Research Institute
Climate – Ocean Nexus

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Marketing Material

Oceans & Climate – Exploring the Nexus

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IN A NUTSHELL

The world's climate scientists and recent extreme weather have shown that even our current **worst estimates of climate scenarios are proving too optimistic[1].**

While cutting emissions is the obvious approach, it is not enough. We need to spread and improve technologies to capture existing carbon from the atmosphere. We also need a much higher carbon price for carbon technology deployment to become economical. Action is also required on refrigerants, food waste, plant-rich diets, health and education[2]. But taking such initiatives will simply not be enough. We need to take care of the natural carbon tanks that exist today: namely our oceans, land and forests. Society's climate strategy must therefore incorporate nature's critical role in emission reduction & removal.

Within this report, we specifically focus on the oceans; their ability to capture and store carbon. Our seas, one of the largest natural tanks for CO_2 emissions, are being damaged by acidification due to rising temperatures, plastic and chemical pollution, overfishing, whaling, seabed mining, resource exploitation and coastal habitat destruction.

Addressing the climate crisis in a comprehensive way requires healthy, sustainable seas. Any action related to sustainable seas ought to be embedded in a global climate policy.

We agree with research recommending policymakers to:

1) Expand marine protected areas to 30% of the oceans by 2030

2) Foster sustainable, people-centered fishing

3) Legally protect coastal areas such as wetlands

4) Ban harmful practices such as bottom trawling, sea-bed mining, whale hunting, shark finning; end perverse fishing subsidies

5) End new offshore fossil fuel exploration and production, including in the arctic

6) Ensure all wastewater pollution sources are bound by regulations

7) Ensure shipping & marine industries pay-up for the damage created by their operations and to internalize environmental externalities

8) Introduce a tax for investment funds that are not effectively dealing with any of the environmental damage caused by their investee companies.

A collective effort by governments, investors, banks, insurers, and companies is required to:

9) Facilitate investment in floating kelp forests and restore mangroves, coral reefs, seaweed, and wetlands.

Private sector recommendations:

10) Investors should embed oceans in systemic engagement and policy advocacy, encouraging companies, such as Ocean 100 with the highest impacts to:

11) Reduce plastic use, improve circularity, help pay for ocean plastic cleanup

12) Cut corporate water pollution and agricultural water pollution

13) Encourage adoption of sustainable and people friendly fishing practices

14) Foster the Blue Economy through the Sustainable Ocean Principles, Science Based ocean targets and with advanced 'sea-tech' solutions

15) Cleanup offshore oil & gas practices; Cease new exploration & production

16) Expect and require green shipping practices and technologies

[1] Nature (August 2021) - Increasing probability of record-shattering climate extremes
[2] DWS analysis of Project Drawdown 2021 www.drawdown.org/solutions/table-of-solutions
** We wish to thank Matthias Kopp of WWF Germany for providing comments on a draft of this report.

1 / The current path to net zero emissions

Climate change is the current primary focus of policymaking, consumers and investors' attention. The most recent reports from the Intergovernmental Panel on Climate Change (IPCC) and Climate Action Tracker have given clear indications that even our current worst estimates are somehow proving too optimistic. We have already warmed by 1.2ºC and we are on a path to 2.9ºC. Figure 1 provides perspective on the cost of inaction to contain temperature within 1.5ºC:

FIGURE 1: HALF A DEGREE OF WARMING MAKES A BIG DIFFERENCE

Climate Parameter	Manifestation	1.5°C heating	2.0°C heating	2.0°C impact
Extreme Heat	Global population exposed to severe heat at least once every five years	14%	37%	2.6x worse
Sea-Ice-Free Arctic	Number of ice-free summers	At least 1 every 100 years	At least 1 every 10 years	10x worse
Sea Level Rise	Amount of sea level rise by 2100	0.40 meters	0.46 meters	0.06 meters
Permafrost	Amount of Arctic permafrost that will thaw	4.8mn km^2	6.6mn km^2	38% worse
Crop Yields	Reduction in maize harvests in tropics	3%	7%	2.3x worse
Fisheries	Decline in marine fisheries	1.5mn tonnes	3mn tonnes	2x worse

Source: DWS Research Institute, World Resources Institute (September 16, 2021), "Ambitious Climate Action by G20 Countries Can Limit Global Warming to 1.7 Degrees Celsius". Forecasts are based on assumptions, estimates, opinions, and assumptions or analyses and may prove inaccurate or incorrect.

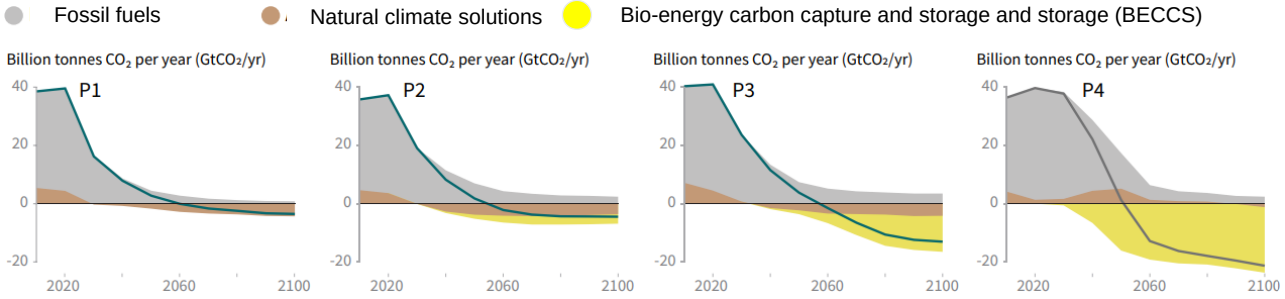
Decarbonisation is the name of the game and the primary focus has been on cutting emissions. Estimates are that by 2030 CO_2 emissions need to be cut by 50% if we are to have a chance to limit global heating to 1.5ºC by 2050.

Naturally there are multiple routes to reach net zero with varying degrees of nature-based and carbon capture climate technologies deployed. One of the most comprehensive studies in this area comes from the work of the Intergovernmental Panel on Climate Change (IPCC) who carry out regular surveys of scenarios such that in their 2019 IPCC Special Report on Global Warming of 1.5°C (SR15), they captured a total of 414 scenarios from 13 different modelling frameworks.

Figure 2 illustrates how much emissions need to be reduced to be compatible with the Net Zero Scenario in four different model pathways. These pathways have been developed from "integrated assessment models" (IAMs) that attempt to represent interactions between human systems (the economy, energy, agriculture) and climate. They are "simplified, stylized, numerical approaches to represent enormously complex physical and social systems"[3]. The four pathways reveal how the available carbon budget consistent with 1.5C can be allocated, for example less action today implies a greater dependency on carbon capture in the future (scenarios P3 and P4). Such a delayed approach would be a high-risk strategy regarding triggering dangerous tipping points in the climate and due to a very high reliance on carbon capture technologies.

[3] Clarke 2014

FIGURE 2: DIFFERENT WAYS TO GET TO NET ZERO – DIFFERENT LEVELS OF CARBON CAPTURE



Source: IPCC 2019

It **is therefore important to bear in mind that the quality of any Net Zero scenario is driven by the quality of carbon negative approaches assumed.** In the IPCC net-zero scenarios, Carbon Capture Use & Storage (CCUS), CCUS combined with bioenergy (BECCS) and natural climate solutions (NCS) are part of the combinations of actions required. All these carbon negative approaches in aggregate are estimated to contribute between 10 to 35 GtCO2 emission removal per year in the various scenarios modelled by the IPCC. This is significant as the carbon negative approaches represent between 30-100% of current fossil fuel emissions.

In other words**, if the carbon negative approaches with near perfect efficiency are not developed, we are likely to significantly overshoot 1.5C warming by the end of the century.** As a result, **while cutting emissions has been the focus of most attention among governments, investors, and corporates, this will not be enough.** We will need to improve and deploy technologies to capture existing carbon from the atmosphere. But while the technology is there, it is currently too expensive. Consequently, we will need a much higher carbon price to make them viable and drive emissions down across multiple sectors and industrial processes.

Digging into what is required to get to a path to net zero – the importance of 'nexus'

If the previous paragraph was about the 'conventional' understanding of the path to net zero emissions, addressing such an issue in a comprehensive manner is a complex project that requires **intervening in multiple areas with a focus on decarbonisation across multiple industries such as the oil and gas, chemical and steel sectors for example**. Analysis[4] conducted by Project Drawdown has revealed some interesting individual- and nature-related actions which can also deliver powerful climate-friendly solutions. **Figure 3** shows the top ten actions by individual action and by sector.

Wind turbines (1st) and photovoltaics (2nd) are widely recognized climate solutions, but we are still a long way to recognize that a sustainable future can be achieved through addressing food waste (4th), changing our diets (5th), health and education (6th). It may be surprising to see refrigeration (3rd) rank as amongst the most important routes to address climate change.

In the past, every refrigerator and air-conditioning unit used to contain chemical refrigerants to absorb and release heat. CFCs and HCFCs are harmful for the ozone layer and were replaced by HFCs (Hydrofluorocarbons), While this replacement was great for the ozone layer, it was terrible for the climate as their 'warming' impact on climate is between 1,000 and 9,000 times greater than carbon dioxide. The good news is that society is beginning to address this issue. It is estimated that by 2028, natural refrigerants, ammonia and propane will be used instead and HFCs will be completely phased out[5]. However, since refrigeration and air-conditioning units typically have long life-spans early adoption of these 'cleaner' units needs to be encouraged.

Intervening in multiples areas requires time and resources, but the point is to highlight that the path to net zero requires working on multiple fronts, and hence the need to move from focusing on the 'single solution' towards a more holistic approach, one where the links between climate and our economic and social activities are well understood and are incorporated into our sphere of actions, whether they are investment, legislation, policymaking, etc. For example, the

[4] Projeect Drawdown 2021 Table of Solutions | Project Drawdown
[5] Projeect Drawdown 2021 https://www.drawdown.org/refrigeration

accounting organization IFRS took the recent decision of focusing on climate change only when it comes to sustainability reporting and not include other factors, such as biodiversity, forestry, etc. It is a policy that falls short because it is not recognizing the importance of the 'nexus' in addressing the climate challenge.

