Challenges in Canadian Marine Conservation Policy

Authors: Laura Apblett, Laurelyne Barbier, Zach Hynna, Gio Pomares, & Jessica Winton

1. Introduction

Beyond holding an intrinsic value, marine biodiversity supports key ecosystem functions (i.e., necessary fluxes of matter and energy) and provides ecosystem services, including oxygen production, fisheries, climate regulation, and opportunities for recreation (Luypaert et al., 2020). However, current trends in marine biodiversity are concerning; some species are considered "threatened," and others are facing extinction due to major anthropogenic threats, such as climate change, pollution, invasive species, habitat destruction, and direct exploitation of resources (Luypaert et al., 2020; O'Hara et al., 2019).

Conservation efforts have been deployed around the world in response to the loss of and eminent threats to both terrestrial and marine biodiversity (Langhammer et al., 2024; Lotze, 2021). In fact, several countries have signed global conservation frameworks such as the Kunming-Montreal Global Biodiversity Framework (KMGBF), which sets targets for the reduction of threats to biodiversity, including the protection of 30% of terrestrial, inland, coastal, and marine water areas by 2030 (UNEP, 2022).

In Canada, which has adopted the KMGBF, marine conservation is managed under several Acts and overseen by several agencies (Government of Canada, 2023; Keen et al., 2024). For instance, the Oceans Act establishes Marine Protected Areas (MPAs) that protect specific areas and their biodiversity by restricting the activities that may take place within their boundaries, based on the Department of Fisheries and Oceans (DFO)'s Marine Protection Standard (Keen et al., 2024). Other Effective area-based Conservation Measures (OECMs) of various sorts are also designed to achieve conservation benefits in defined marine spaces, from National Marine Conservation Areas administered by Parks Canada, to National Wildlife Areas managed by Environment and Climate Change Canada (ECCC), to Marine Refuges administered by the DFO under the Fisheries Act (Government of Canada, 2025; Keen et al., 2024). As such, Canadian marine conservation mainly takes the shape of area-based measures (Government of Canada, 2025).

Unfortunately, conservation efforts, especially reactive approaches aimed at reversing biodiversity trends in the short term, do not always yield conclusive and positive results (Cardador et al., 2015). In 2015, Cardador et al. defined conservation traps as "situations where the application of reactive approaches based on biologically focused solutions results in the need to perpetuate its implementation and its associated costs" (Cardador et al., 2015, p. 457).

