Assessment Oceanic Blue Carbon in the UAE
Policy Options

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A project of The Ocean Foundation

UAE Oceanic Blue Carbon Pilot Study

Abu-Dhabi Global Environmental Data Initiative (AGEDI)

GRID-Arendal

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Contents

About This Report

AN AGEDI Collaboration Project with GRID-Arendal

The UAE Oceanic Blue Carbon Pilot Study aims to provide a first-level assessment of oceanic blue carbon ecosystems and policy opportunities within the UAE. The principal investigators have utilized existing datasets and methodologies to quantify and assess the capacity for fish, cetaceans, dugongs, sea turtles and seabirds inhabiting UAE's marine environment to store and sequester carbon. Through two reports, the analysis represents the world's first oceanic blue carbon audit and policy assessment at the national level and will allow relevant policy and management entities in the UAE to evaluate options for the potential implementation of oceanic blue carbon policies at the local and national level.

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- Dubai Municipality (DM)
- Environment and Protected Areas Authority (EPAA)
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Pixabay

Abstract

Oceanic blue carbon refers to the natural ways that marine vertebrates can trap and sequester carbon, potentially mitigating the effects of climate change. Protecting and enhancing oceanic blue carbon stores may lead to conservation and climate change mitigation benefits. While the science of oceanic blue carbon is nascent and progressing, its relevance to policy and management are unknown. Within this context, a pilot study was conducted in the United Arab Emirates (UAE) to help understand potential oceanic blue carbon policy options in addressing the global climate change challenge and in supporting sustainable fisheries and marine policy. This paper presents the results of a survey of twenty-eight coastal and marine environmental stakeholders, to assess knowledge, attitudes, and perceptions of the concept of oceanic blue carbon and its relevance to policy. This survey's major finding is that the application of oceanic blue carbon policy has significant policy relevance to the areas of climate change, biodiversity conservation and fisheries management. This includes in a national, regional and international context. These findings are a global-first of their kind and considerably contribute to conversations about ocean conservation and management in the context of climate change mitigation.

INTRODUCTION

OCEANIC BLUE CARBON

Covering 70% of the Earth's surface, the ocean is considered the most life-sustaining environment on the planet (Visbeck 2018). It provides a wide array of ecosystems that support global biodiversity, sustain the global economy, contribute to food security worldwide and plays a major role in climate regulation (Hendriks et al. 2010, Mega 2016). Decades of research have provided clear evidence that the ocean is central in regulating the global climate system and buffering against the impacts of climate change (IPCC 2013). The ocean is the main source of thermal inertia in the climate system (Barnett 2001, IPCC 2013) and is the sink for roughly 30% of human-caused carbon dioxide emissions (Landschuetzer et al. 2016).

Carbon in the ocean is stored through the actions of marine life such as coastal vegetation, phytoplankton, krill, fish, seabirds, sea turtles, and marine mammals. This encompasses, coastal ecosystems that fix and store carbon such as mangrove forests, seagrass meadows and salt marshes (i.e., "coastal blue carbon"), oceanic primary production and the ocean's biological carbon pump (Duarte et al. 2004, Nellemann et al. 2009, Sigman et al. 2012, Neuer et al. 2016).

Coastal Blue Carbon

Carbon fixed and stored in coastal and marine ecosystems, in both plant biomass and below sediments

Oceanic Blue Carbon

Carbon fixed and stored in the ocean through the actions of marine life - for the purposes of this study, marine vertebrates

Figure 1. Coastal and oceanic blue carbon (image credit in order of appearance: Steven Lutz, Dimitris Poursanidis, Doug Beckers, Glenn Edney, Peter Prokosch, David Peart).

In this study, we focus on marine fauna, specifically marine vertebrate species, which are termed “oceanic blue carbon” (Figure 1). Recent research has identified nine oceanic blue carbon mechanisms for marine vertebrates (Figure 2) (Lutz and Martin 2014, Lutz et al. 2018). The research of oceanic blue carbon is currently nascent and expanding, however understanding potential policy options is a missing link in understanding the relevance of the concept. Without this knowledge, its relevance to policy and management may not be fully comprehended or appreciated. For example, in defining the potential for coastal and marine ecosystems to be included in climate mitigation policy, Howard et al. (2017) indicate that it is not possible to manage marine fauna for climate mitigation purposes.

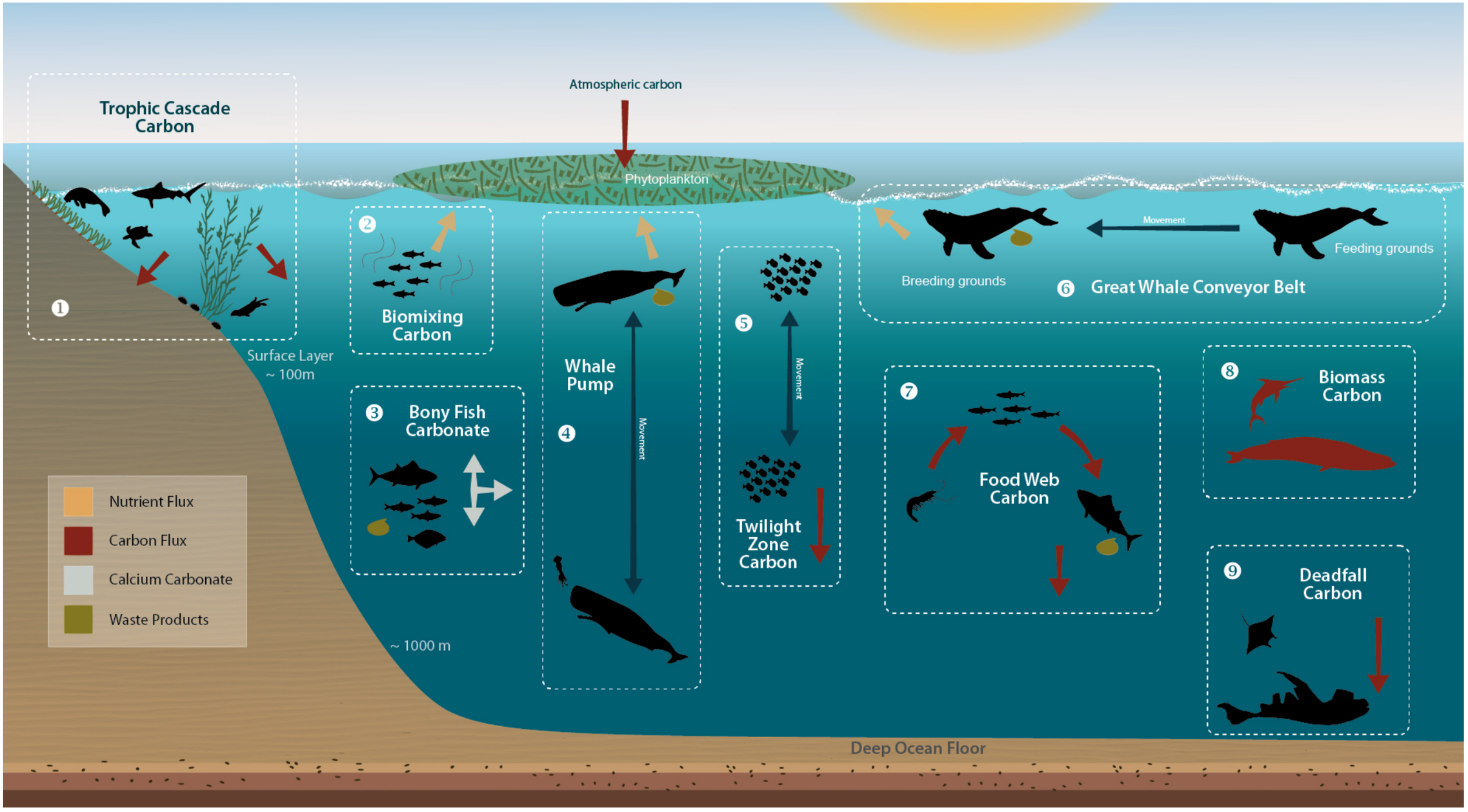

Figure 2. The nine oceanic blue carbon mechanisms for marine vertebrates (Lutz et al. 2018). 1) Marine predators help plants to grow by keeping herbivore populations in check. This helps maintain the carbon storage function of coastal vegetation. 2) The swimming movement of marine animals can stir up nutrients towards surface waters. These nutrients can be used by phytoplankton as they grow, absorbing carbon. 3) Bony fish excrete carbon in the form of calcium carbonate. This raises the pH of seawater and potentially provides a buffer against ocean acidification, which is one effect of climate change. 4) All whales dive underwater to feed and return to the surface to breath. At the surface, they release buoyant fecal plumes that are rich in nutrients that phytoplankton need to grow. 5) Mesopelagic fish migrate towards the surface a night to feed then return to deep waters during the day. This helps transport carbon to deep waters where it can be released as fecal pellets. 6) Many whales migrate from nutrient-rich feeding grounds to nutrient-poor breeding grounds. On the breeding grounds, whales release nitrogen-rich urea that can stimulate phytoplankton growth. 7) Fish eat and repackage food into carbon-rich fecal pellets that sink rapidly. Fecal material that reaches the deep sea can remain locked away for hundreds to thousands of years. 8) All living things are made of carbon and thus serve as carbon reservoirs throughout their lifespans. The larger and more long-lived the animals, the more carbon is stored. 9) When large marine vertebrates die, their carcasses sink to the seafloor. There, the carbon inside their carcasses can support deep-sea ecosystems and be incorporated into marine sediments.

Additionally, in defining criteria for actionable blue carbon ecosystems, Lovelock and Duarte (2019) identify that management is not practical or possible to maintain or enhance carbon stocks and reduce GHG emissions for marine fauna.