FIGURE 3: NATURE RELATED ACTIONS ARE VITAL, BOTH INDIVIDUALLY AND COLLECTIVELY

Top individual actions for reducing and removing carbon emissions	Gigatons CO_{2e} Reduced or Sequestered (2020–2050) – 1.5°C scenario	Top sectors for reducing and removing carbon emissions	Total Gigatons CO_{2e} Reduced / or Sequestered (2020–2050) – 1.5°C scenario
1. Onshore wind turbines	147.72	1. Food, agriculture, land, and oceans	766.31
2. Utility scale solar photovoltaics	119.13	2 Renewable electricity	392.31
3. Refrigerant management & alternative refrigerants	108.28	3. Buildings	254.73
4. Reduced food waste	101.71	4. Transport	97.46
5. Plant rich diets	91.72	5. Health and education	85.42
6. Health and education	85.42		
7. Tropical forest restoration	85.14		
8. Improved clean cookstoves	72.65		
9. Distributed solar photovoltaics	68.64		
10. Silvopasture (integrating trees into livestock pastures)	42.31		

Source: DWS analysis of Project Drawdown 2021 www.drawdown.org/solutions/table-of-solutions

Oceans and the Climate Nexus

Within this report, we start by exploring the climate 'nexus' with Oceans, which are the first of four natural 'tanks' for CO_2 emissions, the others being land, soil and forests. Let us start with some key facts[6] about the oceans:

- **17% of global greenhouse gas emissions are absorbed by the oceans[7]**
- **Catching a kilo of fish emits 1-5kg of CO_2, compared to 50-750kg of CO_2 for a kilo of red meat.** If you think that fish are the solution to meat, think again: one-third of global fisheries are overfished
- In a related matter, **industrial fishing is a larger source of emissions than air travel due to 'bottom trawling' fishing[8]**
- **3.3 billion people that get at least 20% of their daily animal protein from fish may see a deterioration in their living standards.** Global heating means that fisheries' productivity is harmed, which is negatively impacting lower income people the most[9]
- **By 2050, there could be a greater volume of plastic than fish in the oceans[10]**
- **An average human is responsible for emitting 2 tons of CO_2 emissions per year from their eating habits[11]**

[6] MSC (September 2020). www.msc.org/media-centre/press-releases/press-release/annual-report-2019-20
[7] Global Carbon Project (2019)
[8] Sala et al (March 2021) Protecting the global ocean for biodiversity, food, and climate. *Nature* www.nature.com/articles/s41586-021-03371-z
[9] UN DESA (October 2017) Climate Change and Social Inequality www.un.org/en/desa/climate-change-and-social-inequality
[10] WEF (January 2016). The New Plastics Economy. Rethinking the future of plastics
[11] FECYT (2010) Every person emits two tons of carbon dioxide a year through eating, Spanish study finds www.sciencedaily.com/releases/2010/11/101102131108.htm

- **Whales (if not hunted) when they die, sink to the bottom of the ocean; each great whale sequesters 33 tons of CO_2 on average,** taking that carbon out of the atmosphere for centuries. Halting whale hunting will stimulate phytoplankton growth, which captures carbon emissions. **A 1% increase in phytoplankton activity could be equivalent to the sudden appearance of two billion mature trees**[12]
- **The major Atlantic Ocean current, which influences weather systems worldwide, may have been losing stability over the last century and may be approaching a tipping point.** A potential collapse could have severe consequences such as extreme cold in Europe and parts of North America, sea level rise on the US east coast and disrupt key seasonal monsoon around the world[13]
- **Sea levels have risen 20cm between 1901 and 2018 and it is expected that they will further rise by 20cm in the next 30 years** as a result of the melting of the ice sheets, glaciers and thermal expansion[14]
- **91% of ocean species have yet to be classified and 80% of the ocean is unmapped, unobserved, and unexplored**[15]

These facts are based on scientific studies and highlight the important roles played by oceans and the interconnection existing between climate, oceans and our economic and social activities. **They also highlight how little we understand about the negative impact that our actions have on what represents 70% of planet earth**.

The next section of this report therefore provides a summary of the key scientific findings around sea level and temperature rise and why the effectiveness of our oceans as a carbon sink is deteriorating. The third section outlines how the oceans are under attack and the measures required to protect and restore this important carbon sink. The fourth section focuses recommendations for investors, companies, and governments. The final section provides an outline of how an investor agenda could be formulated to safeguard oceans as an important carbon tank.

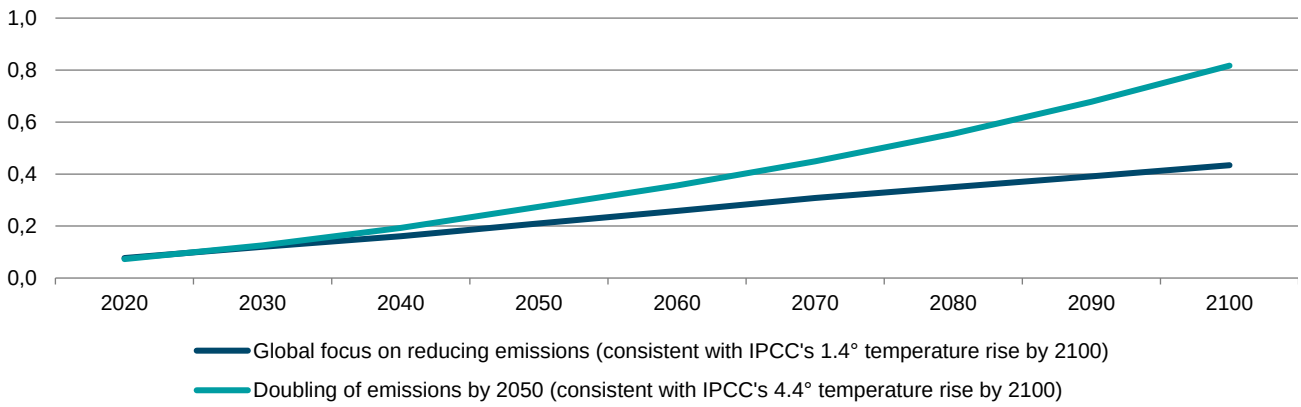
[12] IMF (December 2019). Nature's solution to climate change
[13] Boers, Niklas (August 2021) Observation-based early-warning signals for a collapse of the Atlantic Meridional Overturning Circulation *Nature Climate Change* www.nature.com/articles/s41558-021-01097-4
[14] IPCC Assessment Report 6 (AS6) (August 2021)
[15] NOAA (February 2021) https://oceanservice.noaa.gov/facts/ocean-species.html

2 / The science behind carbon & oceans

2.1 Sea level rise will continue

Over the past 3,000 years, global mean sea level (GMSL) has risen faster in the last century than any other preceding century[16]. Moreover, GMSL will continue to rise even after global emissions have peaked, because oceans respond slowly to warming. Even so, failing to act on global emissions now could still prove disastrous. According to the Intergovernmental Panel on Climate Change (IPCC), sea levels rose by 20cm between 1901 and 2018 yet a similar rise is now projected to occur in the next 30 years alone even if we take more remedial action today[17]. However, the impact on sea level rise differs significantly beyond 2050. **Figure 4** examines the projected increase in sea levels under two major scenarios, namely 1.4ºC and 4.4ºC.

FIGURE 4: PROJECTED SEA LEVEL RISE ACROSS TWO IPCC SCENARIOS

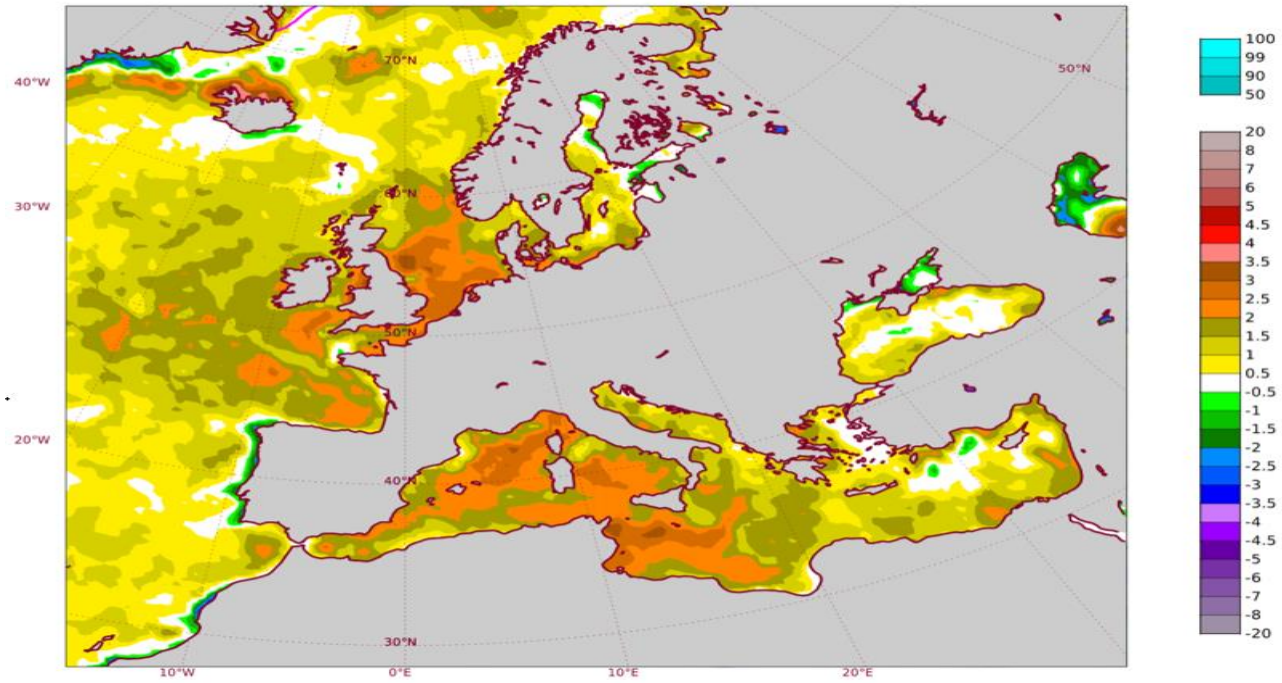


Sources: DWS Research Institute, IPCC Assessment Report 6 (AS6) dated August 2021. Projections are relative to a 1995-2014 baseline. The lines indicate median estimates for sea level rise across the two Shared Socio-Economic Pathways (SSP). SSP1-1.9: The IPCC's most optimistic scenario, this describes a world where global CO2 emissions are cut to net zero around 2050, and the best estimate for global temperature rise in this scenario is 1.4° by 2100. SSP5-8.5: The IPCC's most pessimistic scenario, where current carbon emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fueled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4° higher.

It is widely recognised that global upper ocean (0–700 m) temperatures have warmed since the 1970s and that human activity is largely responsible. In 2020, upper ocean temperatures hit a record high[18] driven by the role oceans play in absorbing just over 90% of the heat trapped by carbon emissions between 1971 and 2010[19].

[16] IPCC Assessment Report 6 (AS6) (August 2021)
[17] IPCC Assessment Report 6 (AS6) (August 2021)
[18] Cheng, L., Abraham, J., Trenberth, K.E. et al (April 2021). Upper ocean temperatures hit record high in 2020. Adv. Atmos. Sci 38, 523-530.
[19] University of Oxford. Zanna, L., Khatiwala, S. et at. (June 2019). Global reconstruction of historical ocean heat storage and transport

FIGURE 5: SEA SURACE TEMPERATURE IN THE NORTH SEA AND THE MEDITERRANEAN VERSUS AVERAGES



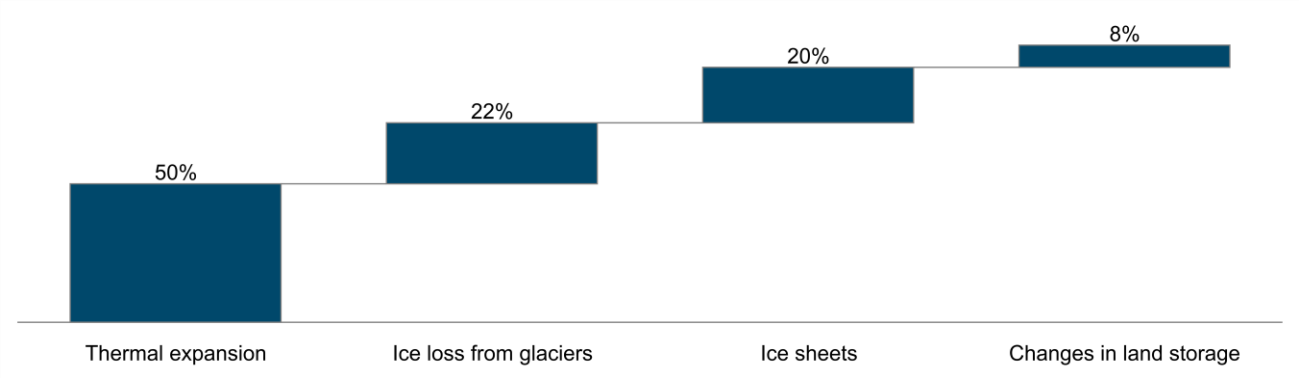
Source: European Centre for Medium-Range Weather Forecasts, September 28 2021. Seas and oceans experience heatwaves too. There is usually a time lag, compared to the heatwaves in the atmosphere that we are used to. This exhibit shows warmer than average temperatures in the North & Mediterranean seas. Because of the lag effect, the marine heatwave in the Mediterranean maybe related to the extreme temperatures across the south of Europe last month.