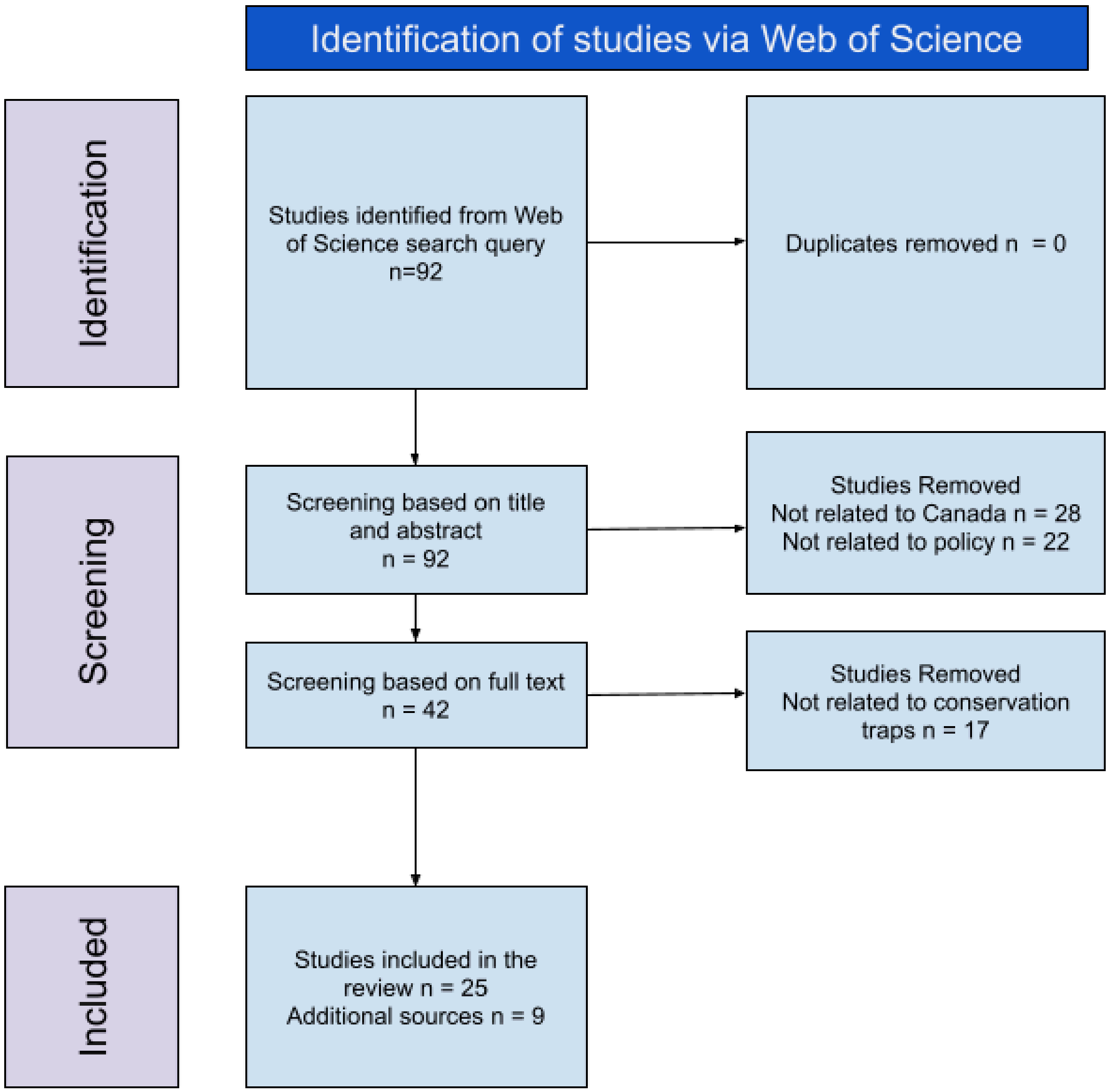
Building on this definition, we investigated more broadly the question "What are the challenges to efficient and sustainable marine conservation in Canada?" by conducting a search within the existing literature. For the purpose of this paper, we build on Cardador et al. (2015)'s conservation trap definition and define efficient conservation by opposition, as conservation that leads to self-sustaining positive biodiversity outcomes in the long run at lower input costs. We found different types of challenges to meeting this ideal. In the following sections, we describe biological factors, political factors, social equity factors, and challenges associated with non-compliance that all impact conservation measures. Finally, we summarize guidelines and strategies for effective conservation in Canada. We believe this paper could inform policy-makers on conservation best practices, leading to higher biodiversity and lower costs in the long term.

2. Methods

To identify articles for this analysis, we conducted a search in the academic literature through Web of Science using the following query:

TITLE(conservation OR biodiversity)
TITLE(marine)
ALL(failure OR success OR effectiveness OR reporting OR efficiency OR efficient)
ALL(canad*)

The search produced 92 results, with no duplicates. We first screened articles by title and abstract. In order to meet the inclusion criteria, papers needed to discuss marine conservation and relate to policy. Case studies not specific to Canada were also removed. Initial screening resulted in a total of 42 papers. We then screened these articles based on their full texts and removed those that did not sufficiently address the issue of conservation traps. This resulted in a total of 25 papers to be included in the following analysis. We identified an additional nine papers to fill any gaps in the information gathered in the original search, including five peer-reviewed articles, three policy and government documents, and one report.



3. Results and Discussion

There were several recurrent themes in our selected papers, which allowed them to be classified under four groups of factors representing challenges to efficient (high costs for little effectiveness and outcome provision) conservation in Canada.

