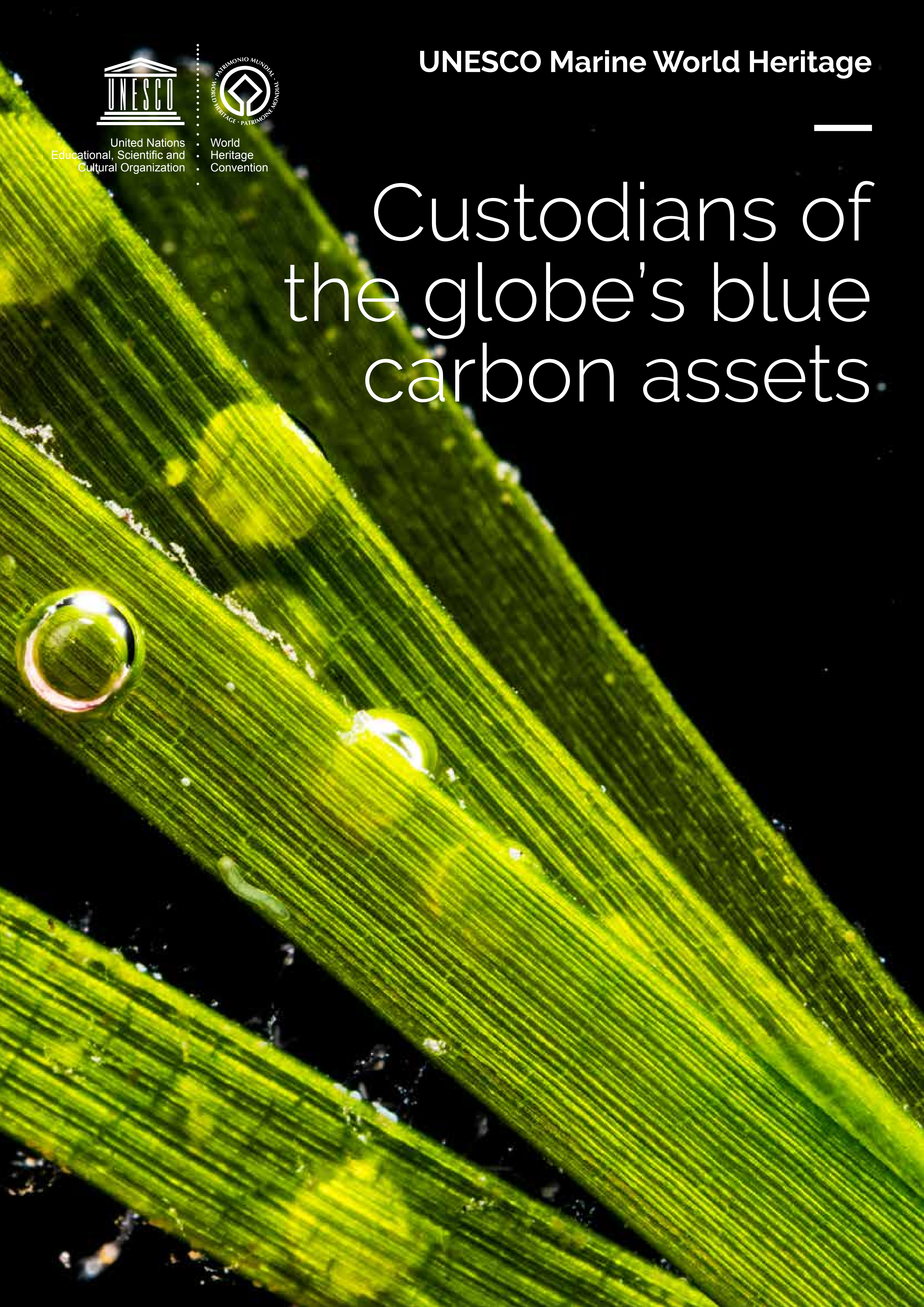

United Nations Educational, Scientific and Cultural Organization

World Heritage Convention

UNESCO Marine World Heritage

Custodians of the globe's blue carbon assets

Published in 2021 by the United Nations Educational, Scientific and Cultural Organization, 7, place de Fontenoy, 75352 Paris 07 SP, France

CLT-2021/WS/1

Suggested citation:

UNESCO. 2020. *UNESCO Marine World Heritage: Custodians of the globe's blue carbon assets*. Paris, France

The idea for this assessment originated during the 4th Marine World Heritage Managers Conference (Glacier Bay National Park and Preserve, 2019). This assessment is made in response to World Heritage Committee Decision 41 COM7 (Krakow/UNESCO, 2017), requesting the World Heritage Centre to further study the current and potential impacts of Climate Change on the OUV of World Heritage properties. The assessment is also responding to the 2017 "UNESCO Strategy for Action on Climate Change", adopted by the 39th session of the UNESCO General Conference, in particular by raising awareness on the impacts of climate change on the world's natural and cultural heritage (art. 76). UNESCO (2017). Available at: http://unesdoc.unesco.org/images/0025/002592/259255e.pdf

Editor: Jove

Cover photo: Oxygen bubbles on seagrass leaves in Ibiza (Spain). © Shane Gross

Graphic design: Aurelia Mazoyer

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Acknowledgements
CMD acknowledges financial support from King Abdullah University of Science and Technology under the Circular Carbon Economy initiative. DKJ acknowledges financial support from EU (FutureMARES, contract #869300). TBA acknowledges support from an Early Career Research Fellowship from the Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine. OS acknowledges financial support from Edith Cowan University. We thank J.P. Draper for assistance with the mangrove spatial data set. The contents in this document are solely the opinions of the authors and do not constitute a statement of policy, decision or position on behalf of the Gulf Research Program of the National Academies of Sciences, Engineering, and Medicine or of the institutions of other authors.

Marine World Heritage comprises at least 21% of the global area of blue carbon ecosystems and 15% of global blue carbon assets - carbon stores that are equivalent to about 10% of global greenhouse gas emissions in 2018.

Moindou, Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems (France). © Martial Dosdane

Executive Summary

Over the last decades scientists have discovered that seagrass meadows, tidal marshes, and mangroves – "blue carbon" ecosystems – are among the most intensive carbon sinks in the biosphere. By sequestering and storing significant amounts of carbon from the atmosphere and ocean, blue carbon ecosystems help mitigate climate change. But conversion and degradation of these ecosystems can also release billions of tons of CO_2 and other greenhouse gases into the ocean and atmosphere and contribute to global warming.

UNESCO's World Heritage List includes the world's most iconic marine protected areas, recognized by the international community for their outstanding biodiversity, beauty, geology and natural habitats. This report is a first assessment of blue carbon assets across the UNESCO marine World Heritage sites, revealing their outsized role as custodians of globally relevant blue carbon resources, including the largest areas of seagrass and mangroves in the ocean. Despite representing less than 1% of the global ocean area, marine World Heritage sites and their immediate surrounding areas for which data was available comprise at least 21% of the global area of blue carbon ecosystems and 15% of global blue carbon assets. These carbon stores are equivalent to about 10% of global greenhouse gas emissions in 2018.

Investing in the conservation and restoration of UNESCO marine World Heritage sites offers significant opportunities to mitigate climate change, meet the goals of the Paris Agreement under the United Nations Framework Convention on Climate Change by including these assets in Nationally Determined Contributions, and finance conservation, at least in part, through the resulting carbon credits. The United Nations Decade of Ocean Science for Sustainable Development and United Nations Decade of Ecosystem Restoration offer a unique opportunity to promote the restoration of these crucial habitats and accelerate reaching the United Nations Sustainable Development Goals by 2030.

