the Green Loan Principles. Blue bonds are still considered a relatively new type of sustainability bonds, with some claiming blue bonds today are where green bonds were about a decade ago.[120] A big challenge for blue bonds is that there is currently no globally standardised guidance for blue financing, but that is about to change. At the UN Ocean Conference this June, five organisations – ICMA, UN Global Compact, UNEP FI, IFC and the ADB – came together and announced their commitment to develop a global guidance on blue bonds that will provide a consistent guide on blue economy typology, eligibility criteria, key performance indicators and best practices. The draft for consultation was launched at the UN Ocean conference, and the coalition aims to finalise the documents by the end of 2022. This is expected to bring clarity to the market and hopefully accelerate the issuance of blue bonds for which there is growing demand.

We would be remiss not to highlight ORRAA[121] (Ocean Risk and Resilience Action Alliance) who are working to direct more investment into ocean resilience. It aims to drive at least $500 million of investment into coastal and ocean natural capital by 2030, and surface at least 50 million novel finance products that positively impact the resilience of at least 250 million climate vulnerable coastal people around the world. The alliance is working with partners to develop a global coastal and ocean financing architecture “the Sea Change Impact Financing Facility (SCIFF)” to rapidly scale up investment into projects that protect and expand coastal and marine nature.

3. Other ocean-focused initiatives

We are also seeing a growing number of sectoral initiatives and provide some global examples in the table below. An exciting cross-industry initiative that has emerged as a result of the Ocean100 scientific paper by Virdin et al. (2021) which we discussed above is called The Ocean 100 dialogues[122]. It is hosted by the World Economic Forum and aims to bring together leaders of the Ocean 100 companies to create a “science-business platform for ocean stewardship”. It is supported by the World Ocean Council, which is a cross-sectoral ocean industry alliance set up by and for the private sector to address issues affecting ocean sustainable development, science and stewardship of the sea. Another exciting initiative focusing on the innovation aspect and bringing together ocean innovators and investors is the 1000 Ocean Startups[123] coalition, which aims to raise awareness about the potential of

[120] https://unglobalcompact.org/take-action/ocean/communication/blue-bonds-accelerating-sustainable-ocean-business

[121] https://oceanriskalliance.org/

[122] https://www.weforum.org/ocean-100-dialogues/home

[123] https://www.1000oceanstartups.org/

innovation for restoring ocean health and to scale transformative startups in the space.

Figure 28. Examples of global sectoral initiatives

There are also many regional initiatives, but this table focuses on global efforts

Sector	Initiative	Description
Shipping	International Maritime Organisation (IMO)	The IMO is a UN agency that is responsible for the safety, security and environmental performance of the shipping industry. It has a total 175 member states and 50 conventions in place to regulate the shipping industry.
	Sustainable Shipping Initiative	This initiative is a multi-stakeholder initiative aimed at improving the sustainability of the shipping industry.
	Getting to Zero Coalition	An alliance of more than 200 organisations, within the maritime, energy, infrastructure and finance sectors supporting by government and IGOs. This coalition is committed to getting commercially viable deep sea zero emission vessel powered by zero emission fuels by 2030
Oil and Gas	IPIECA	IPIECA is a global oil and gas association which brings together members and stakeholders to lead in integrating sustainability and climate action across oil, gas and renewables activities.
	Beyond Oil & Gas Alliance	An international alliance set up by Costa Rica and Denmark with the aim to facilitate the managed phase out of oil and gas production.
Renewables	Ocean Renewable Energy Action Coalition (OREAC)	OREAC was formed in response to the 2019 call for ocean-based climate action by the High Panel for a sustainable ocean economy. It aims are the sustainable development of ocean based-renewable energy and reducing the impacts of climate change.
Fishing	Global Salmon Initiative	This initiative includes a coalition of CEOs committed to uphold sustainable salmon farming practices.
	Seafood Business for Ocean Stewardship	A science-business initiative that includes 10 of the largest seafood companies with commitments to develop more sustainable seafood production and improve ocean health. The collaboration has been coordinated by the Stockholm Resilience Centre with key scientific partners such as Beijer Institute of Ecological Economics, the University of Lancaster and Stanford Center for Ocean Solutions. SeaBOS companies represent over 10% of the world's seafood production and over 600 subsidiary companies.
	Global Sustainable Seafood Initiative	A public-private partnership working together to turn seafood into a driver for good to preserve oceans and promote sustainable seafood. They aim to create guidelines to create a level playing field for the seafood sector, to promote efficient and effective solutions, and to amplify the impact of individual organisations in this space
	Centre for Oceans	The long-term goal of this center is to conserve marine biodiversity and ecosystems. They connect local action and global impact through alliances, learning communities and good strategies. They have a number of initiatives such as eliminating illegal tuna fishing, working with coastal community fisheries, and working on sustainable aquaculture practices.
	Marine Stewardship Council	MSC is an international non-profit organisation that recognises and rewards efforts to protect the ocean and safeguard supplies for the future. It has produced an ecolabel and fishery certification program to recognise and reward sustainable fishing practices.
	Sustainable Fisheries partnership	It is a US registered organisation that operates globally. They work on the major challenges to seafood sustainability and aim to protect ocean wildlife, support small-scale fisheries, improve fisheries management and promote sustainable aquaculture.
Aquaculture	Aquaculture stewardship council	This organisation works with scientists, NGOs, aquaculture producers, retail and food companies and consumers to recognise and award responsible aquaculture. They provide certification to reward sustainable practices.
Plastic Pollution	The Clean Ocean Initiative	Launched in 2018 by several deveopment banks, the initiative aims to identify projects that tackle plastic waste on land as well as in rivers and oceans. It has a goal to finance 2 billion euros in public and private sector projects by 2023.
	Business Coalition for a Global Plastics Treaty	This coalition is convened by the Ellen MacArthur Foundation and WWF to bring together businesses and financial institutions committed to supporting the development of a legal binding UN treaty to end plastic pollution.