Biological Factors

Effective conservation necessitates a comprehensive understanding of the biological factors that determine the success of the species or system being conserved. Conservation objectives, regardless of their targeted outcome, require, at a minimum, a baseline understanding of the environmental and ecological factors influencing the conservation target (Nielsen & Kenchington, 2001). The development of conservation initiatives for specific species, systems, or geographical areas for which there is a lack of comprehensive scientific understanding presents a risk for the initiatives to become conservation traps. Indeed, these measures might have important costs without being effective, therefore resulting in inefficient conservation. The body of biological knowledge required to inform the design of effective conservation initiatives is dependent on the specificity and scale of the conservation objectives (Heck et al., 2012). For example, species-specific conservation initiatives typically require an extensive understanding of biological factors that contribute to the survival of the species in question. The effective design of narrowly scoped conservation programs must be supported by scientific data that justifies not only the reasons for which a conservation intervention is required, but also the spatial design, monitoring methodology, and management of the program. The effective conservation of specific marine species often requires comprehensive data on population genetics, endemism, geographical range, migration patterns, reproductive rates, and broader ecological interactions between the target species and its environment (Mee et al., 2017). Without the meaningful integration of such information into species-specific conservation efforts, conservation traps can be created for the reason aforementioned.

Nielsen and Kenchington (2001) discuss how species-specific conservation efforts in the marine environment are frequently based on limited measures of population abundance and without properly incorporating data relevant to genetic diversity. The authors argue that population data can be misleading as an indicator for conservation effectiveness and that genetic diversity is a more robust indicator for species health (Nielsen & Kenchington, 2001). Further, Mee et al. (2017) illustrate how no-take marine reserves impact the range and rate of movement of large pelagic fishes, which can lead to changes in heritable behavioural genes, thus changing population-level behaviours. This suggests that the effective conservation of large, commercially viable pelagic fish species such as tuna and shark necessitates a thorough understanding of movement behaviour and population genetics to avoid unintended and potentially costly effects (Mee et al., 2017). The above-noted examples of data deficiencies reflect the complexity of species-specific marine conservation. As such, holistic nature and area-based conservation mechanisms are regarded as being significantly more effective (Heck et al., 2012; Maxwell et al., 2020).

As established in the KMGBF, all terrestrial protected areas, MPAs, and OECMs must be designed to reflect the full extent of biodiversity present within the greater region within which the protected area is established (UNEP, 2022). The significance of ecological representativity in effective area-based conservation stated in the KMGBF is widely supported in the literature (UNEP, 2022). The most frequently cited factor relating to biology that influences efficient area-based conservation mechanisms is ecological representativity, which, in practice, suggests that any conservation area should be geographically designed to capture the maximum amount of regional biodiversity within its boundaries (Keen et al., 2024; Maxwell et al., 2020; Novaczek et al., 2017; Pörtner et al., 2023). Incorporating biogeographic regionalization is important in ensuring the ecological representativity of area-based conservation mechanisms such as marine protected areas (MPAs), OECMs, and species-specific conservation areas (Spalding et al., 2016). As defined by Flores-Tolentino et al. (2021), biogeographic regionalization is a hierarchical system that classifies geographic areas in terms of their endemic biota, allowing the definition of homogeneous regions generated from sets of species and the identification of factors that potentially influence their distribution. This practice, though potentially costly and research-intensive, is foundational to understanding biological complexity in marine ecosystems and thus crucial for the design of effective protected areas (Keen et al., 2024; Spalding et al., 2016).

In Canada, many area-based conservation initiatives have been implemented without sufficient scientific understanding of regional biology, resulting in inherently inefficient conservation outcomes (Lemieux & Gray, 2020). A study by Novaczek et al. (2017) concluded that the Eastport MPA, a 2.1km^2 no-take marine reserve established in 2005, located in Bonavista Bay, Newfoundland, Canada, is fundamentally flawed in its design due to a lack of ecological representativity and biological monitoring data. The study found that species richness across all habitats present within the MPA accounted for only 36% of the species richness of Newman

Sound, the regional waterbody within which the Eastport MPA is located. The authors further revealed how the stated conservation objectives of the Eastport MPA do not match its size, boundaries, or management efforts, and were established without a sufficient understanding of the biogeographic regionalization of the marine system. Due to the continual input of resources towards the monitoring and management of the conservationally ineffective Eastport MPA, the area can be considered as a conservation trap resulting from the absence of biologically-based design and monitoring considerations.

