28 March 2021

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Submission: Climate Change Commission - He Pou a Rangi 2021: Draft Advice for Consultation

The New Zealand Marine Sciences Society (NZMSS) - Te Hunga Mātai Moana O Aotearoa is a professional society affiliated to the Royal Society of New Zealand - Te Apārangi. NZMSS has approximately 200 members. We are a non-profit organisation that provides access to, and within, the marine science community, and we identify emerging issues through annual conferences, annual reviews, a list serve and a website www.nzmss.org.nz . NZMSS membership covers all aspects of scientific interest in the marine environment and extends to the uptake of science in marine policy, resource management, the environment and the marine business sector. We speak for members of the society and we engage with other scientific societies as appropriate.

In general, NZMSS supports the important work of the Climate Change Commission ('the Commission'), but identifies a crucial gap in the Commission's advice. We wish to draw the Commission's attention to the lack of coverage on the marine domain. We recommend that the Commission urgently undertakes work to quantify the mass balance of carbon stored in the marine environment, to identify mitigation measures to improve carbon-storage capacity and to reduce disturbance to existing carbon storage. Without this, it is unlikely that Aotearoa New Zealand's climate change mitigation efforts will succeed.

Please contact me at the email address provided below for any further information regarding this submission.

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Submission: 2021 Draft Advice for Consultation

NZMSS congratulates the Climate Change Commission (the Commission) on the release of its 2021 Draft Advice for Consultation and we support the important work the Commission is undertaking.

1. General comments

NZMSS welcomes the release of the Draft Advice for Consultation. We note that the Draft Advice is heavily weighted towards mitigating terrestrial sources of greenhouse gas emissions, and the need to improve policy settings in this domain to facilitate a more rapid reduction in emissions. We wish to draw the Commission's attention to the lack of coverage on the marine domain. A search of the Draft Advice does not mention "marine", and "ocean" is referred to twice – in the context of the Commission stressing the connectivity of the people, land, atmosphere and the oceans.

Recent research has highlighted the essential role that the oceans play in mitigating the effects of climate change. Carbon is captured and sequestered in marine organisms and the seabed. The oceans have absorbed heat and carbon dioxide (CO_2) as global temperatures and CO_2 emissions have risen, which has buffered somewhat the effects of anthropogenic activities on the atmosphere and climate. However, the ability to capture carbon is being directly affected by the way we currently use our marine environment. Carbon-rich sediments are frequently disturbed over significant areas, and international research has shown that labile carbon stores can be remineralised back into seawater, exacerbating the effects of climate change and ocean acidification.

We recommend that the Commission urgently undertakes work to quantify the mass balance of carbon stored in the marine environment, to identify mitigation measures to improve carbon-storage capacity and to reduce disturbance to existing carbon storage. Without this, it is unlikely that Aotearoa New Zealand's climate change mitigation efforts will succeed.

2. Specific comments

Aotearoa New Zealand's marine environment: Our marine environment is significant in size. The Exclusive Economic Zone covers approximately 420 million hectares, or about 15 times the land area of Aotearoa New Zealalnd (refer to Figure 1). The extended continental shelf encompasses about 21 times the land area.[1] This hosts a diverse range of ecosystems from the coast to the abyssal depths, along with at least 17,000 species.

[1] Gordon DP, Beaumont J, MacDiarmid A, Robertson DA, Ahyong ST. 2010. Marine biodiversity of Aotearoa New Zealand. *PLOS One* https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0010905

