Adaptive capacity of marine other effective area-based conservation measures (OECMs) in an era of global climate change: a case study analysis of Canada and the Scotian Shelf

By

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TABLE OF CONTENTS

ABSTRACT

Marine protected areas (MPAs) are often designed and managed with limited consideration of climate change and its impacts, potentially undermining their long-term efficacy. Other effective area-based conservation measures (OECMs) are a relatively new conservation tool that can acknowledge areas with conservation benefits that otherwise do not qualify as MPAs. OECMs have potentially greater adaptive capacity than MPAs, because they can be implemented using faster and more flexible regulations. As Canada advances toward protecting 30% of its marine and coastal areas by 2030 through both MPAs and OECMs, OECMs likely have an important role in ensuring effective conservation through adaptation in a changing climate This study redefines five domains of adaptation described in the literature (assets, flexibility, organization, learning, and agency) in the context of protected areas. Using case study analysis, this research assesses how each of these adaptation domains are reflected in Canada's marine OECM environment and OECM management in Canada's Scotian Shelf-Bay of Fundy (SS-BOF) Bioregion. Results highlight that adaptive capacity of Canada's marine OECMs is substantially lacking at present, and progress to advance all five adaptation domains is crucial to ensuring that Canada's marine conservation system continues to deliver long-term conservation benefits. This research provides guidance to researchers, planners, and decision-makers for developing truly adaptive conservation measures in this era of global climate change.

Keywords: adaptive capacity, adaptive management, climate change, other effective area-based conservation measures, marine protected areas, conservation network

LIST OF FIGURES

LIST OF ACRONYMS

ACCASP – Aquatic Climate Change Adaptation Services Program

AZMP – Atlantic Zone Monitoring Program

CBD – Convention on Biological Diversity

COP – Conference of the Parties

DFO – Fisheries and Oceans Canada

GBF – Global Biodiversity Framework

IPCC – Intergovernmental Panel on Climate Change

IUCN – International Union for Conservation of Nature

MPAs – Marine Protected Areas

OECMs – Other Effective area-based Conservation Measures

SARA – Species at Risk Act

SS-BOF – Scotian Shelf – Bay of Fundy

UN – United Nations

1.0 - Introduction

Climate change is having devastating impacts on the global ocean, its ecosystems, and its inhabitants (Bryndum-Bucholz et al., 2022). Warming ocean temperatures (Frölicher et al., 2018), ocean acidification (Wu et al., 2018), and oxygen depletion (Sampaio et al., 2021) are just a few of the many environmental impacts of climate change on the ocean (Harley et al., 2006). These impacts have led to drastic changes in species distributions, biodiversity, primary productivity, connectivity, species abundance, and ecosystem function (Bryndum-Bucholz et al., 2022; Lotze et al., 2019; Morley et al., 2018; Wilson et al., 2020). Since global recognition of the need to reduce the loss of biodiversity through the United Nations' (UN) Convention on Biological Diversity (CBD) 30 years ago, protected areas have been a critical conservation tool (Lemieux et al., 2022; MacKinnon et al., 2015). More recently, the valuable role of protected areas for biodiversity conservation as changing climate progresses has been demonstrated (Bates et al., 2019; Laffoley et al., 2019; Roberts et al., 2020).

Marine Protected Areas (MPAs) provide ecological benefits that can help to improve ecosystem adaptation and resilience to climate change (Jacquemont et al., 2022). Specifically, MPAs have been shown to increase biodiversity, species richness, maintain species reproductive potential, increase genetic and functional diversity, maintain ecosystem function, and provide coastal protections (Jacquemont et al., 2022; Reimer et al., 2021). As a primary example of MPAs contributing to climate change adaptation, it has been shown that MPAs are successful in protecting areas with a high diversity of species; by protecting areas with more species, the chances of preserving and maintaining ecosystem function is far greater, even if some species are extirpated (Jacquemont et al., 2022). MPAs also have the potential to protect areas that contribute to carbon sequestration, providing alternative climate change adaptation pathways (Jacquemont et al., 2022). While studies have shown the benefits of protected areas in adapting to climate change, the static nature of these conservation tools has led to some questions over their effectiveness in adapting to climate change over the long-term (Jacquemont et al., 2022; Tittensor et al., 2019). As climate change has progressed, causing more apparent and significant impacts, it has become increasingly clear that protected areas alone will be ineffective in achieving global ocean goals, including conservation (Reimer et al., 2021).

The International Union for the Conservation of Nature (IUCN) defines a protected area as “a clearly defined geographical space, recognized, dedicated and managed, through legal or

other effective means, to achieve the long-term conservation of nature...". While protected areas are clearly a critical conservation tool, they are to be established using restrictive tools, like legislation, and should deliver long-term conservation outcomes. Further, protected areas are an intrinsically static conservation tool – their boundaries are rigid, and it has become apparent that climate change might impact their efficiency to achieve conservation goals if they are not made to be dynamic and adaptive (Tittensor et al., 2019; Bryndum-Buchholz et al., 2022). Still, many protected areas have been established under one significant assumption: that environmental conditions are static (Wilson et al., 2020; Tittensor et al., 2019). The impacts of climate change have caused, and are still causing, unprecedented shifts in the environment and global ecosystems, and this assumption does not hold true, threatening the efficacy of protected areas to conserve biodiversity, especially over the long-term (Wilson et al., 2020). Globally, climate change and its long-term impacts are rarely acknowledged or considered in the design and management of protected areas (IPBES, 2019). The changes in environmental conditions brought about by climate change are inevitable; therefore, protected areas must be adaptive to continue to conserve biodiversity, even as biodiversity itself changes (Bryndum-Bucholz et al., 2022; O'Regan et al., 2021).

In 2011, the CBD developed the *2011-2020 Strategic Plan for Biodiversity* and the 20 Aichi Biodiversity Targets (Secretariat of the Convention on Biological Diversity, 2019). As part of Aichi Target 11, the term 'Other Effective area-based Conservation Measures' (OECMs) was introduced as a critical tool for the protection of biodiversity alongside more formal protected areas (United Nations, n.d.; Garcia et al., 2022; Lemieux et al., 2022). In 2018, based on guidance developed by the IUCN (WCPA, 2019), efforts by the Canadian Council on Ecological Areas, and feedback collected from several workshops hosted by the CBD, the following definition for OECMs was adopted by the CBD (Lemieux et al., 2022);

> *A geographically defined area other than a protected area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values (CBD, 2008).*

OECMs differ from protected areas in that they do not require a primary conservation objective, rather they provide conservation outcomes regardless of their primary objective for establishment (Lemieux et al., 2022). Compared to protected areas, OECMs are a relatively new conservation tool, and currently very few countries have implemented OECMs. According to the IUCN's World Database on Protected Areas, only Columbia, Guernsey, Morrocco, the Philippines, South Africa, and, importantly for this paper, Canada have reported marine OECMs to count towards international conservation targets (WDPA, n.d.). As of 2021, approximately 0.1% of the world's marine areas were protected under OECM designations (Gurney et al., 2021). However, some countries, while they have yet to establish and implement OECMs, have begun to develop domestic guidelines for the implementation of OECMs based on the CBD definition and guidelines (Lemieux et al., 2022).

In 2022, during the 15th meeting of the Conference of the Parties (COP), the governing body of the CBD, the Kunming-Montreal Global Biodiversity Framework (GBF) was established and adopted (CBD, 2022). The GBF supports and enhances the previous *2011-2020 Biodiversity Strategic Plan*, introducing four goals to be reached by 2050 and 23 targets to be reached by 2030 (Secretariat of the Convention on Biological Diversity, 2023). Target 3 of the GBF aims to "ensure and enable that by 2030 at least 30% of terrestrial and inland water areas, and of marine and coastal areas, … are effectively conserved and managed through ecologically representative, well-connected and equitably governed systems of protected areas and other effective area-based conservation measures..." (Secretariat of the Convention on Biological Diversity, 2023). Notably, the GBF and Target 3 maintain language from the *2011-2020 Biodiversity Strategic Plan* related to OECMs, highlighting their continued importance in global conservation efforts.

Canada, as a signatory party to the CBD, has committed to protecting and conserving 25% of its coast by 2025 as a steppingstone toward achieving Target 3 to protect 30% of its marine and coastal areas by 2030 through use of both MPAs and OECMs (Lemieux et al., 2022; Trudeau, 2021). At present, Canada has 14.66% of its marine territory protected, and more than one third of this area is protected using OECMs (Fisheries and Oceans Canada, 2023a). While Canada has multiple legislative tools available for the establishment of MPAs (e.g., MPAs implemented under the *Oceans Act* or under the *National Marine Conservation Areas Act*), there is currently only one type of marine OECM – an area-based fishery closure established under the *Fisheries Act* (Fisheries and Oceans Canada, 2022). These fisheries closures, known as marine

refuges, are managed by Fisheries and Oceans Canada (DFO) (Lemieux et al., 2022). Marine refuges are area-based fisheries closures that offer protection through the provision of long-term biodiversity and conservation benefits, thereby qualifying them as OECMs (Fisheries and Oceans Canada, 2022). In the future, Canada looks to develop more types of OECMs through other legislative means, for example, by leveraging the *Species at Risk Act* to protect vital species habitat (Fisheries and Oceans Canada, 2023b).

OECMs have the advantage of being able to support local and Indigenous-led management initiatives, as they have the potential to align with local guiding principles, values, governance systems, and can incorporate multiple ways of knowing and knowledge systems into their management – helping to garner local support that can significantly improve their efficacy (Gurney et al., 2021). Additionally, OECMs are meant to complement protected areas, for example by improving connectivity between sites within a global conservation network (Gurney et al., 2021). Areas designated as OECMs may still permit certain activities within their boundaries, some of which may have harmful impacts (Lemieux et al., 2022). For example, in Canada, activities such as oil and gas and renewable energy development may still be permitted in OECMs, which may undermine their potential conservation benefits (Lemieux et al., 2022). Still, OECMs are an additional conservation tool that can build resiliency to climate change rather than relying solely on traditional conservation tools such as protected areas, which can neglect changes in both the global ecosystem and environment (Gurney et al., 2021).