Sian Ka'an (Mexico). © Inspired By Maps/Shutterstock.com*

1. UNESCO Marine World Heritage

Since its creation in 1972, the World Heritage Convention has been an exemplar for sustainable protection of the globe's most treasured places. The UNESCO World Heritage List ("the List") currently includes 1,121 globally outstanding places – cultural and natural – in 167 countries.[1] The sites reflect our common heritage of humankind and are a legacy to pass on to future generations. In its day-to-day-work, World Heritage unites 194 nations behind the shared responsibility to preserve the world's outstanding places for the benefit of present and future generations.

Since the listing of Everglades National Park (USA) in 1979 and the Great Barrier Reef (Australia) in 1981, **marine sites on the List have grown into a global network of 50 unique ocean places across 37 nations**.[2] Sites are recognized as World Heritage if they demonstrate Outstanding Universal Value (OUV) – and for marine sites, this means possessing exceptional marine biodiversity, singular ecosystems, unique geological processes or incomparable beauty.

Out of the 50 marine sites on the UNESCO World Heritage List, 21 were specifically recognized for their blue carbon ecosystems.[3] Mangrove ecosystems were among the first marine habitats to be recognized for their outstanding value. Everglades National Park (USA) was listed in part for containing one of the world's largest unbroken area of mangroves, followed by Sundarbans National Park (India) and The Sundarbans (Bangladesh) in 1987 and 1997 respectively, and Sian Ka'an (Mexico) for its extensive mangroves. World Heritage recognition for major seagrass beds followed with the addition to the List of Banc d'Arguin National Park (Mauritania) in 1989 and Shark Bay, Western Australia (Australia) in 1991. In 1999, Ibiza, Biodiversity and Culture (Spain), whose meadows of the unique *Posidonia oceanica* are the oldest and largest living organism on the planet, was listed. The Wadden Sea (Denmark, Germany, the Netherlands) was included in 2009 and extended in 2014, adding some of the world's largest tidal flats, including seagrass and tidal marshes.

Collectively, these ecosystems encompass a marine area of 207 million ha, representing 10% of all protected marine area globally as of January 2021.[4] Yet they represent a disproportionately large conservation value. And this value often has a spillover effect extending well beyond site boundaries. For instance:

- Increased awareness of the conservation value of the Ibiza (Spain) site's seagrass meadows – a key reason for listing – led to legislation in 2018 specifying the conservation of seagrass across the entire Balearic Islands.
- Listing of Sundarbans National Park (India) introduced management and conservation tools that have helped stabilize the wider region's mangroves.[5]

Despite its great value, this unique collection of marine World Heritage sites faces a wide range of conservation challenges, from local pressures to global impacts such as marine plastic litter and climate change.[6, 7]

1 http://whc.unesco.org/en/list/, as of January 2021
2 A full list of the 50 marine sites, as of January 2021 is available in Figure 4.
3 Based on analysis of the Statements of OUV.
4 2,051,176,500 ha, https://mpatlas.org accessed 4 January, 2021
5 Ghosh et al., 2015; Sievers et al. 2020
6 The Information System on the UNESCO World Heritage Centre's website offers a repertoire of science-based assessment and decision-making on the state of conservation of World Heritage properties and the threats they face. Thousands of reports and decisions adopted by the World Heritage Committee are accessible, as part of one of the most comprehensive monitoring systems of any international convention. For marine sites: http://whc.unesco.org/en/soc/?action=list&themes=7
7 https://worldheritageoutlook.iucn.org/results

Sundarbans (India). © niladrilovesphotography / Shutterstock.com*

2. An Introduction to Blue Carbon Ecosystems

"Blue carbon" is organic carbon – mainly from decaying plant leaves, wood, roots and animals – that is captured and stored by ocean and coastal ecosystems.[8] **Blue carbon ecosystems include seagrass meadows,[9] tidal marshes and mangroves. Forming a narrow strip that fringes the world's coastlines, blue carbon ecosystems are highly productive**, playing important ecological roles in nutrient and carbon cycling, as nurseries and habitat for a broad range of marine and terrestrial species, in shoreline protection and in sustaining the livelihoods and well-being of local communities.

Despite their critical ecological role, blue carbon ecosystems have received far less attention than more charismatic ecosystems such as coral reefs, with which they are often associated, and are underrepresented in marine protected areas.[10] As a consequence, and given their proximity to the land-ocean boundary, they have suffered extensive losses. About half the historical extent of vegetated soft-sediment habitats has been lost, partly from conversion to other uses, which directly affects mangroves and tidal marshes and indirectly affects seagrass meadows through deteriorated water quality. Other pressures including eutrophication, overfishing and climate change have also led to major losses of seagrass meadows worldwide.

While blue carbon ecosystems are among the most threatened habitats in the world, they play a critical role in climate mitigation and adaptation. Research in the 1990s revealed the important role that coastal vegetated habitats, also known as blue carbon ecosystems, play in global carbon sequestration, by transforming carbon dioxide into biomass through photosynthesis and by accumulating vast stocks of carbon in their sediments.[11]

Organic carbon in sediment comes from detritus released by plants and detritus produced elsewhere, which is trapped and locked in the soils where the plants grow.

Because they store so much carbon, blue carbon ecosystems become sources of CO_2 emissions when they are degraded or destroyed. Protection and restoration of these ecosystems presents a unique opportunity to mitigate climate change. **By conserving blue carbon ecosystems, the large carbon stocks that have accumulated over millennia can be protected. As they are restored, they can regain their function as carbon sinks**. Both strategies were formulated in the United Nations report "*Blue Carbon. The role of healthy oceans in binding carbon*[12]," in which the term "blue carbon" was defined and first used.

Well before their ecological importance was reported and blue carbon strategies were first proposed, UNESCO marine World Heritage sites protected these blue carbon ecosystems and their associated biodiversity. These include:

- The Sundarbans mangroves (India; 1987 and Bangladesh; 1997), remarkable for their population of resident Royal Bengal Tigers and for protecting part of the largest unbroken mangrove areas in the world;
- The world's largest documented seagrass meadows, including the extensive meadows in Everglades National Park (USA; 1979) and in Shark Bay, Western Australia (Australia; 1991);
- The vast shallow- and deep-water seagrass meadows in the Great Barrier Reef (Australia; 1981) - the largest seagrass ecosystem in the world, discovered after its inclusion on the List.

8 http://www.unesco.org/new/en/natural-sciences/ioc-oceans/sections-and-programmes/ocean-sciences/ocean-carbon/coastal-blue-carbon/
9 Extending from the coast to 50 m in depth
10 Duarte et al. 2009; Zhao et al. 2020.
11 Donato et al. 2011; Duarte et al. 2005; Fourqurean et al. 2012; Mcleod et al. 2011; Duarte et al. 2013; Pendleton et al. 2012
12 https://wedocs.unep.org/handle/20.500.11822/7772

3. Blue Carbon Ecosystems and Global Carbon Assets in UNESCO Marine World Heritage Sites[13]

This first assessment of the extent of seagrass meadows, tidal marshes and mangroves and their associated carbon assets in UNESCO marine World Heritage sites was based on information reported in scientific, peer-reviewed literature and information provided by local teams at marine World Heritage sites. These estimates were then coupled with reported estimates of carbon stocks in the soils of the World Heritage sites or, where these were not available, from reports of carbon stocks of other examples of these ecosystems in the same country or bioregion. The assessment includes the contiguous ecosystems in the immediate vicinity of the respective marine World Heritage site boundaries, which are substantial in some cases (e.g., mangrove areas in the Sundarbans). Immediately adjacent ecosystems were included in the assessment for reasons of integrity and ecosystem functioning and because of the observed spillover effect of conservation efforts next to declared World Heritage sites. **The data used in this report is likely to underestimate the total blue carbon assets within the UNESCO marine World Heritage sites, as the extent of some blue carbon ecosystems remains largely unknown even where their existence is confirmed.**