Source: Virdin et al. (2021), Platform websites, Citi Global Insights

4. Global treaties including Post-2020 Global Biodiversity Framework

More than 100 countries have already committed to protecting 30% of oceans by 2030, which is one of the targets of the new global framework for managing nature – ie, "Post 2020 Global Biodiversity Framework" being negotiated at COP15, in Canada on 7-19 December 2022. Other targets that directly relate to the ocean include:

- Target 1. Ensure that all land and sea areas globally are under integrated biodiversity-inclusive spatial planning addressing land- and sea-use change, retaining existing intact and wilderness areas.

- Target 2. Ensure that at least 20 percent of degraded freshwater, marine and terrestrial ecosystems are under restoration, ensuring connectivity among them and focusing on priority ecosystems

- Target 9. Ensure benefits, including nutrition, food security, medicines, and livelihoods for people especially for the most vulnerable through sustainable management of wild terrestrial, freshwater and marine species and protecting customary sustainable use by indigenous peoples and local communities.

We mentioned earlier the ongoing negotiations for an international treaty to protect the High Seas is critical for the success of SDG 14: Life under water, and we expect an agreement to be reached next year. Negotiations for an international legally binding agreement to end plastic pollution is underway, with the UN aiming to complete the finalised treaty by 2024. There are several international agreements already in place for more sustainable maritime transport that are administered by the International Maritime Organisation (IMO). A key IMO convention is the International Convention for the Prevention of Pollution from Ships (MARPOL), which was adopted in 1973 and amended through the years. It includes regulations aimed at preventing and minimising pollution from ships and currently has six technical annexes – prevention of pollution by oil, control of pollution by noxious liquid substances in bulk, prevention of pollution by harmful substances carried by sea in packaged form, prevention of pollution from sewage from ships, garbage from ships, and prevention of air pollution from ships. Other relevant conventions include the Convention on the Prevention of Marine Pollution of Dumping of Wastes and Other Matter 1972 (London Convention), which has been in force since 1975 and applies to deliberate disposal at sea of waste or other matters. The London Protocol came into force in 2006 to modernise and eventually replace the London Convention and is intended to be more protective of the ocean. It prohibits the dumping of all wastes and other materials except those listed in a “reverse list” which can be considered for dumping.[124]

5. Regulation – Europe leading the way

Governments are increasingly recognising and committing to action on environmental issues. For example, in 2021, for the first time the G7 committed to halting and reversing biodiversity loss at the G7 Leaders’ Summit, and G7 Finance ministers & Central Bank Governors have committed to embed climate change and biodiversity loss considerations into economic and financial decision-making. Europe is currently ahead of the curve in terms of regulations, and the EU Taxonomy and the Sustainable Finance Disclosure Regulation (SFDR) are all signs of requirements for climate and nature disclosures to come set against the EU Biodiversity Strategy for 2030. The EU Taxonomy, which aims to channel investment into environmentally sustainable economic activities, came into force July 2020 and contains six environmental objectives where for an activity to be deemed “green”, it must substantially contribute to at least one of the six aims and not cause harm to the other five:

- Climate change mitigation
- Climate change adaptation

[124] Such as dredged material, sewage sludge, fish wastes, organic material of natural origin, vessels and platforms or other man-made structures at sea, and bulky items primarily comprising iron, steel, concrete and similarly unharmful materials for which the concern is physical impact, and limited to the circumstances where such wastes are generated at locations with no land-based alternatives.