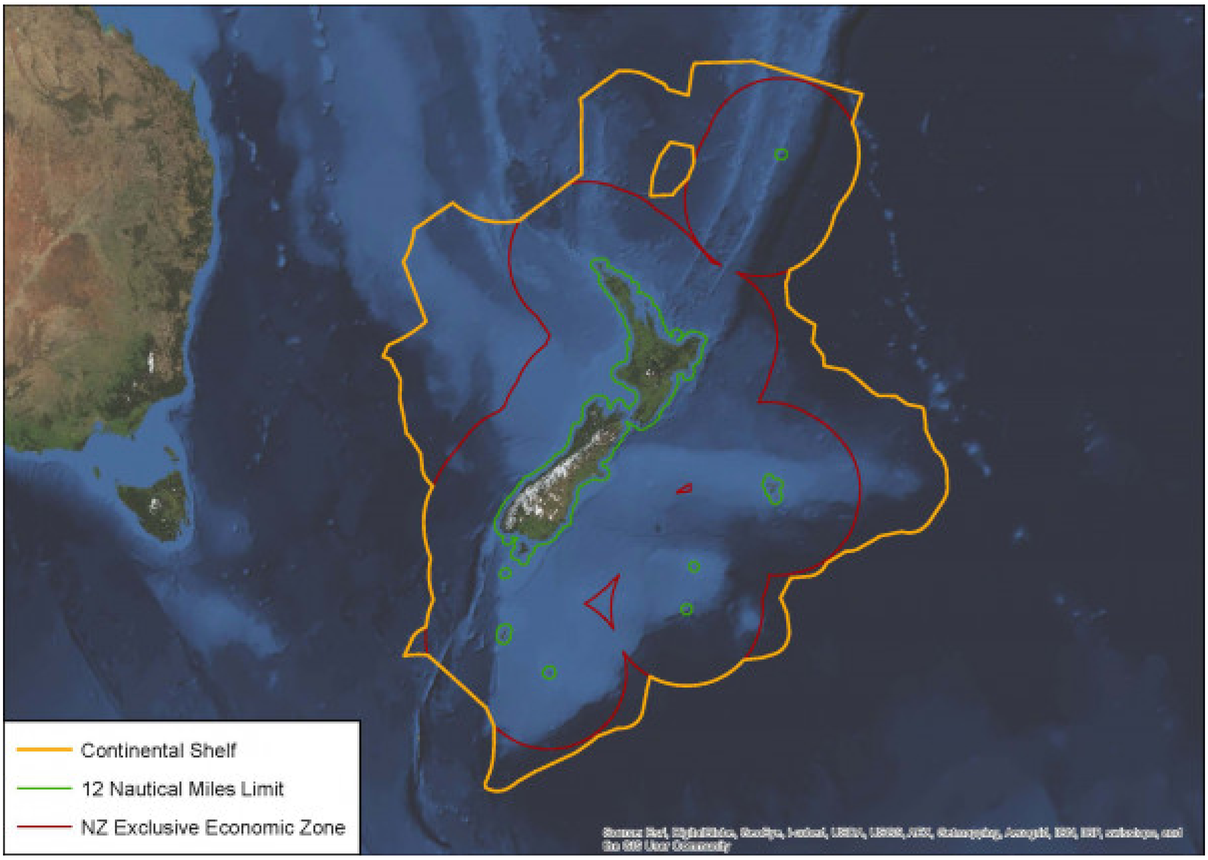

Figure 1: Aotearoa New Zealand's marine environment. Note: EEZ = 12- 200 NM exclusive economic zone (EEZ). Orange border = extended continental shelf covered by the EEZ and Continental Shelf (Environmental Effects) Act 2012. The small triangle-type shapes within the larger EEZ border are international waters. Source: *EPA website.*

Our submission focuses on recent research in three important areas to support the inclusion of our marine environment in the Commission's final advice:

1. The role of the ocean in climate change solutions;
2. Quantifying ocean carbon flows and stores; and,
3. Impacts of human activities on ocean carbon storage.

1. Role of the ocean as a solution to climate change.

In 2019, the 14 member nations of the High Level Panel for a Sustainable Ocean Economy[2] issued an expert report on the mitigation potential of a suite of ocean-based activities and the potential future contribution from carbon storage.[3]

The wide-ranging report included the following observation (p70):

> "The ocean naturally contains nearly 150,000 GtCO2e. This dwarfs the 2,000 GtCO2e in the atmosphere and 7,300 GtCO2e in the land-bqa biosphere. Each year, as a consequence of human activities, approximately 10 billion tonnes of CO2, or about 25 to 30 percent of anthropogenic CO2 emissions, enters the ocean (Global Carbon Project 2018)."