CLIMATE CHANGE CONTEXT

The role that coastal blue carbon ecosystems play in climate mitigation has experienced a rapid recognition with twenty-eight countries including the conservation and restoration of these ecosystems as mitigation actions in national pledges to fulfil the Paris Climate Agreement (Figure 3) (UNFCCC 2015a, Martin et al. 2016). However, actions related to marine life and ocean ecosystems, beyond coastal vegetation (i.e., coastal blue carbon), are largely absent from such pledges. The latest report from the Intergovernmental Panel on Climate Change (IPCC) urges immediate action to prevent major global disasters (IPCC 2018). Recognizing the role that marine life plays in the carbon cycle can potentially help answer that call as an innovative and important strategy for combatting climate change. Accordingly, actions that conserve and restore marine life can potentially help enhance and restore oceanic carbon function. Through oceanic blue carbon, the ocean provides major potential opportunities for action to reduce climate change globally and its impacts on vital ecosystems and ecosystem services.

This work builds on prior studies within the United Arab Emirates (UAE), the Abu Dhabi Blue Carbon Demonstration Project and the National Blue Carbon Assessment, which quantified carbon stocks and the other services provided by coastal and marine blue carbon ecosystems along the coast of the UAE (AGEDI 2013, Kauffman and Crooks 2015).

MITIGATION

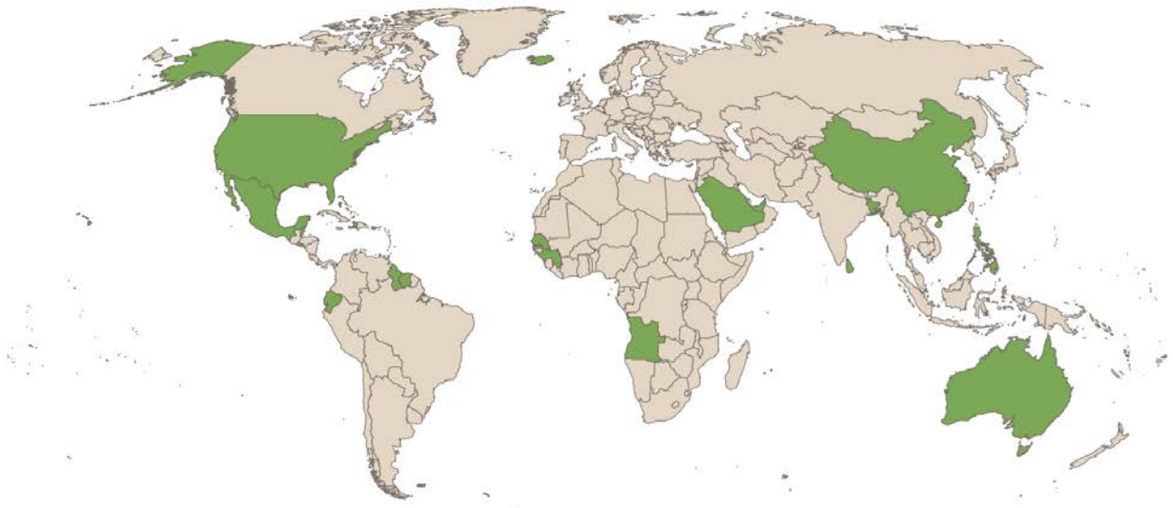

Figure 3. Twenty-eight Nationally Determined Contributions (NDCs) submitted to fulfil the Paris Climate Agreement, include a reference to coastal blue carbon ecosystems in terms of mitigation (Martin et al 2016). These include the NDCs submitted by Angola, Antigua and Barbuda, Australia, Bahamas, Bahrain, Bangladesh, Belize, Brunei, China, Comoros, Cook Islands, Ecuador, El Salvador, Guinea, Guyana, Haiti, Iceland, Kiribati, Marshall Islands, Mexico, Philippines, Saudi Arabia, Senegal, Seychelles, Sri Lanka, Suriname, United Arab Emirates and United States of America.

These initiatives also contributed to the improved understanding of this concept on a regional and international level (Crooks et al. 2013, Crooks et al. 2014, Campbell et al. 2014). These projects enhanced capacity at multiple stakeholder levels, including in the measuring and monitoring of carbon in coastal ecosystems and in the management of associated data. In addition, they identified options for the incorporation of these values into policy and management to support sustainable ecosystem use and the preservation of their services for future generations. This included the recognition of the value of coastal blue carbon into the UAE's Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) (UNFCCC 2015b).

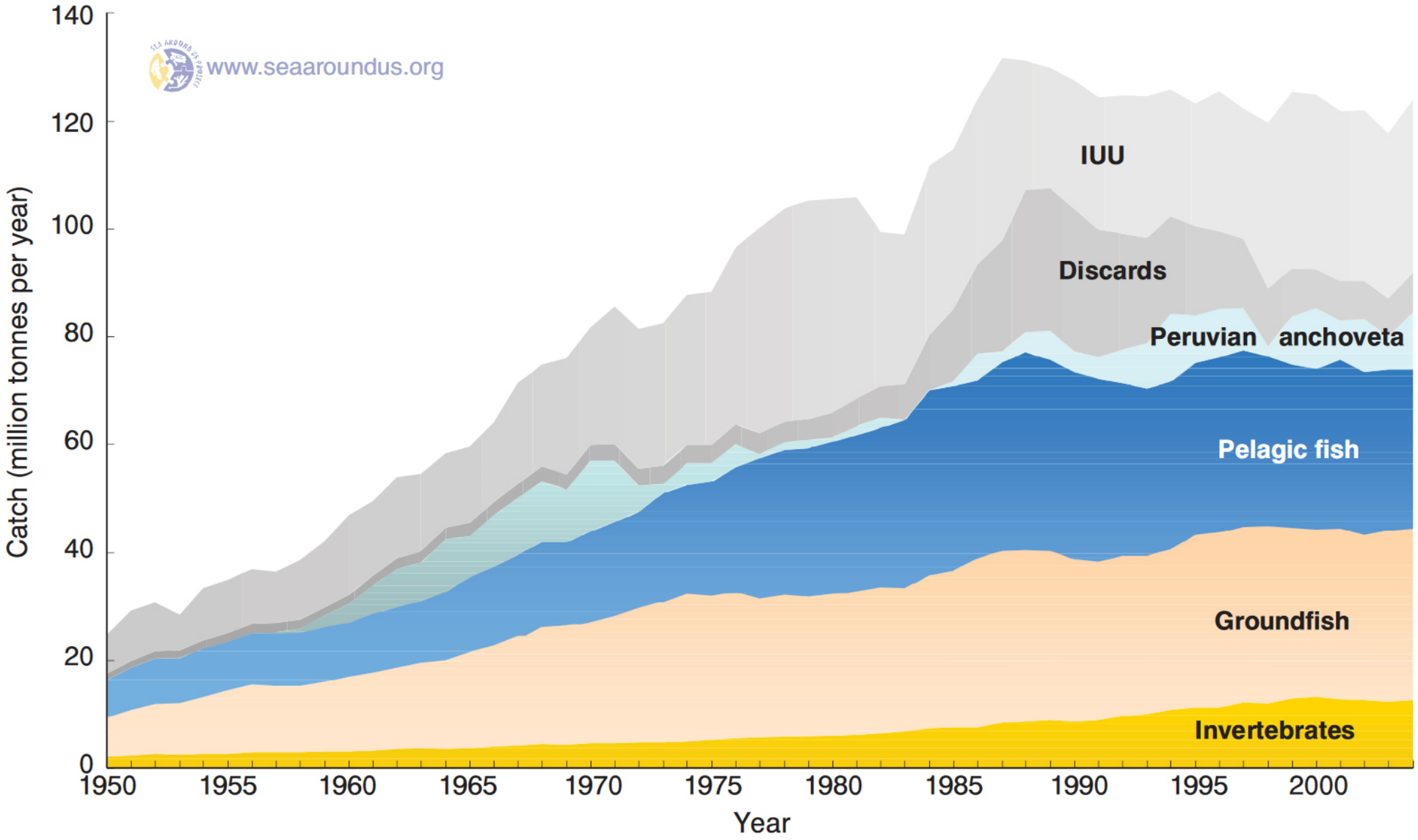

Figure 4. **Global marine fisheries catches, 1950-2004 (Pauly 2008).**

FISHERIES CONTEXT

Marine fisheries throughout the globe are in crisis and there is an urgent need to avert the further escalation of this issue (Coulthard et al. 2011). According to the World Bank (2017), 90% of the world's fisheries were experiencing economic overfishing in 2011. Figure 4 illustrates the global increase of fish catches since 1950.

Furthermore, compliant with the Environment Agency-Abu Dhabithe UAE's fisheries resources are severely overexploited with an estimated 90% decline in the adult (reproductive) stock size for the three key demersal indicator species – Hamour (Orange spotted Grouper – Epinephelus coiodes), Shaari (Spangled Emperor – Lethri nus nebulosus) and Farsh (Painted Sweetlips – Diagramma pictum) (EAD 2019).

Thirty percent is the international sustainable fisheries management threshold below which these stocks are considered to be overexploited yet in the UAE, best available information infers that the relative adult stock size of these three species are considered to be around 10% of their unexploited state" (Environment Agency-Abu Dhabi 2019). The severely overexploited state of the fishery sector is the main driver for the UAE's National Framework Statement for Sustainable Fisheries framework for the years 2019-2030. Proposed actions include the following:

Action 1 - Implementation of management measures commensurate with the state of the fishery - Ministry of Climate Change and Environment (MOCCAE), pursuing, in collaboration with EAD and Competent Authorities, the development and implementation of a suite of fisheries management measures, and their enforcement, that will allow fish stocks to recover by 2030. These measures will seek to achieve the following management measure strategic objectives:

1) Reduce pressure on the fishery;

2) Develop aquaculture research and programmes to support fish stock improvement; and

3) Enhance fish stocks.

Action 2 - Rehabilitation of fisheries habitats - MOCCAE is committed to rehabilitation of fisheries habitats through the cultivation of coral reefs and the installation of artificial reefs for the purpose of biodiversity protection and fisheries recovery.