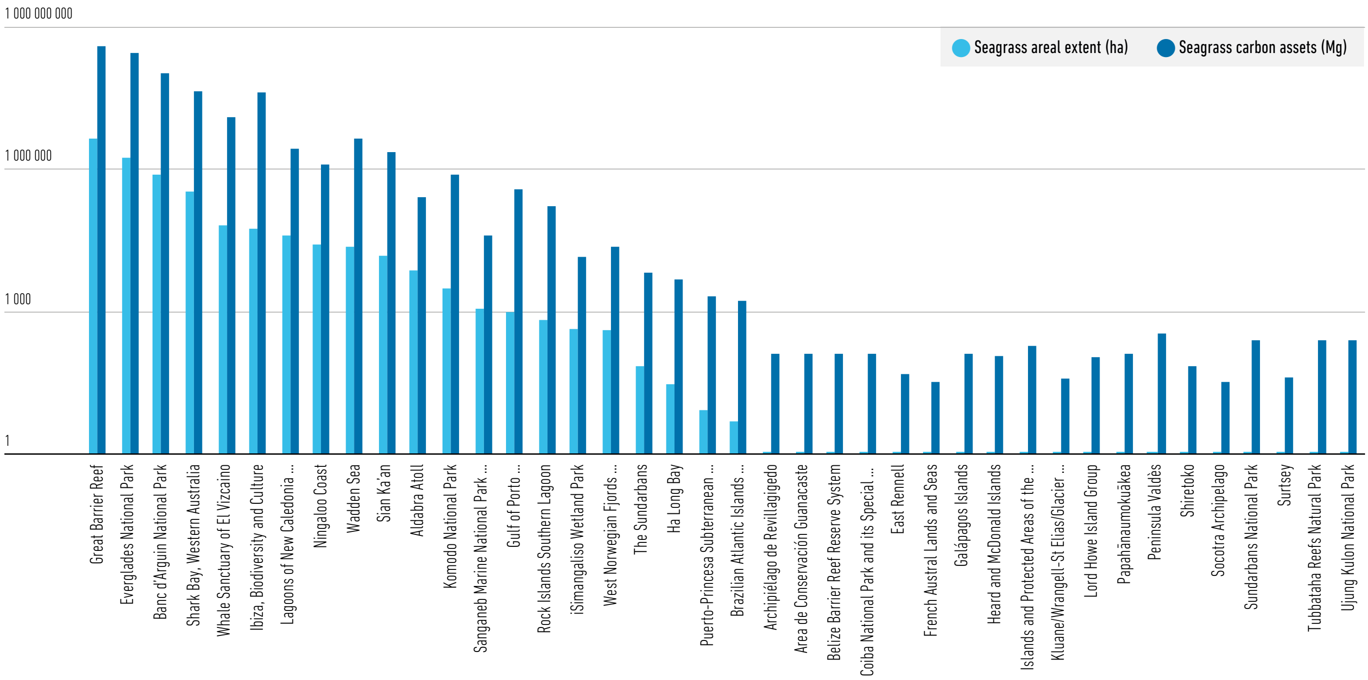
3.1 SEAGRASS MEADOWS

3.1.1 Areal Extent of Seagrass in UNESCO Marine World Heritage Sites

Areal extent of all seagrass within UNESCO marine World Heritage sites*	**7,733,850 ha**
% of documented global seagrass area (26,656,200 ha)[14]	**29%**
UNESCO marine World Heritage sites where seagrass has been documented	**40 of 50 total sites**
Largest seagrass areas (Fig. 1)	→ Great Barrier Reef (Australia): 4,570,000 ha → Everglades National Park (USA): 1,800,000 ha → Banc d'Arguin National Park (Mauritania): 781,000 ha

* Including meadows extending into immediate surrounding areas for which data was available.

Figure 1. Ranked abundance of seagrass area in hectares (ha) and total organic carbon in megagrams (Mg C)[15] stored in UNESCO marine World Heritage sites (2020) using a logarithmic scale. For the 19 sites where seagrass is present but whose extent is unknown, the total C stock was calculated for a conservative area of 1 ha using C stock data for that country or region. For a list of full marine site names and respective countries see Figure 4.



13 Sources of data, assumptions and calculations, references and other materials are available as only appendices at: http://whc.unesco.org/document/185856.
14 McKenzie et al. 2020.
15 1 Megagram = 10^6 grams = 1 million grams = 1000 kilograms = 1 ton.

Seagrass close-up in Shark Bay, Western Australia (Australia).

Marine World Heritage sites contain at least 29% of the world's documented seagrass area. However, vast global seagrass areas are as yet undocumented. Hence, the 7,733,850 ha of confirmed seagrass in marine World Heritage sites when mapped adequately will likely be a significant fraction of the 164,678,800 ha of the global seafloor that may potentially support seagrass.[16]

One quarter of the 40 marine World Heritage sites with documented seagrass area have coverage exceeding 10,000 ha. Sites without seagrasses are typically too low in salinity to support them (e.g., High Coast/Kvarken Archipelago (Finland and Sweden)), are outside the latitudinal distribution range for seagrasses (e.g., New Zealand Sub-Antarctic Islands (New Zealand)), or are on other offshore, exposed islands (e.g., Malpelo Fauna and Flora Sanctuary (Colombia), Gough and Inaccessible Islands (UK)) with rocky shores unsuited to seagrass meadows. This assessment may be further underestimated by a lack of accurate information in sites with seagrass, which were assigned a coverage of 1 ha, but could support a much larger extent in some cases.

3.1.2 Seagrass Carbon Assets in UNESCO Marine World Heritage Sites

Total organic carbon stored in seagrass at UNESCO marine World Heritage sites*	**919 million** megagrams (Mg) C** (equivalent to 3,373 million Mg CO_2)
% of global seagrass carbon stores (3,724 million Mg of C)***	**25%**
UNESCO marine World Heritage sites where seagrass carbon stocks are unknown	**19 of 50 total sites**
Largest seagrass carbon stocks (% total seagrass carbon stocks within all marine World Heritage sites) (Fig. 1)	→ Great Barrier Reef (Australia): 404 million Mg C (44%) → Everglades National Park (USA): 295 million Mg C (32%) → Banc d'Arguin National Park (Mauritania): 109 million Mg C (12%) → Shark Bay, Western Australia (Australia): 44 million Mg C (5%) → Ibiza, Biodiversity and Culture (Spain): 41 million Mg C (5%)

* Including meadows extending into immediate surrounding areas for which data was available.
** Contained in top meter of soil under meadows.
*** Calculated from median soil C storage in top meter of soil under meadows Fourqurean et al. 2012 of 139.7 Mg C ha^{-1} and global seagrass extent in McKenzie et al. 2020.

With the world's largest seagrass meadows, marine World Heritage sites are also custodians of the world's largest seagrass carbon stocks. **Marine World Heritage sites hold 25% of the world's documented seagrass carbon assets.** Five sites contain 97% of seagrass carbon stocks in all marine sites. The seagrass meadows surrounding the coral reefs in the Great Barrier Reef alone host an estimated 11% of the world's seagrass blue carbon.

The estimate that seagrass soils in marine sites hold 25% of the global seagrass carbon stores is probably understated, for two reasons. First, the global median value of soil C stocks in seagrass meadows (140 Mg C ha^{-1}) and thereby the global seagrass carbon stores (3,724 million Mg of C) estimated here are largely biased by data from *Posidonia oceanica* meadows in the Mediterranean Sea, which form peat-like organic soil deposits not common in other seagrass meadows. For example, Ibiza, Biodiversity and Culture (Spain) holds six times more soil carbon stocks per unit area than the mean across all marine World Heritage sites.