When it comes to the sources contributing to sea level rise, these are predominantly the expansion of warm ocean waters, the melting of glaciers on land and the melting of ice sheets on land in Greenland and Antarctica. In terms of attribution, thermal expansion can explain 50% of sea level rise over the 1971–2018 period, while ice loss from glaciers contributed 22%, ice sheets 20% and changes in land water storage 8%, Figure 2.

However, of particular concern is the rate of ice sheet loss which has increased fourfold between 1992–1999 and 2010–2019. Together, ice sheet and glacier mass loss were the dominant contributors to global mean sea level rise during the 2006-2018 period[20], **Figure 6.**

[20] IPCC Assessment Report 6 (AS6) (August 2021).

FIGURE 6: DRIVERS OF SEA LEVELS RISE DURING 1978-2018

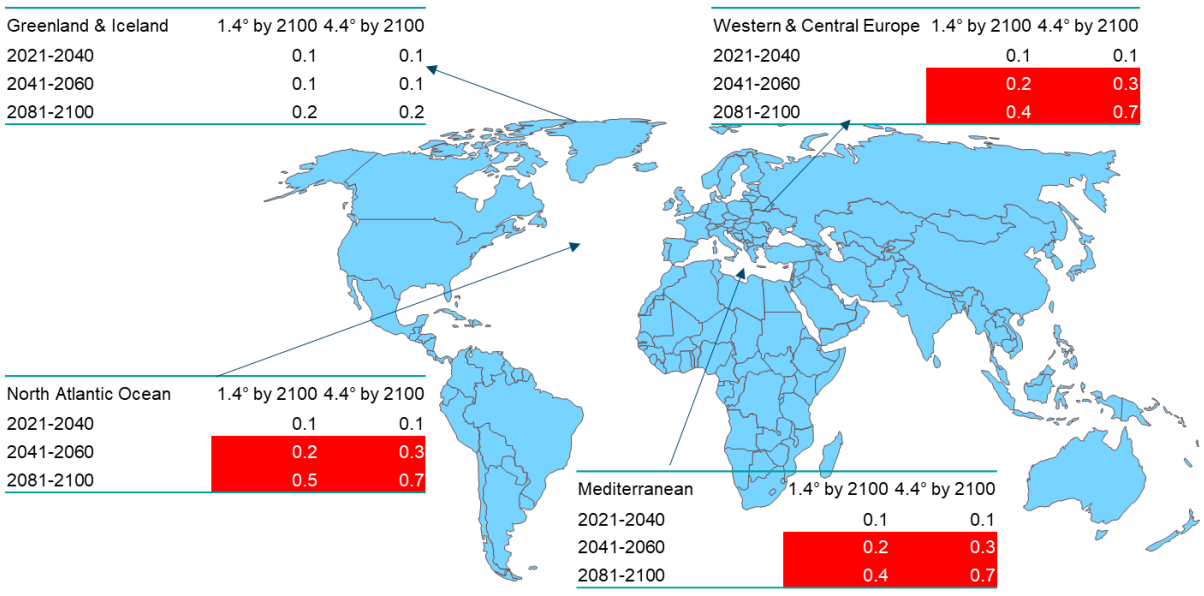


Source: IPCC Assessment Report 6 (AS6) (August 2021). DWS Investment GmbH

2.2 Sea level and temperature increases differ by location

At a regional level, there are also widening disparities of where sea level rise will be more acute. This needs to be better understood to enable a more accurate assessment of the risk to businesses and humanity in general. In **Figures 7 & 8**, we have captured the IPCC's estimates of sea level rise and sea surface temperature rise under two climate scenarios. More than 600 million people worldwide live-in coastal areas that are less than 10 meters above sea level and nearly 2.4 billion people living within 100km of the coast[21]. Given ongoing migration to cities, particularly in Asia, this human exposure to sea level will only intensify.

FIGURE 7: PROJECTED REGIONAL SEA LEVEL RISE (METERS) ACROSS TWO IPCC SCENARIOS



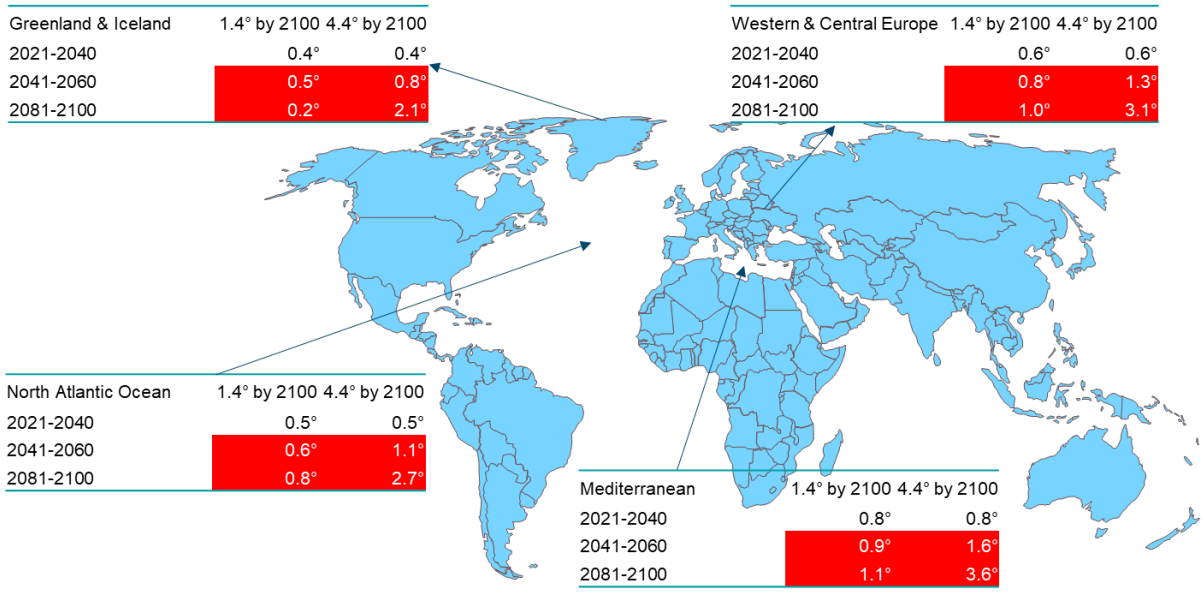
Sources: DWS Investment GmbH, IPCC Assessment Report 6 (AS6) (August 2021). Projections are relative to a 1995-2014 baseline. The tables indicate median estimates for sea level rise across the two Shared Socio-Economic Pathways (SSP). SSP1-1.9: The IPCC's most optimistic scenario, this describes a world where global CO2 emissions are cut to net zero around 2050, and the best estimate for global temperature rise in this scenario is 1.4° by 2100. SSP5-8.5: The IPCC's most pessimistic scenario, where current carbon emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fueled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4° higher.

[21] United Nations Ocean Conference (2017) - Factsheet: People and Ocean

When it comes to sea level rise, a recent study published in *Nature* estimates that the combination of rising tides, waves and storm surges means that extreme sea level events that would have occurred once every 100 years is expected to occur, on average, every year by the end of this century[22]. The study identified specific sea level rise hotspots such as the Southern hemisphere and subtropic areas, the southern half of North America's Pacific Coast, the Philippines, Indonesia the Caribbean, the Mediterranean Sea and the Arabian Peninsula.

In Western and Central Europe, for example, sea surface temperature rise between 1982 and 2018 has been more than double the world average and has been particularly extreme in the Black, Baltic and Mediterranean seas[23]. This is leading to the increasing frequency and duration of marine heatwaves, which are damaging marine life by altering seasonal migration and spawning events. Rising sea temperatures are also affecting climatic conditions on land, such as amplifying heatwaves and triggering more intense precipitation events. Combined these hold considerable risks for those region's agriculture, fisheries and tourism sectors where sea surface temperatures rise is projected to be more extreme.

FIGURE 8: TEMPERATURES IN THE MEDITERRANEAN COULD INCREASE SIGNIFICANTLY



Sources: DWS Investment GmbH, IPCC Assessment Report 6 (AS6) (August 2021). Projections are relative to a 1995-2014 baseline. The tables indicate median estimates for sea level rise across the two Shared Socio-Economic Pathways (SSP). SSP1-1.9: The IPCC's most optimistic scenario, this describes a world where global CO2 emissions are cut to net zero around 2050, and the best estimate for global temperature rise in this scenario is 1.4° by 2100. SSP5-8.5: The IPCC's most pessimistic scenario, where current carbon emissions levels roughly double by 2050. The global economy grows quickly, but this growth is fueled by exploiting fossil fuels and energy-intensive lifestyles. By 2100, the average global temperature is a scorching 4.4° higher.

2.3 The effectiveness of our oceans as a carbon sink is deteriorating

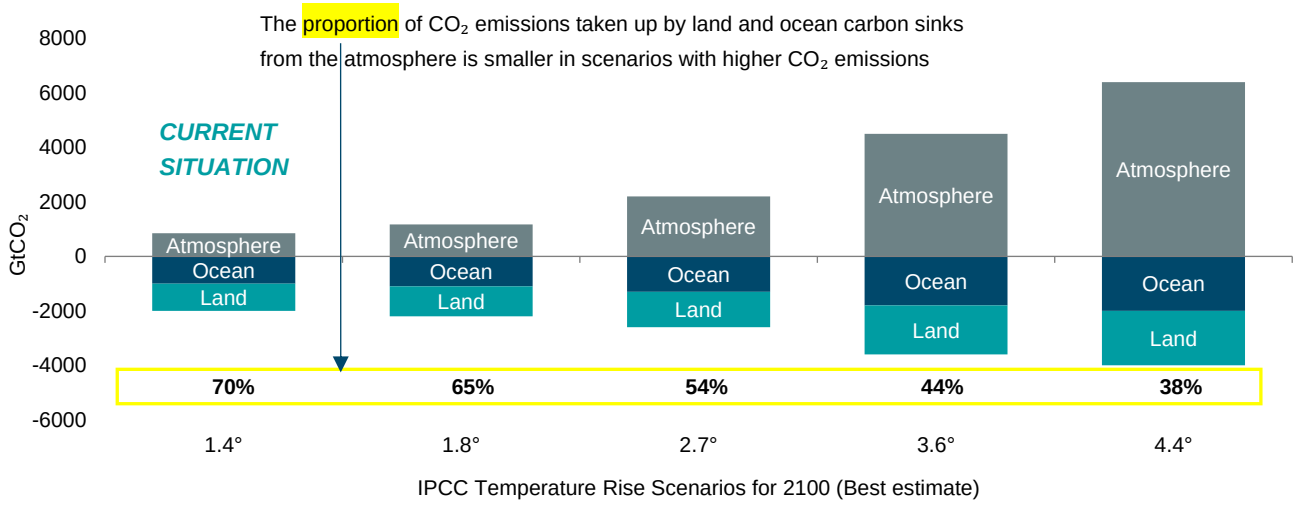
Since past and future greenhouse gas emissions remain in the atmosphere for centuries it will cause ongoing climatic events especially when it comes to changes in the characteristics of our oceans, the composition of our ice sheets and ultimately global sea levels. Based on extensive research, upper ocean stratification, ocean acidification and ocean deoxygenation will continue to increase in the 21st century, albeit at rates dependent on future emissions. Net-net, not only do emissions need to be reduced and where possible eliminated entirely, but we must double down on our efforts to protect the oceans given the vital role they play as carbon sinks. Failure to reduce emissions and protect natural sinks like ocean and land pose significant risks to the planet's ability to sequester carbon. In an environment where global emissions keep on rising it will mean these carbon sinks are projected to absorb, in absolute terms, a progressively larger amount of CO_2. However, the

[22] Nature Climate Change (August 2021). Extreme sea levels at different global warming levels
[23] European Environment Agency (June 2021). European sea surface temperature

efficiency with which these carbon sinks sequester CO_2 from the atmosphere will decline. **Figure 9** reveals the projected proportion of CO_2 emissions taken up by land and oceans in different climate scenarios, but, it will also mean a higher proportion of emitted CO_2 remaining in the atmosphere.