'WHALE CARBON' CONTEXT

Whales are featured in at least four oceanic blue carbon mechanisms (see mechanisms 4, 6, 8 and 9 in Figure 3) and their potential role in climate change mitigation has been recognized in international policy in support of whale conservation and research. During the 67th meeting of the International Whaling Commission (IWC) in 2018, forty-one nations recognized and highlighted the potential role whales play in retaining carbon in the ocean and helping to reduce the effects of climate change, through the passage of two resolutions (Figure 5). These included the 'Resolution on Advancing the Commission's Work on the Role of Cetaceans in the Ecosystem Functioning' and 'The Florianópolis Declaration' (IWC 2018a, IWC 2018b). The resolutions called for the following:

- Encouragement of member states "to integrate the value of cetaceans' ecological roles into local, regional, and global organisations on biodiversity and environment, including climate change" (IWC 2018a). The resolution also commends the IWC's "Scientific and Conservation Committee for their efforts to increase understanding of the contribution of cetaceans to ecosystem functioning," which is a reference to a 2016 resolution passed at the 66th meeting of the IWC in 2016, which asked the IWC's Scientific Committee to research how whale conservation may help mitigate climate change (IWC 2016).

- Recognition that the role of the IWC has evolved to include "the maintenance of healthy cetacean populations to fulfil the vital ecological and carbon cycling roles these animals play in the global marine ecosystem functioning" (IWC 2018b).

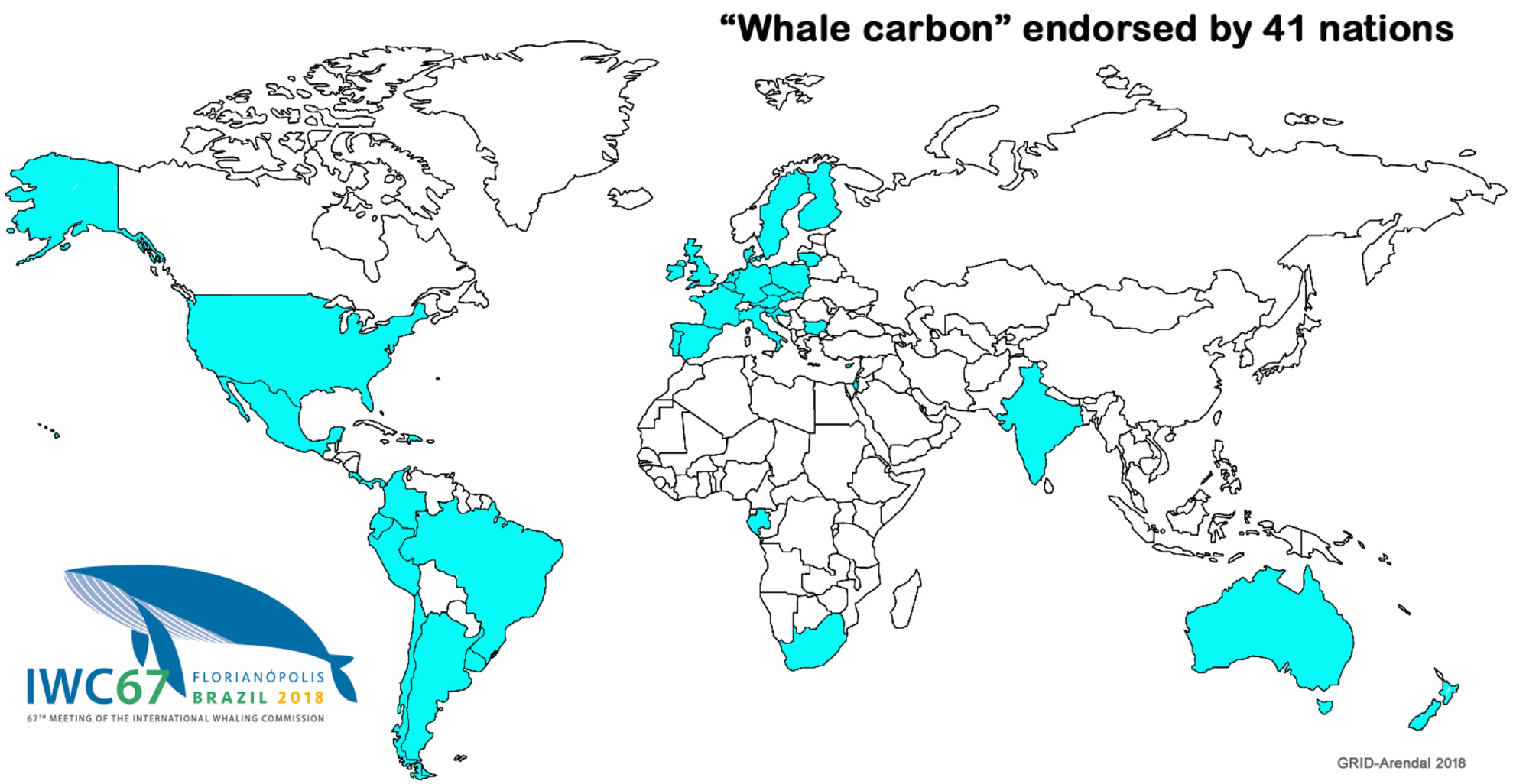

Figure 5. Forty-one nations endorsed the concept of whale carbon at the IWC in 2018 (Lutz and Pearson 2018). These include Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Finland, France, Gabon, Germany, India, Ireland, Israel, Italy, Lithuania, Luxemburg, Mexico, Monaco, Netherlands, New Zealand, Panama, Peru, Poland, Portugal, Slovak Republic, Slovenia, South Africa, Spain, Sweden, United Kingdom, United States of America and Uruguay.

Since 2016, civil society has supported the endorsement of whale carbon at the IWC, including through the submission of reports and related documents that recognize the concept to the 66th and 67th meetings of the IWC (Altherr and Hodgins 2018, AWI 2018, IUCN 2016, WWF 2016, WDC 2016).

KNOWLEDGE AND AWARENESS

The purpose of this study is to assess the awareness of, and perceptions and attitudes to marine polices in order to assist policy makers in the identification of knowledge gaps and build sustainable and effective management of coastal and marine ecosystems.

In order to achieve this goal, the results of a survey about stakeholder's attitudes, knowledge and perceptions of the concept of oceanic blue carbon are presented The results of the survey provide information about stakeholders that can drive the application of oceanic blue carbon policy within the UAE and internationally. These findings are the first of their kind and considerably contribute to conversations about ocean actions in the mitigation of climate change

In particular, researchers have suggested that public perceptions of the potential benefits and impacts of Marine Protected Areas (MPAs) are an important indicator of social acceptability of those MPAs (Blyth et al. 2002, McClanahan et al. 2005, Leleu et al. 2012). If stakeholders perceive that MPAs will provide ecological, social, or economic benefits to their region, they may be more likely to support and comply with MPA regulations. On the contrary, if not understood, societal factors that are impacted by the implementation of different types of protected areas may result in or contribute to negative and/or unexpected outcomes because of human reactions to the regulations. Such reactions may include simply ignoring the rules, increasing extraction of resources due to weak enforcement, while impacts may include exacerbation of socioeconomic hardship due to a closing of traditional fishing grounds, resulting in political backlash (Grober-Dunsmore and Ridgley 2000a, Grober-Dunsmore and Ridgley 2000b). Understanding stakeholder's attitudes toward and perceptions of marine policies can provide key insights into how to best advance said policies.

STUDY HYPOTHESIS

Following the recognition of coastal blue carbon in national and international policy and management, recognition of 'whale carbon' at the IWC, and the context of a global fisheries crisis and the global climate change challenge, the hypothesis that this pilot study aims to test follows:

- **Is the value of oceanic blue carbon relevant to the sustainable management of coastal and marine environmental resources and actions to address the global climate change challenge?**

Methods

Testing the pilot study's hypothesis included assessing the following five themes:

- Identification of views on the potential importance of oceanic blue carbon to marine and climate policies.
- Identification of relevant policies to oceanic blue carbon (this section assumes that oceanic blue carbon can be accounted for). Both marine management and climate policies within the UAE and regional and international agreements were assessed.
- Identification of the types of data needed to incorporate the value of oceanic blue carbon into policy and management.

- Identification of the types of data needed to incorporate the value of oceanic blue carbon into policy and management.
- Identification of potential co-benefits and impacts from the application of oceanic blue carbon.
- Identification of recommendations for the application of oceanic blue carbon.

Existing reports and publications were reviewed for information on relevant climate and fisheries policies within the UAE. This activity guided the development of the survey instrument, which consisted of 48 questions over the themes described. The survey instrument is included in Appendix 1.

It was determined that the most appropriate method to collect data about knowledge, attitudes, and perceptions was through face to face and telephone surveys from a selected sample of key policy stakeholders within the UAE. The survey was administered by an established environmental firm in the UAE with policy experience in May to June 2019. The survey respondents were also identified by the local environmental firm. The survey was designed for a small number, to maximise time and effectiveness of the survey, with a rate of response of 100%. Surveys were administered through individual and focus group interviews, with a total of twenty-eight participants interviewed and twenty-one survey data sets collected.

Data was collected from the respondents assessing their knowledge, attitudes, and perceptions about oceanic blue carbon policy options. The survey questions used for this analysis included multiple choice or 5-point Likert scale-style questions and open-ended questions Interviews lasted an average of 40 minutes, with interviews conducted in English. Consent was requested for each interview. The interview started with a standardized definition of the concept of oceanic blue carbon and a short video shown to each participant.[1]

Survey results

For the following results, the term “majority” refers a percentage of occurrence of 51% to 79% and “vast majority” refers to a percentage of occurrence of 80% and over.

PARTICIPANTS - DEMOGRAPHIC OVERVIEW

This section identifies the stakeholder group and background of the person being interviewed.

Twenty-eight participants were interviewed. The majority (60%) of participants were from the government sector (Figure 6). Other participant sectors were reported as follows: intergovernmental (10%), other (10%), non-government organization (10%), private (5%), and academic (5%). The experience level (years working in their respective fields) of participants ranged from 1 to 32 years with an average of 16.7 years. The vast majority of participants (85%) have been involved in the application of or discussions about coastal blue carbon within the UAE (i.e., that they are familiar with the Abu Dhabi Blue Carbon Demonstration Project and/or the UAE National Blue Carbon Assessment).