Second, for 19 of the 50 marine sites where seagrass is present but its extent unknown, carbon stocks cannot be correctly estimated, highlighting the need for further research on seagrass areal extent and carbon storage within and beyond marine World Heritage sites.

16 Jayathilake et al. 2018.

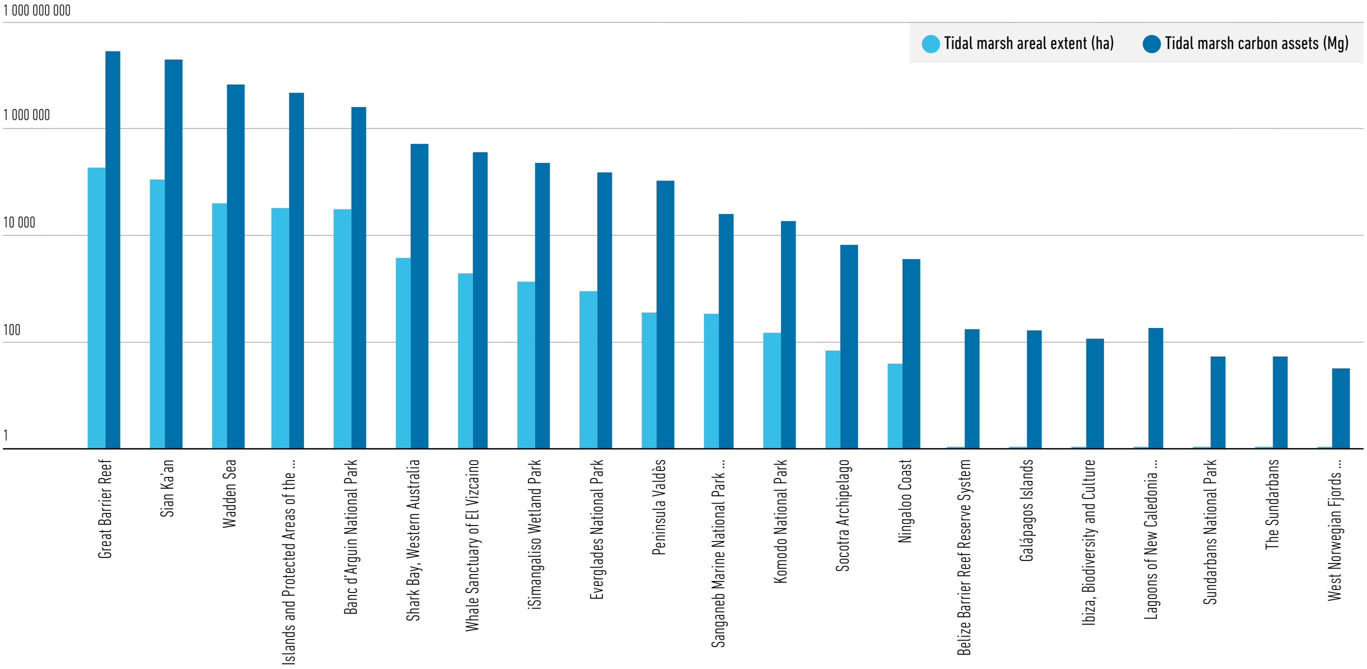
3.2 TIDAL MARSHES

3.2.1 Areal Extent of Tidal Marshes in UNESCO Marine World Heritage Sites

Areal extent of all tidal marshes within UNESCO marine World Heritage sites*	411,682 ha
% of documented global tidal marsh area (5,495,100 ha)	7.5%
UNESCO marine World Heritage sites with tidal marshes	21 of 50 total sites
Largest tidal marsh areas (Fig. 2)	→ Great Barrier Reef (Australia): 186,700 ha → Sian Ka'an (Mexico): 112,640 ha → Wadden Sea (Denmark, Germany, the Netherlands): 40,000 ha

* Including tidal marshes extending into immediate surrounding areas for which data was available.

Figure 2. Ranked abundance of tidal marsh area in hectares (ha) and total organic carbon in megagrams (Mg C) in UNESCO marine World Heritage sites (2020) using a logarithmic scale. For the seven sites where tidal marshes are present but whose extent is unknown, the total C stock was calculated for a conservative area of 1 ha using C stock data for that country or region. For a list of full marine site names and respective countries see Figure 4.



Marine World Heritage sites contain 7.5% of the world's tidal marshes. Tidal marshes are present across many marine sites, but their extent has not been fully assessed. Areal extent was available for 14 of the 21 sites where tidal marsh was noted. For the seven other sites, tidal marshes are known to be present but area estimates were unavailable.

Tidal marsh has been reported by local managers or in the scientific literature at Banc d'Arguin National Park (Mauritania), Komodo National Park (Indonesia), Sanganeb Marine National Park and Dungonab Bay – Mukkawar Island Marine National Park (Sudan) and Socotra Archipelago (Yemen) but is not currently recorded in the global distribution map for this ecosystem.[17] Sites lacking tidal marsh are located in island sites or areas characterized by rocky shores or coral atolls.

The tidal marshes of the top three marine sites in Australia (Great Barrier Reef) and Mexico (Sian Ka'an) and the transnational site in Germany, Denmark and the Netherlands (Wadden Sea) represent 13%, 42% and 58%, respectively, of those countries' (or combined countries') overall tidal marsh extent. Although iSimangaliso Wetland Park (South Africa) is just 0.33% of the marine World Heritage sites' total tidal marsh area, it represents 22% of its host country's tidal marsh area.

3.2.2 Tidal Marsh Carbon Assets in UNESCO Marine World Heritage Sites

Total tidal marsh carbon stored in UNESCO marine World Heritage sites*	**64 million** Mg C** (equivalent to 235 million Mg CO_2)
% of global tidal marsh carbon stores (estimated 889 million Mg C)	**7.2%**
UNESCO marine World Heritage sites where tidal marsh carbon stocks are unknown	**7 of 50 total sites**
Largest tidal marsh carbon stocks, Mg C (% total tidal marsh carbon stocks within all marine World Heritage sites) **(Fig. 2)**	→ Great Barrier Reef (Australia): 29 million Mg C (45%) → Sian Ka'an (Mexico): 20 million Mg C (31%) → Wadden Sea (Denmark, Germany, the Netherlands): 6.7 million Mg C (11%)

* Including tidal marshes extending into immediate surrounding areas for which data was available.
** Contained in upper 1 meter of soil.

Marine World Heritage sites host 7.2% of global tidal marsh carbon assets. Overall, the percentage of total organic carbon stored in each marine site was commensurate with its areal extent. Almost 87% of total tidal marsh carbon stocks in marine sites were stored in the three sites with the greatest areal extent (table above and Fig. 2).

Because tidal marsh extent has not yet been adequately mapped in many of the sites, the estimate that tidal marshes in marine World Heritage sites store 64 million Mg C in the upper 1 m of soil, representing 7.2 % of the global stock, is most likely underestimated.

The average carbon stocks for sites with tidal marsh habitat was 136 megagrams C per hectare (Mg C ha^{-1}), with the highest average carbon stocks found in Península Valdés (Argentina; 300 Mg C ha^{-1}).

The tidal marshes of sites in Australia (Great Barrier Reef), Mexico (Sian Ka'an) and the transnational site in Denmark, Germany and the Netherlands (Wadden Sea) represent 14%, 54% and 55%, respectively, of those countries' (or combined countries') overall tidal marsh carbon stores.