[2] https://www.oceanpanel.org/ . Member Nations: Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, Portugal, and the United Nation's Special Envoy for the Ocean.

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

A number of ocean-based interventions and selected mitigation options were analysed for their potential contribution towards reducing emissions and enhancing the ocean's ability to store carbon more effectively. These included: ocean-based renewable energy; ocean-based transport; emissions from fishing vessels; emissions from aquaculture; increasing ocean-based proteins in human diets; recovery of biodiversity and biomass; restoration and protection of 'blue carbon sinks' (mangroves, salt-marsh, seagrasses); seaweed production; and carbon storage in the seabed (refer to Appendix 1).

Should more ecologically sustainable activities and management occur over time, the ocean could contribute an estimated 6% to 25% reduction in emissions needed by 2050 to achieve the 1.5°C reduction in global temperatures called for under the Paris Agreement. There were a number of caveats to the analysis; nevertheless a compelling and urgent argument was made that policy to mitigate climate change needs to specifically account for activities on and within the ocean.

The counterfactual is that the ocean continues to absorb more CO_2 and becomes more acidic, which reduces its ability to buffer climate change, disrupts ecosystems, and increases food insecurity.

2. Quantifying carbon flows and stores.

The contribution of coastal marine vegetation on the ocean carbon cycle has been the subject of ongoing research over the past two decades.[4] A recent study estimated the organic carbon storage in blue carbon sinks (mangroves, salt-marsh, seagrasses) in Australia, and calculated that loss of these biodiverse vegetated coastal habitats would result in an increase in emissions of between 12-21% annually.[5] Notably, however this excludes kelp forests and other seaweeds, which are important marine habitats throughout New Zealand's coastline, and have been predicted to sequester between 4000 and 1.5 million tons of carbon per year depending on the region considered.[6]

The carbon storage capacity of offshore shelf sediments, which cover ~9% of global marine area, has also received increasing recognition.[7] Marine sediments store more than twice the carbon in the top 1 metre than terrestrial soils, and represent a globally important carbon sink.[8] Much of the carbon-rich sediments (~75%) are located in abyss/basin areas, and over 50% is within countries exclusive economic zones. The long-term carbon storage within these areas is vulnerable to remineralisation into CO_2 as a consequence of human activities, which occur over significant areas of shelf seas.[9]

[4] Duarte C et al. 2004. Major role of marine vegetation on the oceanic carbon cycle. *Biogeosciences Discussions* 1: 659-679. Laffoley, D.d'A. & Grimsditch, G. (eds). 2009. The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. Mcleod, E. et al. 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO^2. *Frontiers Ecology & Environment* 9: 552–560.

[5] Serrano et al. 2019. Australian vegetated coastal ecosystems as global hotspots for climate change mitigation. *Nature Communications* https://doi.org/10.1038/s41467-019-12176-8

[6] Eger et al. In review. The economic value of fisheries, blue carbon, and nutrient cycling in global marine forests. *Nature Ecology and Evolution.*

[7] Diesing et al. 2017. Predicting the standing stock of organic carbon in surface sediments of the North-West European continental shelf. *Biogeochemistry* 135: 183-220. Luisetti et al. 2019. Quantifying and valuing carbon flows and stores in coastal and shelf ecosystems in the UK. *Ecosystem Services* 35: 67-76.

