

Commissioned by



HIGH LEVEL PANEL for
**A SUSTAINABLE
OCEAN ECONOMY**

Summary for Decision-makers

The Ocean as a Solution to Climate Change

Updated Opportunities for Action

About the Ocean Panel

Established in 2018, the High Level Panel for a Sustainable Ocean Economy (Ocean Panel) is a unique initiative made up of world leaders who are building momentum for a sustainable ocean economy in which effective protection, sustainable production and equitable prosperity go hand in hand. By working collaboratively with a wide array of stakeholders, the Ocean Panel aims to identify bold solutions that bridge ocean health, wealth and equity and accelerate and scale responsive action worldwide.



The report¹ summarised here was prepared in support of the work of the Ocean Panel to provide a robust scientific and knowledge base and practical opportunities for action across issues central to the attainment of a sustainable ocean economy. The arguments, findings and opportunities outlined in this report represent the views of the authors alone. Ocean Panel members have not been asked to formally endorse the report and should not be taken as having done so.

The ocean regulates our climate and can significantly buffer the worst impacts of climate change, absorbing anthropogenic carbon dioxide emissions and heat from the atmosphere. But as a consequence, the ocean is warming, becoming increasingly more acidic and de-oxygenated, and sea levels are rising. These impacts are no longer projections of change, but are real and increasingly felt. 2023 has seen the highest ocean surface temperatures since record-keeping began, with the impacts on the marine environment, fisheries and livelihoods still yet to be fully understood.

Climate action is vital for ocean health and livelihoods. To limit the catastrophic impacts of climate change for people and nature, the goals of the Paris Agreement to limit temperature rise to 1.5 °C must be kept within reach. Deep greenhouse gas (GHG) emission reductions are required across all sectors. Urgent scaled-up action is required while undertaking just transitions and ensuring climate resilience.

The ocean can offer solutions for climate action that can unlock a wide range of benefits towards the attainment of the Sustainable Development Goals, and a sustainable ocean economy, guided by 100% sustainable ocean management.

