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AGREED LANGUAGE, NARRATIVE AND FUNDAMENTAL FACTS

Everything in the ocean is connected. The ocean and land are connected. The ocean and climate are connected. Humans and the ocean are connected. We cannot keep ignoring the ocean and expect to thrive.

Evolving the narrative for protecting a rapidly changing ocean, post COVID-19 was published in the peer review Journal Aquatic Conservation in November 2020.

Authors: Laffoley, D. , Baxter, J.M. , Amon, D.J. , Claudet, J ., Hall-Spencer, J.M. , Grorud-Colvert, K. , Levin, L.A. , Reid, P.C. , Rogers, A.D. , Taylor, M.L. , Woodall, L.C. and Andersen, N.F.

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NARRATIVE THEMES

Authored by leading marine scientists from around the world, with inputs from others in the planning stages, the paper expresses the fundamental concern that we do not adequately recognise the role of the ocean on our planet and in the wellbeing and survival of humanity. Until we do, the outlook for our world is bleak.

The paper sets out six narratives which should inform how we think and communicate about the ocean and the decisions that we make arising from this. They are:

1. All life is dependent on the ocean We depend on the ocean for all life on Earth; it nurtures us, but we have done woefully little to nurture it

2. By harming the ocean, we harm ourselves All ocean activities need to be carried out more responsibly with the curtailment of damaging actions that affect current and future values

3. By protecting the ocean, we protect ourselves Humanity's reliance on the ocean means we must protect it to protect ourselves

4. Humans, the ocean, biodiversity, and climate are inextricably linked
The ocean modulates the climate and humans influence the state of the ocean and its biodiversity – what is needed is joined-up action and solutions

5. Ocean and climate action must be undertaken together
If you are not factoring in ocean impacts and solutions, you are not effectively addressing climate breakdown

6. Reversing ocean change needs action now We have no choice. We need to act now or risk closing off future options for action.

The Appendix of the paper outlines what we currently know about the role of the ocean at an Earth system level – relative to its major functions – and the changes that are evidenced.

What follows are the statements which can be made about the ocean drawn down from that work and into briefer, more accessible form.

OVERVIEW

The healthy functioning of the ocean makes all life on Earth possible.

It is essential to human existence and wellbeing, providing vital regulating and functioning services.

Our planet will not be able to sustain marine or terrestrial life as we know it if the state of the ocean continues to deteriorate because of human-induced stressors.

A healthy ocean is essential to human survival.

SCALE

PHYSICAL

There is only one ocean and it works at the Earth system level to make life on our planet possible.

It is made up of distinctive areas and habitats, but they are all connected.

Damage to any part of the ocean can affect us all.

There is only one ocean. It functions as a whole and damage to one area can affect us all. We need to understand and engage with this seriously, urgently and across the board.

TEMPORAL

Ocean ecosystems have dynamics that work at vastly different time scales from millions of years to daily cycles.

Some of the changes occurring today will be impossible to reverse in human generational timescales, for example, those now being seen in changes to ocean circulation.

We cannot reverse all the damage that has already been done or stop the harm now in the system, but we can take urgent action to stop things getting worse.

ROLE OF THE OCEAN

OXYGEN

40-50% of the oxygen in our atmosphere was produced by the ocean in the past; thus, it is true to say that every second breath we take *has come* from the ocean.

The ocean continues to create oxygen - Phytoplankton is responsible for over half of all current production – (Lin et al., 2003; Sekerci & Petrovskii, 2015) with the majority staying in the ocean where it performs a vital role in keeping the ocean functioning.

This phytoplankton produced oxygen is dissolved in seawater and consumed by animals and microbes or eventually enters the atmosphere via the sea surface, where it contributes to the total oxygen budget (Sekerci & Petrovskii, 2015).

The ocean is losing oxygen at an unprecedented rate; the overall level of oxygen in the ocean has decreased by approximately 2% since 1960 (Laffoley & Baxter, 2019; Schmidtko et al., 2017). Some areas have lost much more.

Even very small declines can be catastrophic when oxygen availability is already low (Levin, 2018; Breitburg et al., 2018).

Warming sea temperatures will lead to further decreases in oxygen. (Gao et al., 2019; Keeling, Körtzinger, & Gruber, 2010).

The ability of the ocean to create oxygen is being compromised and this poses a threat to its core functions.

BIOLOGICAL PUMP, CARBON CYCLE AND STORAGE

Removal

The oceanic biological pump is a key mechanism for removing CO_2 from the atmosphere and involves a complex suite of processes which absorb CO_2 from the atmosphere and then transfer it as carbon from the surface of the ocean to its depths (Honjo et al., 2014). In this way it removes over 1 million tons of human-made CO_2 every hour (Sabine et al., 2004). These processes work best in a

natural healthy ocean populated by and shaped through the actions of living organisms from plankton to fish and whales.

Disruption to the strength of the oceanic biological pump has significant consequences for the carbon sequestration capacity of the ocean, and therefore the amount of CO_2 removed from the atmosphere (The Royal Society, 2005).

Human-induced changes to the structure and composition of marine ecosystems has a knock-on effect on the natural function of the biological pump (Rost & Riebesell, 2004)

Storage

The ocean is our planet's largest store of carbon (Lal, 2008), It has absorbed 28% of all human-made CO_2 emissions since 1750 (Gattuso et al., 2015).

Over 50% of global photosynthetic carbon fixation is undertaken by marine photosynthetic organisms.