Marine OECMs, particularly in Canada, may be more adaptive to climate change compared to more formal MPAs, such as those established under the *Oceans Act.* Because OECMs are not entrenched in legislation that can be complex and time-consuming to amend, OECMs as a conservation tool may be more flexible. To be adaptive means to be flexible and dynamic, able to adequately respond to climate change impacts (Santos et al., 2020). To adaptively manage protected areas, management activities must be adjusted over time as new information becomes available (Santos et al., 2020). Adaptive management also includes the adjustment of objectives, goals, and outcomes over the long-term based on the changing climate (Santos et al., 2020). To implement adaptive management, adaptive capacity must be present. Adaptive capacity refers to the ability of a protected area to be adjusted in response to changing conditions (Cinner et al., 2018). Adaptive capacity encompasses different domains that enable adaptive actions to be taken, including the availability of assets, flexibility in management, the

approach to organization, the ability to learn, and the agency to enact change. As climate change continues to significantly alter the global environment, adaptive capacity becomes increasingly important (Cinner et al., 2018). Yet, improving adaptive capacity within static protected areas in this era of global climate change remains challenging.

Building on the five adaptation domains defined by Cinner et al. (2018) (assets, flexibility, organization, learning, and agency) we developed definitions for these domains in the context of protected areas and applied them to assess the adaptive capacity of Canada's marine OECMs. We explore this adaptive capacity in Canada's current OECM environment through analysis of national guidance, programs, mandates, and budgets, and focus on the Scotian Shelf – Bay of Fundy (SS-BOF) Bioregion where Canada's first OECM Management Plan will soon be released. While Canada's OECMs may be more adaptive than legislated MPAs, it will be critical to ensure adaptive capacity is present for Canada to deliver long-term biodiversity conservation benefits as climate change continues to dramatically alter the ocean and its ecosystems.

2.0 - Methodology

2.1 - Developing Protected Area Adaptation Domains

Cinner et al., (2018) define five adaptation domains for building adaptive capacity to climate change in tropical coastal communities: assets, flexibility, organization, learning, and agency. Based on these definitions, we developed alternative definitions for each domain in the context of protected areas. Our domain definitions draw from the peer-reviewed literature to better understand adaptive capacity in the broad context of protected areas – which we consider here to include areas with any level of protection from minimally to fully protected (Grorud-Colvert et al., 2021), as well as OECMs. We used a targeted literature review to develop these definitions.

A targeted literature review is a qualitative approach that allows for a comprehensive collection of information, without following procedures of a systematic review (Hansen, 2021). Using Google Scholar, the following key search terms were used to identify peer-reviewed papers of relevance to the objective of this paper; 'assets', 'organization', 'flexibility', 'agency', 'learning', 'adaptation', 'climate change', 'Canada', 'protected areas', 'fisheries management', 'natural disaster', 'governance', 'governance structure', 'education', 'climate literacy', 'literacy', 'adaptive capacity', 'mitigation', 'financial assets', 'operational assets', 'resources', 'adaptive action', 'ecosystem assets', 'Marine Protected Areas', 'OECMs', 'nature', 'value',

‘environment’, ‘climate adaptation’, ‘law’, ‘policy’, ‘adaptive governance’, ‘social-ecological system’, ‘stakeholders’, ‘ocean literacy’, ‘knowledge governance’, ‘decision-making’, ‘knowledge’, ‘social learning’, ‘empowerment’, ‘nonagency’, ‘barriers’, and ‘limitations’. This included papers related to both protected areas and at least one of the five adaptation domains as defined by Cinner et al. (2018). Additional peer-reviewed literature was found through complimentary databases including ProQuest, Elsevier, and ScienceDirect. Alternative definitions for adaptation domains and literature to inform these definitions were sought from various research fields, including disaster studies, environmental studies, marine protected areas, protected areas in general, psychology, adaptive management, economics, climate research, and more. Multiple definitions and interpretations of adaptation domains were collected to develop robust definitions for each domain in the context of protected areas. This method helped to improve the validity of each definition through triangulation (Creswell, 1994).

Once information relevant to each of the domains converged around common themes (e.g., the ability to switch between a multitude of management actions allowing for flexibility), we ended the targeted literature review and collated all relevant statements from the reviewed literature. A cutting and sorting process was then used to develop a focused definition for each domain. The cutting and sorting method is a systematic approach used to organize and synthesize relevant pieces of information and literature (Ryan & Bernard, 2003). We used iterative cutting and sorting to organize and merge relevant passages of text from reviewed literature under each adaptation domain, working toward a singular definition. For example, this iterative process meant that some passages of text were initially sorted under multiple domains and then later isolated into a single domain as each definition was developed. Using the Cinner et al., (2018) definitions as a foundation, passages of text were then qualitatively combined and refined into a single definition for each adaptation domain in the context of protected areas (Ryan & Bernard, 2003). This process was repeated for each domain to allow for the refinement and adjustment of definitions as others were developed to ensure that each definition was robust and distinct (Vadrot et al., 2022).

2.2 Case Study Analysis – Applying the Protected Area Adaptation Domains

A case study analysis was used to apply the adaptation domains to Canada’s marine OECMs in general, and a regional OECM management plan in particular. With this case study, we assessed how each of the five adaptation domains were reflected in key contextual documents

for Canada's OECMs, including Canada's recently published *Guidance for Recognizing Marine Other Effective Area-Based Conservation Measures 2022*, *Scotian Shelf-Bay of Fundy Bioregional Marine Refuge Management Plan* - Canada's first OECM management plan expected to be published in 2024 (hereafter referred to as the OECM Management Plan), and Canada's *Fisheries Act*, the primary legislative tool enabling OECM establishment in Canada. We analyzed these key documents for evidence of the five adaptation domains and supplemented our analysis with relevant grey literature. This supplementary literature included Canada's federal budgets, DFO departmental plans, Minister mandate letters, and media releases; as well as DFO climate change programs, research initiatives, and policies. We focused on adaptive potential within marine OECMs due to the currently poor understanding, but assumed importance, of the role of OECMs in climate change adaptation. We selected Canada as a case study because it has prioritized the recognition of OECMs to help achieve spatial conservation targets, particularly in achieving the marine and coastal requirement for Aichi Target 11 (Lemieux et al., 2019). Further, Canada is one of the first signatory parties of the CBD to develop their own national guidelines and guiding principles for the recognition, establishment, and management of OECMs (Fisheries and Oceans Canada, 2022; Lemieux et al., 2019).

Canada's marine OECMs, known as marine refuges, are fisheries closures established under the *Fisheries Act* and recognized as providing additional biodiversity and conservation benefits (Fisheries and Oceans Canada, 2022). Six of Canada's 35 current marine refuges are designated in the SS-BOF Bioregion located in Canada's Atlantic Ocean (Figure 1). This Bioregion is currently developing Canada's first OECM Management Plan which was provided for this research by DFO. In complement to analysis of Canada's OECM guidelines, the *Fisheries Act*, and supplementary grey literature, applying these domains to the forthcoming OECM Management Plan allows for assessment of existing adaptive capacity at the management level.

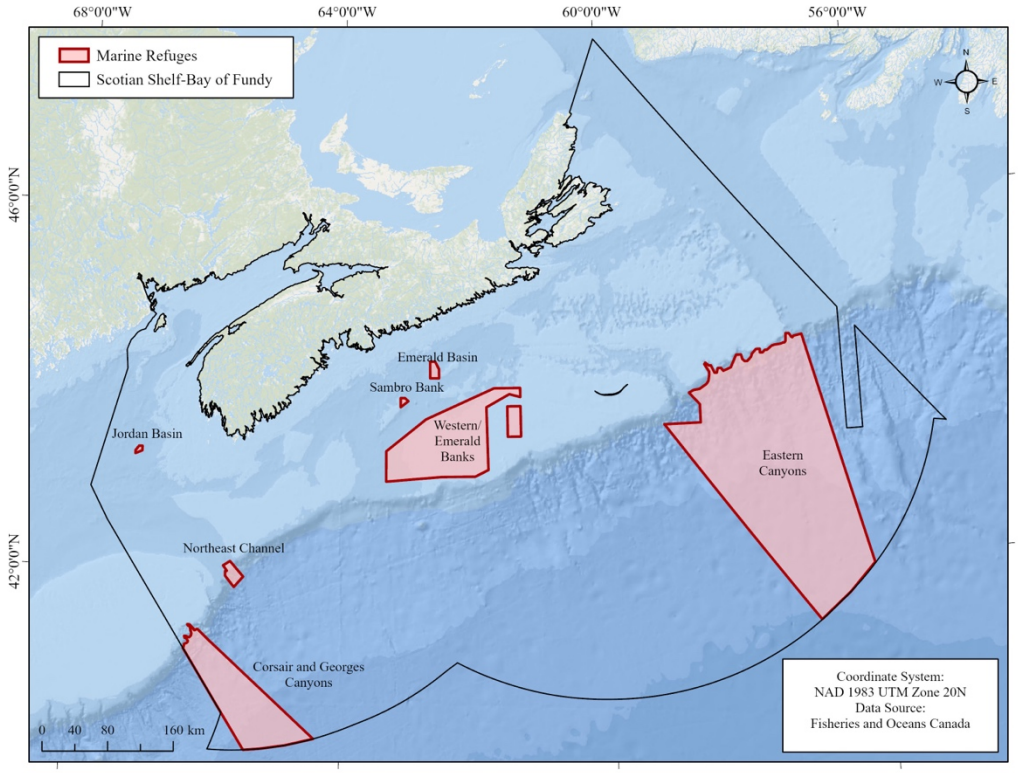

Figure 1. Map of Canada's six marine refuges in the Scotian Shelf – Bay of Fundy Bioregion.

3.0 – Results

Through the completion of our targeted literature review, we have defined the asset domain in the context of protected areas as the operational resources that enable adaptive action; this domain encompasses four different types of assets: financial, technological, human, and governance assets (Figure 2). The flexibility domain is defined as the ability to halt, start, modify or switch to a diversity of potential adaptive actions (Figure 2). In the context of protected areas, the organization domain is defined as the governance system is organized to set collective goals, make decisions about, and implement adaptive action (Figure 2). The learning domain is defined as the capacity to generate, absorb, and process new information about climate change, adaptive actions, and uncertainty (Figure 2). Lastly, we have defined the agency domain in the context of protected areas as the ability to choose to respond to environmental change through adaptive action (Figure 2).