1. *(Fish Carbon - Exploring Marine Vertebrate Carbon Services’ (4:12 minutes): https://vimeo.com/295991431).*

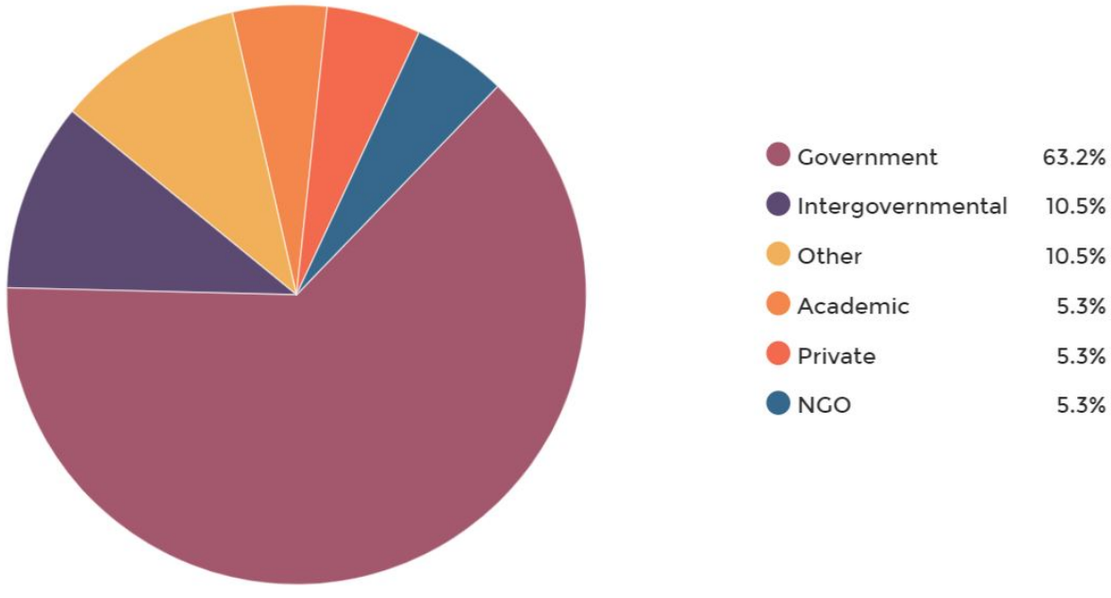

Figure 6. Occupation of survey participants.

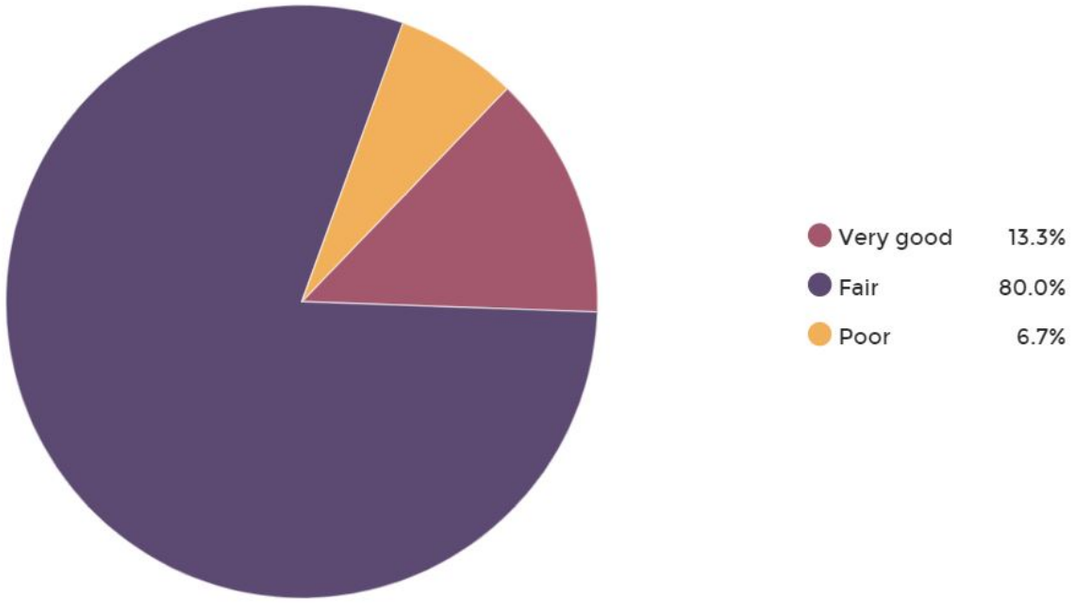

Figure 7. Perception of the general condition of the local marine environment.

PERCEPTION OF MARINE ENVIRONMENT

This section identified a baseline for views on the state of the marine environment.

The vast majority (95%) of participants viewed the general condition of the marine environment in the waters of their local area to be fair to poor (Figure 7). The vast majority of participants viewed the general condition of the marine environment throughout the UAE to be fair to poor. The majority (75%) of participants viewed current level of fishing activity in the waters of their local area to be high. The vast majority (85%) of participants viewed current level of fishing activity in the waters throughout the UAE to be high.

Participants viewed the top three impacts to their local marine environment to be overfishing, climate change and pollution/ dumping (listed in order of relevance) (Figure 8). Participants related that 5 years from now the largest marine environmental problem in the UAE, would be climate change (both direct and indirect effects).

POLICY AND MANAGEMENT

This section aimed to identify views on the potential importance of oceanic blue carbon to marine and climate policies. The majority (65%) of participants viewed that the recognition of the value of oceanic blue carbon could help improve fisheries management within the UAE (Figure 9).

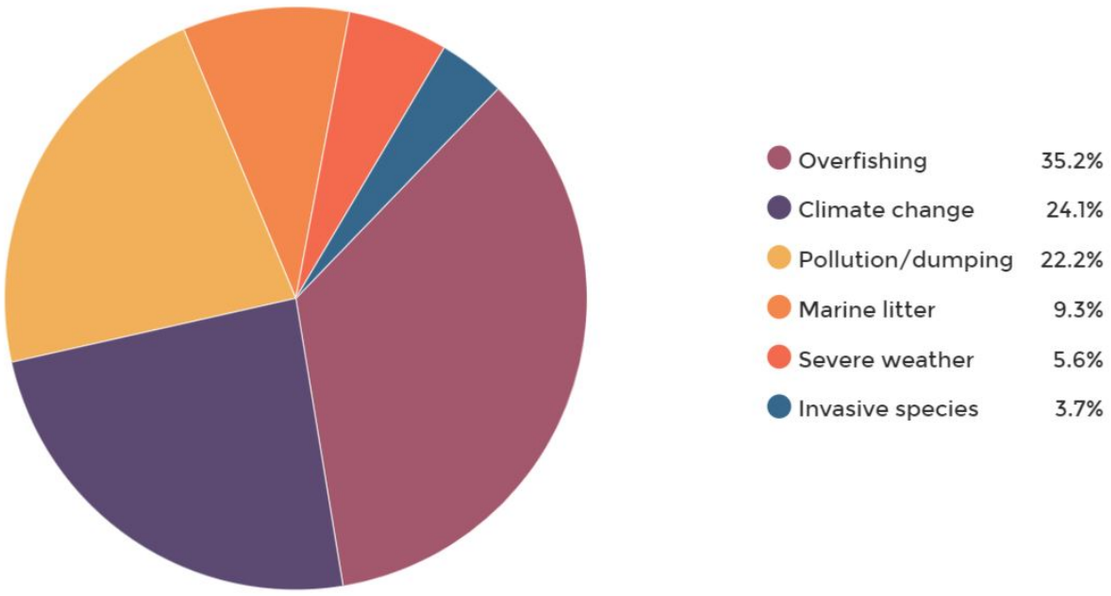

Figure 8. Perception of impacts to the local marine environment.

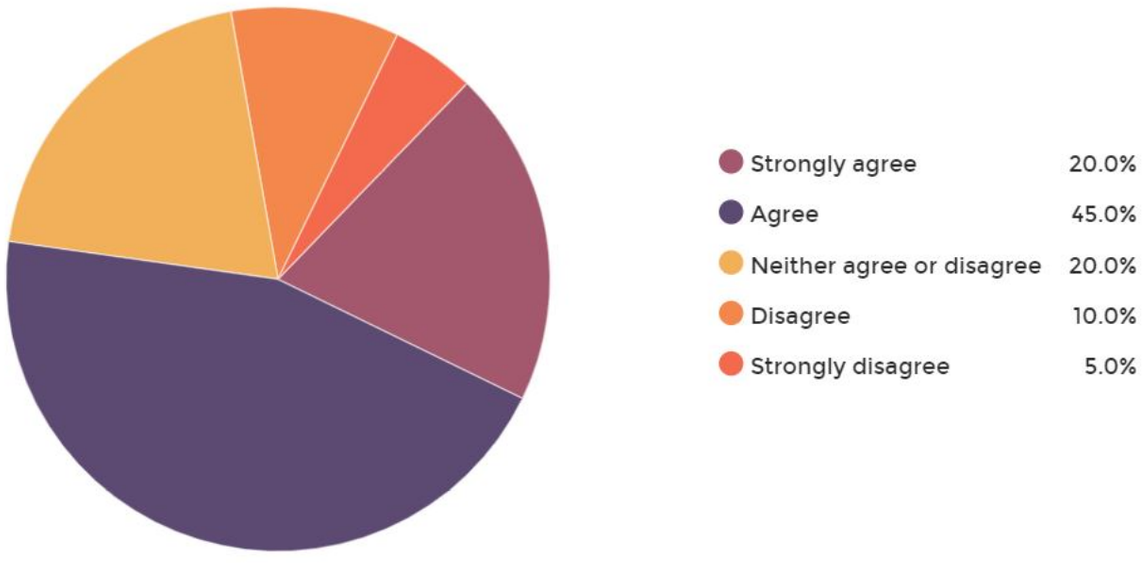

Figure 9. Perception of how recognition of the value of oceanic blue carbon could help improve fisheries management within the UAE.