Since land and ocean carbon sinks respond to past, current, and future emissions, cumulative sinks from 1850 to 2100 are presented in **Figure 9**. During the period 1850 to 2019, the observed land and ocean sink absorbed 1,430 GtCO2 or 59% of carbon emissions. Since on current trends it is estimated that on current plans the planet is set to warm by approximately 2.9ºC by the end of the century it would imply which our oceans and land ecosystems will only be able to absorb little more than 50% of CO_2 emissions compared to 70% rate of sequestration in a 1.4ºC world. Note that land and oceans are not substantial sinks for other GHGs and hence Figure 8 focuses on carbon dioxide exclusively.

FIGURE 9: THE CHALLENGES ARE EVIDENT; OCEANS AND LAND WILL CONTINUE TO PLAY AN ESSENTIAL ROLE UNDER DIFFERENT SCENARIOS (ALBEIGHT NOT ENOUGH) AND MUST BE PROTECTED



Sources: DWS Research Institute, IPCC Assessment Report 6 (AS6) dated August 2021. The chart shows cumulative CO_2 emissions taken up by land and oceans and remaining in the atmosphere (grey) under the five illustrative scenarios from 1850 to 2100.

So-called blue carbon assets are comprised of mangroves, seagrass meadows and tidal marshes. Since the industrial revolution, oceans and their coastal habitats have been responsible for absorbing approximately one third of the CO_2 emittted by humans into the atmosphere[24]. Scientists estimate that oceans also absorb CO_2 roughly two to four times faster than rainforests, but worryingly these ecoystems are being degraded or disappearing at rates four times faster than rainforests[25]. As a result, oceans and their well-being need to be protected with a matter of urgency given the essential role they play in climate change mitigation.

A recent UNESCO report[26], which examined marine World Heritage sites, found that while representing less than 1% of the global ocean area, these marine sites held 15% of global blue carbon assets and stored approximately 10% of global greenhouse gas emissions in 2018. While the World Heritage List is comprised of 50 unique ocean places across 37 countries, three sites in Australia are home to 40% of these blue cabon assets, with the Great Barrier Reef being the most important. A perhaps lesser known site, off the Balearic Islands in the Mediterranean, is the underwater meadows of Posidonia seagrass. These are the oldest and largest living organisms on the planet, with some meadows 200,000 years old, and which capture carbon 15 times more powerfully than a similar sized plot in the Amazon[27].

[24] Biogeosciences: Khatiwala S. et al (April 2013). Global ocean storage of anthropogenic carbon
[25] UNESCO (April 2021). IOC scales up efforts to protect the global blue carbon assets
[26] UNESCO (March 2021). Marine World Heritage (2021). Custodians of the globe's blue carbon assets
[27] BBC (March 2021). Climate change: 'Forever plant' seagrass faces uncertain future

3 / Threats and solutions for our oceans

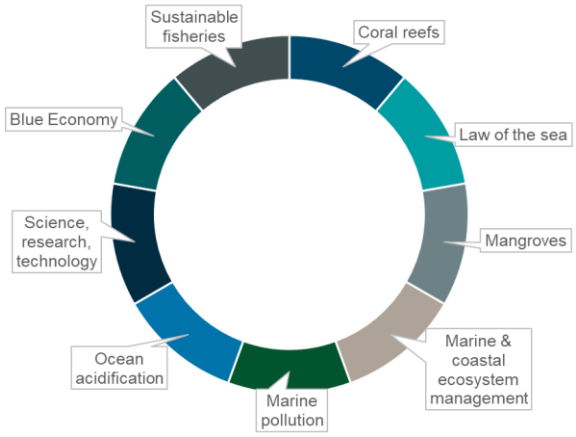
The forces endangering our oceans and the remedial actions required

The main factors affecting the health of our oceans and coastal habitats are:

A. Climate change: Rising water temperatures and acidification
B. Destruction of coastal habitats: Fish farms, demand for firewood
C. Plastic waste: Marine pollution and photosynthesis impacts
D. Chemical run-off: Methane release and eutrophication
E. Overfishing: Predator-prey imbalance, algae blooms and ocean debris
F. Whale hunting and ship strikes: Phytoplankton growth impact

Combined these factors are changing the ability of our oceans to absorb CO_2, which is consequently altering the oceans' role as a carbon sink. According to one report[28], 87% of the area of the ocean has been modified by the direct effects of human activities and most of these to the detriment of this ecosystem. This human interference is illustrated by the fact that at least 55% of the ocean area is covered by industrial fishing, 33% of fish stocks are overfished and 50% of the coral reef system has been destroyed[29]. The 'Communities of Ocean Action', **Figure 10,** illustrate other areas where action is necessary to improve oceans. Our recommendations are closely aligned with these areas of action.

FIGURE 10: COMMUNITIES OF OCEAN ACTION



Source: UN Ocean Conference 2020, Communities of Ocean Action: Implementation of SDG 14

If left unchecked, blue carbon ecosystems could ultimately become carbon emitters amplifying an already exponential rise of carbon in the atmosphere. While we are not there yet, **it is estimated that since the 1940s, loss of carbon sink within mangroves range up to 50% around the world[30]. This assumes significance because mangroves contribute approximately half the estimated total blue carbon sequestration[31]**. To help preserve and restore our oceans health these six factors need addressing.

A. Problem: rising water temperatures and acidification

With more CO_2 in the atmosphere, oceans are working even harder to absorb it. This is affecting the chemical composition of the oceans' water which is becoming more acidic which in turn is affecting the future efficacy of CO_2 absorption. This process of acidification is affecting marine organisms, by inhibiting the forming of shells and skeletons, and is responsible for coral bleaching.

Rising ocean temperatures are also leading to the greater frequency, intensity and duration of marine heatwaves. This refers to periods of above normal water temperatures. Among other things, these events increase the mortality of kelp forests and other coastal vegetation[32]. In 2011, for example, a marine heatwave killed a third of Shark Bay seagrass, one of the three most important marine areas in Australia[33].

[28] Current Biology (July 2018). The location and protection status of Earth's diminishing marine wilderness
[29] WEF (January 2020). Nature Risk Rising
[30] The Ecological Society of America (June 2011), A blueprint for blue carbon
[31] PLOS ONE Publication (September 2012), Estimating Global "Blue Carbon" Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems
[32] Cheung W., Froelicher T. (April 2020). Marine heatwaves exacerbate climate change impacts for fisheries in the northeast Pacific
[33] Nature (March 2018). A marine heatwave drives massive losses from the world's largest seagrass carbon stocks

As air temperatures rise due to climate change, the melting of arctic sea ice implies more radiation is being absorbed by sea water which is disrupting ocean currents and causing sea level rise. Altering ocean temperatures are affecting the migratory routes of marine species and having an impact on the level of invasive species particularly in the Arctic and southern Oceans with disruptive effects on commercial fish stocks.

Another side-effect of oceans warming is that it causes increased levels of evaporation and potentially more destructive hurricanes and typhoons most notably in the eastern Atlantic and central Pacific[34].

Rapidly cutting emissions is the most important action to stave off extreme temperatures and catastrophic ocean acidification.

B. Problem: Destruction of coastal habitats

Estimates suggest the size of the world's tidal marshes has declined by 29% since the beginning of the century[35]. The world has lost 29% of its seagrass meadows over the last century[36] and the area of the world covered in mangroves has declined by between 20-35% over the last 50 years[37]. Just as climate change has contributed to the loss in vegetated coastal habitats, another factor of coastal habitat destruction has been the conversion of these areas to other uses such as fish farms and their harvesting for firewood.

Some solutions such as Marine Protected Areas for creating positive financial value for protecting coastal habitats, can also be deployed to slow or reverse coastal habitat destruction.

C. Problem: Plastic waste: Marine pollution and photosynthesis impacts

If we continue on our current path, by 2050, it is estimated that there will be more plastic than fish in the sea, in volume terms. This reflects the fact that eight million tonnes of plastic waste leaks into the world's oceans every year and that plastic pollution at sea is forecast to double by 2030[38].

The FAO estimates that 10% of ocean plastic is made up of the plastic used in ropes, nets and lines in the fishing industry[39]. Another report found that as much as 70% of macro-plastics, defined as over 20cm in size, found floating at the surface of the ocean were related to fishing activities[40]. And that at least 46% of the Great Pacific Garbage Patch is made up of fishing gear[41]. Most ocean plastic sinks to the ocean floor: less than 1% of the total plastic volume is seen as floating plastic debris[42].

As this plastic breaks down, through sunlight and heat, it releases methane and ethylene two gases which contribute to global warming.

Another factor aggravating the oceans role as a carbon sink is the ingestion by plankton of microplastics which alters the efficiency of photosynthesis and so worsening plankton's ability to sequester carbon dioxide from the atmosphere[43].

D. Problem: Chemical run-off and pollution: Methane release and eutrophication

It is estimated that 80% of the world's wastewater is returned to the environment untreated[44]. Untreated sewage is a source of methane, which has approximately 84 times more warming potential than CO_2[45].

The agricultural sector is one of the major contributors to water pollution globally. This pollution comes in the form of fertilizers and pesticides for crops (nitrates and phosphates) as well as veterinary medicines such as hormones and antibiotics for livestock. Nitrate pollution diminishes the carbon sequestration capacity of coastal habitats such as salt marshes. Globally around 115 million tonnes of mineral nitrogen fertilizers are applied to croplands each year[46]. A fifth of these nitrogen inputs

[34] NOAA (May 2020). Climate change has beeninfluencing where tropical cyclones rage
[35] Ocean Health Index (Seagrass)
[36] Smithsonian Ocean Portal, Reynolds P. (March 2018). Seagrass and seagrass beds
[37] Goldberg L., Lagomasino D., Thomas N., Fatoyinbo T. (June 2020). Global declines in human-driven mangrove loss
[38] WEF (January 2016). The New Plastics Economy. Rethinking the future of plastics
[39] FAO (2021). Our oceans are haunted. How "ghost fishing" is devastating our marine environments
[40] Lebreton et al (2014). Plastic pollution in the world's oceans: More than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea
[41] Lebreton et al (2018). Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic
[42] Nature (January 2021). Seagrasses provide a novel ecosystem service by trapping marine plastics
[43] January 2017. Toxic effects of microplastic on marine microalgae Skeleonema costatus: Interactions between microplastic and algae
[44] CDP (April 2020). Cleaning up their act
[45] Each greenhouse gas has a different global warming potential (GWP) and persists for a different length of time in the atmosphere. The three main GHG and their 20-year GWP are carbon dioxide, methane and nitrous oxide
[46] FAO (April 2018). More people, more food, worse water? A global review of water pollution from agriculture

accumulate in soils and biomass, while 35% enter the oceans. Excessive levels of nutrients in run-off contaminate rivers, lakes and ultimately oceans which is not only a threat to human health, but also causes eutrophication. This relates to excessive levels of nutrients in the water which stimulates the build-up of algae blooms starving aquatic water systems of light and oxygen, or so-called dead zones.