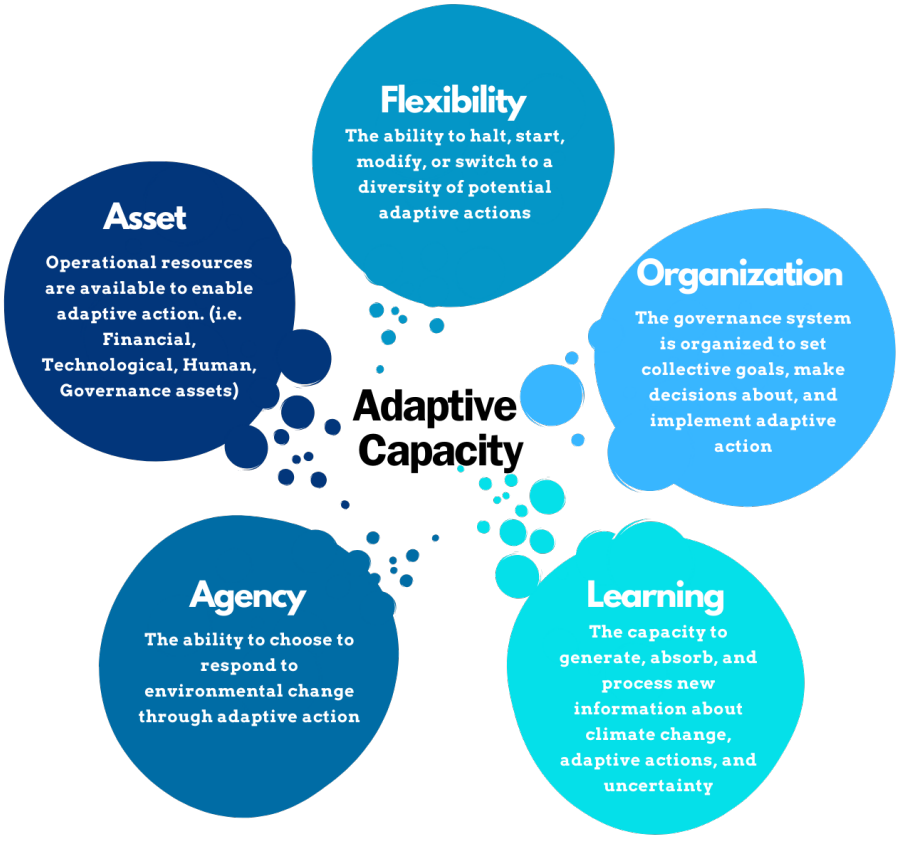

Figure 2. Definitions for five adaptation domains that comprise adaptive capacity in the context of protected areas, including OECMs

3.1 - Asset Domain in Protected Areas

Based on our targeted literature review, we define the asset domain as the operational resources that enable adaptive action, including financial, technological, human, and governance assets (Figure 2). Adaptive actions refer to management actions that could be taken, such as the changing of boundaries, zoning schemes, monitoring, and more. Operational resources are required for effective management, improving adaptation to climate change, as well as for the planning, designing, monitoring, and evaluating of protected areas. However, significant limitations in assets exist and often lead to ineffective and inequitably managed protected areas, such as limited operational assets including restricted budgets and inadequate staffing (Gill et al.,

2017). MPAs with appropriate and adequate operational capacity deliver positive ecological outcomes compared to those with limited operational capacity (Gill et al., 2017). To effectively conserve biodiversity and ecosystem function, as well as to increase the adaptive capacity of protected areas to climate change, adequate operational assets are essential.

Effective management requires investment and financial resources. Financial assets include the long-term sustainable financing of all phases of protected area establishment and management including design, planning, evaluation, and monitoring (Oliveira Junior et al., 2016). Without sustainable funding, efforts to reach current conservation targets for 2025 and 2030 are likely to fail (Bohorquez et al., 2022). Technical resources can also be a significant limiting factor for effective management and adaptive capacity of protected areas (Pomeroy et al., 2005). Technological assets refer to the technology and infrastructure available to protected area management (e.g., monitoring equipment such as remote sensors, boats, oceanography instruments), which results in the availability of long-term data that can also be considered a technical asset. Human assets include qualified staff in sufficient numbers to effectively monitor and manage protected areas (Oliveria Junior et al., 2016). Staff capacity is the most significant factor influencing the efficacy of protected areas in delivering their conservation objectives (Gill et al., 2017). Lastly, governance assets include the tools produced by governing systems that enable adaptive action (e.g., policies, frameworks, mandates).

3.2 - Asset Domain in Canada's OECMs

Canada has limited financial assets dedicated to climate research and other climate change activities, including the development of adaptive actions. The Government of Canada's 2021-2022 Budget allocated a total of $2.3 billion dollars to three federal agencies, including DFO, over five years (Government of Canada, 2021). The purpose of this funding is to increase capacity, allowing DFO and other departments to protect 25% of Canada's marine and coastal areas by 2025, and to "advance progress on effective management to ensure that MPAs and OECMS are effective in achieving their conservation objectives" (Government of Canada, 2021; Fisheries and Oceans Canada, 2021). Our analysis finds that dedicated funding to progress climate research, develop adaptation tools, and advance adaptive management of protected areas is insufficient.

In 2011, DFO established the Aquatic Climate Change Adaptation Services Program (ACCASP) which provides funding to DFO scientists and experts to conduct research and monitoring for the purpose of identifying climate change impacts and vulnerabilities, as well as to carry out climate forecasting to develop adaptation processes and tools (Fisheries and Oceans Canada, 2020). This program represents human assets for adaptive capacity. The ACCASP receives $3.5 million dollars per year and hires 8 full time employees under the program, distributed across Canada in DFO's regional offices. The priorities and objectives of the ACCASP were identified from climate change risk assessments, knowledge, and technology available in 2016. A 2020 evaluation report of the program stated that the ACCASP is inadequate to advance climate change science, as it is currently the only federal program dedicated to climate change research in the marine environment (Fisheries and Oceans, 2020). It was also noted in this evaluation that DFO is not incorporating climate change considerations into their program design and delivery (Fisheries and Oceans, 2020).

Technical assets, including the availability of long-term data that includes baseline conditions is critical for the identification of indicators and thresholds used to measure environmental and ecosystem change (Tittensor et al., 2019). In 1998, DFO's Atlantic regional offices (Gulf Region, Maritimes Region, Newfoundland and Labrador Region, and Quebec Region) established the Atlantic Zone Monitoring Program (AZMP) (Fisheries and Oceans Canada, 2019). The objective of the AZMP was to carry out monitoring of oceanographic conditions in the Atlantic Ocean to provide long-term, multidisciplinary data sets (Fisheries and Oceans Canada, 2019). Since this time, oceanographic data has been collected and reported from this program; however, site-level monitoring is lacking. Though some marine refuges located in the SS-BOF Bioregion fall along the sample transects of the AZMP, not all marine refuges in this Bioregion are captured within the AZMP study area (Fisheries and Oceans Canada, 2019). According to the OECM Management Plan, other research and monitoring activities within the SS-BOF Bioregion are carried out by several federal agencies, academia, and industry members (Fisheries and Oceans Canada, [Unpublished Report]). DFO helps to identify monitoring priorities and supports scientific research and monitoring by external researchers and in collaboration with DFO (Fisheries and Oceans Canada, [Unpublished Report]). The OECM Management Plan highlights that data collection is important to identify environmental changes that may require a response; however, it is unclear how much data is ultimately acquired by DFO

when research and monitoring are carried out by external partners and ocean users (Fisheries and Oceans Canada, [Unpublished Report]).

The OECM Management Plan outlines the legislative and regulative authority governing marine refuges, as well as the associated policy framework (Fisheries and Oceans Canada, [Unpublished Report]), reflecting governance assets in this adaptation domain. A marine refuge is a fishery closure enacted under the *Fisheries Act,* predominantly used for the protection of fish and fish habitat (Fisheries and Oceans Canada, [Unpublished Report]). The *Species at Risk Act* (*SARA*) also has specific provisions to protect fish and fish habitat, including a prohibition against causing the death of fish by means other than fishing, and a prohibition against causing the harmful alteration, disruption, or destruction of fish habitat (*Species at Risk Act*, 2002). Critical habitat prohibitions under *SARA* could potentially be recognized as an OECM (Fisheries and Oceans Canada, 2022); however, this piece of legislation has not yet been used in Canada to establish a marine refuge. Canada has several other governance assets lending to adaptive capacity under this adaptation domain.

The Government of Canada's recent *Guidance for Recognizing Marine Other Effective Area-Based Conservation Measures* (*2022)* (hereafter referred to as the 2022 OECM Guidance) is a policy framework that aids managers in identifying and recognizing marine OECMs and is consistent with international guidelines, such as those from the CBD (Fisheries and Oceans Canada, 2022). Canada also has the *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas*, otherwise known as the SBA Policy, which helps in establishing marine refuges through a process that prevents fishing activity from negatively impacting benthic habitats (Fisheries and Oceans Canada, [Unpublished Report]); Fisheries and Oceans Canada, 2009). In addition, the *Coral & Sponge Conservation Strategy for Eastern Canada (2015)* was developed to aid in the establishment and management of marine refuges in Canada, specifically in the SS-BOF Bioregion where five of the current six marine refuges were established for the purposes of protecting cold-water corals and sponges (Fisheries and Oceans Canada, [Unpublished Report]; Fisheries and Oceans Canada, 2015). This Strategy is not a management plan, but a set of guidelines and processes that can inform management decisions within the region (Fisheries and Oceans Canada, [Unpublished Report]; Fisheries and Oceans Canada, 2015). Lastly, in 2019, the Government of Canada developed the *Federal Marine Protected Areas Protection Standard*

(2023) which states that activities within Canada's marine OECMs will be assessed on a case-by-case basis to ensure the mitigation of risks to site conservation objectives (Fisheries and Oceans Canada, 2023c).

3.3 - Flexibility Domain in Protected Areas

Given the level of uncertainty associated with climate change and its potential impacts, identifying mitigation and conservation measures that can be effective over the long-term becomes challenging. Without knowing, understanding, or being able to identify vital ecological tipping points, this uncertainty and risk related to climate change increases (Barr et al., 2021; Rhodes et al., 2022). Not only is there uncertainty in how climate change may impact marine ecosystems, habitats, and species, but climate change also instills uncertainty in the effectiveness of current and future conservation measures and management practices (Rhodes et al., 2022). To increase the adaptive capacity of protected areas to climate change, flexibility becomes critical to effective conservation. Ensuring flexibility in protected areas means having the ability to halt, start, modify, or switch to a diversity of potential adaptive actions, allowing managers to respond to a wide range of unexpected events as a result of climate change (Figure 2). Being able to change management decisions and learn from the latest information is crucial to increasing the adaptive capacity of protected areas (Barr et al., 2021; Rhodes et al., 2022). While protected areas are generally a static management measure, there is still plenty of room for flexibility in the way that these areas are established, monitored, and managed to increase adaptive capacity (Barr et al., 2021). The importance of flexibility in increasing adaptive capacity can be seen in other marine management measures, like fisheries management. For example, a study comparing two small-scale fisheries in Canada and Sri Lanka found that flexibility was among seven sources of resilience that build adaptive capacity (Galappaththi et al., 2021). The ability of this small-scale fishery in Sri Lanka to switch between several management responses allowed them to better adapt to the emerging impacts of climate change (Galappaththi et al., 2021). Without incorporating flexibility into protected area management, procuring long-term conservation benefits as ecosystems shift in response to climate change is unlikely.