The majority (55%) of participants viewed that the recognition of the value of oceanic blue carbon could help improve the condition of the marine environment within the UAE. The vast majority (85%) of participants viewed that the recognition of the value of oceanic blue carbon could help the UAE meet its goals in addressing climate change (Figure 10).

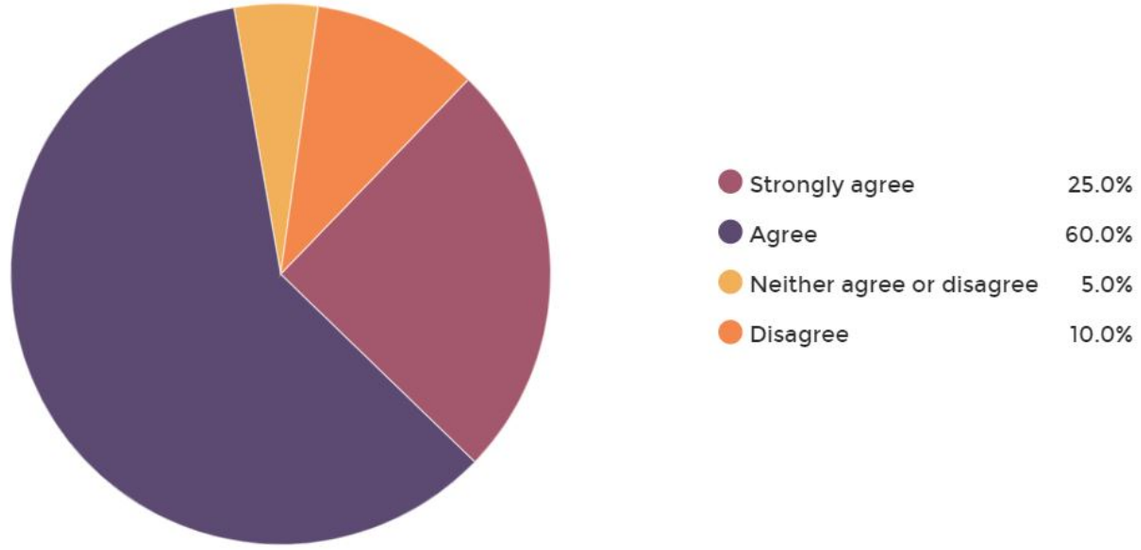

Figure 10. Perception of how recognition of the value of oceanic blue carbon could help the UAE meet its goals in addressing climate change.

RELEVANT POLICIES

This section aimed to identify policies relevant to oceanic blue carbon. It was assumed in this section that oceanic blue carbon could be accounted for.

Participant's views on the potential relevance of the value of oceanic blue carbon to marine management strategies and climate policies within the UAE are identified in Table 1.

Participants related a range of other potentially relevant national policies and management. This include the following: National Plan of Action (NPOA) for species and habitats, Policies on marine litter, National Fisheries Framework, Aquaculture policies, Align research with education and higher ministry, National Adaptation Programme - Environment sector, Coastal sustainability strategy, Green growth initiative has marine component, Emirate level adaptation strategies, National Framework for Sustainable Fisheries 2019-2030.

Participant's views on the potential relevance of the value of oceanic blue carbon to regional and international agreements are identified in Table 2.

Table 1. Views on the relevance of oceanic blue carbon to national policies and management.

National Marine management strategy / climate policy	Relevance rate (% of respondents)
Fisheries management	80%
The management of sharks	80%
The management of Humour	70%
The management of sea turtles	90%
The management of marine mammals	85%
National policy on biodiversity	85%
The management of MPAs within the UAE	80%
National climate change policies	95%
Coastal zone management within the UAE	80%

Table 2. Views on the relevance of oceanic blue carbon to regional and international agreements.

Importance of blue carbon in regional and international agreements	Relevance rate (% of respondents)
National carbon accounting under the Paris Climate Agreement	75%
National climate pledges to fulfil the Paris Climate Agreement	80%
Regional fisheries management	80%
Actions to fulfil the CBD	85%
International efforts to manage whales	80%
International efforts to manage endangered species	80%
International efforts to manage marine biological diversity in waters beyond national jurisdiction	90%
International efforts to address illegal, unreported and unregulated (IUU) fishing	35%*
Actions to achieve UN SDG 13: Climate Action	95%
Actions to achieve UN SDG 14: Life Below Water	85%

* Participants views were split approximately equally between 'relevant' (35%), 'not relevant' (30%) and 'don't know' (35%);

Participants related a range of other potentially regional and international agreements or treaties. This include the following:

- Regional Organization for the Protection of the Marine Environment (ROPME);
- Indian Ocean Rim Association (IORA);
- Convention on Migratory Species (CMS) convention agreements;
- Gulf Cooperation Council (GCC) Wildlife Convention;
- Regional Commission for Fisheries (RECOFI);
- Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention);
- Marine turtles;
- Important Bird and Biodiversity Areas (IBAs);
- Key Biodiversity Areas (KBAs);
- Important Marine Mammal Areas;
- Ecologically or Biologically Significant Marine Area (EBSA) descriptions;
- International Panel of Experts on Sustainable Food Systems (IPES);
- International Union for Conservation of Nature (IUCN);
- Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA).

APPLICATION AND DATA NEEDS

This section aimed to identify the types of data needed to incorporate the value of oceanic blue carbon into policy and management.

Infographics were the majority of the format in which participants would prefer to receive data on oceanic blue carbon. Other formats included the following: publications, technical reports, videos, e-calculator (for marine vertebrate biomass carbon), text-based article, charts, executive briefs, interactive maps, excel sheet (numbers), executive summary for decision making, ArcGIS, statistical reports, raw data for decision makers.

Other factors, than the potential mitigation of climate change, that participants reported would help oceanic blue carbon to be incorporated into policy and management regimes included the following:

- Improving scientific knowledge in the region;
- Improving species conservation and management/ integrated species management plan;
- Ecosystems services values;
- Sustainable use of marine resources;
- Habitat conservation;
- Economic implications of carbon values after knowing impacts of fish stocks;

- Recognition of species as part of natural capital for the country;
- Co-benefit of improved fisheries management;
- Ecological resilience and resistance of species to massive eutrophic changes;
- Improving citizen science;
- Advancing baseline data collection;
- Improving food security reports on overfishing.

The majority (60%) of participants viewed that the incorporation of the value of oceanic blue carbon into policy and management would be somewhat difficult, with 25% of participants viewing its application as very hard (Figure 11).

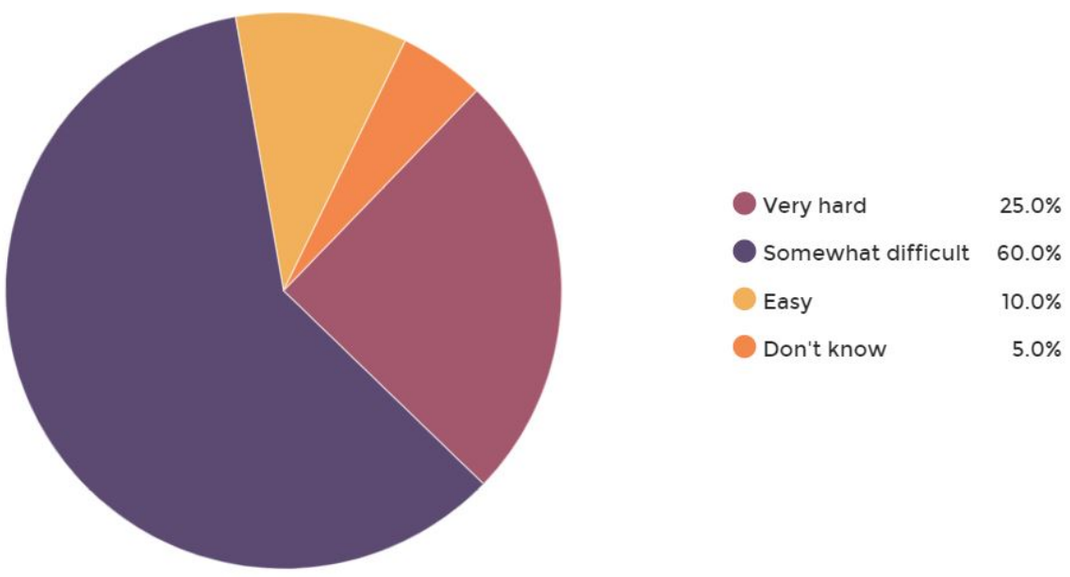

Figure 11. Perception of the difficulty in incorporating the value of oceanic blue carbon into policy and management.

Participants related a multitude of other issues that the concept of oceanic blue carbon would need to overcome, including the following:

- Collection of scientifically accurate data as some animals are not very easy monitor (green turtles are migratory, but hawksbills and dugongs stay in the area);
- Carbon accounting for migratory species as some species are unexplored;
- Accuracy of quantification and measurement methods for biomass carbon;
- Validation of data – how will the data be published, and how to interpret the linkages in a clear way;
- Need for consistent, extensive, and comprehensive survey work in the region;
- Lack of standardized methods for collecting baseline data;
- Lack of consistent, historic baseline data including data management and monitoring in the region;
- Lack of data and awareness, and uncertainty in the science behind oceanic blue carbon;
- Connecting oceanic blue carbon to climate change and relating it to local lifestyles (per carbon footprint) in 5-20 years;
- Fisheries and marine wildlife management in terms of dugong mortalities, and fisheries regulation;

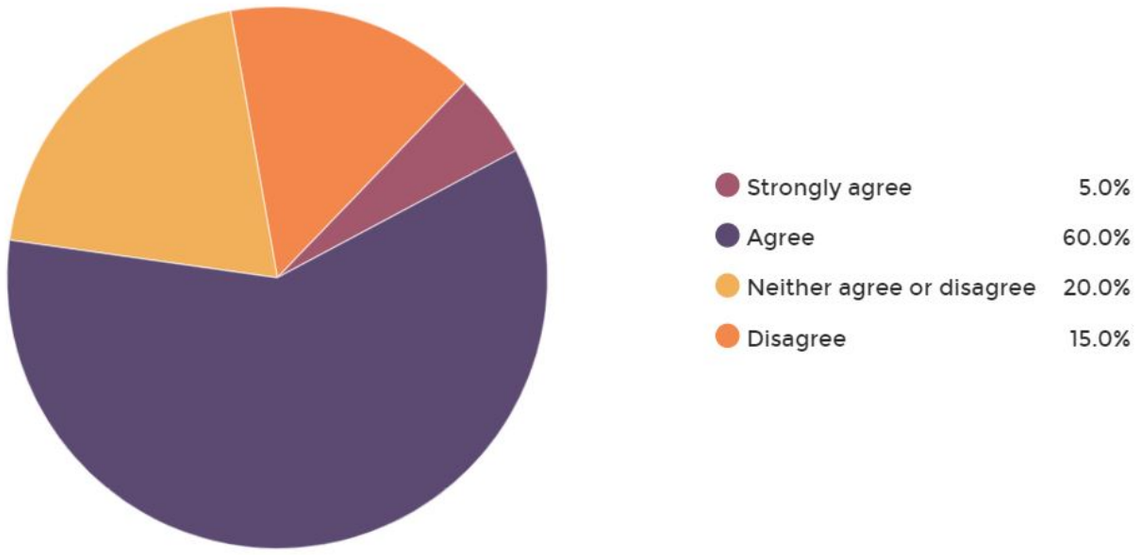

Figure12. Perception that recognition of the value of oceanic blue carbon can help increase marine biodiversity within the UAE.