Although not included in this assessment, it is worthwhile mentioning that several coastal cultural World Heritage sites also protect tidal marshes. For example, the buffer zone of the Mont-Saint-Michel and its Bay (France) includes almost 50,000 ha of tidal marshes.

Shorebirds in the Wadden Sea (Denmark, Germany, the Netherlands)
© Jort van Gils/Shutterstock.com*

17 Mcowen et al. 2017.

Royal Bengal Tiger in the Sundarbans (Bangladesh/India) © Soumyajit Nandy

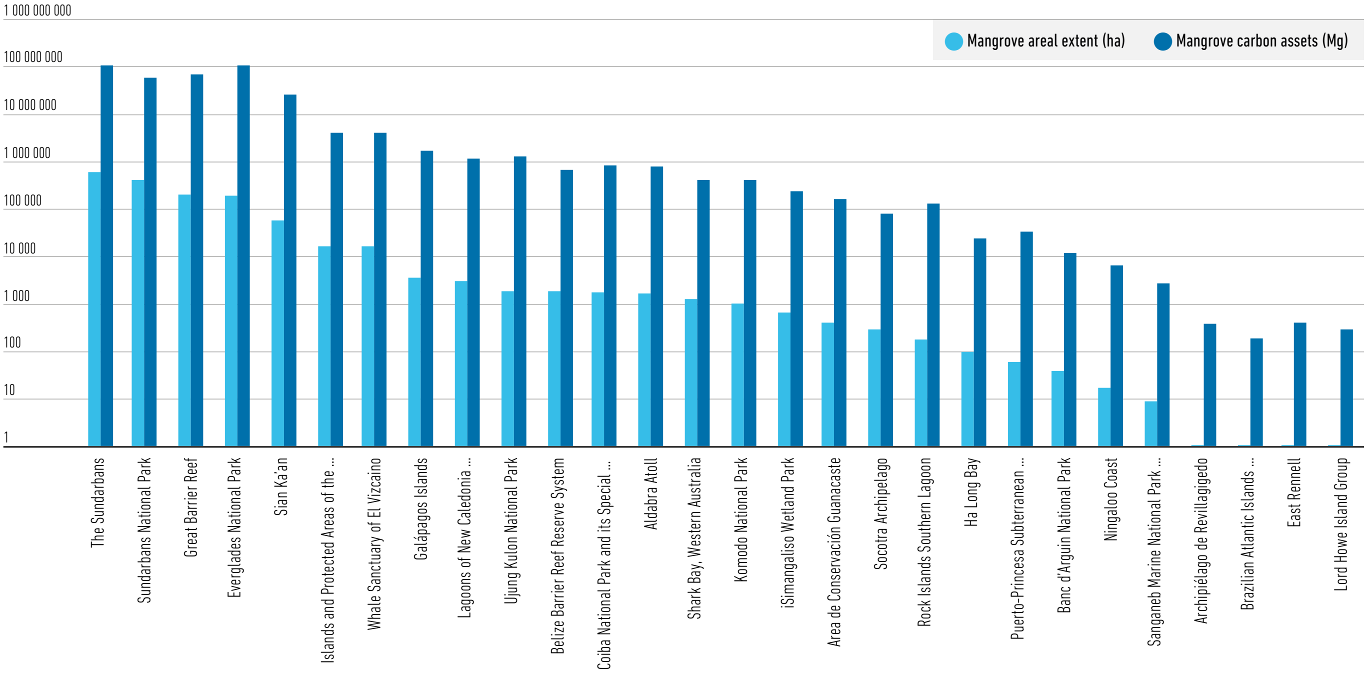
3.3 MANGROVES

3.3.1 Areal Extent of Mangroves in UNESCO Marine World Heritage Sites

Areal extent of all mangroves within UNESCO marine World Heritage sites*	**1,536,800 ha**
% of documented global mangroves area (13,776,000 ha):	**11%**
UNESCO marine World Heritage sites with mangroves	**28 of 50 total sites**
Largest mangrove areas (Fig. 3)	→ The Sundarbans (Bangladesh): 601,700 ha → Sundarbans National Park (India): 426,000 ha → Great Barrier Reef (Australia): 207,000 ha → Everglades National Park (USA): 192,200 ha

*Including mangroves extending into immediate surrounding areas for which data was available.

Figure 3. Ranked abundance of total mangrove area in hectares (ha) and total organic carbon in megagrams (Mg C) in UNESCO marine World Heritage sites (2020) using a logarithmic scale. For one site (East Rennell) the mangrove extent is unknown and its total C stock was calculated for an estimated 1 ha using C stock data available for the region. Total C stock includes C stored both in the soil and biomass. For a list of full marine site names and respective countries see Figure 4.



Marine World Heritage sites cover 11% of the world's documented mangrove area.[18] Six sites comprise 98% of the mangrove area in marine World Heritage sites, including the Great Barrier Reef (Australia), Everglades National Park (USA), The Sundarbans (Bangladesh) and Sundarbans National Park (India), Sian Ka'an (Mexico), and Islands and Protected Areas of the Gulf of California (Mexico). The Sundarbans (Bangladesh), Sundarbans National Park (India) and their adjoining mangrove areas represent the largest continuous mangrove area in the world, with a staggering combined total of over 1,000,000 ha (Fig. 3).

Unlike seagrass and tidal marsh habitats, the extent of global mangroves has been thoroughly examined at fine spatial resolutions using remote sensing. While not part of this assessment, this allows, for example, an estimation of additional mangrove habitat in non-marine natural World Heritage sites, 10 of which contain a combined additional 230,306 ha of mangroves (Appendix 3). The largest of these is Lorentz National Park (Indonesia), with 189,129 ha of mangroves – the third-largest mangrove holding of all natural World Heritage sites (excluding adjoining areas). The addition of mangroves in these non-marine sites brings total World Heritage holdings to an estimated 13% of the world's global mangroves.

3.3.2 Mangrove Carbon Assets in UNESCO Marine World Heritage Sites

Total mangrove carbon stored in UNESCO marine World Heritage sites*	**386 million** Mg C** (equivalent to 1,415 million Mg CO_2)
% of global mangrove carbon stores (estimated 4,190 – 5,030 million Mg C)	**8% - 9%**
UNESCO marine World Heritage sites where mangrove carbon stocks are unknown	**1 of 50 total sites**
Largest carbon stocks within marine World Heritage sites* **(% total mangrove carbon stocks within all marine World Heritage sites)**	→ The Sundarbans (Bangladesh): 108 million Mg C (28%) → Everglades National Park (USA): 105 million Mg C (27%) → Great Barrier Reef (Australia): 70 million Mg C (18%) → Sundarbans National Park (India): 60 million Mg C (15%) → Sian Ka'an (Mexico): 27 million Mg C (7%)

* Including mangroves extending into immediate surrounding areas for which data was available.
** Includes carbon in mangrove biomass and top meter of soil.

Marine World Heritage sites host 9% of global mangrove carbon assets. Mangroves contain two primary carbon pools: carbon stored in soils and carbon stored in living tree biomass. Most of the carbon stored in mangroves in marine sites and their adjoining areas is in their soils (~322 million Mg C in the top meter), constituting ~83% of the total mangrove carbon stock. The remaining 17% (~64 million Mg) of stored carbon is in their tree biomass.

Within their designated boundaries, marine sites contribute 240 million Mg C (Fig. 3). Mangroves adjoining the sites – specifically, national parks, reserves and sanctuaries in the Sundarbans mangroves and the El Vizcaino Biosphere Reserve (Mexico) – contribute an additional 146 million Mg C to total organic carbon stores. These large adjacent carbon stocks highlight the importance of a broader network of protection for mangroves and their rich carbon stocks.