The deep sea of greater than 200 m depth occupies approximately 60% of the Earth's surface and plays a major role in carbon cycling; below 2000 m it contributes to long-term biological carbon storage and burial in the biosphere (Arístegui, Gasol, Duarte, & Herndld, 2009; Smith et al., 2009).

Damage to the structure and composition of the ocean will impact on its ability to remove CO_2 from the atmosphere and protect us from climate breakdown. We need a living, healthy ocean to store the carbon removed.

WATER

97% of fresh water is cycled through the ocean.

Evaporation and precipitation govern the loss and gain of freshwater and the balance between these two processes determines the surface salinity of the ocean (Schmitt, 2008). Salinity, in turn, plays a key role in thermohaline circulation.

Human-induced changes are intensifying the global water cycle causing freshwater regions to become fresher whilst salty regions become saltier (Durack et al., 2012). This is predicted to increase in a warmer world (Durack, Wijffels, & Matear, 2012).

Intensification of the global water cycle will have widespread impacts on ecosystems and societies (Durack et al., 2012) including changes in water quality and availability, food security, health and sanitation, and biodiversity (Grover, 2015).

Human-induced changes in the ocean are impacting the water cycle with a threat to food security, water availability, security and health.

NUTRIENTS

Nutrients are essential for the growth and health of all plants, including phytoplankton. Quantities are sufficiently small in the ocean that an imbalance can affect the rate of primary productivity, and ultimately the capacity of the ocean to sequester CO_2 from the atmosphere (Bristow, Mohr, Ahmerkamp, & Kuypers, 2017; Falkowski, Barber, & Smetacek, 1998). This is manifesting as a result of climate change whereby increased heating of the ocean reduces mixing of nutrient rich deeper waters with nutrient depleted shallow waters, a process called stratification. Thus ocean warming is predicted to reduce ocean primary production.

The appearance of excess nutrients in the ocean at local or regional scales from human development causes eutrophication, which contributes to oxygen depletion (Breitburg et al., 2018) and can lead to deoxygenation and hypoxia causing deterioration of water quality (Chislock, Doster, Zitomer, & Wilson, 2013).

Changes in the balance of nutrients in the ocean are affecting the creation of food webs, the sequestration of CO_2 and the availability of oxygen.

WEATHER

The ocean regulates global weather and climate through the storage and transport of heat around the planet, via the conveyor belt-like system known as thermohaline circulation.

The warming of the ocean as a result of climate breakdown is contributing to an increase in the intensity and duration of extreme weather events such as tropical cyclones, flooding, heatwaves and droughts (Trenberth et al., 2018).

Intensification of sea surface winds since the 1990s, likely caused by changes in atmospheric circulation, has resulted in a speeding up of ocean currents, equivalent to a 15% increase per decade in the energy of currents (Hu et al., 2020).

This acceleration could have effects which will be felt around the planet, with changes to ocean heat storage, CO_2 uptake and weather patterns (Voozen, 2020).

Warming in the Earth's lower atmosphere is causing an intensification of existing patterns of ocean evaporation and precipitation leading to extreme weather events such as floods and droughts.

The ocean's role in regulating weather is being damaged by climate breakdown, specifically warming, leading to extreme weather events, decreased CO_2 removal and heat storage, all of which have consequences for human survival.

CLIMATE

The ocean is a vital component of the planet's climate system (Bigg et al., 2003). Without the ocean, our climate would be vastly different. The ocean can absorb as much as 97% of solar radiation which hits its surface (Bigg et al., 2003) and transport the heat from one location to another via the circulation of currents, making the ocean a critical part of the of the Earth's temperature regulation.

In the past 50 years the ocean has absorbed 93% of the excess heat generated by greenhouse gas emissions (Levitus et al., 2012). The average global sea surface temperature has increased by approximately 0.11˚C every decade since the 1970s and an estimated 1˚C since the Industrial Revolution (IPCC, 2019).

Because the ocean plays such a critical role in regulating Earth's climate, a rise in sea temperature will also result in changes to the climate system. Detrimental feedback loops between the ocean and climate could have catastrophic consequences for humankind.

This is the story that arises from these key points

Ours is a blue planet and we are all creatures of the sea because a healthy ocean is essential for our survival.

We have one ocean, it functions as a whole and damage to one area can affect us all. The changes happening, caused by climate breakdown and other human-made stressors, are cumulative and dangerous to human life. We cannot reverse all the damage that has already been done or stop the harm now in the ocean system, but we can take urgent action to stop things getting worse.

Here's why we should do so.

The ability of the ocean to create oxygen is being compromised and this poses a threat to its core functions.

Damage to the structure and composition of the ocean will impact on its ability to remove CO_2 from the atmosphere and protect us from climate breakdown. We need a living, healthy ocean to store the carbon removed.

Human-induced changes in the ocean are impacting the water cycle with a threat to food security, water availability, security and health. Changes in the balance of nutrients in the ocean are affecting the creation of food webs, the sequestration of CO_2 and the availability of oxygen.

The ocean's role in regulating weather is being damaged by climate breakdown leading to extreme weather events, decreased CO_2 removal and heat storage, all of which have consequences for human survival.

Because the ocean plays such a critical role in regulating Earth's climate, a rise in sea temperature will also result in changes to the climate system. Detrimental feedback loops between the ocean and climate could have catastrophic consequences for humankind.

Everything in the ocean is connected. The ocean and land are connected. The ocean and climate are connected. Humans and the ocean are connected. We cannot keep ignoring the ocean and expect to thrive.

We are all creatures of the sea and we need it to survive.