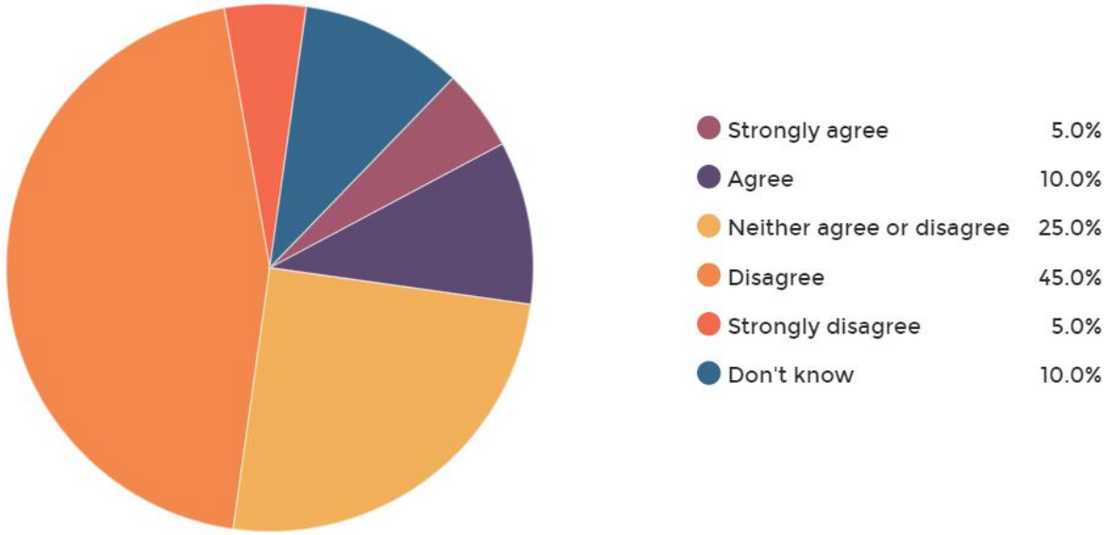

Figure 13. Perception that recognition of the value of oceanic blue carbon can help improve socioeconomic equality within the UAE.

There needs to be a more informed and systematic assessment and approach to find out what is the best option for the UAE, what are the options, list of priorities, which is more efficient for the UAE;

Need to involve other stakeholders such as those from CO2 producing industries.

CO-BENEFITS AND IMPACTS

This section aimed to identify potential co-benefits and impacts from the application of oceanic blue carbon.

The majority (65%) of participants agreed that the recognition of the value of oceanic blue carbon could help increase marine biodiversity within the UAE (Figure 12). Participants were split regarding the recognition of the value of oceanic blue carbon helping to improve marine based food security within the UAE, with 37% strongly disagreeing, 36% neither agreeing nor disagreeing and 23% agreeing. The majority of participants did not agree that the recognition of the value of oceanic blue carbon could help increase marine based tourism within the UAE, with 40% neither agreeing or disagreeing, 30% strongly disagreeing and 20% agreeing. Half (50%) of the participants viewed that the recognition of the value of oceanic blue carbon would not help improve socioeconomic equality within the UAE, with 25% neither agreeing or disagreeing, 10% indicating not knowing and 15% agreeing (Figure 13).

Participants related a range of other potential co-benefits from the application of oceanic blue carbon, including the following:

- Improving climate change resilience;

- Providing additional tools for policy and management;
- Supporting the concept of natural capital, which is linked to different initiatives;
- Supporting improved biodiversity;
- Supporting an aesthetically pleasing environment;
- Positive effects on human health;
- Consideration of oceanic blue carbon will serve as an additional data layer for conservation of species and will allow better conservation of marine vertebrate habitat areas allowing them to thrive;
- Improving general environmental conditions leading to nutrient transfer/build-up from and between terrestrial and marine environments;
- Improving coastal resilience/security from oil-spills or any catastrophic changes;
- Putting the UAE in the map by leading global research;
- Supporting increasing carbon drivers for decision making;
- Supporting improved awareness/outreach of importance for conservation and better appreciation of area;
- Increase regional and international awareness on oceanic blue carbon and could set as an example for other countries to follow

Participants related a range of potential impacts or negative consequences from the potential future application of oceanic blue carbon, including the following:

- Risk – we won't know the full implications of oceanic blue carbon until we see the results;
- It highlights only one ecosystem value, whereas a systems approach may be better for management and addressing stressors;
- The need for accurate baseline data will be high;
- The practicality of implementation and relevance to fisheries at local level.
- How to account for the difference between demersal and pelagic species?
- Applying oceanic blue carbon may entail short term economic stress as implementation of policies will likely affect livelihoods;
- Uncertainty in oceanic blue carbon science may cause a lack of support for policy;
- Understanding whether oceanic blue carbon is the highest priority in local policies, look into other impactful areas;
- Lack of awareness among stakeholders leading to ignorance of the subject matter;
- Advancing the concept may lead to the stopping of fishing which can result in negative economic consequences.

FUTURE APPLICATION

This section aimed to identify recommendations for the application of oceanic blue carbon.

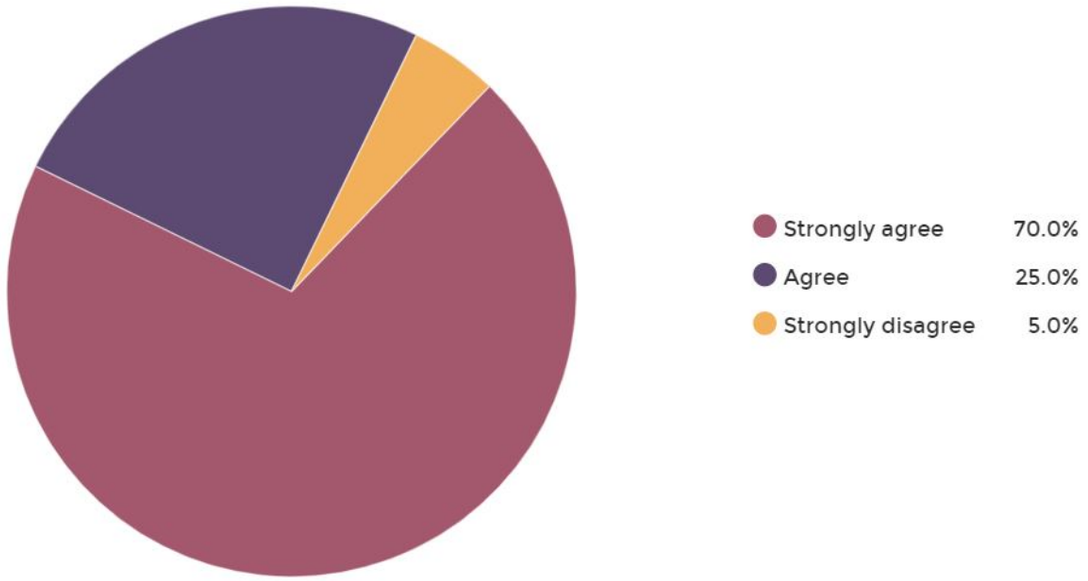

Figure 14. Perception that international recognition of the value of oceanic blue carbon should be increased.

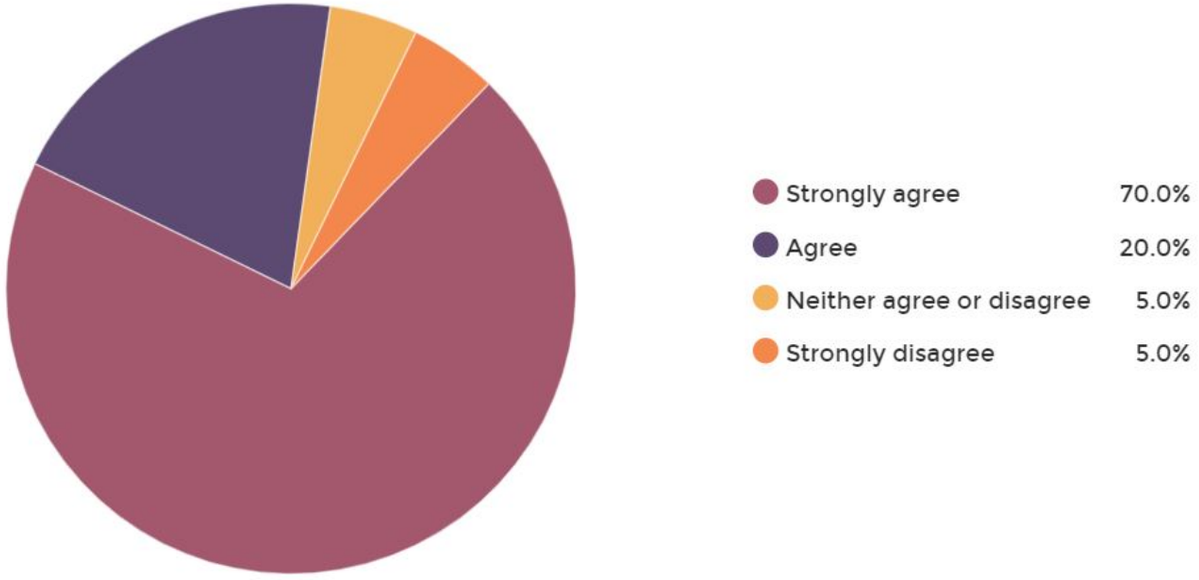

Figure 15. Perception that scientific research of oceanic blue carbon should be supported and funded

The vast majority (95%) of participants agreed that international recognition of the value of oceanic blue carbon should be increased (Figure 14). The vast majority (90%) of participants agreed that scientific research of oceanic blue carbon should be supported and funded (Figure 15). The vast majority (95%) of participants agreed that value of oceanic blue carbon should be incorporated into strategies for conservation and climate change mitigation (Figure 16).