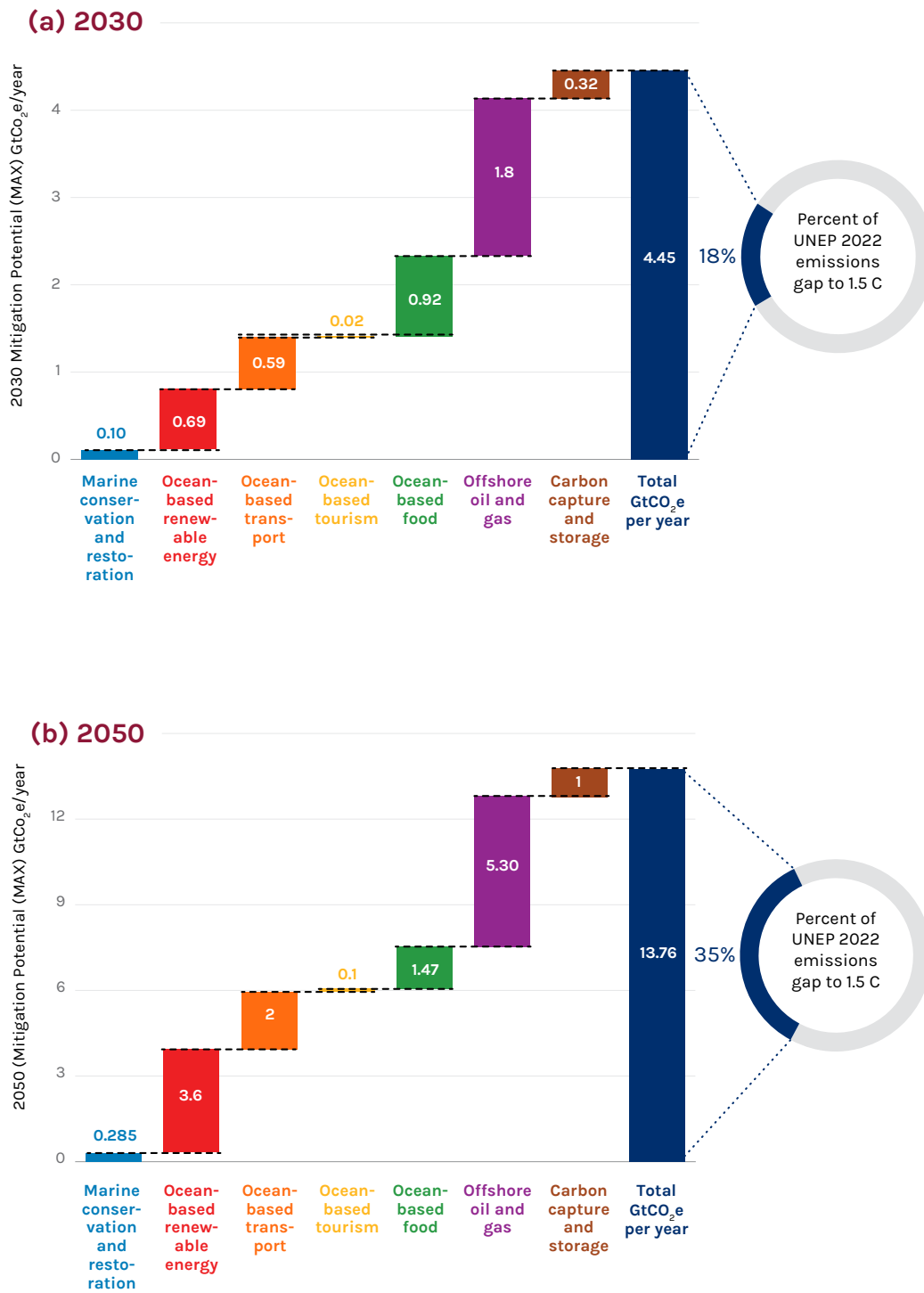
The report assesses the potential of ocean-based climate solutions to reduce and sequester GHG emissions, taking stock of latest science and knowledge. This updates and expands on the 2019 report, *The Ocean as a Solution to Climate Change: Five Opportunities for Action*, and includes a new assessment of the climate change mitigation potential of solutions in two additional areas—offshore oil and gas and ocean-based tourism—alongside greater exploration of marine carbon dioxide removal (mCDR) technologies.

The report offers decision makers a menu of solutions for ocean-based climate action to consider as part of national climate action plans, pathways and strategies, including the integration and strengthening of ocean-based actions in Nationally Determined Contributions (NDCs) under the United Nations Framework Convention on Climate Change (UNFCCC), and alongside Sustainable Ocean Plans. Suggested priorities for actions (Table 1) are offered to support decision makers in advancing action.

Many solutions are ready to implement now, and accelerated action is required. This report provides a snapshot of the global scale of GHG emission reductions in 2030 and 2050 that could be realised if all solutions are fully implemented. It highlights the significant contribution ocean-based sectors could make to keeping global temperature rise below 1.5 °C, but only if urgent action is taken.

Analysis finds that full implementation of ocean-based climate solutions that are ready for action now could reduce the “emissions gap” by up to 35 percent on a 1.5°C pathway in 2050—an estimated reduction in GHG emissions of between 1–4 Gt of CO₂e per annum in 2030 and 4–14 Gt CO₂e in 2050 (see Figure 1).

Figure 1. Maximum potential contribution of ready-to-implement ocean-based mitigation options to closing the emissions gap in (a) 2030 and (b) 2050



Note: Ready-to-implement solutions are those assessed for the purposes of this report as mature or at the stage of early adoption.