The amount of carbon stored in marine sites and immediate surrounding areas was slightly lower than expected based on area (11% of total global area but only 9% of the global carbon stored). This difference primarily stems from the relatively low soil carbon density in the Sundarbans deltaic sediments.

In addition to these marine sites, 10 non-marine natural World Heritage sites containing mangroves that grow along tidal

Aldabra Atoll (Seychelles) © Janske van de Crommenacker

floodplains contribute yet another 133 million Mg of carbon (Appendix 3), for a grand total of ~519 million Mg C stored in mangroves in natural World Heritage sites and their adjoining properties (equivalent to 1,903 million Mg of CO_2), or about 12% of the total organic carbon stored in mangroves globally.

Almost all the mangrove carbon stored in marine World Heritage sites and their adjoining areas is located in just four critical sites (Fig. 3). Everglades National Park (USA), which hosts the second-largest mangrove carbon stocks of all marine sites, is especially important. The site was inscribed on the UNESCO List of World Heritage in Danger in 2010. Its mangroves face several pressures including sea-level rise, altered hydrologic regimes, adjacent urban and agricultural growth, and oil and gas exploration upstream of the site.[19]

18 This assessment refers to 'mangroves' and not 'mangrove forests'. The term 'forest' is defined differently across countries and is based in part on height and crown cover. For example, the scrub mangroves in Sian Ka'an would not be classified as forest in Mexico, where forests are defined as comprising trees over 4 m tall.

19 World Heritage Committee decisions: https://whc.unesco.org/en/list/76/documents/

3.4 TOTAL BLUE CARBON ECOSYSTEMS IN UNESCO MARINE WORLD HERITAGE SITES

UNESCO marine World Heritage sites contain a much larger percentage of the world's blue carbon ecosystems than their size would suggest. Despite covering just 0.57% of global ocean area and only 10% of global marine protected area, the 50 marine sites on UNESCO's World Heritage List and their immediate surrounding areas for which data was available contain at least 21% of the world's blue carbon ecosystems. In some marine sites, blue carbon ecosystems are known to be present but remain uncharted and their area unknown. This is mostly the case for seagrass, which is difficult to identify from remote sensing. Seagrass habitats constitute 80% of the blue carbon ecosystems in marine World Heritage sites.

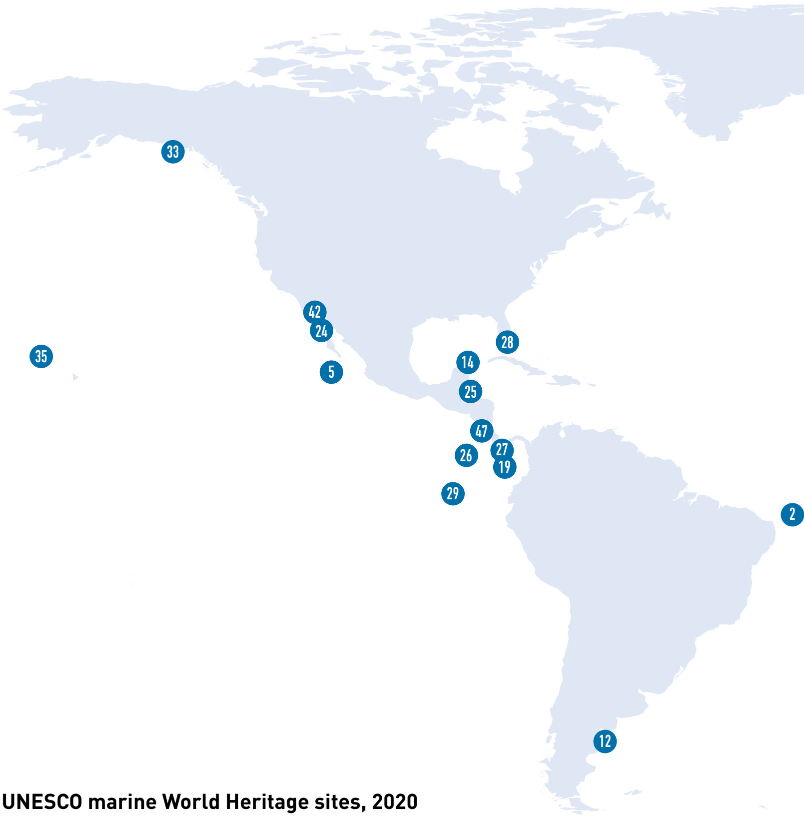


Figure 4. Presence/absence and extent of blue carbon ecosystems in UNESCO marine World Heritage sites, 2020

● orange (over 100,000 ha) ● green (1,000-99,999 ha) ● blue (1-999 ha)

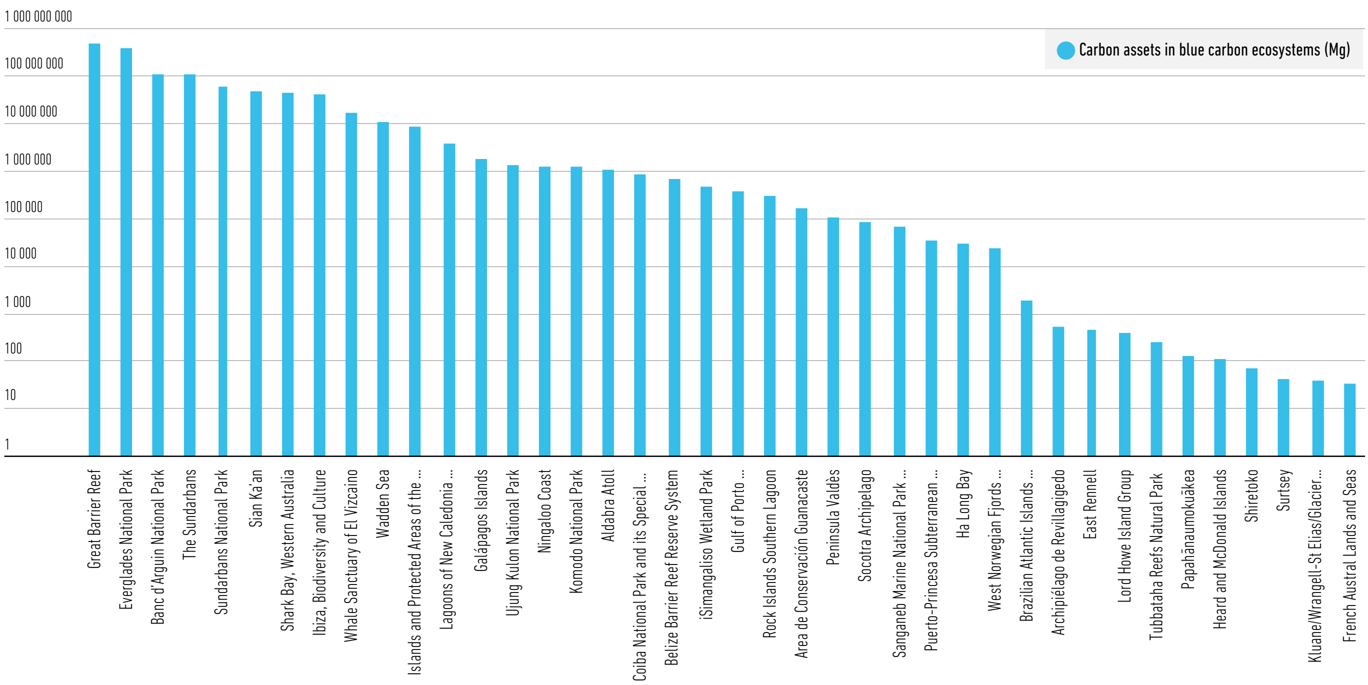
○ (outlined) Ecosystems extending beyond marine World Heritage site boundaries included for this assessment ● grey (area unknown)