In the past 50 years, the number of ocean areas where oxygen levels are too low to support marine life have increased four-fold such that today there are now around 400 dead zones with a combined area greater than that of the UK[47].

Another factor responsible for the increasing pollution of the seas and oceans is the disposal of bilge water from vessels. While governed by the International Convention for the Prevention of Pollution from Ships (MARPOL), certain marine areas of the world remain dumping grounds for waste products.

E. Problem: Overfishing: Predator-prey imbalance, algae blooms and ocean debris

It is estimated that of the world's assessed fisheries, approximately one-third are overfished. This means that the number of fish being caught is above the reproductive rate leading to a decline in fish stocks over time. Over the last thirty years, the amount of fish eaten has risen by 122%, most of which has come from aquaculture (527% growth), which is heavily dependent on wild fisheries as a source of feed[48].

Academic research found that 63% of fishery subsidies (USD 22bn), encourage unsustainable or illegal fishing[49] by funding construction of new fishing vessels or reducing the cost of fuel.

Overfishing upsets the natural balance of marine ecosystems. Just as chemical run-off encourages algae blooms, one study revealed where top-predatory fish populations in the Baltic Sea were overfished, it allowed mid-level predator populations to increase rapidly. The mid-level predators feed primarily on algal-eating species such as snails and crustaceans. As a result, the balance within the marine ecosystem is disrupted, allowing algae blooms to flourish. Feeding primarily on algal-eating species such as snails and crustaceans, marine ecosystems' balance allowing algae bloom to flourish[50].

UN reports recognise the role of modern slavery in the fishing industry but there are few reliable estimates of its prevalence. Individuals can be lured into seemingly legitimate fishing employment but are then unable to leave due to threats of violence, physical confinement, withholding of wages and debt from recruitment. The Global Slavery Index initiative[51] has documented the factors that contribute to modern slavery finding that the fishing industries in China, Japan, Russia, Spain, South Korea, Taiwan, and Thailand are particularly at risk. These countries generate 39% of the world's fishing catch. Low risk is seen in Denmark, Iceland, Norway, and the US that only generate 12% of the world's fishing catch.

A DWS chart of the week[52] from August 2021 documented how indigenous peoples number close to 500 million people across 90 countries and live in or manage 40% of the world's land which represents 80% of the globally remaining biodiversity. This land will include many fisheries and key ecosystems affecting the oceans. If we want better protection of the climate, biodiversity and the world's oceans, it is necessary to enable a better future for indigenous peoples to be ecological defenders. A key challenge to this goal is that 15% of the world's poorest people are indigenous peoples.

F. Problem: Whale hunting and ship strikes: Phytoplankton growth.

The rules governing whale hunting originated under the Convention for the Regulation of Whaling signed in 1946 and supervised by the International Whaling Commission. While commercial whaling was banned in 1986 some countries such as Japan and Norway still operate whale hunting fleets. This hunting is harmful to ocean health.

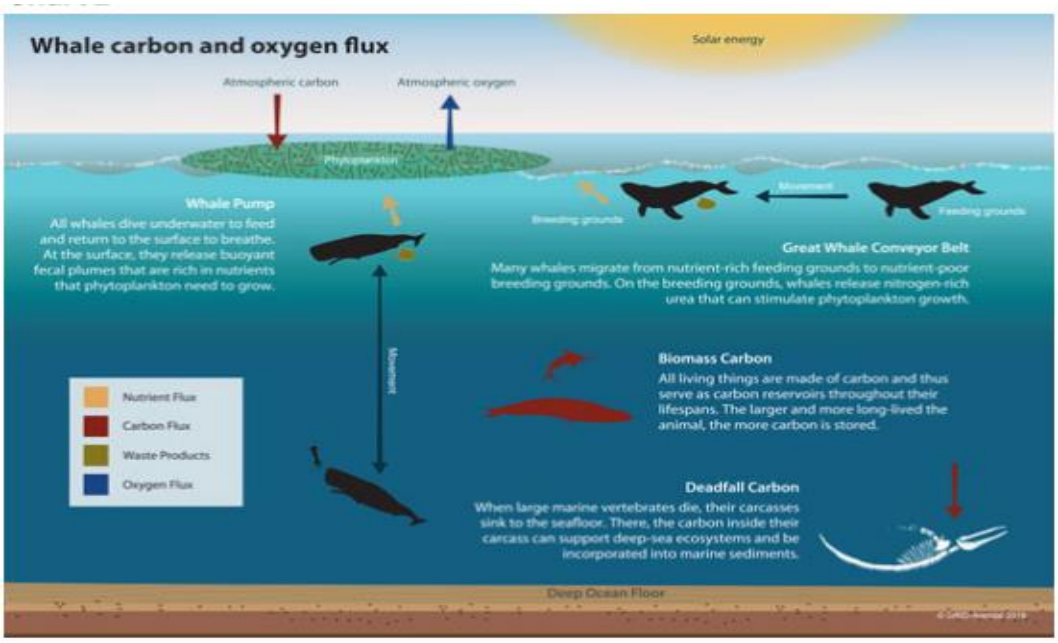
The IMF recently summarised marine biologists' research that whales, especially great whales, play a significant role in capturing carbon from the atmosphere[53]. This reflects the fact that whales' waste products contain exactly the substances,

[47] WEF (2020) Nature Risk Rising
[48] FAO (2020). State of World Fisheries and Aquaculture www.fao.org/state-of-fisheries-aquaculture
[49] UBC 2018
[50] Nature (October 2009). Overfishing linked to algal blooms
[51] Global Slavery Index (2018) www.globalslaveryindex.org/2018/findings/importing-risk/fishing/
[52] DWS (2021) From victims to ecological defenders www.dws.com/en-gb/insights/cio-view/charts-of-the-week/cotw-2021/chart-of-the-week-20210806/
[53] IMF (December 2019). Nature's solution to climate change

notably iron and nitrogen, phytoplankton need to grow. In addition, whales bring minerals up to the ocean surface through their vertical movement, called the “whale pump,” and through their migration across oceans, called the “whale conveyor belt.”, Whales have a multiplier effect of increasing phytoplankton production wherever they go, **Figure 11**.

Preliminary modelling and estimates indicate that this fertilizing activity adds significantly to phytoplankton growth in the areas which whales frequent. Even a 1 percent increase in phytoplankton productivity thanks to whale activity would capture hundreds of millions of tons of additional CO_2 every year, equivalent to the sudden appearance of 2 billion mature trees.

FIGURE 11: THE ROLE OF WHALES IN MARINE ECOSYSTEMS



Source: IMF (December 2019). Nature’s solution to climate change

A conservative estimate puts the **value of the average great whale, at more than USD 2 million, and easily over USD 1 trillion for the current stock of great whales**.

Continued recovery of whales may help to buffer marine ecosystems from destabilizing stresses. As long-lived species, they enhance the predictability and stability of marine ecosystems[54].

[54] The Ecological Society of America (September 2014). Whales as ecosystem engineers

4 / Investor action agenda

The ocean covers around 70% of planet earth. For centuries it has been used as a 'free resource' for our economic activities. It is also been used as a 'dump' for our waste. Because of the vast size and little governance over it, humans were able to dump in the oceans much of what could not be economically made good again. This is essentially the reason why 80% of wastewater is untreated. Still the damage we are creating is reaching critical points. The point of this report is to say that rather than starting by looking at uneconomical solutions for carbon capture, we should start by looking after the existing natural tanks. This will require action across multiple stakeholders such as investors, policymakers and NGOs.

FIGURE 12: RECOMMENDATIONS FOR PROTECTING THE OCEANS

Action points	Role of the government	Role of the private sector
Expansion of marine protected area	✓✓	✓
Conservation zones	✓✓	✓
Legally protect coastal areas	✓✓	✓
Banning harmful practice	✓✓	✓
End offshore fossil fuel exploration	✓✓	✓
Mandatory treatment of wastewater	✓✓	✓
Sustainability/carbon tax for ocean restoration	✓✓	✓
Systematic investor engagement	✓	✓✓
Business case to support coastal ecosystems	✓	✓✓
Plastic use	✓	✓✓
Sustainable and people friendly fishing	✓✓	✓✓
Foster Blue Economy	✓✓	✓✓
Greening shipping	✓✓	✓✓

✓✓ indicates leadership role in the implementation of the action points while
✓ indicates supportive or enabling role towards implementation of the action points
For example, the private sector can work towards making protection of ocean ecosystems financially viable, but the government will need to play an enabling role in the form of regulation, taxation, incentives or blended finance

Source: DWS Research Institute, October 2021

Recommended action for Governments:

1) **Expanding marine protected areas to 30% of the oceans by 2030**. This idea is part of the draft outcome of the negotiations on a new global biological framework[55] and the UN Global Ocean Treaty, currently under negotiation. This would represent a significant increase in the size of protected areas today, which amount to just 7%[56]. We think that there is a good chance for this idea to be agreed – but pressure from investors and progressive companies on governments to make and implement these commitments is necessary.

2) **Creating 'conservation zones' for countries and companies to sustainably manage fisheries as a common resource**. The UN Convention on the Law of the Sea (UNCLOS) is an international treaty that was signed in 1982. One of its main provisions is to give countries property rights up to 200 nautical miles from their shore. Beyond this zone are

[55] CBD (2021) https://www.cbd.int/article/draft-1-global-biodiversity-framework
[56] WEF (March 2021). Protecting the ocean is key to fighting climate change

the high seas to which no sovereign country can claim independent jurisdiction. This creates the problem for fish and ocean wildlife as there is no formal law to provide protection and conservation. To address this challenge, it has been proposed[57] that conservation zones could be created and managed by an international trustee of the UN to sustainably manage resources on the high seas. All countries could benefit from sustainable production instead of an erosion of fisheries. Trade sanctions could potentially be a tool to enforce the rules of the conservation zones. While there would be significant issues and questions on implementation, the need to protect fisheries is so great that approaches like this are needed. Companies and financial institutions supportive of sustainable oceans, will likely have to put significant pressure on countries to negotiate arrangements.

3) **Legally protect coastal areas like wetlands.** Recognising the legal rights of nature is another important priority. Ecosystems like wetlands, mangroves, coral reefs and kelp forests can capture carbon, provide fish habitats, support local livelihoods with tourism and fisheries, reduce coastal erosion and the impacts of sea level rise. A Universal Declaration of the Rights of Wetlands has been proposed[58]. Similar legal protections are needed in all countries to ensure remaining habitats are protected and restored.

4) **Banning harmful practices (i.e. bottom trawling, sea-bed mining, whale hunting, shark finning); ending perverse fishing subsidies**

Bottom trawling: Scientific research[59] published in Nature found that fishing fleets that drag weighted nets along the ocean floor (bottom trawling) is responsible for one gigaton of carbon emissions per year – higher than pre-pandemic aviation emissions, as well as being very damaging to ocean ecosystems. Bottom trawling is one of the least cost-effective fishing methods as there is very little left to catch in some areas. Bottom trawling should therefore be banned.

Sea-bed mining: The International Seabed Authority (ISA) is mandated through the UN Convention on the Law of the Sea to regulate mineral-related activities in the international seabed. Up until now, licenses given for seabed exploration have been undertaken for environmental study purposes and not for commercial reasons. However, with the demand of rare earth metals and other highly-prized metals such as cobalt and platinum increasing, this has raised calls for the development of seabed mining. However, the impact of large mining operations and commercial extraction of the deep sea, in excess of 200 metres, threatens marine ecosystems.

Given the likely lead times in terms of permits and approvals, it is thought commercial seabed mining could occur from 2026. However, with lengthy negotiations relating to the governance in this area with the ISA, a small island state in the Pacific Ocean, Nauru, which has partnered with a company and has called the “two-year trigger” rule which requires on the ISA to speed up negotiations relating to deep sea mining. This would mean the possibility of a mining permits being lodged as soon as 2023[60].