Opportunities for action are identified across seven sectors:

- **MARINE CONSERVATION AND RESTORATION:** Expanding nature-based solutions, including mangroves, tidal marshes and seagrass beds, to unlock the extensive benefits for people, nature and climate and prevent further degradation of habitats and release of GHG emissions.
- **OCEAN-BASED RENEWABLE ENERGY:** Scaling ocean-based renewable energy, primarily offshore wind, and continuing to invest in bringing other energy sources, such as tidal power and floating solar, to commercial scale.
- **OCEAN-BASED TRANSPORT:** Decarbonising ocean-based transport across freight shipping, in line with the revised International Maritime Organization's GHG Strategy, including actions to increase operational and logistical efficiencies and through investments in zero emission fuel technology and infrastructure.
- **OCEAN-BASED TOURISM:** Decarbonising ocean-based tourism, focusing on cruise vessels and utilising technological advances in vessel design to reduce energy consumption as well as pollutants such as sulphur oxides, nitrous oxides and particulate carbon that are harmful to marine ecosystems and human health.
- **OCEAN-BASED FOOD:** Utilising low carbon ocean-based protein to reduce emissions from global diets, taking into account fisheries, including replenishing wild fish stocks, aquaculture and dietary shifts.
- **OFFSHORE OIL AND GAS:** Reducing oil and gas consumption is critical for meeting global climate commitments. Stopping the expansion of offshore oil and gas extraction should go hand-in-hand with a demand-led phase-down of current production, with planned transitions starting with the least energy efficient and highest emission intensity operations.
- **MARINE CARBON DIOXIDE REMOVAL AND CARBON CAPTURE AND STORAGE:** Recognising that mCDR solutions are not fully mature or ready for implementation, a focus must remain on technological development and further research, addressing policy and governance considerations including environmental safeguards, alongside continuing to develop and utilise carbon capture and storage (CCS) below the seabed.

Accelerating ocean action towards implementation

Critical action is required across all sectors, globally and at scale to reduce GHG emissions in line with keeping a limit of 1.5 °C temperature rise within reach. Ocean-based climate solutions can make a significant contribution to the much needed global response to climate change, and where many solutions are ready for implementation now.

Ten key action areas are highlighted to support accelerated implementation, alongside a range of suggested sector-level priority actions (summarised in Table 1):

1. Translate pledges into action
2. Foster collaboration and research into emerging solutions
3. Prioritise marine nature-based solutions
4. Re-examine the role of offshore oil and gas in global energy supply
5. Make the necessary capital investments to decarbonise maritime transport
6. Strengthen ocean-based climate finance
7. Monitor, evaluate and correct to track progress and evaluate impacts
8. Encourage and provide incentives for international cooperation
9. Align ocean-based and terrestrial solutions
10. Embrace urgency, inclusivity and fairness

Strengthening ocean-based climate action is a key pillar towards a sustainable ocean economy, and to achieving 100% sustainable ocean management, recognising the range of benefits for climate, nature and people. An integrated, inclusive and holistic approach is required, and Sustainable Ocean Plans can provide a framework to guide this approach and maximise benefits for all.

Financing the solutions is an urgent, time-sensitive challenge. It is estimated that US\$1 trillion of additional finance is needed by 2030, and \$2 trillion total finance will need to flow between 2030 and 2050 to facilitate a rapid transition to the ocean-climate solutions outlined in the report. This will require innovative solutions, new partnerships and re-aligning of finance flows with nature-positive and net zero pathways.

INFORMATION BOX

100% sustainable ocean management and Sustainable Ocean Plans as championed by the Ocean Panel

In 2020, the members of the Ocean Panel committed to sustainably managing 100% of the ocean area under their national jurisdiction, guided by Sustainable Ocean Plans, by 2025.* These plans provide a holistic framework for ocean-related governance to facilitate sustainable use of the ocean and maximise benefits for future generations. An effective Sustainable Ocean Plan embraces nine attributes (inclusive, integrative, iterative, place-based, ecosystem-based, knowledge-based, endorsed, financed, and capacitated), but there is no one-size-fits-all approach. Sustainable ocean plans are adaptable frameworks tailored to national contexts. They bring existing ocean governance together into an integrated whole, filling gaps and iterating over time.