3.4 - Flexibility Domain in Canada's OECMs

As stated in the 2022 OECM Guidance, OECM management actions can be adapted over time through several different means including compliance, policy, and monitoring practices

(Fisheries and Oceans Canada, 2022). Overall, according to this 2022 OECM Guidance, OECMs can be used to protect a variety of different types of sites that may be important for carbon sequestration or those that may provide adaptation benefits as a type of nature-based solution to climate change (Fisheries and Oceans Canada, 2022).

Marine refuges can be established through three different processes: variation orders, licensing conditions, and Biodiversity Protection Regulations (Fisheries and Oceans Canada, [Unpublished Report]). As of 2023, all marine refuges within the SS-BOF Bioregion have been established through variation orders under the *Fisheries Act* and then incorporated into license conditions to restrict fishing activity (Fisheries and Oceans Canada, [Unpublished Report]). Establishing marine refuges through variation orders and licensing conditions allows for continual adjustments to be made as they are required (Fisheries and Oceans Canada, [Unpublished Report]; Fisheries and Oceans Canada, 2022). Proposed activities within marine refuges are assessed on a case-by-case basis (Fisheries and Oceans Canada, 2023c) to ensure risks are mitigated and biodiversity and conservation benefits are minimally impacted, allowing adjustments to management as required (Fisheries and Oceans Canada, [Unpublished Report]). Further, throughout the OECM Management Plan the importance of marine refuges in providing resilience to climate change is acknowledged, and it is clearly stated that conservation objectives and measures should be adaptive in the face of inevitable climate and environmental change (Fisheries and Oceans Canada, [Unpublished Report]). Priority actions and objectives may also be changed and adapted over time, as required, to ensure that each site continues to deliver long-term biodiversity and conservation benefits (Fisheries and Oceans Canada, [Unpublished Report]).

Flexibility is also woven into the way that OECMs are governed in Canada. The 2022 OECM Guidance specifically states that the governance of OECMs, and the governance system as-a-whole, may adapt over time, and decisions and rules made may also be adapted over the long-term (Fisheries and Oceans Canada, 2022). The coordination of management and the governance system, as well as the application of the guiding principles set out in this 2022 OECM Guidance can be adapted, not only over time, but to the specific site and its conservation objectives to ensure effective adaptive management (Fisheries and Oceans Canada, 2022). Further, if an OECM fails to meet the criteria set out in the 2022 OECM Guidance, and only

after all adaptive actions and steps have been taken, an OECM can lose its status (Fisheries and Oceans Canada, 2022). This provision in the 2022 OECM Guidance provides evidence that OECMs must be actively and adaptively managed to ensure they continue to be effective in meeting their conservation objectives.

Temporal flexibility is also critically important for adaptive capacity, ensuring the ability to switch between adaptive actions in an efficient manner in response to a rapidly changing environment (Tittensor et al., 2019). Marine refuges, while established for the long-term with no end-date, are generally more flexible because they are less entrenched in legislation compared to *Oceans Act* MPAs. Once established, *Oceans Act* MPAs must be adapted through legislative and regulatory amendments that can cause delays between environmental change and adaptive action (Agardy et al., 2016; Hopkins et al., 2016; Lalonde et al., 2022; O'Regan et al., 2021).

In the SS-BOF Bioregion, the OECM Management Plan acknowledges climate change and describes climate change management objectives (Fisheries and Oceans Canada, [Unpublished Report]). Each of these objectives consists of priority actions, one of which is to identify potential actions for adaptive management (Fisheries and Oceans Canada, [Unpublished Report]). Still, the OECM Management Plan does not identify specific adaptive, practical, or applicable actions that could be taken, such as implementing boundary changes, limiting the practical flexibility of OECMs without a clear ability to halt, start, modify, or switch between actions (Fisheries and Oceans Canada, [Unpublished Report]).

3.5 - Organization Domain in Protected Areas

In the past decade, there has been growing attention brought to the governance of protected areas (Bennett & Dearden, 2014; Grorud-Colvert, 2021; Ramirez, 2016; van Kerkhoff et al., 2019). It has become increasingly evident that demands for climate adaptation imposed on contemporary governance systems have not evolved to sufficiently enact adaptive solutions that allow for both ecosystems and governance to change as climate change progresses (van Kerkhoff et al., 2019). Protected areas are highly complex, often governed or managed by several different entities, including government, non-governmental organizations, industry, local communities, rights holders, and many others (Munera & van Kerkhoff, 2019; Nyaupane et al., 2022). The complexity and difficulty in governing and managing protected areas arise from interactions and power dynamics between these groups (Nyaupane et al., 2022). The success of protected areas in

adapting to climate change is rooted in governance systems that set collective goals, make decisions about, and implement adaptive action (Munera & van Kerkhoff, 2019). The organization domain refers to just that – a governance system that is organized to set collective goals, make decisions about, and implement adaptive action (Figure 2). This domain differs from governance assets, under the assets domain, as organization refers more broadly to the governance system while assets are products of the governance system (e.g., policy, strategy, guidance).

Many challenges in implementing an adaptive governance approach arise from governance systems that focus only on the biophysical dimension, lacking acknowledgement of social and political aspects (Munera & van Kerkhoff, 2019; Craig et al., 2017). Several key features of an adaptive governance system include the recognition of uncertainty and change, the inclusion of diverse knowledge, the promotion of adaptive goals, and a range of governance systems from the local, provincial, and national level (Akamani, 2020; Nyaupane et al., 2022). Factors contributing to the inefficient management of protected areas include a lack of transparency, accountability, and inequity within governance systems (Bennett & Dearden, 2014). In contrast, adaptive co-management governance systems that are flexible and collaborative, bringing together various rights holders and stakeholders operating at a wide range of levels, can adjust management strategies based on the availability of new information (Nyaupane et al., 2022). The need for adaptive organizations in governance is substantial in the face of climate change to effectively manage protected areas and OECMs in a way that will increase adaptive capacity, ensuring delivery of long-term biodiversity and conservation benefits.

3.6 - Organization in Canada's OECMs

The primary purpose of an OECM in Canada is to protect marine biodiversity by providing long-term biodiversity and conservation benefits, organized around a collective goal set by the OECM governance system (Fisheries and Oceans Canada, 2022; Fisheries and Oceans Canada, [Unpublished Report]). Canada's recent 2022 OECM Guidance states that the governance and management of OECMs are led by a governing authority with jurisdiction to make and enforce long-term decisions. For example, DFO is the lead governing authority over the governance and management of marine refuges (Fisheries and Oceans Canada, [Unpublished Report]; Fisheries and Oceans Canada, 2022); however, activities other than fishing, such as oil

and gas exploration, shipping and marine navigation, and renewable energy development, are managed by other governing authorities, such as the Canada-Nova Scotia Offshore Petroleum Board, Transport Canada, and Natural Resources Canada (Fisheries and Oceans Canada, [Unpublished Report]). The OECM Management plan is a guide to help coordinate the management and governance of both existing and future marine refuges to promote stronger collaboration between DFO and the other relevant governing authorities (Fisheries and Oceans Canada, [Unpublished Report]).

In addition to the 2022 OECM Guidance, and to facilitate a collaborative effort in reducing risks to marine refuges in the SS-BOF Bioregion, the OECM Management Plan provides guidance for the establishment of a Coordination Committee (Fisheries and Oceans Canada, [Unpublished Report]). The Coordination Committee is a multi-sectoral forum to support implementation of the OECM Management Plan, share information, provide feedback, and contribute to monitoring efforts for marine refuges in this Bioregion (Fisheries and Oceans Canada, [Unpublished Report]). Further, the Coordination Committee acts as a participatory mechanism, which is important for reducing conflict between governing authorities, stakeholders, rights holders, and other ocean users to be able to make decisions and set collective goals (Bennett & Dearden, 2014; Nyaupane et al., 2022; Ramirez, 2016). The OECM Management Plan recognizes the need for increased collaboration and communication, specifically in relation to climate change, to continue to manage marine refuges effectively and adaptively (Fisheries and Oceans Canada, [Unpublished Report]).

3.7 - Learning Domain in Protected Areas

The Intergovernmental Panel on Climate Change (IPCC) considers a ‘lack of knowledge’ one of many significant factors hindering adaptive capacity to climate change (Williams et al., 2015; IPCC, 2014). Existing international frameworks used to build adaptive capacity also note the significance of knowledge, learning, and knowledge sharing in increasing capacity (Williams et al., 2015). It is critical to understand the cultural and socio-ecological contexts that shape decisions about environmental systems in each protected area (Munera & van Kerkoff, 2019). The learning domain is defined as the capacity to generate, absorb, and process new information about climate change, adaptive actions, and uncertainty (Figure 2). Learning occurs across multiple scales including temporal, spatial, and governance scales (Cinner et al., 2018). Learning

and acquiring knowledge is critical, as it allows stakeholders, rights holders, and managers to not only make sense of their surroundings and environment, but also to better prepare for the future (Jones et al., 2017).

Decision-makers are facing increasing pressure to acknowledge and consider long-term climate information, transitioning from being reactive to climate change to proactively anticipating potential impacts, finding solutions, and increasing willingness to act on solutions (Jones et al., 2017; Williams et al., 2015). Constraints to increasing capacity to generate, absorb, and process new climate information include a vast disconnect between the producers of such information and decision-makers, mismatched communication, and a lack of collaboration or engagement between stakeholders and rights holders (Jones et al., 2017). Further, climate information is spatially and temporally limited and often clouded in uncertainty due to limited financial, technical, and scientific assets (Jones et al., 2017). Where the learning domain is evident, stakeholders and rights holders may better understand knowledge processes. Then, new knowledge processes can be developed, allowing stakeholders and rights holders to better understand climate change, and allowing for the development of effective adaptive management strategies and decision-making (Munera & van Kerkhoff, 2019).