- The sustainable use and protection of water and marine resources
- The transition to a circular economy
- Pollution prevention and control
- The protection and restoration of biodiversity and ecosystems

So far, only the criteria for the first two climate objectives have been set out, but the others are in the works, which includes "Sustainable use and protection of water and marine resources". Complementary to the EU Taxonomy is SFDR, which is a set of rules to make the sustainability of funds more comparable and came into effect in March 2021. SFDR forms part of the EU's wider Sustainable Finance Framework and aims to promote sustainable investment across the EU but is expected to transcend its borders. A key component of SFDR is the Principal Adverse Impact (PAI) regime, which is a set of environmental, social and governance indicators that finance actors will be required to report by June 2023. They include indicators on carbon emissions, waste, water use, social violations, gender parity as well as biodiversity impacts. For example, there is a specific indicator that targets activities negatively affecting biodiversity sensitive areas, where investors will have to disclose the *"share of investments in investee companies with sites/operations located in or near to biodiversity sensitive areas where activities of those investee companies negatively affect those areas."*

The EU also has a Common Fisheries policy that aims to ensure all fishing activities by European fleets are environmentally, socially and economically sustainable. The latest reform in 2013 included a goal of fish stock management at maximum sustainable yield by 2020 for all managed stock, however even though progress has been made, the goal has not been met and many fish stocks remain overexploited.[125] Nordic countries score highly on Minderoo Foundation's Global Fishing Index which rank countries by grade based on their progress on restoring fish stocks and governance capacity. Overall, the index finds that there is a clear gap between commitments and action with no countries have achieved an A or B grade where most fish stocks are assessed and known to be sustainable, only 10 countries received a "C" which includes Iceland, Norway, Sweden and Denmark.

A deforestation regulation is also in the works: proposed by the European Commission last year, it aims to make it obligatory for companies to verify that goods sold in the EU have not been produced on deforested or degraded land. The proposal currently covers terrestrial forests, but there have been calls to expand the scope to more ecosystems including wetlands and mangroves.[126]

6. Taskforce on Climate-related Financial Disclosures (TCFD)/ Taskforce on Nature-related Financial Disclosures (TNFD) /Science-Based Targets Network (SBTN)

The Taskforce on Climate-related Financial Disclosures (TCFD) was created in 2015 to develop a consistent set of climate-related financial risk disclosures for use by companies, banks and investors. G7 nations have agreed on mandatory reporting, as well as several others including Switzerland and New Zealand. Related to TCFD and catching up quickly is the Taskforce on Nature-related Financial Disclosures (TNFD), which launched in June 2021 and is currently in its beta v2.0 framework with a finalised version expected in September 2023. Similar to the TCFD, compliance will be voluntary to start but mandatory disclosure requirements are expected over time.

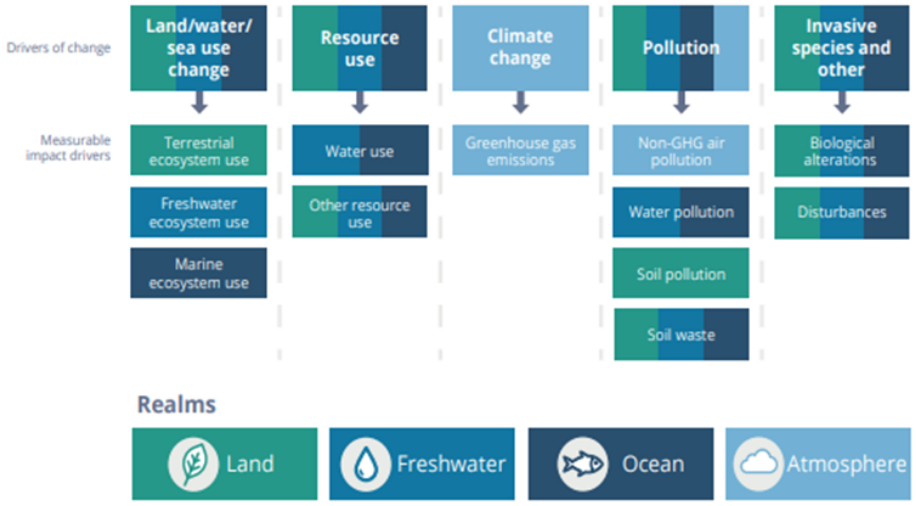
[125] The Pew Charitable Trusts (2021) Lessons from implementation of the EU's Common Fisheries Policy; WWF (2022) Sustainable fisheries

[126] European Parliamentary Research Service (2022) Towards deforestation-free commodities and products in the EU