Due to concerns about the impact of deep-sea mining, several vehicle, battery and electronics manufacturers joined WWF in calling for a moratorium on seabed mining. However, the mining company commissioned analysis which concluded that the life-cycle environmental and social impacts of deep-sea mining are lower than land-based mining[61]. The Sustainable Blue Economy Finance Principles include a precautionary approach when scientific data is not available. Thus, due to the uncertainties of the damage caused and any benefits of seabed mining, a precautionary approach is needed and thus a moratorium on seabed mining should be instituted.

Whale hunting: Regrettably the signs for enforcing increased whale protection are not promising. In July 2019, Japan resumed commercial whaling having left the International Whaling Commission at the end of 2018[62]. In Norway, the country’s

[57] McGuire, Chad (2003) UNCLOS and the high seas: problems and suggested solutions to the creation of a common pool resource
[58] Davies et al (2021) Towards a Universal Declaration of the Rights of Wetlands *Marine and Freshwater Research 72* www.publish.csiro.au/mf/pdf/MF20219
[59] Nature (January 2021) - Dredging up fish dinners does lasting damage to the sea floor
[60] The Economist (July 2021). Deep sea mining may be a step closer to reality
[61] Jamasmie, Cecilia (April 2021) www.mining.com/deep-green-hits-backs-at-firms-opposing-seafloor-mining
[62] Ministry of Foreign Affairs of Japan (December 26, 2018). Statement by chief Cabinet Secretary

Minister of Fisheries and Seafood announced that country's self-determined annual quota of 1,278 whale kills would be unchanged from the previous three years[63].

Due to the climate benefits of whales and their broader biodiversity benefits, we believe investors should join together in calling for Iceland, Japan and Norway to end whaling.

Shark finning[64]: Sharks, while being among the fiercest predators in the ocean, also show the most vulnerability. Three-quarters of open-ocean shark and ray species are threatened with extinction, primarily because of overfishing. For years, scientists have warned that these plummeting numbers could be catastrophic. Because sharks are top predators that help keep the food web in check, it would logically follow that they are keystone species—species that have a disproportionately large effect on their ecosystems. Without keystone species, ecosystems change or even disappear. Shark Bay research has shown that sharks support their ecosystems not necessarily as hunters, but as regulators. By keeping their environments stable and resilient, sharks could help slow climate change and dampen the effects of extreme weather events, such as heat waves and hurricanes.

Despite the importance of sharks in maintaining the balance in the ocean ecosystems, nearly 100 million sharks are estimated to be killed each year. The real figure could be anywhere between 63 and 273 million sharks each year. The shark fin trade accounts for around 73 million shark mortalities every year. It is difficult to say exactly how many sharks are left as counting ocean populations is challenging, but, it is known that some shark populations have experienced significant declines – some in excess of 90%. Ending shark finning is thus a key priority.

Perverse fishing subsidies: The draft outcome of the negotiations on a new global biological framework calls for biodiversity harming subsidies to be phased out. While this is welcome, some caution is in order as G7 governments have agreed on the need to phase out fossil fuel subsidies since 2009 and yet there are still at least US$100bn in subsidies for fossil fuels[65].

5) End new offshore fossil fuel exploration and production, including in the arctic

The International Energy Agency's net zero pathway concludes that beyond projects already committed as of 2021, there should be no new oil and gas fields approved for development[66]. These conclusions are also supported by academic research published in *Nature* in September 2021. To have a 50% chance of keeping temperatures below 1.5°C, nearly 60% of oil and gas, and 90 per cent of coal must remain unextracted with oil and gas production declining 3% per year. To have a greater chance of keeping the temperature increase below this level will likely require stronger reductions.

Investors have a role to encourage companies to voluntarily adopt such targets and cease new exploration and production, but governments have key responsibility to cease providing approvals for new exploration and production.

6) All wastewater must be treated. Stronger effort is required to reduce agricultural water pollution

Since the agricultural sector is the main culprit in chemical run-off and water contamination in rivers, tributaries and oceans, efforts to improve farming practices are critical. This can include improving animal feeding operations, reducing overgrazing and over-ploughing, and introducing a more efficient use of pesticides and fertilizers.

Governments have a key role to play in regulating and enforcing all manner of companies to reduce their water use and pollution. As well, many water utility companies are publicly owned thus governments need to ensure that proper practices and technologies are used.

[63] Orca 2021 www.orcaweb.org.uk/our-work-orca-news/item/norway-set-2021-whaling-quota
[64] National Geographic www.nationalgeographic.com/animals/article/surprising-ways-sharks-keep-the-ocean-healthy and WWF www.wwf.sg/get_involved/say_no_shark_fin/
[65] ODI (2018) www.odi.org/en/publications/g7-fossil-fuel-subsidy-scorecard-tracking-the-phase-out-of-fiscal-support-and-public-finance-for-oil-gas-and-coal
[66] IEA (May 2021) www.iea.org/reports/net-zero-by-2050

An estimated 80% of the world's wastewater is returned to the environment untreated[67]. CDP found that more than half of the 2,934 companies reporting, are monitoring the quality of their wastewater discharges but only 4.4% of businesses are reporting progress against water pollution reduction targets. Investors with over US$110 trillion in assets are requesting companies to disclose on water through CDP in 2021. Companies already disclosing are also encouraged to request key suppliers to report on their water impacts and risks and collaborate in building sustainable value chains.

For instance, Ceres' report "Feeding Ourselves Thirsty"[68] evaluated 40 food companies within four industries with the highest exposure to water risks: Agricultural Products, Beverages, Meat and Packaged Foods. This group includes some of the largest U.S.-based and publicly traded companies, as well as a small number of large private and non-U.S. companies. While company performance had improved over the prior two assessments, there is still a significant gap. DWS's Research Institute team is partnering with Ceres' Valuing Water Initiative to develop further analysis of the materiality of water risk. These and other initiatives are vital to accelerate the agribusiness sector's adoption of more sustainable practices.

7) Ensure shipping & marine industries pay-up for the damage created by their operations and/or internalize environmental externalities

Maritime shipping transports between 80-90% of the world's goods[69], is comprised of just over 98,000 commercial ships[70] which in 2018 contributed 2.9% of global CO2 emissions[71]. In addition, ships also release pollutants including bilge dumping, that is the illegal discharge of contaminated wastewater at sea. The IMO, the UN's regulatory agency for the sector, set a target of cutting GHG emissions from the sector by 50% below 2008 levels by 2050[72]. The ways to achieve this will span from energy efficiency, carbon taxes and the adoption of zero carbon fuels[73]. So far, the focus has been on the reduction in the sulphur content of maritime fuels from 2020[74]. The next step is now focused on CO_2 emission reduction.

One proposal from the IMF to help decarbonise the sector is the introduction of a carbon tax or fuel levy on international maritime fuels. In addition, from 2023, the shipping sector will be added to the EU's emission trading scheme[75].The shipping industry itself has set out how a mandatory global tax on fuel consumed could operationally work. However, the shipping industry only proposes a modest carbon tax with revenues used to fund research and development that would push the sector towards zero-emissions vessels from 2030[76].

We think there is a case for a broader tax across marine industries to address the multiple negative sustainability impacts and to fund ocean restoration such as collecting ocean plastics.

8) Introduce a tax for investment funds that are not effectively dealing with any of the environmental damage caused by their investee companies

Our report *"A transformational framework for water risk"*[77] set out our analysis for what is required for investors to shift from an ESG financial risk management approach of single materiality to a double materiality focus on real world environmental and social improvements. One of our recommendations is to ensure that investment funds that truly help society in managing sustainability problems, should have lower fees than funds that just adopt an ESG risk management approach.

A tax on 'do nothing' funds would tilt the playing field by ensuring sufficient quality and quantity of stewardship and policy advocacy. There are multiple questions about how such a tax could be implemented but we think the sustainable finance public policy debate needs to include a tax on investment funds to incentivize sufficient stewardship activity. As one potential

[67] CDP (2021). Global Water Report 2020 - CDP
[68] Ceres (January 2020). Feeding ourselves thirsty feedingourselvesthirsty.ceres.org/
[69] OECD (2018). Ocean shipping and shipbuilding https://www.oecd.org/ocean/topics/ocean-shipping/
[70] UNCTAD (2020). Review of Maritime Transport 2020. At the beginning of 2020, the total world fleet amounted to 98,140 commercial ships of 100 gross tons and above
[71] RMI Shipping efficiency Shipping Efficiency - RMI
[72] International Maritime Organisation (2018). IMO action to reduce greenhouse gas emissions form international shipping
[73] UNFCCC (March 2021). Shipping needs 5% zero-carbon fuels by 2030 to meet green goal
[74] IMO (December 2019). IMO 2020 – cleaner shipping for cleaner air
[75] Reuters (July 2021). EU proposes adding shipping to its carbon trading market
[76] Freight Waves (December 2019). Shipping unveils blueprint for collecting future carbon tax
[77] DWS Research Institute (December 2020) www.dws.com/insights/global-research-institute/a-transformational-framework-for-water-risk

guide to the magnitude of an appropriate tax, Willis Towers Watson suggested that asset owners and managers should be voluntarily allocating a quarter of a basis point of every asset managed, to stewardship[78].

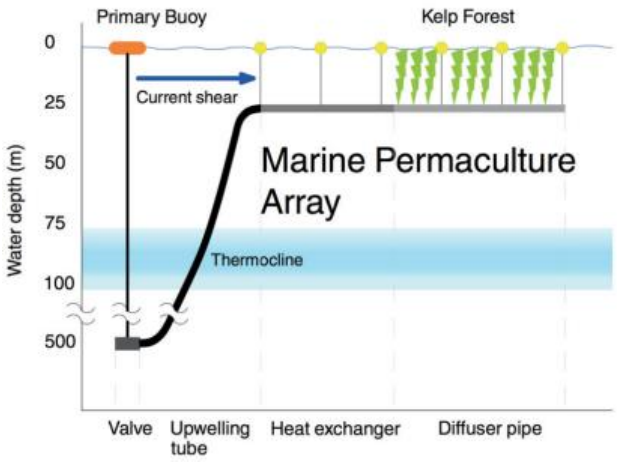
Recommended joint action by the public and private sectors:

9) Facilitate a business case for corporates, investors, banks and insurers to support floating kelp forests, protect & restore mangroves, coral reefs, seaweed, and wetlands

Protecting and restoring coastal habitats like mangroves, wetlands, coral reefs, seaweed and kelp forests can have multiple benefits. These ecosystems can support local fisheries, are essential areas of marine biodiversity, can improve defence against sea level rise and flooding, capture carbon, improve water quality and oxygen content and can boost new income opportunities for coastal communities which may, in turn, help relieve pressure of overfishing.

These positive externalities need to be part of the business case for governments, investors, banks, insurers and companies to invest in protecting and restoring key coastal ecosystems.

FIGURE 13: MARINE PERMACULTURE ARRAYS



Source: Climate Foundation 2020

Marine Permaculture Arrays, **Figure 13** are one interesting way to support expansion of kelp forests. These are lightweight latticed structures roughly half a square mile in size, submerged 80 feet (27 meters) below sea level, to which kelp can attach. Kelp growth can be encouraged further by attaching buoys which rise and fall with the waves, powering pumps that bring up colder, nutrient-rich waters from deeper oceans levels. As kelp soaks up the nutrients and grow, it helps establish an area rich in plant and animal life. These floating kelp forests can sequester carbon dioxide, while providing food, feed, fertilizer, fibre, and biofuels to the world.

Results to date[79] indicate that a marine permaculture array that covers one square kilometre could produce 3,000–10,000 tonnes of kelp for food and fertiliser, yield hundreds of tonnes of fish, and sequester up to 10,000 tonnes of CO_2 per year.