[8] Atwood et al. 2020. Global patterns in marine sediment carbon stocks. *Frontiers in Marine Science* doi: 10.3389/fmars.2020.00165

[9] Sala et al. 2021. Protecting the global ocean for biodiversity, food and climate. Nature https://doi.org/10.1038/s41586-021-03371-z

3. Impacts of human activities on ocean carbon storage.

Physical disturbance of seafloor sediments causes resuspension into the water column, leading to exposure to oxygen and heterotrophic metabolism that can result in remineralisation.[10] For example, a recent study in the Mediterranean compared carbon storage in trawled and untrawled deep-water areas, and found that continuous erosion and sediment mixing in trawled areas led to coarser reworked sediments which lost ~30% organic carbon and led to a 52-70% loss of labile compounds through degradation.[11] The scale of this disturbance type is significant in Aotearoa New Zealand's marine waters, with the Government reporting 335,812,000 hectares exposed to bottom-contact fishing methods from 1990-2016.[12] The consequences of these frequent and intense disturbances also contributes to increasing acidity of seawater. Ocean acidification is a significant threat to global biodiversity and marine ecosystems, and is one of the most deleterious in its effects on Aotearoa New Zealand's marine environment.[13]

Land use activities are also resulting in damage to coastal vegetation by the smothering of seagrass, limiting light for benthic primary producers such as kelp forests, and loss of shellfish beds from excessive terrigenous sedimentation[14] (Figure 2). The ongoing adverse effects on coastal ecosystems are likely to be exacerbated by future clearfell harvesting of radiata pine, planted on marginal hill country to mitigate climate emissions and stem erosion.

In addition to increased terrigenous inputs and destructive fishing methods, productivity and carbon storage of coastal ecosystems in New Zealand is indirectly impacted by fishing. For example, decades of research on coastal reefs tell us that poorly or unmanaged fishing leads to a shift in balance from highly productive kelp forests to barren landscapes dominated by sea urchins.[15] Furthermore, new research has shown us that increases in the frequency and magnitude of marine heatwaves, as a result of Climate Change, has the capacity to further degrade the resilience of coastal ecosystems to local stressors and, in some cases, remove coastal vegetation all together.[16] This loss of coastal vegetation has vast implications for carbon sequestration potential. Effective management of land practices and fishing can greatly increase the contribution of marine ecosystems to carbon sequestration and should therefore be a valued component of climate change mitigation strategies in the future.

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[10] For example, as described in Bianchi TS et al. 2016. Redox effects on organic matter storage in coastal sediments during the Holocene: a biomarker/proxy perspective*. Annual Review of Earth and Planetary Sciences* 44: 295–319.

[11] Paradis et al. 2021. Persistence of biogeochemical alterations off deep-sea sediments by bottom trawling. *Geophysical Research Letters*, *48*, e2020GL091279. https://doiorg/10.1029/2020GL091279.

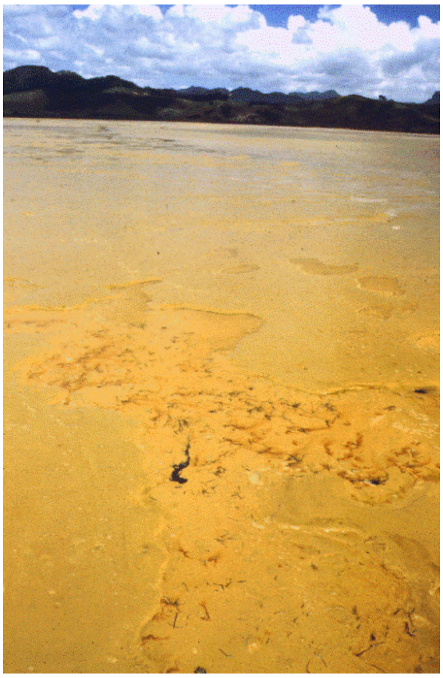
[12] Ministry for the Environment and Statistics New Zealand. 2019. *Our Marine Environment.2019*. New Zealand's Environmental Reporting Series. NZ Government.

[13] MacDiarmid AB et al. 2012. Assessment of anthropogenic threats to New Zealand marine habitats. *New Zealand Aquatic Environment and Biodiversity Report No. 93*. Ministry for Primary Industries, Wellington, NZ. 255p.

[14] Thrush SF. 2004. Muddy waters: elevating sediment input to coastal and estuarine habitats. *Frontiers in Ecology and the Environment,* 2(6): 299–306.