Fully integrating Sustainable Ocean Planning across ocean-related Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs) and National Biodiversity Strategies and Action Plans (NBSAPs) enables countries to achieve synergistic outcomes for the ocean, climate and biodiversity. These plans should be in line with the 2030 Agenda for Sustainable Development. They must address pressures from all land- and sea-based sources while considering climate change impacts.

Sustainable ocean plans take a big picture approach that can bridge gaps across broader climate and nature goals. By linking ocean, biodiversity and climate goals, these plans can restore ocean health while at the same time enabling sustainable ocean economies that equitably benefit coastal communities.

Note: *Countries joining the Ocean Panel after 2020 may commit to develop and be guided by Sustainable Ocean Plans within five years of joining.
Source: Ocean Panel 2021.

Table 1. Short-term priorities and opportunities to deliver on mitigation potential of ocean-based climate action areas

MARINE CONSERVATION AND RESTORATION	
Government	<ul style="list-style-type: none">▪ Assess national blue carbon and nature-based solution (NbS) opportunities.^a▪ Analyse national and international legal and policy frameworks to include blue carbon in sustainable development, climate change, forestry, biodiversity and marine resource management regulations, including national GHG inventories and NDCs by implementing the IPCC Wetlands Supplement from the Intergovernmental Panel on Climate Change.^b▪ Enact regulation and policies to halt ecosystem losses and promote restoration. Set appropriate conditions based on global standards (clarity on land tenures, policy predictability, when possible public funding to de-risk investments) to attract private capital.▪ Designate marine protected areas (MPAs) as an integral part of marine spatial planning (MSP) to enhance conservation, maximise climate and biodiversity benefits.▪ Use non-market-based approaches, including community-based natural resource management and civil society cooperation aimed at the conservation of biodiversity (Target 19^c).▪ Recognise the wider ecosystem services and benefits for water quality, biodiversity, fisheries, aquaculture, coastal protection and climate change adaptation to develop appropriate financial and regulatory incentive tools.▪ Increase investments in R&D and citizen science programs to fill priority knowledge gaps.▪ Explore robust global or regional carbon pricing structures.
Private sector	<ul style="list-style-type: none">▪ Set targets and/or pledges for ecosystem protection and restoration (as relevant to land ownership, operations or supply chains).^c▪ Increase investments in coastal NbS projects (e.g. in project development, regulatory approvals, financial management, project implementation, research and development), including through impact funds and other instruments (Target 19^c).▪ Increase investment in conservation and restoration of blue carbon ecosystems through innovative finance (insurance, debt swaps, taxes, and carbon credits), carbon pricing mechanisms, and public-private partnerships (Target 19^c).▪ Partner with local communities to deliver all aspects of projects (including verification) (Target 19^c).▪ Implement the International Union for Conservation of Nature's NbS standard guidelines and the High Quality Blue Carbon Principles^d for investments (e.g. equitable benefit sharing).▪ Examine supply chains and eliminate components that lead to degradation of coastal and marine ecosystems and work towards positive impact on ecosystems.

MARINE CONSERVATION AND RESTORATION (CONTINUED)

Research community

- Develop robust, low-cost monitoring technologies (e.g. using remote sensing) for monitoring success of blue carbon projects.
- Improve seagrass and seaweed restoration techniques for large-scale implementation. Link management of offsite factors, e.g. improvement of catchment water quality, to restoration outcomes.
- Improve documentation and understanding of seaweed carbon fluxes and sequestration in relation to management action.
- Increase accuracy and knowledge of spatial and temporal variability of estimates of mitigation by blue carbon ecosystems, including impacts of climate change.
- Identify new opportunities for blue carbon projects (develop frameworks to aid identification of sites for blue carbon projects and co-benefits for communities).
- Characterise co-benefits of NbS projects, including social outcomes. Develop robust, standardised guidelines for projects.
- Develop knowledge on wider impact both at project scale and economy-wide as well as at global scale to better inform policy and action.
- Collaborate with the government, the private sector and communities to support projects and policy development.