3.8 - Learning Domain in Canada's OECMs

Within Canada's OECM environment, references are made to climate change via monitoring, where applicable monitoring practices should include changes caused by climate change, indicating Canada's intention to generate new climate information (Fisheries and Oceans Canada, 2022). Within the OECM Management Plan there are objectives to increase knowledge and understanding, to "identify site- and network-scale vulnerabilities to climate change", as well as to "increase understanding of climate vulnerabilities at the species, habitat, and ecosystem level, current contributions to climate change resilience, and to conduct climate vulnerability assessments tailored to site-specific conservation objectives" (Fisheries and Oceans Canada, [Unpublished Report]). At the forefront, working towards adaptive governance through the production and dissemination of climate change knowledge, particularly through monitoring, appears to be a primary objective in Canada and in the SS-BOF Bioregion (Fisheries and Oceans Canada, 2022; Fisheries and Oceans Canada, [Unpublished Report]). In addition, the ACCASP within DFO works to inform management by conducting and contributing scientific information

on Canada's oceans through the lens of climate change (Fisheries and Oceans Canada, 2020). This program is evidence, to some extent, of Canada's capacity to collect and process new climate change information.

While there is currently no monitoring plan for marine refuges within the SS-BOF Bioregion, there are indications within the OECM Management Plan that a monitoring plan will be developed (Fisheries and Oceans Canada, [Unpublished Report]). Notably, intentions for a monitoring plan are described, specifically to "incorporate climate change into the SS-BOF marine refuges monitoring plan(s)" and to identify climate change research priorities, indicators, and thresholds for each marine refuge (Fisheries and Oceans Canada, [Unpublished Report]). The OECM Management Plan provides evidence of Canada's intention to carry out long-term monitoring for the adaptive management of OECMs and to make use of climate change indicators to monitor sites. Site profiles for each of the six marine refuge sites are also included within an appendix in the OECM Management Plan. These profiles include a section acknowledging existing data and knowledge pertinent to climate change. Site profiles are further evidence of Canada's ability to generate, absorb, and process new information about climate change in OECMs (Fisheries and Oceans Canada, [Unpublished Report]).

3.9 - Agency Domain in Protected Areas

The agency domain is defined as the ability to choose to respond to environmental change through adaptive action (Figure 2). Agency is ultimately synonymous with self-efficacy and an individual's, community's, or society's ability to act based on one's own will to act (Brown & Westaway, 2011). Agency is seldom considered in the climate change literature, which is inattentive to the fact that agency becomes increasingly crucial under the high levels of uncertainty brought on by climate change and its associated impacts (Woroniecki et al., 2019). Agency is often thought of as being responsible for the mitigation of climate change and is considered a significant factor in determining how individuals and societies at large will respond to uncertainty and environmental change (Toivonen, 2022). Acknowledging agency stresses the importance of individuals and communities in addressing climate change and instills a sense of power in the face of climate change (Brown & Westaway, 2011).

Perceptions of the severity of climate change and its effects can often be diluted, resulting in delayed action. The constant flux of scientific findings being presented on climate change can

trigger feelings of overwhelm and paralysis, which may create significant mental barriers to initiate action (Toivonen, 2022). Several other social structures and factors can play a significant role in agency, affecting the ability to choose to respond to environmental change, such as gender, ethnicity, culture, age, economic status, experience, societal and individual perceptions of climate change, and much more (Brown & Westaway, 2011). Understanding agency, and the interactions between humans and the environment, will help to identify responses and strategies to address climate change (Brown & Westaway, 2011). Furthermore, understanding agency is vital to building adaptive capacity to climate change to enable individuals and communities to persist and thrive in an ever-changing environment (Brown & Westaway, 2011). The agency to respond to climate change is needed to catalyze adaptive action in protected area management.

3.10 - Agency Domain in Canada's OECMs

Under the *Fisheries Act*, the Minister of Fisheries, Oceans and the Canadian Coast Guard has the authority to make regulations that would prohibit fishing, types of fishing gear and equipment, types of fishing vessels, and prohibit classes of vessels or groups of people from fishing for the purposes of conserving marine biodiversity (*Fisheries Act, 1985*). Powers of the Minister under the *Fisheries Act* provide the potential for the agency needed to choose adaptive action. According to Section 9.1(1) of the *Fisheries Act*, "The Minister may, if he or she is of the opinion that prompt measures are required to address a threat to the proper management and control of fisheries, and the conservation and protection of fish, make a fisheries management order with respect to any aspect of fisheries in any area of Canadian fisheries waters" (*Fisheries Act,* 1985). Although it is not specifically mentioned, climate change is a threat to the effective management of fisheries, thus the Minister has the ability to choose to take adaptive action to ensure the sustainability of Canadian fisheries.

The Prime Minister of Canada provides a mandate to all Ministers to outline the primary goals and objectives they are to accomplish while in office. Within the Mandate letter of the Minister of Fisheries, Oceans and the Canadian Coast Guard, the Minister is asked to work towards modernizing the *Oceans Act* to consider climate change and the impacts it has on the marine environment in ocean management (Trudeau, 2021). It is important to note that while the *Oceans Act* is explicitly mentioned, the *Fisheries Act* under which marine refuges are established, is not. Further, there is no public evidence of progress being made towards

modernizing the *Oceans Act* to explicitly consider climate change and its impacts. In addition, the Minister was asked to work towards expanding climate vulnerability assessments to better inform marine planning and conservation (Trudeau, 2021).

The 2022 OECM Guidance must be implemented by all implicated federal departments in Canada and within existing and future sites (Fisheries and Oceans Canada, 2022). The required application of these guidelines and its guiding principles across federal authorities establishes agency, to some extent, to choose adaptive action (Fisheries and Oceans Canada, 2022). Similarly, DFO has the agency to choose adaptive action as the primary governing authority in the management and establishment of marine refuges (Fisheries and Oceans Canada, [Unpublished Report]). Further, within the OECM Management Plan, DFO has an objective to "ensure climate change is incorporated into the management of marine refuges", which is further evidence of DFO's agency to choose to take adaptive action in response to climate change (Fisheries and Oceans Canada, [Unpublished Report]). Similar notions are found throughout the OECM Management Plan, including references to adaptive management of marine refuges in response to climate change threats and impacts (Fisheries and Oceans Canada, [Unpublished Report]). Lastly, DFO's *2023-2024 Departmental Plan* states that DFO aims to address challenges facing the ocean including climate change, as well as to study the impacts of climate change on fisheries and help Canada move towards a more climate-resilient future (Fisheries and Oceans Canada, 2023d).

4.0 - Discussion

With this research, we developed definitions for five adaptation domains – assets, flexibility, organization, learning, and agency – that influence the adaptive capacity of MPAs and OECMs and demonstrated their utility in assessing adaptive capacity through a Canadian case study. Our analysis highlights the importance of assessing this capacity in OECMs that may be more adaptive than strict MPAs owing to the potential for speed and flexibility in implementation and dynamic responses to climate change (Tittensor et al., 2019). Testing this assumption, our study provides evidence of where adaptative capacity is present, and where it is lacking, in a country that is clearly advanced in the use of OECMs as a conservation tool (Lemieux et al., 2022). Our results indicate that the five domains, in general, are seldom reflected within both Canada's OECM enabling environment and in the management of OECMs. While it

is evident that Canada has acknowledged climate change as an issue and adaptive management as a solution, the adaptive capacity for OECMs to continue to procure long-term conservation and biodiversity benefits in the face of climate change is clearly lacking.

At the forefront, the operational assets needed to improve the adaptive capacity of Canada's marine OECMs are insufficient. Canada currently does not have any dedicated funding to manage OECMs in a way that increases their long-term adaptive capacity (Government of Canada, 2021). First, without dedicated, ongoing funding for climate change research in the marine environment, Canada's goal to adaptively manage marine OECMs, ensuring their continued protection of biodiversity and meaningfully contributing to conservation targets, is unlikely. As climate change impacts become more apparent and more damaging (Bryndum-Bucholz et al., 2022; Lotze et al., 2019; Tittensor et al., 2019), financial investments to enable adaptive action will only get more costly the longer they are delayed (Jones et al., 2017). Canada has only one program, the ACCASP, dedicated to climate change research in the marine environment, employing eight full-time staff to conduct research in all three of Canada's extensive coastlines (Fisheries and Oceans, 2020). There are clearly insufficient human assets, and this sentiment is apparent in the ACCASP's program evaluation that states: "there is no dedicated group within DFO that coordinates climate change efforts for the department. Because of its expertise, the ACCASP has taken on a part of this role. However, the current mandate and resources of the ACCASP are insufficient to fulfill this expanding role and focus on ACCASP-specific activities" (Fisheries and Oceans Canada, 2020).

Within the SS-BOF Bioregion, the AZMP has provided technical assets through the collection of oceanographic data since 1998 (Fisheries and Oceans Canada, 2019). The availability of baseline environmental data provided by the AZMP is critical to identify indicators of significant environmental change to inform management; however, the availability of data from the AZMP is limited and environmental data is not collected from each marine refuge on the Scotian Shelf (Fisheries and Oceans Canada, 2019). At present, there is no discussion or evidence of climate change indicators used in the AZMP. The fact that environmental data from long-term monitoring does not currently exist for each marine refuge limits the adaptive capacity of Canada's OECMs, as it intensifies challengesto observe environmental chance to then inform adaptive management. Lastly, Canada has several governance assets to establish marine OECMs; however, very few have been used for the

management of marine OECMs or to adapt OECMs to changing conditions to increase resiliency (Fisheries and Oceans Canada, [Unpublished Report]). Governance assets that specifically enable adaptive management are clearly lacking. Together, these limitations and gaps in Canada's operational, financial, technical, human, and governance assets restrict the adaptive capacity of OECMs and threaten their ability to deliver long-term biodiversity and conservation benefits.

Evidence of flexibility is interwoven throughout Canada's OECM environment, including management of OECMs in the SS-BOF Bioregion; however, whether it is sufficient to increase adaptive capacity is less clear. In several instances, the 2022 OECM Guidance and the OECM Management Plan affirm that "management actions may be adapted over time and can include one or more of the following: compliance and enforcement programs, implementation policies, monitoring processes and collaborative agreements, and traditional and cultural practices" (Fisheries and Oceans Canada, 2022; Fisheries and Oceans Canada, [Unpublished Report]). Still, no management process has been identified in Canada that would encourage, or that may allow for, adaptive management toward improving the adaptive capacity of marine OECMs. An example of a management process that would allow for the increase in adaptive capacity to climate change may look like re-assessing management strategies and measures frequently to account for ecosystem change and possible range shifts (Tittensor et al., 2019).