In sum, as reflected in the literature, the effectiveness of species-specific conservation in the marine environment is highly limited by a lack of scientific understanding of complex aquatic systems. Low effectiveness, accompanied by potentially high implementation costs, leads to inefficient conservation measures and conservation traps. Resources for conservation are therefore better allocated to area-based conservation mechanisms that prioritize ecosystem-level conservation. Regardless of the advantages of area-based conservation, a robust understanding of the biological interactions that structure marine ecosystems is required for the delineation of effective protected areas. The creation of marine protected areas without the consideration or sufficient understanding of the biogeographic regionalization of the area can lead to conservation areas that lack biological representativity.

Political Factors

While biological and ecological oversights impede the technical implementation of conservation efforts, these challenges never appear in a vacuum in practice. They are frequently subject to– and in some cases, caused by– the political sphere. Muntoni et al. (2019) note that MPA efficiency is dependent on "their size, level of protection, location, and successful funding and enforcement" (Muntoni et al., 2019, p. 473). However, while the delineation of MPAs often involves scientific input to optimize species conservation, these recommendations are often undermined by political and economic interests.

How politics may counter the effectiveness of conservation efforts is best seen in the case of the Laurentian Channel MPA. The Laurentian Channel MPA boundaries were drafted to conserve sixteen priority species. However, the final delineation only contained six and was 33% smaller than the original proposal. Muntoni et al. (2019) observed five political considerations that pressured the DFO to reduce the MPA boundaries. While a small reduction occurred to avoid overlapping with the French territory of St. Pierre and Miquelon, the main driver behind shrinking the MPA boundary was Canada's economic interests. Large swaths of the MPA were eliminated to protect the interests of the oil and gas industry, and especially the fishing industries (Muntoni et al., 2019). Still, the resources invested in its development, compared with the final effectiveness in terms of conservation outcomes, suggest these conservation measures are less efficient than they could have been, hinting at a conservation trap.

While conservation objectives are not always contradictory to economic interests and in fact can promote a more sustainable economy, such as through tourism and fishery income, which can be further supported through strong MPA regulations (Heck & Dearden, 2012), government optics are best when conservation efforts can be celebrated without sacrificing economic gain (Ward et al., 2018). The literature suggests that ineffective, borderline symbolic MPAs such as that of the Laurentian Channel, have become unfortunately common in Canada's conservation strategy. Lemieux and Gray (2020) argue that Canada has striven to become a leader in marine conservation disingenuously. For example, in 2017, the DFO reclassified 51 fishery closures as MPAs or OECMs. However, despite the reclassification, the Department has done nothing further to protect "biodiversity from many other activities that are permitted in ocean ecosystems, including […] oil and gas exploration and mining, and […] industrial-scale commercial fishing" (Lemieux & Gray, 2020, p. 486) in these areas. On paper, the reclassifications have bolstered the government's conservation track record, as it has technically preserved substantial marine territory. However, because of the lack of clear-cut objectives and regulations for these MPA-adjacent zones, these classifications reflect the essence of Cardador et al. (2015)'s definition of a conservation trap, albeit with an investment in political advantages rather than ecological benefits. Moreover, they do not match the IUCN's definition of OECMs or MPAs, pointing to a stark contrast between global standards and Canada's practices (Lemieux & Gray, 2020).