OCEAN-BASED RENEWABLE ENERGY

Government

- Utilise area-based management frameworks and marine spatial planning, including Sustainable Ocean Plans, to guide development and minimise conflict amongst ocean users.
- Provide a stable economic and regulatory framework to stimulate investment in required infrastructure for an accelerated deployment of ocean-based energy systems.
- Improve the transparency of siting and permitting processes.
- Introduce attractive financial support and guarantee schemes.
- Establish processes to resolve cross-border regulatory issues.
- Offer education and capacity building to create a skilled workforce and capacities for manufacturing repair, and installation.

Private sector

- Strengthen and expand supply chains, including where to site suppliers.
- Develop efficiency of technology deployment and supply chain to reduce costs.
- Identify alternative materials and resources to avoid supply chain constraints and reduce costs.
- Enhance social responsibility and acceptability.
- Establish targets and/or pledges related to biodiversity protection and restoration associated with ocean-based renewable energy deployment and operation.

OCEAN-BASED RENEWABLE ENERGY (CONTINUED)

- Research community**
- Increase research on environmental and social impacts of large-scale offshore wind (OSW) energy and multi-use of ocean space.
 - Develop technology components that reduce cost and dependency on critical materials.
 - Further investigate the potential to install large-scale floating solar installations at sea.
 - Understand the potential benefits of co-location with other ocean-based industries (e.g. desalination plants and aquaculture).

OCEAN-BASED TRANSPORT

- Government**
- Develop and communicate national targets and pledges for the decarbonisation of domestic vessel fleets and associated national infrastructure.
 - Develop national and/or regional plans on the role and carbon intensity of trade.
 - Commit to decarbonisation of national energy systems faster or as fast as the low-carbon transition in the international vessel fleet.
 - Support the revision of the IMO's short-term measure policies—improving stringency, enforcement and effectiveness of the existing regulations such as Carbon Intensity Indicators (CIIs) and the Energy Efficiency eXisting ship Index (EEXI) and the development and adoption of new IMO mid-term measures.
 - Refine the IMO Life Cycle Assessment (LCA) guidelines and use in policy.
 - Adopt basket of goal-based IMO mid-term measures, enabling equitable transition.
 - Provide support and incentives for early adopters of zero emission technologies.
 - Revise the IMO Data Collection System (DCS) to include cargo carried.
- Private sector**
- Sign up for voluntary initiatives that robustly and transparently measure alignment to limit global warming to 1.5°C.
 - Form value-chain clubs around early adoption zero emission opportunities.
 - Include decarbonisation opportunity and risk efficiently into contracting.
- Research community**
- Evaluate options to reduce cost, address safety, and increase efficiency of renewable-based fuels both in the form of electricity in combination with batteries, low-carbon fuel made from renewables and carbon capture and storage (CCS) on board.
 - Assess performance of complementary efficiency technologies, including wind.
 - Identify and rectify market and nonmarket barriers and failures to enable larger uptake of more energy-efficient technologies and cooperation patterns.

OCEAN-BASED TOURISM

- Government**
- Monitor and track GHG emissions (scope 1–3) from global cruise tourism to devise and revise climate policies for the sector.
 - Implement voluntary disclosure of per passenger emission levels following the example of aviation industry to empower users in their decision making.
 - Blend-in obligations for sustainable biofuels in jurisdictions such as the European Union.
 - Set standard CII to track progress; the CII must reflect actual operations.
 - Adopt stringent and effective IMO mid-term policy measures (GHG levy and GHG fuel standard).