Participants related a number of other thoughts or views on oceanic blue carbon including the following:

- The concept seems abstract, it would be important to study and visualize where it could be most impactful;
- Interested to know the outcomes of the study, especially the strong connection to migratory species. A priority focus in species with high abundance or megafauna would make more sense;
- Looking forward to the integration of oceanic blue carbon into policies at the Emirate and national level, and possible cross-cutting into other policies;
- This could serve as a new language and tool to be incorporated into fisheries management;
- A new idea which will get a lot criticism potentially, to avoid this we need to make sure methodologies are secure and gaps are minimized;
- Local recognition would be needed to spread awareness on oceanic blue carbon;
- Results can be used at different levels e.g. Ramsar, MPAs to show its significance;

- Will increase in amount of whales' trade-off the increase in CO2 emissions? What are the knock-on effects of increase in whale populations? There should be a narrative on the benefits of oceanic blue carbon to form strong arguments against sceptics;

- Incorporate the concept into a positive storyline to speak about fisheries and species by highlighting how much carbon they store and how the system is interconnected;

- Uncertainty regarding quantification of carbon in marine vertebrates;

- It can further help understand the ability of species and reinforces the value of protecting species and habitats;

- Research should also consider other data such as looking at the ecology of marine vertebrates (species, stock amount), to identify appropriate protection measures, and to set a quota for these animals.

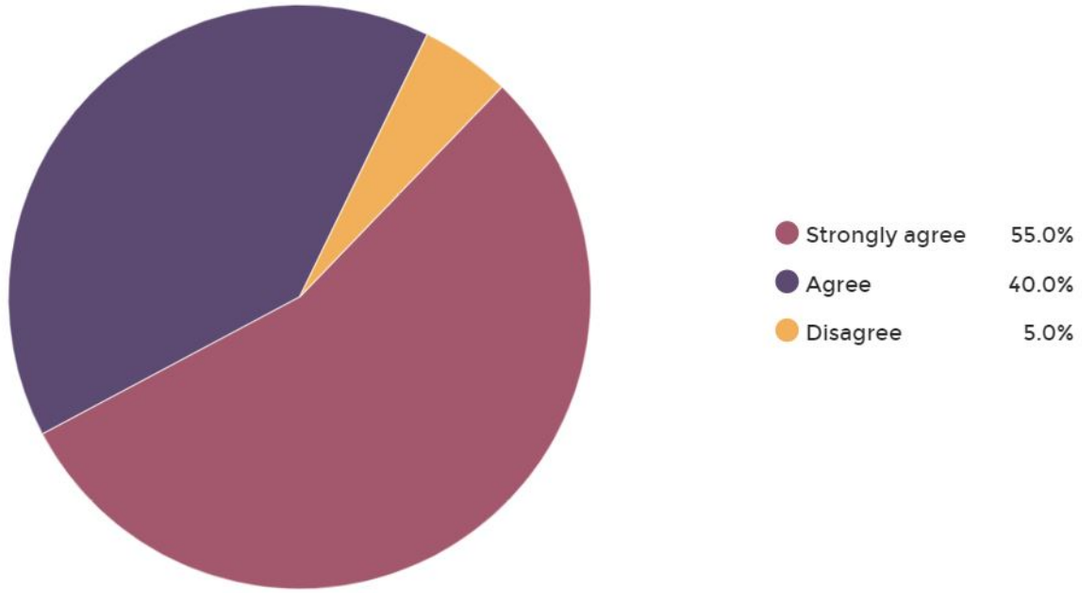

Figure 16. Perception that the value of oceanic blue carbon should be incorporated into strategies for conservation and climate change mitigation.

Discussion

KEY FINDINGS

Overall, the survey's key finding is that the application of oceanic blue carbon policy has significant policy potential in the arenas of climate change, biodiversity conservation and fisheries management. Key results included the following for each of the study's five themes:

1. The application of oceanic blue carbon is potentially relevant to national policies related to fisheries and climate change, including through:

A. The majority of participants viewed that the recognition of the value of oceanic blue carbon could help improve fisheries management within the UAE.

B. Participants viewed the potential application of oceanic blue carbon to be very relevant to specific marine management and climate policies within the UAE. This includes general fisheries management, the management of threatened and endangered species (including sharks, Hamour, sea turtles and marine mammals), UAE national policy on biodiversity, Marine Protected Areas (MPAS) and coastal zone management. The vast majority of participants viewed oceanic blue carbon as relevant to national climate change policies.

2. The application of oceanic blue carbon is potentially relevant to international agreements on biodiversity and climate change, including through:

A. The vast majority of participants viewed that the recognition of the value of oceanic blue carbon could help the UAE meet its goals in addressing climate change.

B. Participants viewed the potential application of oceanic blue carbon to be very relevant to regional and international agreements. This includes National carbon accounting under the Paris Climate Agreement, national climate pledges to fulfil the Paris Climate Agreement, Regional fisheries management, actions to fulfil the Convention on Biological Diversity (CBD) and to manage marine biological diversity in waters beyond national jurisdiction, international efforts to manage whales and endangered species, and actions to achieve UN SDG 13 and 14.

C. Many additional potentially relevant regional and international agreements or treaties were identified. These included the Regional Organization for the Protection of the Marine Environment (ROPME), Ramsar Convention, Convention on Migratory Species (CMS), among others.

3. Infographics were the majority of the format in which participants would prefer to receive data on oceanic blue carbon.

4. Regarding potential co-benefits and impacts from the application of oceanic blue carbon, participants reported a wide range of factors, including the following:

A. Factors that would help support the incorporation of oceanic blue carbon into policy and management, other than the potential mitigation of climate change, included biodiversity conservation, the research sector and understanding ecological co-benefits.

B. Potential co-benefits from the application of oceanic blue carbon, other than climate change mitigation, included increasing resilience to the impacts of climate change and putting the UAE in the map by leading global research.

5. Regarding recommendations for the application of oceanic blue carbon participants reported a wide range of suggestion, including the following:

A. The vast majority of participants agreed that international recognition of the value of oceanic blue carbon should be increased, that scientific research of oceanic blue carbon should be supported and that value of oceanic blue carbon should be incorporated into strategies for conservation and climate change mitigation.

B. Participants reported a wide range of other thoughts regarding the application of oceanic blue carbon. Chief among these were priority focus on megafauna, exploring the possible cross-cutting of oceanic blue carbon into other policies and the importance of spreading awareness.

LIMITATIONS AND DRAWBACKS

This assessment is based on a limited number of survey responses (28 persons surveyed in total) in only one country. Most of the participants have already been involved in the application of or discussions about coastal blue carbon in the UAE.

Understanding the application of oceanic blue carbon was viewed as somewhat difficult to hard by the majority of participants, with many barriers to its application reported [2]. Chief among this included recognition from the scientific community and the accuracy of actual data needed to counter scepticism.

Participants related a range of potential impacts or negative consequences from the application of oceanic blue carbon. Chief among these were an understanding of whether oceanic blue carbon should be a high priority for the UAE, given other pressing policy issues, and that the application of oceanic blue carbon may entail short-term economic stress.[3]

RECOMMENDATIONS

Several important avenues for future policy research that will advance the application of oceanic blue carbon have been revealed by this study. This include the following:

- This assessment of oceanic blue carbon policy in the UAE should be considered a first-order approximation. Additional perceptions and attitudes data are needed from an increased number of countries, from a greater number of participants and from more diverse stakeholder representation. This would allow for a broader understanding of the potential policy opportunities for oceanic blue carbon, a more robust statistical figure and the appreciation of different views between stakeholder groups.

- Scientific research should be placed foremost, prior to the implementation of oceanic blue carbon policy options. Sustainable policy must be based on robust scientific knowledge and there is a critical need to avoid ‘over-promising’ with regard to potential climate solutions.

- The potential impacts or negative consequences from the application of oceanic blue carbon should be fully explored

2. The author reflects that similar views were offered during the implementation of the concept of coastal blue carbon at its introduction, approximately ten years ago.

3. The author notes that similar issues face the current implementation of coastal blue carbon in other countries.

and incorporated into potential economic modelling, especially with potential impacts to the fisheries sector. It is important to understand the potential ‘winners’ and ‘losers’ from the application of any policy.

Conclusion

Oceanic blue carbon – the natural ways that marine vertebrates can trap and store carbon – is an emerging concept. Yet this study has proved its relevance to the sustainable management of coastal and marine environmental resources and actions to address the global climate change challenge. Even though this assessment is a first-order approximation, it is a ‘world’s first’ in terms of understanding how the ocean can be harnessed to achieve meaningful action to address the global climate change challenge. The results of this study are relevant to the implementation of the concept of blue carbon as well as the management of marine fauna, with noteworthy insights including:

- The recognition of the value of whale carbon as a significant for policy related to the sustainable management of whales, as suggested by the International Whaling Commission (IWC 2016, 2018 a, 2018 b), as indicated through:
    - 80% of interviewees supporting the view that oceanic blue carbon is relevant to international efforts to manage whales;
    - The observation that marine megafauna should be a primary focus in advancing the oceanic blue carbon concept; and

- The response that cross-cutting policies should be explored to determine the relevance of oceanic blue carbon in other conservation and climate change policy areas (as has occurred through recognition of whale carbon at the IWC - an international body concerned with the management of species and not climate change).