The evidence collected in this study shows that, compared to *Oceans Act* MPAs, marine OECMs in Canada may be more flexible in many ways. First, marine OECMs can be established through three different processes: variation orders, licensing conditions, and Biodiversity Protection Regulations (Fisheries and Oceans Canada, [Unpublished Report]). The availability of multiple ways for establishing OECMs is a source of flexibility. Further, establishing marine refuges through variation orders and licensing conditions can allow for the continual adjustment of management as required as they are not established through regulation and can be ordered by the Minister "if he or she is of the opinion that prompt measures are required to address a threat to the proper management and control of fisheries and the conservation and protection of fish..." (Fisheries and Oceans Canada, 2022; *Fisheries Act*, 1985). Currently, no marine refuge in Canada has been established through Biodiversity Protection Regulations (Fisheries and Oceans Canada, 2022), which, if implemented, could delay establishment should a regulatory process be

required, which will in turn reduce the adaptive capacity of marine refuges and make them similarly inflexible as MPAs.

Second, the protection standards for OECMs in Canada state that "existing or foreseeable activities in federal marine OECMs will continue to be assessed on a case-by-case basis to ensure that the risks to the biodiversity and conservation benefits have been avoided or mitigated effectively" (Fisheries and Oceans Canada, 2022; Fisheries and Oceans Canada, 2023c). The process for permittance of activities within OECMs is far less rigid and defined compared to the protection standards of MPAs, allowing for a more flexible approach to the management of sites, potentially increasing adaptive capacity. Most notably, marine OECMs have significant potential to be more adaptive than MPAs as they are not as entrenched in legislation and regulation as many of Canada's MPAs (e.g., those established under the *Oceans Act* or the *Canada National Marine Conservation Areas Act*). If formal MPA management needs to be altered, they must undergo regulatory amendments which can delay action in response to a rapidly changing environment. While the OECM Management Plan does acknowledge the need for adaptive management, and outlines climate change objectives, the plan fails to provide practical steps and actions for adaptive management (Fisheries and Oceans Canada, [Unpublished Report]). Without identifying and describing these practical actions, the ability to stop, start, or switch between management actions as required is limited, potentially creating rigidity in management which should otherwise be flexible to ensure that OECMs continue to meet their conservation objectives. Ultimately, acknowledging climate change and the need for adaptive actions and processes is an essential first step; however, significant work remains to operationalize adaptive management of OECMs.

OECM governance is organized to ensure the long-term provision of biodiversity and conservation benefits. DFO is the lead governing authority with the jurisdiction to manage Canada's current and only type of marine OECMS, marine refuges; however, DFO relies heavily on other regulators and governing bodies to restrict activities other than fishing within these areas (Fisheries and Oceans Canada, [Unpublished Report]). The OECM Management Plan helps to coordinate governance and management, though the plan does not advise on a governance system that would enable adaptive action (Fisheries and Oceans Canada, [Unpublished Report]). Further, the introduction of multiple federal authorities into the governance system introduces a range of perceptions, agendas, and priorities that may conflict

and limit the ability of these governing bodies to work together to set collective goals and enable adaptive action (Mahon & Fanning, 2019; Nyaupane et al., 2022; Ainsworth et al., 2020). Still, the OECM Management Plan may overcome this challenge by establishing a Coordination Committee to help organize marine OECM governance. This participatory mechanism has the potential to facilitate and promote knowledge sharing and the integration of multiple priorities and preferences into marine OECM governance, which can help to reduce conflict (Ainsworth et al., 2020). The Coordination Committee also provides a platform for acknowledging uncertainty produced by climate change and the need for adaptive action (Akamani, 2020; Nyaupane et al., 2022). While the evidence collected in this study demonstrates Canada's acknowledgement of the need for an adaptive governance system, a genuinely adaptive governance system is clearly absent.

Canada's OECM environment shows that the learning domain appears to be highly conceptualized, but yet to be implemented. Both the 2022 OECM Guidance and the OECM Management Plan express that OECM monitoring should consider climate change and its impacts (Fisheries and Oceans Canada, 2022; Fisheries and Oceans Canada, [Unpublished Report]). This is evidence of Canada's intention to expand and process new climate information, central to the learning domain. For example, the OECM Management Plan includes a clear objective to incorporate climate change and its impacts into an eventual monitoring plan, providing more evidence that Canada intends to increase their capacity to generate and process information on climate change (Fisheries and Oceans Canada, [Unpublished Report]). Despite this promising evidence, this domain also lacks evidence of practical steps to initiate collection of climate change information and incorporate it into management to transition from one-time, traditional, or reactive management into adaptive management. Without implementation of the learning domain, Canada's capacity to adapt OECMs is limited.

While evidence of the assets, flexibility, organization, and learning domains exists, to varying extents, throughout Canada's OECM environment, the agency domain is scarcely present within the analyzed documents. Climate change is a significant threat to fisheries and oceans management in Canada, likely reducing the efficacy of current management measures, including marine refuges. Currently, according to the *Fisheries Act*, the Minister of Fisheries, Oceans and the Canadian Coast Guard has the authority under the *Act* "to address a threat to the proper management and control of fisheries and the conservation and protection of fish"

(*Fisheries Act, 1985*). Therefore, the Minister may have the agency to choose to respond to significant environmental change imposed by climate change threats to fisheries and fish (*Fisheries Act, 1985*). The current Mandate of the Minister (Trudeau, 2021) assigns responsibility to amend the *Oceans Act* to acknowledge climate change; however, this responsibility is not extended for the *Fisheries Act*. Given this, the agency to consider climate change in the establishment and management of marine refuges established under the *Fisheries Act* is not directly evident. DFO has set goals for 2023 and 2024 to address climate change and expand climate research, potentially bolstering agency within DFO (Fisheries and Oceans Canada, 2023d). While there is evidence for some agency to exist in Canada, evidence of agency is not explicit. Still, it is generally accepted that DFO, as Canada's lead ocean regulatory authority, can choose to act to respond to climate change and its impacts through governance, policy, and management that can increase adaptive capacity.

We used a targeted literature review to develop adaptation domain definitions in the context of protected areas. While this method was effective, our definitions may be strengthened if complemented by a systematic review to ensure that the full breadth of information is captured. Our study also relied on availability of public materials to conduct the case study analysis, except the OECM Management Plan provided to the authors by DFO before its anticipated 2024 publication. We do not presume that all information pertinent to this analysis would be readily available to the public, as OECMs and adaptive management are active undertakings of DFO. Future work may benefit from the collection and incorporation of expert and practical knowledge through interviews, focus groups, or surveys. While we focused our research on Canada's approach to marine OECMs, other countries advancing OECMs could be assessed to compare approaches, management strategies, governance structures, establishment procedures and, ultimately, adaptive capacity. Lastly, our study assessed the five domains within Canada's OECM environment, and in the management of Canada's OECMs, as independent domains. It is clear from our work that adaptation domains are interdependent, and future research to understand interdependencies may provide further guidance to planners, managers, and decision-makers in increasing adaptive capacity of marine OECMs in a way that may be more efficient and less expensive.

Through our research and efforts to assess the five adaptation domains independently, it has become clear that the domains are deeply interdependent. Rather than implementing domains

in isolation, their interrelations should be considered and opportunities for mutual strengthening explored. For example, in assessing the organization domain, which refers mostly to the way in which the governance system is structured to enable adaptive action, the flexibility domain becomes important. A governance system must include a certain amount of flexibility in decision-making to be able to adapt decisions, objectives, and goals over time in response to climate change (Rhodes et al., 2022; Munera & van Kerkhoff, 2019). The governance system should also be organized such that as new information is made available through the learning domain, this information can be processed and integrated into decision-making processes, with the agency to choose to respond, and the flexibility to halt, start, modify, or switch to adaptive actions.

Without learning and the capacity to generate, absorb, and process new information about climate change, the development of effective adaptive management strategies and actions will not occur, thus limiting the diversity of potential adaptive actions and reducing flexibility (Jones et al., 2017). Further, the inability to generate and process new information may lead to the development of ineffective adaptive actions and strategies which could increase the costs, resources, and assets that have gone into deploying these actions, showing the link between the learning and asset domain (Jones et al., 2017). According to the IPCC, the availability of technical assets, such as long-term data, is not enough to increase the adaptive capacity of protected areas, the capacity needed to absorb and process the long-term data is critical (Williams et al., 2015). Lastly, the agency and the ability to choose to respond to environmental change through adaptive action is not likely unless the assets (financial, technological, human, and governance) needed to enable adaptive action are in place (Woroniecki et al., 2019). These are only a few of the multitude of interdependencies that exist between all five domains, and all will have significant impacts on the adaptive capacity of protected areas in this era of global climate change.

4.1 - Management Recommendations

The evidence collected in this study indicates that Canada has met some criteria of each adaptation domain, though the adaptive capacity needed to ensure long-term delivery of conservation benefits from OECMs and, relatedly, to ensure the long-term sustainability, efficiency, and adaptability of protected areas is unlikely without advancement in all five

domains. Based on this research, we provide three management recommendations to increase the adaptive capacity of protected areas to climate change.

1. The Government of Canada should substantially increase long-term funding dedicated to climate research and initiatives to advance the development of adaptation tools and climate monitoring, as well as to hire full-time dedicated staff to tackle climate change related issues.

2. The Government of Canada should clearly define operational actions and adaptive measures for adaptive action. It would be highly beneficial for Canada to explicitly state that OECMs are dynamic measures that can be used to mitigate and adapt to climate change.

3. The Government of Canada and the scientific community should assess the five adaptation domains and their interdependencies to better understand current adaptive capacity, to identify practical steps toward implementing each domain, and to harnessing synergies among adaptation domains that may most efficiently improve adaptive capacity.

5.0 - Conclusion

Our results indicate that Canada's OECMs have limited adaptive capacity to climate change, despite their clear importance in securing long-term conservation benefits. We find that the five adaption domains are infrequently and scarcely reflected in the management of Canada's marine OECMs and in Canada's overall OECM enabling environment. To build adaptive capacity, progress must be made to advance each of the five adaptation domains in earnest; it is not sufficient to only possess one or two of these domains. Overall, these results are concerning given that Canada has invested heavily in OECM guidance and establishment, yet evidence of adaptive capacity remains limited. Canada must prioritize building adaptive capacity into their marine conservation system to ensure that it remains effective in conserving biodiversity long into the future and in this era of global climate change.