Heck et al. (2012) synthesize these previous themes in their exploration of how governance influences MPA effectiveness. Using case studies from provincially-managed MPAs in British Columbia, the authors note how one of the greatest detriments to the success of MPAs – human activity – is difficult to regulate due to the overlapping provincial and federal jurisdictions and the lack of collaboration therein (Heck et al., 2012). Moreover, this study reflects the primary issue from Lemieux and Gray (2020), albeit at the provincial level. Heck et al. (2012) note how MPAs are ascribed with certain values (e.g., protection of marine mammals, promotion of recreational activities), but are rarely supported by management plans, once again suggesting only a tokenistic interest in conservation.

The suggestion that MPAs have long been appealing to governments as a way of advocating for conservation without having to be held accountable for supporting these efforts. The lack of strict regulatory policies provides a comfortable ambiguity that allows governments to delineate MPAs while also balancing economic interests. It is clearly demonstrated through the literature that any political intent to conserve a marine area is easily outweighed by, for example, the fishing and mining industries. These confused attempts to satisfy both environmental goals and prevent disruptions to the fisheries result in MPAs that ultimately do not protect what they were meant to. In sum, investment in "counterfeit" conservation measures has the potential to create costs without generating compelling conservation outcomes, therefore hindering efficient marine conservation.

Social Equity Factors

Disregard for social equity is another critical cause of marine conservation failure. In policy terms, social equity looks at how costs and benefits of a program are distributed amongst society (Bennett et al., 2021). Historically, conservation policy has often been executed in a top-down fashion, without necessarily considering the people most affected by the policy. This form of policy implementation not only causes harm to those who depend on the marine environment for their livelihoods (by forcing them to change their ways of life), but it also produces a conservation trap by driving up the costs of enforcement (Bennett et al., 2021; Heck et al., 2012). When the public's needs and wants are neglected, citizens are much less likely to support policy, forcing conservationists to commit more resources to monitoring and administration (Ward et al., 2018). In contrast, developing relationships with local communities and recognizing local commitments to conservation can increase support for conservation initiatives, improve compliance, and integrate the resources of citizen scientists and conservationists into policy implementation, leading to lower costs and higher effectiveness, and therefore more efficient conservation (Bennett et al., 2021; Giakoumi et al., 2018; Heck et al., 2012).

As Canada works to reach its KMGBF commitments through the radical expansion of its marine conservation areas, the federal government will run the risk of undermining its own efforts if social equity concerns are not addressed (Bennett et al., 2017, 2021). Because of this, it is crucial to understand how the scientific community and political decision-makers can efficiently and effectively use their limited resources to develop marine conservation policy that avoids compounding social challenges. Key components of promoting and sustaining social equity include stakeholder recognition and engagement, acknowledgement of local connections to the marine environment, accommodating decision-making processes, open channels of communication and idea transmission, and opportunities for local management and leadership (Bennett et al., 2021; Pörtner et al., 2023). Well-integrated stakeholder engagement processes can ensure that all of these key components are met and that marine conservation policies are successful (Giakoumi et al., 2018; Heck et al., 2012; Ward et al., 2018). A final aspect of social equity is met by reviewing the distribution of expenses and burdens. Studies have shown that local communities tend to amass a disproportionate share of the costs, both monetary and otherwise, of conservation policies. Equitable conservation measures, therefore, must evaluate and mitigate these costs, as well as develop ways to create benefits for local communities (Bennett et al., 2021; Pörtner et al., 2023).

In their study of local residents' attitudes to a National Marine Conservation Area (NMCA) near Burgeo, Newfoundland, Ward et al. (2018) describe what can occur when local communities are not sufficiently informed or included in marine conservation planning. Burgeo residents exhibited a strong relationship with the marine environment, both practically and culturally, citing the need to access the ocean for subsistence, recreational, and spiritual activities (Ward et al., 2018). In actuality, Parks Canada allows and supports such types of activities within NCMAs, but over half of the study participants did not know what this type of marine conservation measure was (Ward et al., 2018). As such, they were opposed to the government's intentions to create a marine conservation area in the region (Ward et al., 2018). This study clearly points to the importance of access to information and formal recognition of local environmental connections.