The global coalition Business for Nature is leading a COP15 business advocacy campaign urging governments to “Make it Mandatory” and require all large businesses and financial institutions to assess and disclose their impacts and dependencies on nature by 2030.[127]

Organisations are encouraged to adopt to the LEAP approach for nature-related risk & opportunity assessment, which stands for Locate (Interface with Nature), Evaluate (dependencies & impacts), Assess (Material risks & opportunities), and Prepare (to respond & report). For dependencies and impacts on nature, organisations are expected to consider assessment metrics for: 1) impact drivers; 2) state of nature; and 3) ecosystem services. The framework says organisations should start by identifying priority impact drivers related to each of the four realms (ocean, freshwater, land and atmosphere), and then should be assessed across direct operations, upstream and downstream.

Figure 29. TNFD's classification of nature change drivers and measurable impact drivers



Source: TNFD (2022) The TNFD Nature-Related Risk and Opportunity Management and Disclosure Framework – Beta v0.2 (with permission)

Also, where possible, impact drivers should be measured using both absolute metrics and the associated rate of change metric, as well intensity/efficiency and prevalence metrics, and should be contextualised quantitively or qualitatively. The assessments for climate predominantly use one metric, tonnes of carbon, but for nature it is more difficult as location matters and there are a diverse set of metrics. This is why we encourage corporates to start mapping out dependencies and impacts now and not wait until the framework is finalized; there is already sufficient resources and guidance to get started. TNFD have noted that they will also be developing “realm” specific guidance for future releases which includes “ocean”.

The table below summarises some examples of metrics that TNFD have provided in the beta v2.0 framework which relate to the ocean realm.

[127] https://www.businessfornature.org/make-it-mandatory-campaign

Figure 30. Examples of metrics provided by the latest draft TNFD framework for impact drivers related to the ocean

Impact driver	Indicator	Metric	Unit of measure
Land/water/ sea use change	Extent of marine area converted	Area of marine area converted/degraded by ecosystem type (before and after) and business activity	km^2 or equivalent
	Marine ecosystem use overlap with legally protected and internationally recognised areas	Percentage of marine area owned, leased, and/or operated within legally protected or internationally recognised areas (e.g. UNESCO World Heritage sites, UNESCO Biosphere Reserves, Ramsar sites, Key Biodiversity Areas)	percentage
Pollution	Volume of water discharged to legally protected, internationally recognised or water-stressed areas	Volume of water discharged (total, freshwater, other) to areas of water stress and legally protected and internationally recognised areas (e.g. legally protected areas, UNESCO World Heritage sites, UNESCO Biosphere Reserves, Ramsar sites, Key Biodiversity Areas)	cubic metre or equivalent
	Water-related detrimental incidents	Number of water-related detrimental impact incidents experienced by organisation by location	count
Resource use	Use of natural resources sourced from marine areas	Quantity of high-risk commodities sourced from marine areas split into types (such as gravel, oil, seafood, energy)	tonnes
	Use of wild species	Share of wild species extracted from legally protected and internationally recognised areas (e.g. legally protected areas, UNESCO World Heritage sites, UNESCO Biosphere Reserves, Ramsar sites, Key Biodiversity Areas)	count
	Plastic production	Volume of plastic produced	tonnes

Source: TNFD, Citi Global Insights

Figure 31. Examples of realm-specific metrics for the ocean provided by the latest draft TNFD framework

Physical state	Chemical state	Compositional state	Structural state	Functional state	Landscape/ seascape
Water clarity; (Micro)plastic concentration	Chlorophyll a concentration; Oxygen concentration; pH (or dissolved CO_2)	Coral species richness; Fish species richness	Reef bleachedness; Kelp/ seagrass height, Density or cover; Live coral cover	Ratio between fishing mortality and fishing at maximum sustainable yield; Biological oxygen demand	Seagrass meadow cover

Source: TNFD, Citi Global Insights

Working together with the TNFD is the Science-Based Targets Network (SBTN), which is developing criteria, guidance and resources to help companies set science-based targets for climate, biodiversity, water, land and ocean. The first release of SBTs for nature is expected in early 2023 and will focus on issues related to water use and water pollution. Subsequent guides for other "realms" are to follow. Earlier this year, SBTN received funding to develop guidance on SBTs for seafood value chains; the initial focus will be on retail and consumer goods value chains, coastal and marine tourism, cross-realm pollution, and a coastal nexus workstream which aims to address multiple pressures holistically. TNFD and SBTN are also working towards a consistent and integrated guidance for companies to allow them to set science-based targets with SBTN and disclose nature-related risks through TNFD.