REFERENCES

Agardy, T., Claudet, J., & Day, J. C. (2016). 'Dangerous Targets' revisited: Old dangers in new contexts plague marine protected areas. Aquatic Conservation: Marine and Freshwater Ecosystems, 26, 7–23. https://doi.org/10.1002/aqc.2675

Ainsworth, G. B., Redpath, S. M., Wilson, M., Wernham, C., & Young, J. C. (2020). Integrating scientific and local knowledge to address conservation conflicts: Towards a practical framework based on lessons learned from a Scottish case study. Environmental Science and Policy, 107, 46–55. https://doi.org/10.1016/j.envsci.2020.02.017

Akamani, K. (2020). Integrating deep ecology and adaptive governance for sustainable development: Implications for protected areas management. Sustainability (Switzerland), 12(14), 1–21. https://doi.org/10.3390/su12145757

Barr, S. L., Larson, B. M. H., Beechey, T. J., & Scott, D. J. (2021). Assessing climate change adaptation progress in Canada's protected areas. Canadian Geographer, 65(2), 152–165. https://doi.org/10.1111/cag.12635

Bates, A. E., Cooke, R. S. C., Duncan, M. I., Edgar, G. J., Bruno, J. F., Benedetti-Cecchi, L., Côté, I. M., Lefcheck, J. S., Costello, M. J., Barrett, N., Bird, T. J., Fenberg, P. B., & Stuart-Smith, R. D. (2019). Climate resilience in marine protected areas and the 'Protection Paradox.' In Biological Conservation (Vol. 236, pp. 305–314). Elsevier Ltd. https://doi.org/10.1016/j.biocon.2019.05.005

Bennett, N. J., & Dearden, P. (2014). Why local people do not support conservation: Community perceptions of marine protected area livelihood impacts, governance and management in Thailand. Marine Policy, 44, 107–116. https://doi.org/10.1016/j.marpol.2013.08.017

Bohorquez, J. J., Dvarskas, A., Jacquet, J., Sumaila, U. R., Nye, J., & Pikitch, E. K. (2022). A New Tool to Evaluate, Improve, and Sustain Marine Protected Area Financing Built on a Comprehensive Review of Finance Sources and Instruments. Frontiers in Marine Science, 8(January). https://doi.org/10.3389/fmars.2021.742846

Brown, K., & Westaway, E. (2011). Agency, capacity, and resilience to environmental change: Lessons from human development, well-being, and disasters. Annual Review of Environment and Resources, 36, 321–342. https://doi.org/10.1146/annurev-environ-052610-092905

Bryndum-Buchholz, A., Boerder, K., Stanley, R. R. E., Hurley, I., Boyce, D. G., Dunmall, K. M., Hunter, K. L., Lotze, H. K., Shackell, N. L., & Tittensor, D. P. (2022). Downloaded from www.facetsjournal.com by 64. https://doi.org/10.1139/facets

CBD. (2008). *Defining protected areas: an international conference in Almeria, Spain*. https://portals.iucn.org/library/node/10127

CBD. (2022). *Kunming-Montreal Global Biodiversity Framework*. Convention on Biological Diversity. (https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04 -en.pdf)

Cinner, J. E., Adger, W. N., Allison, E. H., Barnes, M. L., Brown, K., Cohen, P. J., Gelcich, S., Hicks, C. C., Hughes, T. P., Lau, J., Marshall, N. A., & Morrison, T. H. (2018). Building adaptive capacity to climate change in tropical coastal communities. Nature Climate Change, 8(2), 117–123. https://doi.org/10.1038/s41558-017-0065-x

Craig, R. K., Garmestani, A. S., Allen, C. R., Tony, A., Birgé, H., Decaro, D., Fremier, A. K., & Gosnell, H. (2017). Balancing stability and flexibility in adaptive governance: The new challenges and a review of tools available. Ecology and Society, 22(2), 1–31.

Creswell, J. W. (1994). *Research design: Qualitative & quantitative approaches.* Sage Publications, Inc.

Fisheries Act, Revised Statutes of Canada (R.S.C., 1985, c. F-14). Retrieved from the Justice Laws website: https://www.laws-lois.justice.gc.ca/eng/acts/F-14/

Fisheries and Oceans Canada. (2009). *Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas*. Government of Canada. https://www.dfo-mpo.gc.ca/reports-rapports/regs/sff-cpd/benthi-eng.htm

Fisheries and Oceans Canada. (2015). *Coral & Sponge Conservation Strategy for Eastern Canada 2015*. Government of Canada. https://www.dfo-mpo.gc.ca/oceans/publications/cs-ce/index-eng.html

Fisheries and Oceans Canada. (2019). *Atlantic Zone Monitoring Program (AZMP)*. Government of Canada. https://www.dfo-mpo.gc.ca/science/data-donnees/azmp-pmza/index-eng.html

Fisheries and Oceans Canada. (2020). *Summary of the Evaluation of the Aquatic Climate Change Adaptation Services Program (ACCASP)*. Government of Canada. https://www.dfo-mpo.gc.ca/ae-ve/evaluations/19-20/accasp-psaccma-summary-eng.html

Fisheries and Oceans Canada. (2022). *Government of Canada Guidance for Recognizing Marine Other Effective Area-Based Conservation Measures, 2022.*https://www.dfo-mpo.gc.ca/oceans/publications/oecm-amcepz/oecm-guidance-directives-amcez-2022-eng.pdf

Fisheries and Oceans Canada. (2023a). *Marine refuges across Canada*. https://www.dfo-mpo.gc.ca/oceans/oecm-amcepz/refuges/index-eng.html

Fisheries and Oceans Canada. (2023b). *Guidance*. https://www.dfo-mpo.gc.ca/oceans/oecm-amcepz/guidance-eng.html

Fisheries and Oceans Canada. (2023c). *Marine Protected Areas (MPA) Protection Standard*. Government of Canada. https://www.dfo-mpo.gc.ca/oceans/mpa-zpm/protection-standard-norme-protection-eng.html

Fisheries and Oceans Canada. (2023d). *2023-24 Departmental Plan*. Government of Canada. https://www.dfo-mpo.gc.ca/rpp/2023-24/dp-eng.html

Fisheries and Oceans Canada. [Unpublished Report]. *Scotian Shelf – Bay of Fundy Bioregional Marine Refuge Management Plan.*

Frölicher, T. L., Fischer, E. M., & Gruber, N. (2018). Marine heatwaves under global warming. Nature, 560(7718), 360–364. https://doi.org/10.1038/s41586-018-0383-9

Galappaththi, E. K., Ford, J. D., Bennett, E. M., & Berkes, F. (2021). Adapting to climate change in small-scale fisheries: Insights from indigenous communities in the global north and south. Environmental Science and Policy, 116, 160–170. https://doi.org/10.1016/j.envsci.2020.11.009

Garcia, S. M., Rice, J., Himes-Cornell, A., Friedman, K. J., Charles, A., Diz, D., Appiott, J., & Kaiser, M. J. (2022). OECMs in marine capture fisheries: Key implementation issues of governance, management, and biodiversity. Frontiers in Marine Science, 9. https://doi.org/10.3389/fmars.2022.920051

Gill, D. A., Mascia, M. B., Ahmadia, G. N., Glew, L., Lester, S. E., Barnes, M., Craigie, I., Darling, E. S., Free, C. M., Geldmann, J., Holst, S., Jensen, O. P., White, A. T., Basurto, X., Coad, L., Gates, R. D., Guannel, G., Mumby, P. J., Thomas, H., … Fox, H. E. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. Nature, 543(7647), 665–669. https://doi.org/10.1038/nature21708

Government of Canada. (2021). *Budget 2021: A recovery plan for jobs, growth, and resilience*. https://www.canada.ca/en/department-finance/news/2021/04/budget-2021-a-recovery-plan-for-jobs-growth-and-resilience.html

Grorud-Colvert, K., Sullivan-Stack, J., Roberts, C., Constant, V., Horta E Costa, B., Pike, E. P., Kingston, N., Laffoley, D., Sala, E., Claudet, J., Friedlander, A. M., Gill, D. A., Lester, S. E., Day, J. C., Gonçalves, E. J., Ahmadia, G. N., Rand, M., Villagomez, A., Ban, N. C., … Lubchenco, J. (2021). The MPA guide: A framework to achieve global goals for the ocean. In Science (Vol. 373, Issue 6560). American Association for the Advancement of Science. https://doi.org/10.1126/science.abf0861

Gurney, G. G., Darling, E. S., Ahmadia, G. N., Agostini, V. N., Ban, N. C., Blythe, J., Claudet, J., Epstein, G., Estradivari, Himes-Cornell, A., Jonas, H. D., Armitage, D., Campbell, S. J., Cox, C., Friedman, W. R., Gill, D. A., Lestari, P., Mangubhai, S., McLeod, E., … Jupiter, S. D. (2021). Biodiversity needs every tool in the box: use OECMs. In Conservation Letters (Vol. 595, pp. 646–649). Nature. https://doi.org/10.1038/d41586-021-02041-4

Hansen, S. (2021). Developing a Model of Construction Contract Management Competency in a Developing Country: Quantitative Approach. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 13(4). https://doi.org/10.1061/(asce)la.1943-4170.0000504

Harley, C. D. G., Hughes, A. R., Hultgren, K. M., Miner, B. G., Sorte, C. J. B., Thornber, C. S., Rodriguez, L. F., Tomanek, L., & Williams, S. L. (2006). The impacts of climate change in coastal marine systems. Ecology Letters, 9(2), 228–241. https://doi.org/10.1111/j.1461-0248.2005.00871.x

Hopkins, C. R., Bailey, D. M., & Potts, T. (2016). Perceptions of practitioners: Managing marine protected areas for climate change resilience. Ocean and Coastal Management, 128, 18–28. https://doi.org/10.1016/j.ocecoaman.2016.04.014

IPBES (2019): Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz, and H. T. Ngo (editors). IPBES secretariat, Bonn, Germany. 1148 pages. https://doi.org/10.5281/zenodo.3831673

IPCC. (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* IPCC. *https://www.ipcc.ch/report/ar5/syr/*

IUCN WCPA Task Force on OECMs. (2019). *Recognising and reporting other effective area-based conservation measures*. doi:10.2305/iucn.ch.2019.patrs.3.en

Jacquemont, J., Blasiak, R., Le Cam, C., Le Gouellec, M., & Claudet, J. (2022). Ocean conservation boosts climate change mitigation and adaptation. In One Earth (Vol. 5, Issue 10, pp. 1126–1138). Cell Press. https://doi.org/10.1016/j.oneear.2022.09.002