Map ID	UNESCO marine World Heritage site, *country*	Seagrass	Tidal marsh	Mangrove
1	Banc d'Arguin National Park, *Mauritania*	orange (outlined)	green	blue
2	Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves, *Brazil*	blue		blue
3	Ogasawara Islands, *Japan*			
4	Aldabra Atoll, *Seychelles*	green		green
5	Archipiélago de Revillagigedo, *Mexico*	grey		blue
6	French Austral Lands and Seas, *France*	grey		
7	Gough and Inaccessible Islands, *United Kingdom of Great Britain and Northern Ireland*			
8	Ha Long Bay, *Viet Nam*	blue		blue
9	High Coast/Kvarken Archipelago, *Finland / Sweden*			
10	Komodo National Park, *Indonesia*	green	blue	green
11	Natural System of Wrangel Island Reserve, *Russian Federation*			
12	Peninsula Valdès, *Argentina*	grey	blue	
13	Shark Bay, Western Australia, *Australia*	orange	green	green
14	Sian Ka'an, *Mexico*	green	orange	green
15	The Sundarbans, *Bangladesh*	blue	grey	orange (outlined)
16	Wadden Sea, *Germany / Netherlands / Denmark*	green	green	
17	Tubbataha Reefs Natural Park, *Philippines*	grey		
18	Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems, *France*	green (outlined)	grey	green
19	Malpelo Fauna and Flora Sanctuary, *Colombia*			
20	Ningaloo Coast, *Australia*	green	blue	blue
21	Puerto-Princesa Subterranean River National Park, *Philippines*	blue		blue
22	Shiretoko, *Japan*	grey		
23	Surtsey, *Iceland*	grey		
24	Whale Sanctuary of El Vizcaino, *Mexico*	green	green	green (outlined)
25	Belize Barrier Reef Reserve System, *Belize*	grey	grey	green
26	Cocos Island National Park, *Costa Rica*			
27	Coiba National Park and its Special Zone of Marine Protection, *Panama*	grey		green
28	Everglades National Park, *United States of America*	orange (outlined)	blue	orange
29	Galápagos Islands, *Ecuador*	grey	grey	green
30	Great Barrier Reef, *Australia*	orange	orange	orange
31	Gulf of Porto: Calanche of Piana, Gulf of Girolata, Scandola Reserve, *France*	green		
32	iSimangaliso Wetland Park, *South Africa*	blue (outlined)	green	blue
33	Kluane/Wrangell-St Elias/ Glacier Bay/Tatshenshini-Alsek, *United States of America / Canada*	grey		
34	New Zealand Sub-Antarctic Islands, *New Zealand*			
35	Papahānaumokuākea, *United States of America*	grey		
36	Rock Islands Southern Lagoon, *Palau*	blue		blue
37	Sanganeb Marine National Park and Dungonab Bay – Mukkawar Island Marine National Park, *Sudan*	green	blue	blue
38	Socotra Archipelago, *Yemen*	grey	blue	blue
39	Ujung Kulon National Park, *Indonesia*	grey		green
40	West Norwegian Fjords – Geirangerfjord and Nærøyfjord, *Norway*	blue (outlined)	grey	
41	Heard and McDonald Islands, *Australia*	grey		
42	Islands and Protected Areas of the Gulf of California, *Mexico*	grey	green	green
43	East Rennell, *Solomon Islands*	grey		grey
44	Macquarie Island, *Australia*			
45	Phoenix Islands Protected Area, *Kiribati*			
46	St Kilda, *United Kingdom of Great Britain and Northern Ireland*			
47	Area de Conservación Guanacaste, *Costa Rica*	grey		blue
48	Ibiza, Biodiversity and Culture, *Spain*	green	grey	
49	Lord Howe Island Group, *Australia*	grey		blue
50	Sundarbans National Park, *India*	grey	grey	orange (outlined)

4. Global Contribution of UNESCO Marine World Heritage Sites to Blue Carbon Assets

Total organic carbon assets in each of the sites (Fig. 5, Appendix 2) is determined largely by the area of blue carbon ecosystems in each site and in adjoining waters (Fig. 4). A ranking of marine sites by total organic carbon assets therefore closely matches their ranking by blue carbon ecosystem area (Appendix 2).

Figure 5. Ranked carbon assets in megagrams of carbon (Mg C) of blue carbon ecosystems in UNESCO marine World Heritage sites (2020) using a logarithmic scale. For a list of full marine site names and respective countries see Figure 4.



The blue carbon ecosystems hosted in marine World Heritage sites regularly constitute a significant portion of the carbon stocks in the country where they are located. Hence, for many nations with marine World Heritage sites, including these carbon stocks in Nationally Determined Contributions (NDCs) and investing in restoration is an effective strategy to mitigate carbon emissions and is key to reaching their targets of the 2015 Paris Agreement.

If these habitats are disturbed, billions of tons of CO_2 and other greenhouse gases such as methane are at risk of being emitted to the atmosphere. Collectively, carbon stocks in UNESCO marine World Heritage sites and their immediate surrounding areas for which data was available (5.02 billion tons CO_2) would result in a one-off increase of annual greenhouse gas emissions from land-use changes by about 10% if they were completely destroyed and their carbon stocks were released into the atmosphere.[20]

5. Conservation Benefits of UNESCO Marine World Heritage Sites for Blue Carbon Ecosystems

The conservation benefits of blue carbon ecosystems within marine World Heritage sites extend well beyond their carbon stocks and sequestration services. Blue carbon ecosystems – particularly seagrasses - help improve water quality by trapping sediments and by taking up and processing nutrients. They also can improve conditions for adjacent ecosystems, including coral reefs.

Blue carbon ecosystems are essential for marine and terrestrial biodiversity. A wide range of terrestrial species - almost five times more than originally thought - use mangroves, including the Royal Bengal Tiger. All blue carbon ecosystems support fisheries as fish nursery grounds and as food providers, underpinning coastal food webs, including those in coral reefs. Blue carbon ecosystems contribute significantly to the livelihoods and cultural practices and values of local and traditional communities living within the UNESCO marine World Heritage sites.

Blue carbon ecosystems also play a significant global role in protecting coasts and climate change adaptation and help reduce coastal wave energy, reducing the impacts of storms and other extreme events. Blue carbon ecosystems raise the seafloor by trapping sediment and other particles with their extensive and productive root systems. Accumulation of sediment over time may enable these habitats to keep pace with sea level rise while storing vast quantities of carbon. Over long periods, these accretions of sediment have also provided high-resolution records of past environmental conditions.

Blue carbon ecosystems within marine sites are also important reservoirs of genetic diversity for rehabilitating adjacent sites degraded by human activities or extreme events. For example, the seagrasses of the Wadden Sea (Denmark, Germany, the Netherlands) are providing vital genetic resources for the recovery of seagrasses in adjacent waters, where they have been lost due to poor water quality.

6. Funding Conservation through Blue Carbon Markets

Conserving blue carbon ecosystems in marine World Heritage sites can mitigate climate change and help nations avoid additional emissions of CO_2 and other greenhouse gases. **That conservation may be funded, at least in part, by emerging opportunities in blue carbon markets**.

Accessing these opportunities requires demonstrating that any carbon benefits derived from conservation and restoration are directly related to these actions, and that in their absence the habitat would have been degraded, leading to carbon emissions.

> Investing in the conservation and restoration of UNESCO marine World Heritage sites offers significant opportunities to mitigate climate change and meet the goals of the Paris Agreement.