Other initiatives have included work by the Nature Conservancy partnering with a group of hotels in Mexico to create a trust fund for maintaining and restoring coral reefs[80]. SwissRe helped them create the first parametric insurance product for a coral reef. Willis Towers Watson developed the Global Ecosystem Resilience Facility to scale up this type of insurance.

Another innovative example of coastal protection comes from the Conservation International and Colombian mangrove conservation project which has issued carbon credits under the Verified Carbon Standard. This has brought mangrove forests into direct contact with global carbon markets and so altering the economic value of a mangrove, which previously was worth more dead than alive.

Restoration of mangroves is another important priority. Restoring 700,000 hectares of mangroves across 25 countries, might cost over US$11bn over twenty years but capture 380 million tonnes of carbon by 2040, improve flood protection and restore coastal ecosystems[81]. DWS is a member of the Climate Finance Lab. One of the Lab's endorsed projects is the Restoration Insurance Service Company[82] (RISCO) which is seeking to create new revenue streams for mangrove conservation and

[78] Willis Towers Watson (April 2019) www.willistowerswatson.com/en-GB/insights/2019/04/investor-stewardship-one-hand-on-the-wheel
[79] The Economist Group World Ocean Initiative (March 2020). Trillion trees initiative, meet ocean forests; Climate Foundation 2020
[80] The Nature Conservancy (December 2020). Launch of the Coastal Zone Management Trust, Quintana Roo, Mexico / New York Times (December 2020). A race against time to rescue a reef
[81] Earth Security March 2021. Financing the Earth's Assets: The Case for Mangroves - Earth Security
[82] Climate Finance Lab 2019 - https://www.climatefinancelab.org/project/coastal-risk-reduction/

restoration by incorporating mangroves' risk reduction value into insurance products and monetizing the mitigation value through blue carbon credits with a pilot in the Philippines.

Additionally, there is increasing interest in the growth in seaweed production for human food, animal feed and biofuels. According to the World Bank, regenerative ocean farming of seaweeds in an area less than 5% of US waters could absorb 10 million tonnes of nitrogen and 135 million tonnes of carbon. As a result, not only helping to reduce nitrogen based agricultural pollution, but also the potential of using carbon credits to improve the profitability of the seaweed business[83].

Recommendations for the private sector

10) Investors should embed ocean sustainability in systemic engagement and policy advocacy, focusing on companies with the highest oceans impact:

Transforming society's approach to the oceans is no different than the challenges we face with regard to other social or environmental priorities. It requires investors to have a transformative investment framework. Our report *"A transformational framework for water risk"*[84] set out our analysis for what is required so sustainably address water risk. A similar approach is required to address the sustainability of the oceans.

If investors are to accelerate society's progress towards ocean sustainability, investors will be required to move beyond an 'outside-in' focus on financial risk management and towards an 'inside-out' focus of using investor influence and capital for positive change. Many of the conclusions of our water risk paper are equally valid for ocean sustainability, for instance:

_ Ensuring the correct alignment of roles along the investment chain by managing the many conflicts of interest towards separating responsibilities for legislation, accounting and investing
_ Avoiding placing too much onus on investors (who are not scientists or human rights experts) to identify, measure, manage and influence all manner of sustainability risks. Companies, countries, and the accounting profession must take greater responsibility for better measuring the true sustainability impacts on the economy
_ The importance of government legislation, regulation, and pricing of social/environmental externalities since investors do not have the ability or right to pull such levers for change

In parallel to DWS's transformational investment framework, other commentators have correctly set out that addressing sustainability issues requires a different approach[85]. Managing company and portfolio level financial risks by tilting portfolios only shifts the problem, while company by company engagement does not address systemic risks. Systemic risks and externalities negatively impact the return of many asset classes. It is therefore in the interest of asset owners and beneficiaries to truly address systemic problems like climate and ocean sustainability. This is a costly challenge that the investment industry and governments need to work together to enable investors to use their full ability to accelerate societal transformation.

Ocean 100

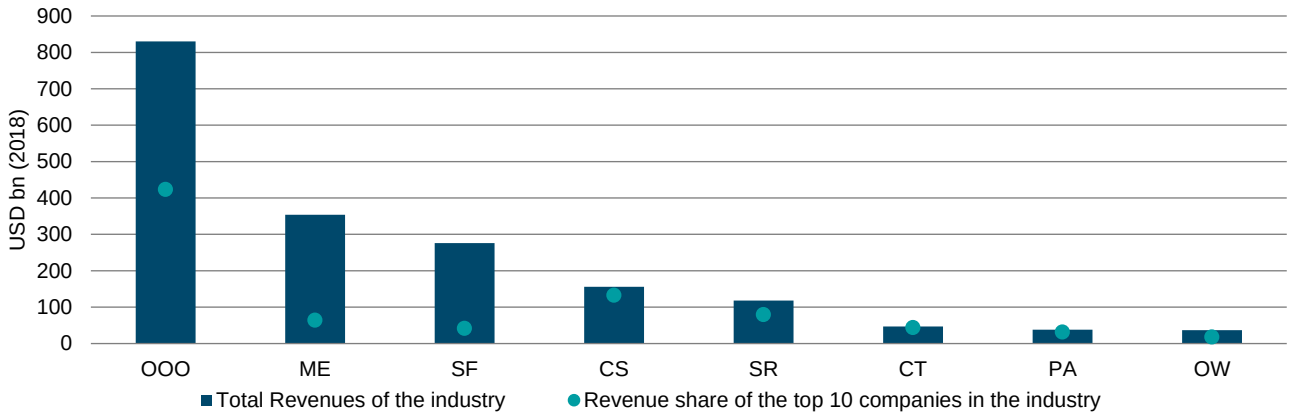
Research studies have analysed the companies with largest revenues linked to the ocean. The research[86] looked at eight industries which OECD has defined as core to the ocean or blue economy. **Figure 14** examines these industries in terms of size (revenue) and market concentration. We find that the size of the top ten companies captures a large proportion of the total industry, with the exception of the seafood and marine equipment and construction industries.

Across the industries assessed here, the top 100 companies (i.e., the "Ocean 100") generated a total of USD 1.1 trillion in revenues in 2018, representing 60% of the total revenues of USD 1.9 trillion generated by these ocean industries. Furthermore, sixty of the top 100 companies are publicly listed on stock exchanges (though several are majority state-owned). Since there is such a concentration of large, listed companies dominating the ocean economy means there is opportunity for forceful engagement enabling fast-track conversations about ocean stewardship. Given their size and

[83] World Bank (2016). Seaweed aquaculture for food security, income generation and environmental health in tropical developing countries
[84] DWS Research Institute (December 2020) www.dws.com/insights/global-research-institute/a-transformational-framework-for-water-risk
[85] Preventable Surprises 2021;
[86] Virdin et al. (2021), Science Advances www.science.org/doi/10.1126/sciadv.abc8041

influence, voluntary sustainability commitments by the Ocean 100 could set new industry norms and accelerate transformation towards sustainability and support governments in enacting regulations. The concentration is also in specific parts of the world. Half of all revenues end up in just seven countries: the USA, Saudi Arabia, China, Norway, France, the U.K. and South Korea. Chinese companies among the Ocean 100 are predominantly involved in offshore oil and gas, shipbuilding, port operations.

FIGURE 14: MAJOR INDUSTRIES WITHIN THE OCEAN ECONOMY



OOO: Offshore oil & gas; ME: Marine equip & construction; SF: Seafood; CS: Container shipping; SR: Shipbuilding and repair; CT: Cruise tourism; PA: Port activities; OW: Offshore wind
Sources: DWS Research Institute, Virdin et al. 2021, Science Advances (2018)

11) Reduce the use of plastics and carry the costs of collecting floating plastics

An estimated 80% of marine plastic comes from land-based sources, with 50% originating from just five Asian economies: China, Indonesia, the Philippines, Vietnam and Thailand[87]. As economic growth has increased in these countries, so has plastic consumption, which has outpaced the development of effective solid waste management systems. One example of an initiative in the area of waste management and plastics recycling is "Project STOP" which implements a low-cost waste management system in which all households and institutions benefit from collection, and plastics are kept out of the environment. For instance, Project STOP is working with the Indonesian government to reduce the country's ocean plastic levels by 70% by 2025.

Another effort is led by The Ocean CleanUp[88] non-profit organisation which has successfully tested a floating boom to collect ocean plastic as well as a solar powered Interceptor™ to collect plastic in rivers. They aim to deploy Interceptors™ in 1,000 rivers and create a fleet of booms to collect 50% of ocean plastic within five years.

Recent studies have shown how seagrasses, such as the Posidonia meadows in the Mediterranean, play a role in trapping plastic, but it is not yet clear how this may be affecting these aquatic ecosystems[89].

When it comes to addressing the fishing industry's responsibilities for waste plastic fishing nets, the Global Ghost Gear Initiative, launched in 2015, brings together more than 100 members from across the private and public sector to address the problem of abandoned, lost or discarded fishing gear (ALDFG) around the world. GGGI has developed the Best Practice Framework for the Management of Fishing Gear (BPF) provides guidance on how to prevent fishing gear loss. Healthy Seas[90] is another organisation working to address plastic ocean pollution by working with volunteer divers to collect waste fishing nets that kill countless species and breakdown into micro-plastics.

[87] Ocean Conservancy (2017). Stemming the tide: Land-based strategies for a plastic-free ocean
[88] Ocean Cleanup 20201 https://theoceancleanup.com/
[89] Nature (January 2021). Seagrasses provide a novel ecosystem service by trapping marine plastics
[90] Healthy Seas 2021 www.healthyseas.org DWS Group is a sponor of Healthy Seas

There is also a need for a complete overhaul of how plastics are made and how and in what form they enter the global economy. When it comes to replacing fossil fuel derived plastics, the Ellen MacArthur Foundation's New Plastics Economy is an initiative to build momentum towards a plastics system that works. Applying the principles of the circular economy, it brings together key stakeholders to rethink and redesign the future of plastics, starting with packaging.

Currently, more than 500 organisations support the New Plastics Economy Global Commitment[91], including governments and companies representing 20% of all plastic packaging produced worldwide. They have pledged to:

(i) Eliminate all problematic and unnecessary plastic items
(ii) Innovate to ensure that necessary plastics are reusable, recyclable, or compostable
(iii) Circulate all the plastic items we use to keep them in the economy and out of the environment

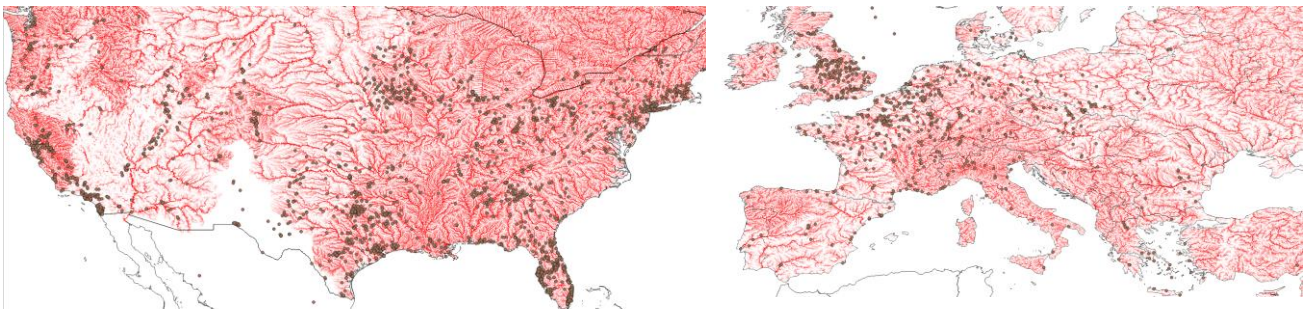
To coordinate this global effort, the Plastics Pact was established that brings together stakeholders at the national and regional level to implement a concrete set of ambitious, time bound local targets. This involves countries such as Australia/New Zealand/Pacific Islands, Canada, Chile, France, the Netherlands, Poland, Portugal, South Africa, US and UK.