[15] Shears NT, Babcock RC. 2003. Continuing trophic cascade effects after 25 years of no-take marine reserve protection. *Marine Ecology Progres Series*, 246, 1–16.

[16] Smale DA. 2020. Impacts of ocean warming on kelp forest ecosystems. *New Phytologist* 225(4): 1447-1454.



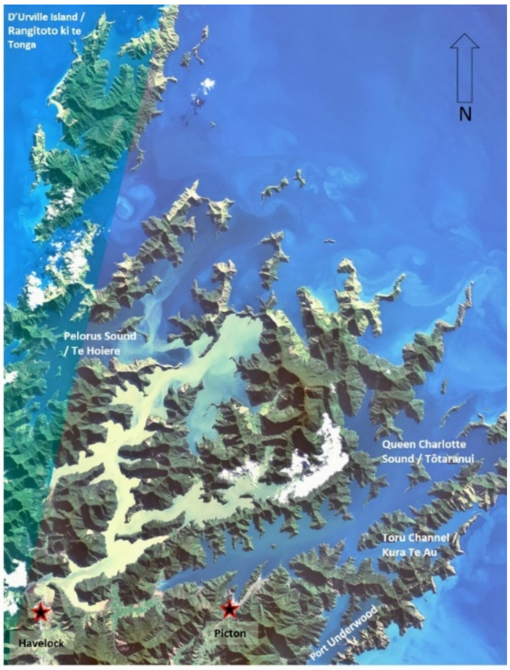


Figure 1: (Left) Terrigenous sediment dump smothered a carbon-sequestering seagrass bed in an estuary. Photo: Michele Wilkinson. (Right) Sediment discharge into Pelorus/Te Hoiere Sound after an estimated 1 in 3.1 year rainfall event in July, 2018. Photo: Ben Knight.

3. Summary/recommendation/s

NZMSS has identified a significant evidence gap in the Climate Change Commission's Draft Advice for Consultation, and calls on the Commission to include the oceans in its Final Advice to mitigate greenhouse gas emissions.

- **Relevance**: The ocean has great capacity to sequester and store carbon, far in excess of terrestrial environments.
- **Measurability:** The mass balance of carbon stores and flows can be modelled and monitored, but urgent scientific work is required to inform the Commission's advice.
- **Management**: Human activities on land and in the ocean are directly impacting on the carbon storage and retention on and within the seabed. These activities are avoidable and must be managed more effectively to improve ocean carbon storage.
- **Urgency**: The oceans are in trouble, and are warming, rising, and acidifying. Marine ecosystems and biodiversity are under threat from cumulative and multiple stressors.

NZMSS recommends that the Commission urgently undertakes work to quantify the mass balance of carbon stored in the marine environment, to identify mitigation measures to improve carbon-storage capacity and to reduce disturbance to existing carbon storage. Without this, it is unlikely that Aotearoa New Zealand's climate change mitigation efforts will succeed.

NZMSS invites the Commission to engage with us to address the current significant gap in its advice. We further offer to facilitate access to scientific experts to assemble evidence and provide impartial, accurate, and balanced analysis to support the Commission's work.

Appendix 1: Assessment of ocean-based climate action. From: Hoegh-Guldberg et al. 2019. “The Ocean as a Solution to Climate Change: Five Opportunities for Action”. World Resources Institute. Washington DC. http://www.oceanpanel.org/climate.