There are other initiatives and resources that organisations can already tap into – for example, Business for Nature and Finance for Biodiversity. In our Citi GPS report on Biodiversity, we spoke to Eva Zabey the executive Director of Business for Nature who set out a clear and compelling case for businesses to take action on nature loss. One of the commitment platforms that targets SDG 14 specifically, which Business for Nature highlights, is the New Plastics Economy Global Commitment where signatories have committed to ambitious 2025 targets for a circular economy for plastic.

Conclusions

In this note, we have shown the economic, environmental and societal significance of the world's largest ecosystem – the ocean – and how it is connected to climate change, nature loss and pollution, which are all driving ocean health degradation and causing an "ocean emergency". This in turn is driving negative feedback loops and impacting the ocean's productivity and resilience, which has far-reaching implications for societies and economies. An example that clearly demonstrates the integral and central role marine ecosystems play is that of coral reefs, which cover <1% of the planet's surface but sustain 25% of marine life and directly supports over 500 million people globally. We've already lost half of the world's coral reefs in the past 30 years as a result of human pressures in the form of climate change, pollution, habitat destruction and over-exploitation, and if global warming reaches 2^{o}C, scientists predict mass coral mortality. This will have serious implications for coastal protection, coastal tourism, local communities who depend on coral reefs for food and income, as well as potentially disastrous knock-on effects that result from losing a quarter of marine life. On the other hand, nature-based solutions such as mangrove restoration offer potential win-win-win solutions for the planet, people and economy. The ocean needs urgent protection and restoration, which needs to go hand-in-hand with tackling the direct and indirect drivers of ocean degradation. However, activities in the marine environment are on the rise in both intensity and diversity, and the need to balance and ensure ocean sustainability with increased activity is an important and urgent challenge.

The business and finance communities have made and are making progress on climate action. More recently, the attention has turned to nature loss on a terrestrial basis. However, interest and focus on the marine environment beyond marine-based industries is still largely nascent, and UN SDG 14 remains one of the least prioritised and funded global goals. Businesses and finance actors have vital roles to play, so we simply cannot achieve a sustainable ocean economy without ocean-positive economic activities and financing.

We make the case that corporates and financial institutions should care about ocean health from both a risk and opportunity perspective:

- Ocean degradation is not a siloed issue but is intrinsically connected to climate change, which most corporates and financial institutions are now taking action on.

- Ocean issues are not just relevant for marine-based industries since most land-based industries contribute to ocean degradation directly or indirectly through one or more of the root causes – habitat destruction, over-exploitation, climate change, and pollution.

- Corporates and finance actors will be increasingly asked to assess, report and disclose their dependencies and impacts on the marine environment as well as ocean-related risks – TNFD for example.

- Growing awareness and action on ocean issues from civic society and governments are leading to increased targeted action, which can increase risks for businesses that include operational risk, market risk, regulation and reputational risk.

- There are also plenty of ocean-related opportunities for businesses and finance actors:

    - Ocean-based climate solutions
    - Innovations in ocean-positive products, services and business models

    - Ocean data products and services
    - Blue carbon credits which are underrepresented and underfunded
    - Emerging sectors – i.e. offshore renewables, marine biotechnology and pharmaceuticals
    - Innovative financial instruments and partnerships – i.e. for conservation and restoration
- Ocean degradation is not separate to climate change and biodiversity loss - taking a more holistic view and connecting the dots across key issues can help stakeholders take more effective action, as well as identify growth opportunities.

Recommendations

We hope this note has helped to raise awareness and bring some clarity on why the business and finance communities should pay closer attention to the marine environment. We aim to dive deeper into the practical solutions for delivering a sustainable ocean economy in future publications; in this note, we share some of our thoughts on solutions and key action areas for the business and financial communities as well as other important stakeholders.

There are currently many siloes when it comes to ocean governance and action, but we are presented with a unique opportunity to connect the siloes and build innovative partnerships to support a healthy and productive ocean. In order to make this happen, we think an important step for private, public and finance sectors is to upskill and recognise (1) the significance of oceans on our sustainability journey, (2) the risks associated with business as usual for business, society, and environment, as well as (3) the opportunities that comes from supporting a sustainable ocean economy. To help improve ocean literacy as well as enable more effective action, we encourage the private, public and finance sectors to establish closer relationships and collaborations with academia and NGOs who have substantial expertise, knowledge and access. We also believe there is an opportunity for business and finance actors to play a bigger role in international gatherings on the topic, such as the UN Ocean conference, as well as engage further at other relevant international conferences such as the COP conferences for climate and biodiversity.

Building on from that, businesses can embed ocean considerations into their strategies and actions for climate change and nature loss, which include:

- Follow the guidance of TCFD/TNFD and SBTN and start assessing dependencies and impacts as well as risks for direct operations and along the supply chain.