Jones, L., Champalle, C., Chesterman, S., Cramer, L., & Crane, T. A. (2017). Constraining and enabling factors to using long-term climate information in decision-making. Climate Policy, 17(5), 551–572. https://doi.org/10.1080/14693062.2016.1191008

Laffoley, D., Baxter, J. M., Amon, D. J., Currie, D. E. J., Downs, C. A., Hall-Spencer, J. M., Harden-Davies, H., Page, R., Reid, C. P., Roberts, C. M., Rogers, A., Thiele, T., Sheppard, C. R. C., Sumaila, R. U., & Woodall, L. C. (2020). Eight urgent, fundamental and simultaneous steps needed to restore ocean health, and the consequences for humanity and the planet of inaction or delay. Aquatic Conservation: Marine and Freshwater Ecosystems, 30(1), 194–208. https://doi.org/10.1002/aqc.3182

Lalonde, S., Abashidze, A., & Solntsev, A. (2022). Marine Protected Areas and Other Effective Area-based Conservation Measures. Arctic Review on Law and Politics, 13, 312–337. https://doi.org/10.2307/48710671

Lemieux, C. J., Gray, P. A., Devillers, R., Wright, P. A., Dearden, P., Halpenny, E. A., Groulx, M., Beechey, T. J., & Beazley, K. (2019). How the race to achieve Aichi Target 11 could jeopardize the effective conservation of biodiversity in Canada and beyond. Marine Policy, 99, 312–323. https://doi.org/10.1016/j.marpol.2018.10.029

Lemieux, C. J., Kraus, D. T., & Beazley, K. F. (2022). Running to stand still: The application of substandard OECMs in national and provincial policy in Canada. Biological Conservation, 275. https://doi.org/10.1016/j.biocon.2022.109780

Lotze, H. K., Tittensor, D. P., Bryndum-Buchholz, A., Eddy, T. D., Cheung, W. W. L., Galbraith, E. D., Barange, M., Barrier, N., Bianchi, D., Blanchard, J. L., Bopp, L., Büchner, M., Bulman, C. M., Carozza, D. A., Christensen, V., Coll, M., Dunne, J. P., Fulton, E. A., Jennings, S., … Worm, B. (2019). Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change. Proceedings of the National Academy of Sciences of the United States of America, 116(26), 12907–12912. https://doi.org/10.1073/pnas.1900194116

MacKinnon, D., Lemieux, C. J., Beazley, K., Woodley, S., Helie, R., Perron, J., Elliott, J., Haas, C., Langlois, J., Lazaruk, H., Beechey, T., & Gray, P. (2015). Canada and Aichi Biodiversity Target 11: understanding 'other effective area-based conservation measures' in the context of the broader target. Biodiversity and Conservation, 24(14), 3559–3581. https://doi.org/10.1007/s10531-015-1018-1

Mahon, R., & Fanning, L. (2019). Regional ocean governance: Integrating and coordinating mechanisms for polycentric systems. Marine Policy, 107. https://doi.org/10.1016/j.marpol.2019.103589

Morley, J. W., Selden, R. L., Latour, R. J., Frölicher, T. L., Seagraves, R. J., & Pinsky, M. L. (2018). Projecting shifts in thermal habitat for 686 species on the North American continental shelf. PLoS ONE, 13(5), 1–28. https://doi.org/10.1371/journal.pone.0196127

Múnera, C., & van Kerkhoff, L. (2019). Diversifying knowledge governance for climate adaptation in protected areas in Colombia. Environmental Science and Policy, 94, 39–48. https://doi.org/10.1016/j.envsci.2019.01.004

Nyaupane, G. P., Poudel, S., & York, A. (2022). Governance of protected areas: an institutional analysis of conservation, community livelihood, and tourism outcomes. Journal of Sustainable Tourism, 30(11), 2686–2705. https://doi.org/10.1080/09669582.2020.1858089

O'Regan, S. M., Archer, S. K., Friesen, S. K., & Hunter, K. L. (2021). A Global Assessment of Climate Change Adaptation in Marine Protected Area Management Plans. Frontiers in Marine Science, 8. https://doi.org/10.3389/fmars.2021.711085

Oliveira Júnior, J. G. C., Ladle, R. J., Correia, R., & Batista, V. S. (2016). Measuring what matters – Identifying indicators of success for Brazilian marine protected areas. Marine Policy, 74(February), 91–98. https://doi.org/10.1016/j.marpol.2016.09.018

Pomeroy, R. S., Watson, L. M., Parks, J. E., & Cid, G. A. (2005). How is your MPA doing? A methodology for evaluating the management effectiveness of marine protected areas.

Ocean and Coastal Management, 48(7–8), 485–502. https://doi.org/10.1016/j.ocecoaman.2005.05.004

Reimer, J. M., Devillers, R., & Claudet, J. (2021). Benefits and gaps in area-based management tools for the ocean Sustainable Development Goal. Nature Sustainability, 4(4), 349–357. https://doi.org/10.1038/s41893-020-00659-2

Ramirez, L. F. (2016). Marine protected areas in Colombia: Advances in conservation and barriers for effective governance. Ocean and Coastal Management, 125, 49–62. https://doi.org/10.1016/j.ocecoaman.2016.03.005

Rhodes, J. R., Armsworth, P. R., Iacona, G., Shah, P., Gordon, A., Wilson, K. A., Runting, R. K., & Bryan, B. A. (2022). Flexible conservation decisions for climate adaptation. In One Earth (Vol. 5, Issue 6, pp. 622–634). Cell Press. https://doi.org/10.1016/j.oneear.2022.05.010

Roberts, C. M., O'Leary, B. C., & Hawkins, J. P. (2020). Climate change mitigation and nature conservation both require higher protected area targets. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794). https://doi.org/10.1098/rstb.2019.0121

Ryan, G. W., & Bernard, H. R. (2003). Techniques to Identify Themes. Field Methods, 15(1), 85–109. https://doi.org/10.1177/1525822X02239569

Sampaio, E., Santos, C., Rosa, I. C., Ferreira, V., Pörtner, H. O., Duarte, C. M., Levin, L. A., & Rosa, R. (2021). Impacts of hypoxic events surpass those of future ocean warming and acidification. Nature Ecology and Evolution, 5(3), 311–321. https://doi.org/10.1038/s41559-020-01370-3

Santos, C. F., Agardy, T., Adrade, F., Calado, H., Chowder, L. B., Ehler, C. N., Garcia-Morales, S., Gissi, E., Halpern, B., Orbach, M., Portner, H.-O., & Rosa, R. (2020). Integrating climate change in ocean planning. *Nature Sustainability*, *3*(2020), 505–516. https://doi.org/10.1038/s41893-020-0513-x

Secretariat of the Convention on Biological Diversity, & United Nations Environment Programme (2019). *Strategic Plan for Biodiversity 2011–2020 and the Aichi Targets: Living in Harmony with Nature*. https://wedocs.unep.org/20.500.11822/27533

Secretariat of the Convention on Biological Diversity. (2023). *2030 Targets (with Guidance Notes)*. https://www.cbd.int/gbf/targets/

Species at Risk Act, Revised Statutes of Canada (S.C. 2002, c. 29). Retrieved from the Justice Laws website: https://laws-lois.justice.gc.ca/eng/acts/S-15.3/page-1.html

Tittensor, D. P., Beger, M., Boerder, K., Boyce, D. G., Cavanagh, R. D., Cosandey-Godin, A., Crespo, G. O., Dunn, D. C., Ghiffary, W., Grant, S. M., Hannah, L., Halpin, P. N., Harfoot, M., Heaslip, S. G., Jeffery, N. W., Kingston, N., Lotze, H. K., McGowan, J., McLeod, E., … Worm, B. (2019). Integrating climate adaptation and biodiversity

conservation in the global ocean. Science Advances, 5(11), 1–16. https://doi.org/10.1126/sciadv.aay9969

Toivonen, H. (2022). Themes of climate change agency: a qualitative study on how people construct agency in relation to climate change. Humanities and Social Sciences Communications, 9(1), 1–11. https://doi.org/10.1057/s41599-022-01111-w

Trudeau, Justin. (2021). *Minister of Fisheries, Oceans and the Canadian Coast Guard Mandate Letter*. Office of the Prime Minister. https://www.pm.gc.ca/en/mandate-letters/2021/12/16/minister-fisheries-oceans-and-canadian-coast-guard-mandate-letter

United Nations. (n.d.). *Aichi target 11 - convention on biological diversity*. Convention on Biological Diversity. https://www.cbd.int/aichi-targets/target/11

Vadrot, A. B. M., Ruiz Rodríguez, S. C., Brogat, E., Paul Dunshirn, Langlet, A., Tessnow-von Wysocki, I., & Wanneau, K. (2022). Towards a reflexive, policy-relevant and engaged ocean science for the UN decade: A social science research agenda. In Earth System Governance (Vol. 14). Elsevier B.V. https://doi.org/10.1016/j.esg.2022.100150

van Kerkhoff, L., Munera, C., Dudley, N., Guevara, O., Wyborn, C., Figueroa, C., Dunlop, M., Hoyos, M. A., Castiblanco, J., & Becerra, L. (2019). Towards future-oriented conservation: Managing protected areas in an era of climate change. Ambio, 48(7), 699–713. https://doi.org/10.1007/s13280-018-1121-0

WDPA. (n.d.). Protected Planet. https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA

Williams, C., Fenton, A., & Huq, S. (2015). Knowledge and adaptive capacity. Nature Climate Change, 5(2), 82–83. https://doi.org/10.1038/nclimate2476

Wilson, K. L., Tittensor, D. P., Worm, B., & Lotze, H. K. (2020). Incorporating climate change adaptation into marine protected area planning. In Global Change Biology (Vol. 26, Issue 6, pp. 3251–3267). Blackwell Publishing Ltd. https://doi.org/10.1111/gcb.15094

Woroniecki, S., Wamsler, C., & Boyd, E. (2019). The promises and pitfalls of ecosystem-based adaptation to climate change as a vehicle for social empowerment. Ecology and Society, 24(2). https://doi.org/10.5751/ES-10854-240204

Wu, H. C., Dissard, D., Douville, E., Blamart, D., Bordier, L., Tribollet, A., Le Cornec, F., Pons-Branchu, E., Dapoigny, A., & Lazareth, C. E. (2018). Surface ocean pH variations since 1689 CE and recent ocean acidification in the tropical South Pacific. Nature Communications, 9(1). https://doi.org/10.1038/s41467-018-04922-1