Investors have a role to encouraging more plastic using companies to reduce, redesign and eliminate plastic, and to contribute to the cost of cleaning up and collecting ocean plastics by supporting initiatives such as those we have cited. Investors also have a role to encourage governments to set waste management and taxation policies to reduce and properly collect, recycle, and appropriately dispose of all wastes including plastics.

12) Cut corporate water pollution including related to agriculture

To explore the link between land and water pollution and oceans, at DWS Research Institute's request, S&P Trucost explored the potential to show how facilities owned by the 100 largest land and water polluting companies, are near major rivers in the US and Europe as shown in **Figure 15**. As major rivers often end up flowing into the oceans, investor, and regulator pressure on companies to reduce pollution at source is a key action.

FIGURE 15: POLLUTING CORPORATE FACILITIES ARE OFTEN CLOSE TO MAJOR RIVERS



Source: S&P Trucost initial analysis 2020 - deeper red colour indicates a larger river

13) Encourage adoption of sustainable and people friendly fishing practices

The think-tank Planet Tracker has published a series of reports investigating the impact that financial institutions have in financing global wild-catch fisheries and seafood trade. Reports examined the financial implications of a collapse in yellowfin tuna in the Indian ocean, how green bonds can assist the aquaculture industry transitioning to sustainable sources of feed, seafood processing companies, Japanese company practices.

An example of how consumer goods retailers can help drive stronger fishing practices can be seen the growth of Marine Stewardship Council (MSC) labelled products which accounted for over a third of all fish and seafood retail sales in the UK in 2019/20, Responding to growing consumer demand (and likely investor expectations as well), UK retailers collectively

[91] Ellen MacArthur Foundation, UNEP FI (November 2020). The Global Commitment 2020 Progress Report https://www.newplasticseconomy.org/projects/global-commitment

doubled the number of certified own-brand products available to shoppers between 2015/16 and 2019/20. Last year, there were over one thousand MSC labelled products available across all ten leading retailers and own-brand labelled product sales topped 110,000 tonnes, representing nearly 63% of all sales across all sectors[92].

The MSC standards are focused on environmental issues around wild captured seafood but their approach has been expanded[93] starting in 2014 to include a focus on forced labour and modern slavery starting.

Investors have a role in encouraging more consumer goods companies and hotels to use their procurement power and consumer education towards sustainable and people friendly fishing by supporting growth of MSC labelled products.

14) Foster the Blue Economy through the Sustainable Ocean Principles, Sustainable Blue Economy Finance Principles, Science based ocean targets and by deploying advanced 'sea-tech' solutions

The UN Global Compact developed the Sustainable Ocean Principles, which 88 companies across a variety of sectors have signed (as of September 2021). Investors have a role to encourage more companies, particularly those with high revenue reliance on the oceans, to commit to the Principles. UNEP FI developed a parallel set of principles for financial institutions.

The Science Based Targets Network is developing methodologies for nature based, context specific targets that corporates could adopt, building on the success of the Science Based Targets Initiative for emission reduction targets. Methodology development efforts cover biodiversity, oceans, land, and water[94]. There are a number of resources on the SBTN's website to help companies prepare for when methodologies are available. We encourage forward thinking companies to participate in trialling the application of methodologies.

But principles are not enough - outdated technologies and working practices continue to prevail in across marine industries. 'SeaTech' is a term used to refer to marine industry applications of big data, blockchain, biotech and the internet of things technologies. There is good potential for technology developments to help to advance the sustainable oceans agenda. For instance, "Underwater sensors, robots and cameras will reveal sea creatures to catch and avoid, changing ocean conditions and goings-on in farmed fish pens"[95]. Katapult Ocean[96] is an example of an initiative that invests in startup companies that build profitable businesses with a positive impact on oceans. Fish 2.0 is a community of innovators and investors focused on growing sustainable seafood. These types of developments may create private equity investment opportunities. As well, shareholders can encourage companies to adopt SeaTech business strategies as part of companies' sustainability goals.

15) Cleanup offshore oil and gas operations; and cease new exploration and production

Offshore oil and gas dominate the Ocean 100 list of companies with the greatest revenue linked to the oceans. The only corporation from outside that industry to make the top 10 largest companies is a company from the container shipping industry.

The offshore oil and gas industry directly impacts the oceans at multiple stages of its value chain. Many of the largest companies aim to follow good practices to reduce these impacts, but the impacts still exist and are harmful.

- **Oil Exploration**: Seismic Surveys: Seismic surveys, also referred to as 'air gun blasting', are conducted to locate and estimate the size of an offshore oil reserve. In order to conduct surveys, ships use 'airgun arrays' to emit high-decibel explosive impulses to map the seafloor. The noise from seismic surveys can damage or kill marine life. High decibels are known to reduce the presence of zooplankton, impair fish eggs and larvae, and temporarily if not permanently deafen adult and juvenile fish and marine mammals.
- **Drilling and Processing Oil-Drilling Muds**: The process of drilling releases thousands of gallons of polluted water (2,700 tonnes), known as "drilling muds". These muds contain toxic substances like benzene, zinc, arsenic, radioactive materials, and other contaminants used to lubricate drill bits and maintain pressure.

[92] MSC UK and Ireland (2020) www.msc.org/docs/default-source/uk-files/marketreport_2020_interactive.pdf
[93] MSC (2021) www.msc.org/what-we-are-doing/our-approach/forced-and-child-labour
[94] https://sciencebasedtargetsnetwork.org/earth-systems/ocean
[95] Jain, Monica (June 2019) The rise of sea-tech www.greenbiz.com/article/rise-seatech-new-world-wide-web
[96] Katapult Ocean Accelerator - Katapult 2021

_ **Oil Spills**: Oil spills are an unavoidable part of offshore oil drilling. Oil spills can irreparably damage entire ecosystems. For instance, a study[97] published in May 2015 identified lung and adrenal lesions consistent with petroleum product exposure in several deceased bottlenose dolphins. The dolphins had been stranded in the northern Gulf of Mexico since the start of the Deepwater Horizon oil spill.

_ **Carbon emissions from use of fossil fuels**: According to the UNEP Production Gap Report, global oil production must decline by 4% and global gas production by 3% to be consistent with a 1.5°C pathway[98]. The International Energy Agency's net zero pathway concludes that beyond projects already committed as of 2021, there should be no new oil and gas fields approved for development[99]. These conclusions are also supported by academic research published in *Nature*[100] in September 2021. To have a 50% chance of keeping temperatures below 1.5°C, nearly 60% of oil and gas, and 90 per cent of coal must remain unextracted with oil and gas production declining 3% per year.

The Institutional Investors Group on Climate Change (IIGCC) published expectations for what net zero should mean in the oil and gas sector. The standard states (page 19): "*To avoid the risk of sanctioning long lived investment that would contribute to global emissions exceeding the 1.5°C budget or result in stranded assets, oil and gas companies should decrease overall fossil fuel capex. Upstream investment, particularly exploration and new oil projects, should be significantly curtailed given the need for production to decrease before 2030. The capital saved can be returned to shareholders or re-invested in low-carbon energy assets to accelerate the transition.*"

Continued improvements in cleaning up the offshore oil and gas industry's environmental impacts is necessary. An example can be seen in investor efforts to create improve transparency and practices regarding tailings from onshore conventional mining. Following the catastrophe at the Brumadinho, Brazil mine, investors, and the mining industry co-convened efforts to establish an international standard for tailing storage facilities[101]. A similar effort may be necessary to further strengthen the reduction in environmental impacts of existing offshore oil and gas production.

16) Greening shipping with practices and technologies to cut emissions and eliminating the discharge of harmful bilge water

International shipping also contributes to whale deaths through ship strikes. Warming sea water is altering feeding areas which can push whales into areas of greater shipping traffic, as is happening in the Gulf of St Lawrence, Canada[102]. Several high-risk ship strike areas have already been identified including the Mediterranean (Straits of Gibraltar and Hellenic Trench), Sri Lanka, Canary Islands, Panama and the Arabian Sea. It is believed minor routing changes in high-risk areas, and, to a lesser extent, speed restrictions could lead to a substantial reduction in strikes. However, progress in securing buy-in and commitments from international shipping companies to reduce ship strikes has been limited according to the International Fund for Animal Welfare[103].

In December 2016, the Rocky Mountain Institute launched BetterFleet, the first publicly available and comprehensive online portal revealing the operational efficiency of ships throughout the world. A growing number of companies are using the ranking to select which company transports their goods and materials. Several ports have also created incentives for lower emission ships. Financial institutions have a role to encourage the shipping industry and its customers to reduce their ocean impacts.

Another aspect of shipping requiring attention is ship speeds and shoreline erosion. This is a topic which has received attention in both the scientific and popular literature, particularly as the rates of this process seem to be increasing[104]. The detrimental impacts of shoreline erosion can be wide ranging, from economic impacts due to property destruction and tourism reduction, and to ecological impacts resulting from the loss of sensitive habitats. While erosion is a natural process of change over time, but it is often caused or amplified by humans through, e.g., subsidence induced by groundwater

[97] Deepwater Horizon oil spill contributed to high number of Gulf dolphin deaths - National Oceanic and Atmospheric Administration (May 2015)
[98] UNEP (December 2020) www.unep.org/resources/report/production-gap-2020
[99] IEA (May 2021) www.iea.org/reports/net-zero-by-2050
[100] Welsby et al (September 2021) www.nature.com/articles/s41586-021-03821-8
[101] Global Tailings Review (2021) https://globaltailingsreview.org
[102] For a complete list of high-risk areas see IWC Strategic Plan to Mitigate Ship Strikes (March 2017)
[103] International Fund for Animal Welfare (IFAW) 2020 https://oceanconference.un.org/commitments/?id=21408
[104] Zaggia et al. (2017) whttps://www.ncbi.nlm.nih.gov/pmc/articles/PMC5663627/

extraction, the construction of hard coastal protection structures, or the reduction of river sediment inputs into coastal systems. All these processes have been extensively covered by scientific investigation.

The impact of vessel navigation on coastal systems is not as widely discussed, even though this process may be the most important factor controlling shoreline erosion in relatively sheltered coastal segments. The problem emerged when high-speed passenger ferries were introduced in the 1980s, and large and fast high-speed craft capable of carrying passengers and vehicles became common in the 1990s, with new and significant adverse effects being observed in numerous locations worldwide[105]. More attention is needed on ships and shoreline erosion.

Conclusion

This whitepaper extends our work in the area of natural capital following on from our analysis of freshwater risk at the end of last year. We show why oceans are critical in achieving net zero objectives, but, the multitude of factors that are putting our oceans at risk and provide recommendations as to the actions required to protect and restore these ecosystems. We explain why oceans must move front and centre in global climate policy. A future whitepaper, will examine the important role land, soil and forests play in carbon sequestration and why these carbon sinks also need protecting.

Fourteen Heads of State led the High-Level Panel for a Sustainable Ocean Economy. Their report[106] sets out a positive vision: by 2050 oceans could be supporting six times more sustainable seafood product, forty times more renewable energy, twelve million new jobs by 2030 and USD15.5 trillion in net sustainable ocean benefits while creating 20% of the world's needed greenhouse gas emission reductions to keep the world within 1.5°C of warming.

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[105] Parnell, K et al. (2007) www.jstor.org/stable/26481640
[106] High Level Panel for a Sustainable Ocean Economy (December 2020) https://oceanpanel.org/

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