- Identify synergies and trade-offs across issues and opportunities to tackle them together.

- Engage with suppliers, peers, and other industries – learn from each other's experiences and expertise and collaborate. Land-based industries can learn from marine-based industries, and we are encouraged to see several cross-industry and sectoral initiatives such as Ocean 100, World Ocean Council and UN Global Compact Sustainable Ocean Principles.

- The Mitigation Hierarchy can serve as a useful tool to help limit the negative impacts on biodiversity and ecosystems. It considers four steps: Avoidance, Minimize, Restore and Offset. In our tipping point report on Carbon offsets, we highlighted that in the hierarchy of methods to reduce GHG, offsets should be seen as a last resort. In this situation, we should not forget about

blue carbon and the sequestration potential of mangroves, sea grasses, salt marshes, as well as other marine ecosystems.

- Apply an ocean lens to business opportunities and potential new revenue streams.

The finance and investment community play vital roles in driving more capital towards the conservation and sustainable use of the ocean and its resources. UN SDG 14 is severely underfunded, and there is a huge opportunity for the deployment of private capital at scale. Key recommendations include:

- Investors should engage with investee companies on ocean issues and how they are addressing them.

- Explore investment opportunities in solutions for ocean health, which can include ocean-based climate solutions and other nature-based solutions.

- Engage and collaborate with peers and lean on expertise – for example, UNEP FI Sustainable Blue Economy Finance Principles.

- Engage with clients on ocean issues and how their own activities are driving ocean degradation, support both marine-based and land-based industries on their sustainable transition to net zero, nature and ocean positive.

- Develop new financing tools and explore opportunities for innovative partnerships and financial instruments for example, blue bonds, blended finance, debt conversion, insurance products.

Government commitments and actions also must align with a sustainable ocean economy and are critical for providing enabling frameworks and conditions as well as financing. Key action areas include:

- Agree and finalise international treaty on the protection of the high seas.

- Tackle fragmented governance infrastructure and connect the siloes of regional and sectoral organisations.

- Redirect harmful subsidies to support sustainable practices.

- Help attract private capital to support UN SDG14 such as through enabling frameworks and blended finance structures.

- Embed ocean, nature and climate considerations into economic and financial decision making.

It is not an exaggeration to say humankind’s survival and prosperity depends on a healthy ocean. Right now, we are driving a vicious cycle of harm, and if life in the ocean disappears, so does human life. We can no longer turn a blind eye to the damage our activities are causing the marine environment, but instead must embrace the challenge and connectivity across ocean degradation, biodiversity loss, and climate change and turn the vicious cycle in a more virtuous one. The private sector and the finance community have contributed substantially to the degradation of the ocean – both directly and indirectly – but they are also vital to conserving and restoring ocean ecosystems. Now is the time to step up, take action, and harness the immense opportunities that a sustainable ocean economy has to offer. As Sir David Attenborough puts it, *“We are in reach of a whole new relationship with the ocean, a wiser, more sustainable relationship. The choice lies with us."* Let us collectively choose the wiser and more sustainable path.

Appendix

The tables below provide examples of how industries contribute to ocean degradation via the stressors.

Figure 32. Examples of impact from marine-based industries (part 1)