Although stakeholder engagement is a non-negotiable component of effective conservation policy, it remains critical to include scientific findings as part of policy design. The creation of the Canadian Laurentian Channel MPA, introduced in the previous section, is an example of how the stakeholder engagement process, and in particular *non-local* stakeholders, can reduce MPA effectiveness (Muntoni et al., 2019). While there were several reasons for reducing the proposed MPA size by one-third, one major factor was to come to an agreement with the fishing industry. The size reduction mitigated the impacts to the fishing industry by almost two-thirds, but it also caused the MPA's effectiveness to decrease by 43%. Additionally, the loss in revenue caused by the MPA would have equalled less than 0.001% of the Canadian fisheries sector's total annual value, meaning that the MPA's potential impacts on the fisheries industry were relatively small compared to its potential benefits to marine biodiversity (Fisheries & Oceans Canada, 2023). The oil and gas sector also attempted to keep access to the Laurentian Channel MPA, despite the fact that the area was likely of low value (Muntoni et al., 2019). The Laurentian Channel MPA creation process demonstrates how scientifically backed marine conservation policy can be compromised by influential industries, whether or not that policy generates any significant social or economic impacts. It also takes time and resources away from local communities, who should be the primary stakeholders in decision-making processes (Giakoumi et al., 2018).

It is critical to develop a marine conservation policy that fully integrates social equity and that effectively protects biodiversity. Without consideration for social equity, marine protection policy risks falling into a conservation trap whereby the costs of implementation and enforcement are high and the actual benefits to marine biodiversity are low. While effectively integrating social equity factors into policy can be challenging, it is possible. Moreover, if we are to achieve our conservation goals, it is vital.

Mismanagement & Non-Compliance

Mismanagement and non-compliance within marine conservation areas are another factor which, unfortunately, has no universal solution. Each conservation area faces a unique set of challenges and has difficulty balancing conservation management tactics, which tend to be implemented with an idealized universal lens, rather than issues of non-compliance, which receive tailored solutions (Iacarella et al., 2023). Iacarella et al. (2023) identify a particular shortfall known as boundary fishing. When MPAs have hard boundaries, industry activities are often simply pushed to the edges of the MPA rather than eliminating the practice outright. This is also known as “fishing the edge”. Compliance is improved when there are less rigid boundaries, such as through the usage of buffer zones surrounding the MPA.

Non-compliance can never be *completely* nullified, but there are many strategies that reinforce the likelihood of compliance (Giakoumi et al., 2018). Many researchers have found that stakeholder engagement, as discussed in the previous section, is one of the most impactful factors in an MPA’s success measures (Giakoumi et al., 2018; Iacarella et al., 2023; Lancaster et al., 2017). Communities are significantly more likely to comply when MPAs have consultation built into their frameworks (Giakoumi et al., 2018). However, no standard framework for information dissemination during MPA enforcement currently exists, and over 60% of non-compliance measures are the result of poor stakeholder engagement (Lancaster et al., 2017). Therefore, it is critical to manage these tactics in an MPA’s development phase to reduce harmful practices before they become routine and unsustainable.

Additionally, numerous management problems appear in the planning phase for the MPAs. This tends to be the result of failure to consider the longevity of chosen conservation strategies (Giakoumi et al., 2018). One problematic area is biological mismanagement, as suggested earlier in the paper. A recurring theme throughout the literature is the express focus on using individual actions to boost biological diversity the most, such as translocation of species (Iacarella et al., 2023; Swan et al., 2016). This is inefficient, as translocation efforts may boost marine ecosystem recovery at the cost of population restoration, which creates a feedback loop, requiring sustained intervention to maintain this balance (Swan et al., 2016). The resource intensity of translocation produces results similar to those of less resource-intensive interventions through management processes. Efforts would be better spent on management tactics that are far more resource-efficient, such as boosting compliance.