- Private sector**
- Sign up for voluntary initiatives that robustly and transparently measure alignment to limit global warming to 1.5°C.
 - Implement structured fees at port for cruise ships that imply a significantly higher cost for ship owners.
 - Invest in research, development, and design of energy-efficient and low-carbon cruise ship technology.
 - Design, order and build cruise vessels with low energy consumption and zero GHG emission fuels.

- Research community**
- Research options for utilising a standard connection for shore power to increase utilisation.
 - Further research design of energy-efficient components and activities (such as hull cleaning).

OCEAN-BASED FOOD

- Government**
- Enhance sustainable management and enforcement of ocean fisheries globally, with a focus on the use of MPAs and implementing rebuilding plans for depleted stocks.
 - Promote electrification and decarbonisation of all aquaculture site energy inputs.
 - Promote efficient licensing processes and strategic marine spatial planning for ocean aquaculture to avoid unplanned growth and maximise synergies with other ocean users and technologies (including ocean-based renewable energy).
 - Utilise area-based management frameworks, including Sustainable Ocean Plans, to guide development and minimise conflict between ocean users.
 - Review national regulatory and incentive structure to align with efforts to decarbonise ocean based food.

- Private sector**
- Scale best practices for fisheries management and marine aquaculture, including adaptative fisheries management to promote adaptation to climate change.
 - Investment in species-targeted aquaculture strategies (e.g. improved genetics, husbandry practices) to reduce feed conversion ratio in fed aquaculture.

OCEAN-BASED FOOD (CONTINUED)

Research community

- Enhance development of monitoring, evaluation and enforcement tools that enhance sustainable fisheries and aquaculture management.
- Improve assessment and monitoring of data-poor fish stocks to facilitate management and rebuilding.
- Expand analyses on diet influences on human health to seek more options that are good for people and the planet.
- Make assessment of limits to sustainable ocean-based dietary protein sourcing.

OFFSHORE OIL AND GAS

Government

- Initiate processes to withdraw fossil fuel subsidies in countries which currently provide them.
- Establish governance to stop the granting of new licenses for offshore oil and gas extraction.
- Review offshore oil and gas leases that are not yet operational with a view to withdraw such leases.
- Invest public finance in energy security and access for economically vulnerable communities.
- Plan retraining, skill diversification and social protection.
- Enact legislation and/or regulation to ban routine flaring.

Private sector

- Invest in technology and practices to reduce methane leaks and end routine flaring in countries where it is still allowed.
- Increase energy efficiency in offshore oil and gas operations.
- Operators work with governments to develop and enact decommissioning plans.
- Operators reduce average reservoir depletion rates from ~8 percent per year to ~4 percent per year.
- Investors and financial institutions signal that new oil and gas exploration and new infrastructure is not worthwhile and reprioritise investment in renewable energy infrastructure.

Research community

- Investigate impacts of decommissioning of structures and materials on the health of surrounding coastal communities and marine environments.
- Identify gaps and opportunities for investment in training and skills development to ensure opportunities for transitioning the work force.

MARINE CARBON DIOXIDE REMOVAL AND CARBON CAPTURE AND STORAGE

Government

- Develop a model international governance framework to establish suitable guardrails for future research, field testing and potential deployment.
- Develop domestic legal frameworks specific to mCDR which set regulatory standards.
- Harness mCDR projects as an opportunity to increase equity and justice initiatives.
- Sponsor research including supporting incremental testing and monitoring programs.
- Support research on the environmental and societal implications of mCDR.

Private sector

- Coordinate with government and research sectors to sustain a transparent research infrastructure.
- Co-design research objectives with indigenous and coastal communities.
- Construct robust monitoring, reporting, and verification plans, which include life cycle emissions accounting for net removal estimates.
- Develop and follow a mCDR code of conduct.
- Provide early investments to catalyse innovation in the mCDR landscape.