	Land/sea use change & over-exploitation		Pollution					Climate change
	Direct exploitation	Land/sea use change	Noise and light	Oil spills	Plastic	Sewage and other debris	Nutrients/ chemicals /metals	GHG emissions
Marine – Oil & Gas		- Exploration, production and decommissioning of offshore rigs and supporting facilities can degrade and destroy marine and coastal habitats - Direct physical disturbance could come from anchor chains, drill cuttings, drilling fluids, laying of pipelines, discharge of produced water - Research has found that anchor operations and discharges of produced water and cuttings impact coral communities directly through physical disturbance and increased local sedimentation	- Noise and light pollution from seismic surveys, operations and decommissioning - Research has found that acoustic disturbance has led to disruption of behaviour i.e. feeding, migration, masking of sounds used for navigation and communication, physical injury, localised displacement - The introduction of considerable amounts of artificial light e.g. gas flares, electric lighting can affect ecological processes	- Oil spills and leaks from ships and rigs - Greatest risk comes from "blowouts" e.g. Deepwater Horizon incident - Marine mammals, seabirds, shellfish are extremely vulnerable to oil pollution	- Galley waste and litter from platform and ships, paints, end-of-life dismantling	- Each drill well generates thousands of gallons of waste drilling cuttings and muds which contain materials used for operations - Excess cement, sewage water from ships and rigs - Waste and debris from decommissioning of installations	- Chemical contaminants from drill cuttings, formation water brought up with hydrocarbons, additives used to improve technical performance - Drilling muds contain toxic metals including lead, mercury, cadmium that could end in up seafood supply chains - Produced water contains benzene, arsenic, lead and various amounts of radioactive pollutants	- Research has found in 2015, crude oil production contributed 1.7 Gigatons of CO2eq of GHG emissions, ~5% of total fuel combustion GHG emissions
Marine – Commercial fishing	- Overfishing can lead to collapse of fish stocks - Overfishing and fishing activities can impact other marine life – 'ghost' fishing, bycatch, interruption/erosion of food webs	- Fishing practices such as bottom trawling destroys natural habitats	- From fishing vessels and operations	- Spills and leaks from fishing vessels	- Abandoned, lost or discarded fishing gear, marine coatings, feed sacks, buoys contribute to loss of marine life through entanglement and 'ghost' fishing - Lost/abandoned fishing gear has impacted 40% of known marine mammal species - Galley waste and litter thrown overboard - Abandoned vessels	- Gallery waste, sewage and other marine debris from fishing vessels and equipment	- Leakage of chemicals from vessels i.e degreasers, ammonia	- Seafood products can have high carbon emissions due to production, habitat destruction, energy in supply chains
Marine – Shipping		- Dredging for shipping channels, vessel routes and accidents (i.e. collisions, groundings) can damage natural habitats	- Noise pollution from operations	- Spills and leaks from tankers and vessels	- Loss of shipping goods and plastic pellets, galley waste and litter thrown overboard, marine coatings	- Toxic waste from vessels and shipping operations	- Pollutants from vessels can alter marine biochemistry including CO2, Sox, NOx, anti-fouling paints, bilge water, untreated ballast water and fuel residue - Chemical spills from chemical seaborne trade	- GHG emissions from vessels - Shipping accounts for 2-3% if global GHG emissions
Marine – Port infrastructure & services		- Construction of ports, dredging, port operations can damage marine environments and conflict with other industries	- Noise and light pollution from construction and operations	- Spills and leaks from port operations and vessels	- Loss of shipping goods and plastic pellets	- Disposal of sewage and other waste directly into the sea - Toxic discharge from port areas can impact local marine environments	- Pollutants from port operations and vessel can alter marine biochemistry and impact health of marine life	- Shipping emissions in ports mostly comes from containerships and tankers - Emissions of CO2, NOx and SOx - Emissions from inter-modal transport networks which serve ports

Source: Citi Global Insights

Figure 33. Examples of impact from marine-based industries (part 2)

	Land/sea use change & over-exploitation		Pollution					Climate change
	Direct exploitation	**Land/sea use change**	**Noise and light**	**Oil spills**	**Plastic**	**Sewage and other debris**	**Nutrients/ chemicals /metals**	**GHG emissions**
Marine – Aquaculture	- Farming of some species relies on wild fish catch for feed - Outbreak and spread of disease in fish farms puts local species at risk - Escape events can lead to unnatural competition with wild species	- Siting of farms can lead to habitat degradation and destruction i.e. mangroves which leads to loss of species and ecosystem services, livelihoods	- Some farms take measures to deter predators e.g. using acoustic deterrent devices which can cause pain to marine life and keep them away from important feeding/breeding grounds		- Plastic waste from aquaculture installations including cages, buoys, ropes and lines, poles and nets, fishing gear, plastic sheeting as well as packaging, storage boxes	- Leaching of effluents can lead to eutrophication which reduces oxygen levels and causes suffocation of marine species - E.g. Tilapia and carp have especially high levels of nutrient run-off	- Operations can use harmful chemicals, pesticides, nutrients, anti-microbials that can leak/leach into surrounding waters affecting marine life and ecosystems - E.g. Farm products such as chlorine and copper used for cleaning ponds, tanks and equipment can be toxic for marine life	Research has found that global aquaculture accounted for ~0.49% of GHG emissions in 2017
Marine – Coastal tourism	- Tourism can add to the consumption of local seafood and put pressure on fish populations - Tourism activities may also directly exploit local marine life	- Construction of tourism development and traffic – people and transportation – puts pressure on marine environments and can lead to degradation and loss of habitats	- Noise and light pollution from construction of tourism development and activities	- Oil spills and leaks from related marine transportation such as cruise ships	- Plastic pollution from tourism activities e.g. visitors, accommodation, businesses	- Discharge and disposal of sewage, cement, fuels and other waste from tourism development and activities	- Discharge of pollutants from tourism activities - SOx and NOx from cruise ships	- Tourism activities are sources of GHG emissions
Marine – Seabed mining		- Habitat degradation and loss from mining activities - Sediment plumes lead to fragmentation of ocean habitats	- Noise and light pollution from operations - High light and noise levels at seabed have impacts on ecosystems that are adapted to dark and silent conditions	- Oil spills and leaks from vessels and equipment	- Galley waste from vessels - Loss of equipment and gear	- Discharge and disposal of waste from vessels - Loss of equipment and gear - Creation of sediment plumes - Discharge of waste water from vessels may contain sediment which disrupts photosynthesis and degrades productivity - Ore spills during transfer	- Potential release of toxic elements from sediment plumes caused by mining process - Discharge of waste water from vessels may contain heavy metals	- More research is still needed to better understand the climate impacts of seabed mining
Marine - Renewables		- Siting, construction, operation and decommissioning of farms causes seabed disturbance which can lead to habitat degradation and loss - Operations can lead to collisions between equipment and animals such as migratory birds and marine life	- Noise from construction and operation can disrupt and distress marine life especially marine mammals - Research has found that noise from operating turbines could impact the use of foraging areas by some marine mammals	- Oil spills and leaks from vessels - Accidental spills of lubricant oils from installations	- Galley waste from vessels - Loss of equipment and gear	- Waste disposal from vessels - Debris from installation - Loss of equipment and gear	- Pollutants from operations, maintenance activities and service vessels e.g. leaching of chemicals from antifouling paints and accidental spills of hydraulic fluids - Contaminants potentially discharged could include metals, booster biocides, chemicals used as dielectric fluids, hydrocarbons, coolants - Excess heat and electromagnetic field generation from undersea cables can affect local marine life	