Conservation or restoration activities to generate carbon credits may also be possible where conservation actions for marine sites are not being pursued for lack

20 The blue carbon stocks within marine World Heritage sites (5.02 billion tons CO_2 equivalents in the top 1 m of soil of tidal marsh, mangrove and seagrass, plus the stock in mangrove biomass) were compared to: (1) total greenhouse gas emissions in 2018 including those from land-use changes (55.3 billion tons CO_2 equivalent) as reported by the UNEP 2019 Emissions Gap Report (https://wedocs.unep.org/bitstream/handle/20.500.11822/30798/EGR19ESEN.pdf); and (2) total greenhouse gas emissions in 2017 with forest and other land use (52.5 billion tons CO2 equivalent) as reported by the UNFCCC 2019 Annual Report (https://unfccc.int/sites/default/files/resource/unfccc_annual_report_2019.pdf).

of financial resources, if sites were damaged before World Heritage designation, or if sites have been damaged by natural events. Wherever blue carbon ecosystems have suffered losses, it may be possible to use carbon financing to support their restoration.

The return on investment for marine World Heritage sites is therefore high. And the investment is relatively lower-risk. Funding from carbon projects requires that carbon stocks are permanent, often for 100 years. Because the World Heritage designation includes a commitment to conserve in perpetuity, it provides greater confidence in the permanence of carbon stocks. World Heritage designation also enjoys a strong commitment of individual nations and the international community as a whole to safeguard these unique places for future generations. Indeed, requests from the World Heritage Committee already have led to active and planned programs to:[21]

- Improve water quality (Great Barrier Reef (Australia); Ibiza, Biodiversity and Culture (Spain));
- Manage water and sediment fluxes in deltas (The Sundarbans (Bangladesh); Sundarbans National Park (India);
- Restore mangroves (Everglades National Park (USA); The Sundarbans (Bangladesh); Sundarbans National Park (India); Belize Barrier Reef Reserve System (Belize)); Islands and Protected Areas of the Gulf of California (Mexico));
- Rehabilitate other areas, engaging with indigenous communities (Shark Bay, Western Australia (Australia)).

To date, however, many countries have not incorporated blue carbon strategies into their portfolio of climate change mitigation policies. Together with IUCN and Conservation International, UNESCO's Intergovernmental Oceanographic Commission has created the Blue Carbon Initiative with the aim to foster financial incentives, policy mechanisms, comprehensive methods for assessing blue carbon stocks and emissions, feasibility studies of blue carbon accounting, and more scientific research.[22]

Marine World Heritage sites could also serve as priority sites for testing and applying blue carbon finance schemes. **Scientists, investors and green financial managers have particularly important roles in supporting such an effort, safeguarding these sites for future generations**.

Blue carbon ecosystems within UNESCO marine World Heritage sites not only provide vital ecosystem services but also are a crucial strategy for nations to deliver on their commitments under the Paris Agreement and the SDGs, Targets 14.2 and 14.5 in particular.[23]

Yet climate change is affecting marine sites at an unprecedented rate and blue carbon assets are particularly vulnerable to extremes in weather related to climate change and eutrophication. **If not properly managed or protected, blue carbon ecosystems can become carbon emitters**. Although marine World Heritage sites are protected and managed to avoid deterioration, seagrass and mangrove ecosystems in particular are suffering impacts, including climate change, that threaten their survival and could trigger the release of ancient soil carbon stores as atmospheric CO_2.

7. Additional Research

This assessment provides a first scientific analysis of blue carbon ecosystems and assets across UNESCO marine World Heritage sites and their contribution to climate mitigation. Further work to strengthen this first assessment and provide a more comprehensive analysis that informs States Parties, the World Heritage Committee, conservation groups and the global community as a whole may involve additional efforts, supported by the United Nations Decades of Ocean Science for Sustainable Development and Ecosystem Restoration, including:

- Systematically assessing and monitoring the extent and health of blue carbon ecosystems in UNESCO marine World Heritage sites, allowing for analysis of long-term trends and roles in climate change mitigation and adaptation. For shallow seagrass meadows, remote sensing may reveal areal extent (with field confirmation). For tidal marshes, site specific measurements of organic carbon stocks are needed;
- Referencing World Heritage sites under Nationally Determined Contributions (NDCs)—not only marine sites but also natural and coastal cultural sites;
- Supporting the sites' management authorities with both financial resources and capacity building in closing the blue carbon knowledge gap. Such conservation and restoration actions may offer opportunities for carbon financing through the United Nations carbon offset platform (offset.climateneutralnow.org), thereby generating additional resources for investing in conservation and restoration of these globally outstanding World Heritage sites to the benefit of present and future generations.

21 Decisions from the World Heritage Committee: http://whc.unesco.org/en/soc/?action=list&themes=7

22 https://www.thebluecarboninitiative.org/

23 14.2: By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans; 14.5: By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information.

United Nations Educational, Scientific and Cultural Organization · World Heritage Convention

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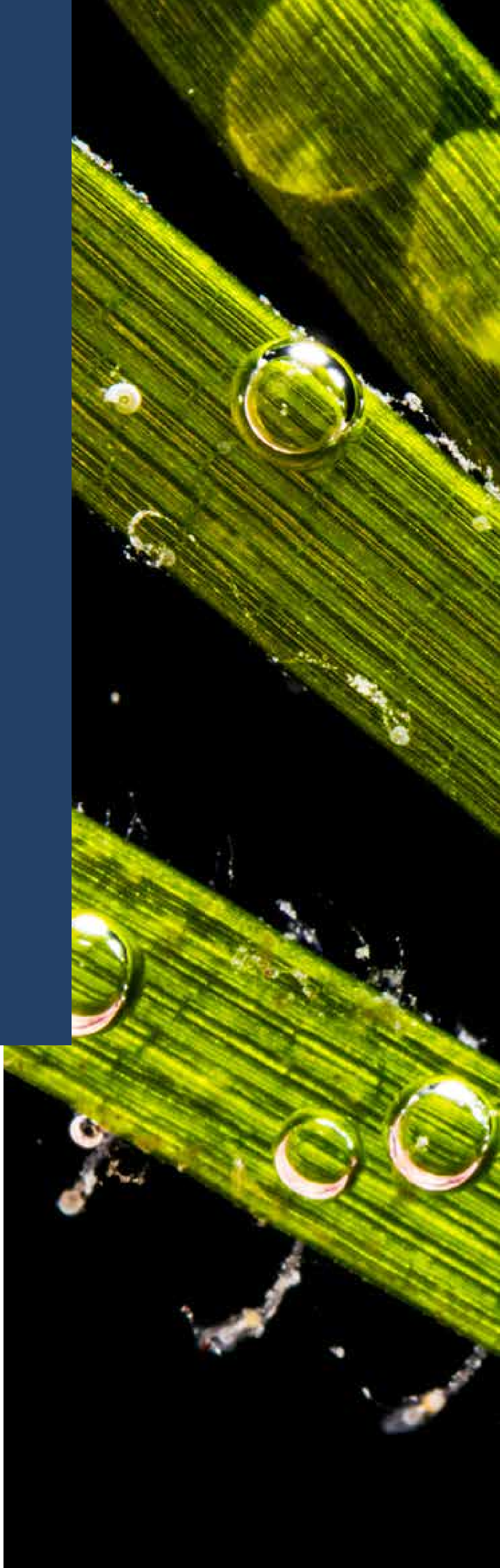

In the framework of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030)

United Nations Educational, Scientific and Cultural Organization · Intergovernmental Oceanographic Commission · 2021 2030 United Nations Decade of Ocean Science for Sustainable Development

This assessment received the financial support of the French Biodiversity Agency (*Office français de la biodiversité*) and the Government of the Principality of Monaco

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