Research community

- Conduct cross-sectoral research on the social and environmental impacts of mCDR strategies.
- Conduct field and pilot studies to understand the efficacy and impacts of mCDR. Incorporate mCDR methods into integrated assessment models and consider interactions with Sustainable Development Goals.
- Push forward innovative sensor and model designs to allow for more robust monitoring, reporting and verification.
- Improve the resolution of ocean chemistry baseline measurements.

Source: a. Schindler Murray et al. 2023; b. IPCC 2013; c. CBD 2022; d. Conservation International et al. 2022.

References

CBD (Convention on Biological Diversity). 2022. *Kunming-Montreal Global Biodiversity Framework*. CBD/COP/15/L.25. Montreal: CBD Secretariat, United Nations Environment Programme. <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>.

Conservation International, Salesforce, The Nature Conservancy, Ocean Risk and Resilience Action Alliance, Friends of Ocean Action at the World Economic Forum, and Meridian Institute. 2022. *High-Quality Blue Carbon Principles and Guidance: A Triple-Benefit Investment for People, Nature, and Climate*. Arlington County, VA: Conservation International and The Nature Conservancy; San Francisco: Salesforce; Washington, DC: Ocean Risk and Resilience Action Alliance; Geneva: Friends of Ocean Action at the World Economic Forum; Dillon, CO: Meridian Institute. https://climatechampions.unfccc.int/wp-content/uploads/2022/11/HQBC-PG_FINAL_11.8.2022.pdf.

IPCC (Intergovernmental Panel on Climate Change). 2013. *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands Methodological Guidance on Lands with Wet and Drained Soils, and Constructed Wetlands for Wastewater Treatment*, edited by T. Hiraishi, T. Krug, K. Tanabe, N. Srivastava, B. Jamsranjav, M. Fukuda, and T. Troxler. Geneva: IPCC. https://www.ipcc.ch/site/assets/uploads/2018/03/Wetlands_Supplement_Entire_Report.pdf.

IPCC. 2023. *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by H. Lee and J. Romero. Geneva: IPCC. <https://doi.org/10.59327/IPCC/AR6-9789291691647>.

Ocean Panel (High Level Panel for a Sustainable Ocean Economy). 2021. *100% Sustainable Ocean Management: An Introduction to Sustainable Ocean Plans*. Washington, DC: Ocean Panel. https://oceanpanel.org/wp-content/uploads/2022/06/21_REP_Ocean-SOP_v10.pdf.

Schindler Murray, L., B. Milligan, O.S. Ashford, E. Bonotto, M. Cifuentes-Jara, L. Glass, J. Howard, et al. 2023. *The Blue Carbon Handbook: Blue Carbon as a Nature-Based Solution for Climate Action and Sustainable Development*. Washington, DC: High Level Panel for a Sustainable Ocean Economy. <https://oceanpanel.org/publication/blue-carbon/>.

-
1. Ove Hoegh-Guldberg, Eliza Northrop, Oliver S. Ashford, Thierry Chopin, Jessica Cross, Carlos Duarte, Steve Gaines, Tess Geers, Stefan Gössling, Peter Haugan, Mark Hemer, Jennifer Howard, Claire Huang, Andreas Humpe, Gabriella Kitch, David Koweek, Dorte Krause-Jensen, Catherine E. Lovelock, Kathryn Matthews, Patrick Mustain, Finn Gunnar Nielsen, Robert Parker, Joyashree Roy, Tristan Smith, Shreya Some, Ya-Yen Sun, Torsten Thiele and Peter Tyedmers. 2023. "The Ocean as a Solution to Climate Change: Updated Opportunities for Action." Special Report. Washington, DC: World Resources Institute. Available online at <https://oceanpanel.org/publication/ocean-solutions-to-climate-change>.



HIGH LEVEL PANEL *for*
**A SUSTAINABLE
OCEAN ECONOMY**

10 G Street NE
Suite 800
Washington, DC 20002, USA
+1 (202) 729-7600

oceanpanel.org