Source: Citi Global Insights

Figure 34. Examples of impact by land-based industries

	Pollution	Climate change
Land – Urban development	- Plastic waste from flooring, roofing, insulants, pipes, paints and sealants	- In 2018, the construction industry accounted for 11% of energy-related CO_2 emissions
Land – Agriculture & livestock	- Plastic waste comes from irrigation pipes, greenhouse covers, containers, fencing, protective meshes, pellets for delivery of chemicals and fertilisers, seed coatings and mulchings	- Agriculture and food are responsible for almost 1/3 of global GHG emissions - Livestock emissions account for roughly 32% of human-caused methane emissions
Land – Waste management	- Wastewater treatment plants are a major source of microplastic - Exposed plastics from landfill can be transported by wind - Chemicals and plastic particles can leach from landfill into surrounding environments	- Landfills release methane and account for approx. 5% of global GHG emissions
Land – Energy extraction	- Oil spills and leaks from operations and transport can end up in waterways - Toxic chemicals used in operations can leach and end up in waterways	- Research has found that coal mining emits 52 million tonnes of methane per year, more than the oil or gas sector.
Land – Thermal power generation	- Oil spills and leaks from operations and transport can end up in waterways - Power plants not only withdraw water for cooling but also for other processes including operating air pollution control technologies (i.e. scrubbers) and managing waste resulting in toxic pollutants entering waterways - E.g. mercury is released from the burning of coal which ends up in water bodies and fish – it has been found to impair brain development of infants and linked to heart disease and dementia in adults	- In 2019, coal fired power generation accounted for 30% of global CO_2 emissions
Land – Transportation	- Oil spills and leaks from cars, trucks, trains, planes can end up in waterways - Plastic pollution from abrasion of tyres, road surfaces and markings - According to OECD, 78% of microplastic leakage to oceans is from tyres	- In 2019, transport accounted for 27% of global CO_2 emissions
Land – Industry (plastics)	- Oil spills/leaks and toxic chemicals used in manufacturing can end up in waterways - Trillions of plastic pellets are lost to the environment every year	- In 2019, plastics generated 1.8 billion tonnes of GHG emissions, accounting for 3.4% of global emissions) - OECD projects that GHG emissions from plastics lifecycle will more than double between 2019 and 2060
Land – Industry (chemicals)	- Oil spills and leaks can end up in waterways - Plastic pollution can come from microplastic coated fertilisers, pesticides and other chemicals, as well as equipment and waste - Toxic chemicals used in manufacturing, and manufactured chemicals can end up in waterways e.g. pesticides, antibiotics, pharmaceutical waste	- The chemical sector is the largest industrial energy user - In 2019, it emitted 1.2 GtCO2 in direct CO_2 emissions (3.6% of global CO2 emissions)
Land – Industry (textiles)	- Plastic pollution from synthetic products including carpets, building materials, clothes - Washing of synthetic textiles releases microplastic particles	
Land – Industry (HPC)	- Personal care products a major source of microplastics	
Land – Industry (Food & drink)	- Plastic waste comes from single-use plastic products food and beverages	

Source: Citi Global Insights

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