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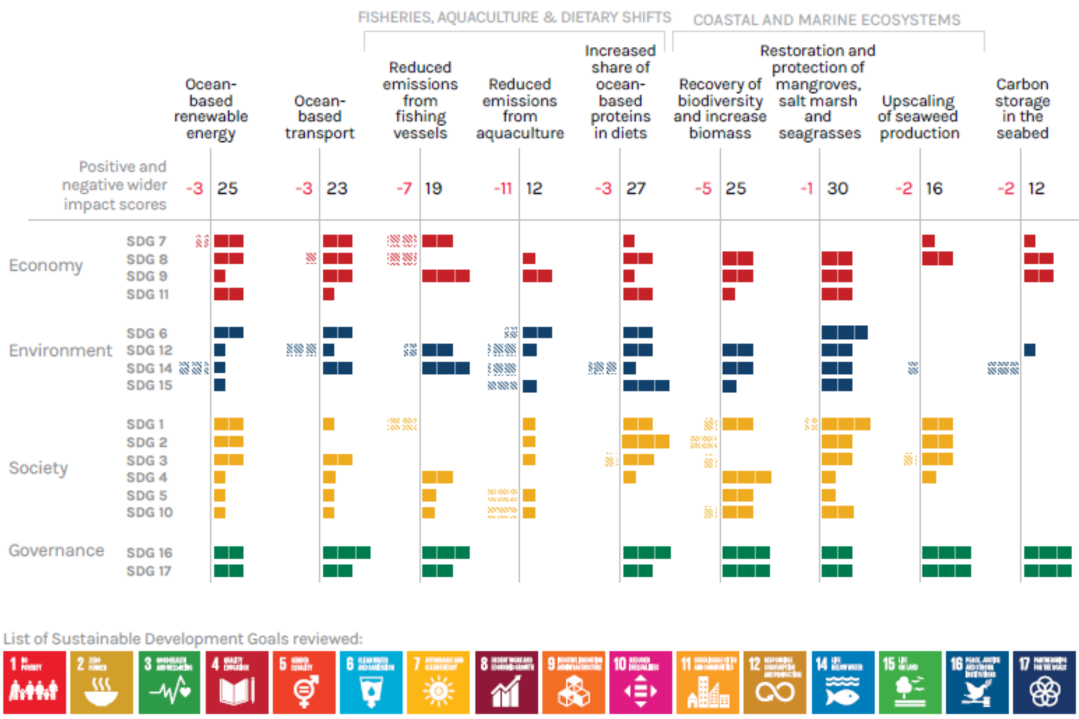
Table ES-1. Summary of Global Mitigation Potential Offered by Each Area of Ocean-based Climate Action

AREAS OF OCEAN-BASED CLIMATE ACTION	2030 MITIGATION POTENTIAL ($GTCO_2E$/YEAR)	2050 MITIGATION POTENTIAL ($GTCO_2E$/YEAR)
1. Ocean-based renewable energy	0.18–0.25	0.76–5.40
2. Ocean-based transport	0.24 – 0.47	0.9 – 1.80
3. Coastal and marine ecosystems	0.32–0.89	0.50–1.38
4. Fisheries, aquaculture, and dietary shifts	0.34–0.94	0.48–1.24
5. Carbon storage in the seabed (Action in this Area Requires Further Research Prior to Implementation at Scale)	0.25–1.0	0.50–2.0
Total	1.32–3.54	3.14–11.82
Total percentage contribution to closing emissions gap (1.5°C pathway)	4–12 %	6–21%
Total percentage contribution to closing emissions gap (2°C pathway)	7–19%	7–25%

Source: Authors

Figure 7. Linkage Scores of Ocean-based Interventions and Selected Mitigation Options across the Wider Impact Dimensions



Source: Authors

Notes: Wider-impact dimensions cover various sustainable development dimension as well as 2030 Sustainable Development Goals (SDG). The figure shows the relative strength of the relationship between a selected set of ocean-based mitigation options and the SDGs. For each mitigation option, the positive linkage score with a particular SDG (depicted with solid bars) is shown in the right-hand column and negative linkage score (depicted by shaded bars) in the left-hand column. Scores range from +3 (indivisible) to −3 (cancelling) (Nilsson et al. 2016). A zero score (no bar and no colour) means no impact was found in this review of the literature. Each colour represents a particular wider impact dimension: Red bars for economy (SDG 7, 8, 9, 11); blue bars for environment (SDG6, SDG12, SDG14, SDG15); yellow bars for society (SDG1, SDG2, SDG3, SDG4, SDG5, SDG10) and green bars for Governance (SDG 16, SDG 17). Further information on the linkage scores and the associated confidence levels are provided in the Annex.