- Recognition of the relevance of oceanic blue carbon to climate change and other policy areas, with evidence to suggest it is possible and practical to manage marine fauna for climate mitigation purposes (in contradiction to previous views, such as advanced by Howard et al. 2017 and Lovelock and Duarte 2019, discussed in Section 1).

As well as a potential tool to address climate change, the results obtained suggest that the concept of oceanic blue carbon has broad potential implication for the management of marine resources including fisheries and biodiversity conservation.

It represents a potential opportunity to combine ocean conservation with climate action. The methodology used in this project could be easily replicated and expanded. Further discussion of the concept at the national, regional and international levels is justified.

However, simply discussing a policy's potential relevance will not achieve its intended goals in implementation, and much more remains to be accomplished – in science and policy – in enacting sustainable and robust science-based policy utilizing the value of oceanic blue carbon.

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Appendix 1
Survey Instrument

Oceanic Blue Carbon Policy Survey Instrument

Survey #:

Date:

Location:

Interviewee:

Interviewer:

Survey instructions

1. Introduce yourself and the project. Clearly state the project objectives: This survey aims to identify views on the potential application of the concept of Oceanic Blue Carbon in policy and management.

2. Ask consent for interview. Consent given: Yes / No

2. Describe Oceanic Blue Carbon: The concept of 'Oceanic Blue Carbon' refers to how marine animals can help sequester carbon through a range of natural processes that include storing carbon in their bodies, excreting carbon-rich waste products that sink into the deep sea, and fertilizing or protecting marine plants. In particular, scientists are beginning to recognize that vertebrates, such as fish, seabirds and marine mammals, have the potential to help lock away carbon from the atmosphere thereby assisting to mitigate for the impacts of climate change.

2. Show 'Fish Carbon - Exploring Marine Vertebrate Carbon Services' video (4:12 minutes): https://vimeo.com/295991431. This video describes the various Oceanic Blue Carbon mechanisms. The terms 'Fish Carbon' and 'Oceanic Blue Carbon' are synonyms in this context.

3. Implement survey, it should about 20 minutes.

4. Thank participant for their time and contribution.

General Background/Stakeholder Group - *This section identifies the stakeholder group and background of the person being interviewed.*

(G 1) What is your current **occupation**? Government / Non-Government Organization / Fishing industry / Other: _____

(G 2) How many years have you been working in this field? _____

(G 3) Have you been involved in the application of or discussions about **coastal blue carbon** in the U.A.E.? Yes / No

Perception of Marine Environment – *This section identifies a bassline for views on the state of the marine environment.*

(P 1) What is the **general condition** of the marine environment in the Gulf Waters in **Abu Dhabi**? very good / fair / poor / don't know

(P 2) What is the **general condition** of the marine environment in the Gulf Waters throughout the **U.A.E.**? very good / fair / poor /don't know

(P 3) What is the current **level of fishing activity** in the Gulf Waters in **Abu Dhabi**? (Recreational and industrial activity combined)

high / correct level / low / none / don't know

(P 4) What is the **level of fishing activity** in the Gulf Waters throughout the **U.A.E.**? (Recreational and industrial activity combined)

high / correct level / low / none / don't know

(P 5) What are the **top three impacts** to your **local marine environment** and why? (In order of importance, do not prompt)

Impact 1 overfishing / pollution/dumping / marine litter / climate change / severe weather / invasive species / other _____

Impact 2 overfishing / pollution/dumping / marine litter / climate change / severe weather / invasive species / other _____

Impact 3 overfishing / pollution/dumping / marine litter / climate change / severe weather / invasive species / other _____

(P 6) Five years from now, what do you think will be the **largest marine environmental problem** in the U.A.E.?_____

Policy and Management - *This section aims to identify views on the potential importance of Oceanic Blue Carbon to marine and climate policies.*

(5 = strongly agree, 4 agree, 3 neither agree or disagree, 2 disagree, 1 strongly disagree)

(P 1) Recognition of the value of Oceanic Blue Carbon can help improve **fisheries management** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(P 1) Recognition of the value of Oceanic Blue Carbon can help improve the **management of marine mammals** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(P 2) Recognition of the value of Oceanic Blue Carbon help improve the **condition of the marine environment** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(P 3) Recognition of the value of Oceanic Blue Carbon can help the U.A.E. meet its **goals in addressing climate change**	5 / 4 / 3 / 2 / 1	Don't know

Relevant Polices - *This section aims to identify policies relevant to Oceanic Blue Carbon. <u>This section assumes that Oceanic Blue Carbon can be accounted for.</u>*

(RP 1) How potentially relevant is the value of Oceanic Blue Carbon to the following **marine management and climate policies within the U.A.E.**?

a.	**Fisheries management** (e.g., the designation of catch limits, seasonal regulations, etc.)	Relevant / Not relevant / Don't know
b.	The management of **sharks**	Relevant / Not relevant / Don't know
c.	The management of **Hamour**	Relevant / Not relevant / Don't know
d.	The management of **sea turtles**	Relevant / Not relevant / Don't know
e.	The management of **marine mammals** (e.g., Dugongs, whales and dolphins)	Relevant / Not relevant / Don't know
f.	**National policy on biodiversity** (e.g., National Biodiversity Strategy and Action Plan)	Relevant / Not relevant / Don't know
g.	The management of **Marine Protected Areas** (MPAs) within the U.A.E.	Relevant / Not relevant / Don't know
h.	**National climate change policies** (e.g., National Climate Change Plan of the United Arab Emirates)	Relevant / Not relevant / Don't know
i.	**Coastal zone management** within the U.A.E.	Relevant / Not relevant / Don't know
j.	Other national policies & management? _____	Relevant / Not relevant / Don't know

(LP 2) How potentially relevant is the value of Oceanic Blue Carbon to the following **regional and international agreements**?

a. **National carbon accounting** under the Paris Climate Agreement Relevant / Not relevant / Don't know

b. **National climate pledges** to fulfil the **Paris Climate Agreement** (e.g., actions in Nationally Determined Contributions (NDCs))

Relevant / Not relevant / Don't know

c. **Regional fisheries management** (e.g., Action Plan for the Protection of the Marine Environment and Coastal Areas in UAE and the Arabian Gulf)

Relevant / Not relevant / Don't know

d. Actions to fulfil the **Convention on Biological Diversity** (e.g., 2020 Aichi Biodiversity Targets) Relevant / Not relevant / Don't know

e. International efforts to manage **whales** (e.g., Resolutions under the International Whaling Commission) Relevant / Not relevant / Don't know

f. International efforts to manage **endangered species** (e.g., Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES))

Relevant / Not relevant / Don't know

g. International efforts to manage **marine biological diversity** in waters **beyond national jurisdiction** (e.g., discussions currently ongoing at the UN regarding the UN Convention on the Law of the Sea)

Relevant / Not relevant / Don't know

h. International efforts to address **illegal**, **unreported** and **unregulated** (IUU) **fishing** Relevant / Not relevant / Don't know

i. Actions to achieve UN Sustainable Development Goal 14, to **conserve and sustainably use the oceans, seas and marine resources for sustainable development**

Relevant / Not relevant / Don't know

j. Actions to achieve UN Sustainable Development Goal 13, to **take urgent action to combat climate change and its impacts**

Relevant / Not relevant / Don't know

k. Other regional and international agreements or treaties? _____ Relevant / Not relevant / Don't know

Application & Data Needs - *This section aims to identify the types of data needed to incorporate the value of Oceanic Blue Carbon into policy and management.*

(AD 1) What **key factors** or **kind of data** is needed in order to incorporate the value of Oceanic Blue carbon into policy and management?
(e.g., annual carbon estimates, specifies specific estimates, geographic data)

_____

(AD 2) Other than the potential mitigation of climate change, what **other factors** would help support the incorporation of Oceanic Blue carbon into policy and management?
(e.g., significant co-benefit, the supporting of other policy objectives)

_____

(AD 3) In your opinion, **how difficult** will it be to incorporate the value of Oceanic Blue carbon into policy and management?

Very hard / Somewhat difficult / Easy / Don't know

(AD 4) Are there any **other issues** that the concept of Oceanic Blue Carbon would need to overcome? _____

Co-Benefits and Impacts - *This section aims to identify potential co-benefits and impacts from the application of Oceanic Blue Carbon*

(5 = strongly agree, 4 agree, 3 neither agree or disagree, 2 disagree, 1 strongly disagree)

(BI 1) Recognition of the value of Oceanic Blue Carbon can help **increase marine biodiversity** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(BI 2) Recognition of the value of Oceanic Blue Carbon can help **improve marine based food security** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(BI 3) Recognition of the value of Oceanic Blue Carbon can help **increase marine based tourism** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(BI 4) Recognition of the value of Oceanic Blue Carbon can help **improve socioeconomic equality** within the U.A.E.	5 / 4 / 3 / 2 / 1	Don't know
(BI 5) Other potential co-benefit? _____	5 / 4 / 3 / 2 / 1	Don't know

(BI 6) Can you think of any **potential impacts or negative consequences** from the application of Oceanic Blue Carbon? _____

Recommendations - *This section aims to identify a few recommendations for the application of Oceanic Blue Carbon*

(5 = strongly agree, 4 agree, 3 neither agree or disagree, 2 disagree, 1 strongly disagree)

(R 1) **International recognition** of the value of Oceanic Blue Carbon should be increased 5 / 4 / 3 / 2 / 1 Don't know

(R 1) **Scientific research** of Oceanic Blue Carbon should be supported and funded 5 / 4 / 3 / 2 / 1 Don't know

(R 3) The value of Oceanic Blue Carbon should be incorporated into strategies for **conservation and climate change mitigation** 5 / 4 / 3 / 2 / 1 Don't know

(R 4) Do you have any other thoughts or views on Oceanic Blue Carbon you would like to share? _____

- Thank you -

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