Another issue with managing marine conservation areas is the development of effective monitoring techniques. One method explored by Lancaster et al. (2017) found that reducing the burden of monitoring the MPAs through implementing technological modernization (such as video monitoring) is a key shortfall in the management of MPAs, as technological practices remain out of date for reducing non-compliance. As observed by Lancaster et al. (2017), much of

Rockfish Conservation Areas (RCAs)/MPA illegal fishing effort was most likely accidental as “one-quarter of surveyed recreational fishers had never heard of RCAs, and 60% were not confident of RCA locations” (Lancaster et al., 2017, p. 811), indicating the need for intervention along RCA trails. This finding of misinformed non-compliance being a major factor reinforces the findings that lack of surveillance was the largest contributing factor in MPA failure, according to Giakoumi et al. (2018) and Iacarella et al. (2023). The administrative burden of monitoring MPAs is too large to manage without legislative intervention, as supporting legislation was also found to greatly predict success (Giakoumi et al., 2018). The current reliance on Automatic Identification Systems (AIS) for tracking fishing vessels is not sufficient in capturing fishing effort, and it is therefore important to manage systemic factors as a means of improving marine conservation (Iacarella et al., 2023).

The holistic management of multiple input systems is equally important as biological factors themselves for MPAs as government objectives in different climate actions, such as hydropower, are at odds with biodiversity (Pörtner et al., 2023). This can input negative effects into MPAs through downstream effects as hydropower projects, forest ecosystem management, and other non-marine-based systems, all play roles for marine environments and can be disastrous for marine ecosystems, especially in regards to biodiversity. Institutional rivalry has been found to be a contributing factor in MPA failures when goals are at odds (Giakoumi et al., 2018). The disconnect between methods achieving these goals can negate the effectiveness and sustainability of conservation actions, and thus all systems, not exclusively marine environments, must be considered in the establishment of an MPA for long-term success. (Pörtner et al., 2023). MPAs should analyze the synergy between different systemic actions of the region, and prioritize biodiversity actions that produce positive effects on climate action within the region.

Additionally, ignoring components of internationally recognized conservation frameworks is a recurring problem, resulting in inefficiencies where regional goals are at odds with global conservation (Giakoumi et al., 2018; Swan et al., 2016). The differences between defined “success” among frameworks create compliance issues through what is recognized as globally effective conservation tactics versus the implemented regional measures. There needs to be an active managerial pursuit of legal consistency and explicit objectives, as there is a strong positive correlation with MPA success when these management actions are in place (Giakoumi et al., 2018).

Guidelines for Effective Conservation

In light of the challenges to efficient Canadian marine conservation identified in the previous sections, we have extracted several lessons from our selected papers. These may help constitute guidelines for efficient conservation to be followed by decision makers to avoid conservation traps.

First, there are biophysical considerations that must be taken into account when designing area-based conservation measures. Among the studies, a recurrent best practice related to the biology aspects of conservation measures among the studies was to ensure ecological representativity in terms of biological diversity, habitats, and environments, using strategies such as biogeographic regionalization (Ban et al., 2014; Flores-Tolentino et al., 2021; Maxwell et al., 2020). While Nielsen & Kenchington (2001) also promote population-specific conservation measures and taking population interactions for design, ecosystem-level conservation might be even better as per the *Biological Factors* section. Connectivity should also be sought out in creating conservation networks, while redundancy and replication of habitats and features throughout multiple protected areas offer insurance in case of unexpected disturbances (Ban et al., 2014; Maxwell et al., 2020). There was a call for carefully selecting the location to capture areas of high biodiversity, high biological importance, or high provision of ecosystem services, as well as unique and vulnerable areas (or species) (Ban et al., 2014; Maxwell et al., 2020; Nielsen & Kenchington, 2001). Spalding et al. (2016) suggest prioritizing ecosystem services provision to MPA size and avoiding resource-extractive activities within MPAs.

Moreover, climate change is changing anthropocentric uses of marine environments; Muir (2002) highlights how warmer waters correlate to increased boat traffic in marine environments, indicating conservation goals would benefit from climate resilience efforts (Muir, 2002). In fact, Keen et al. (2024) offer strategies to integrate climate resilience into conservation measures design: encouraging representativity of habitats, species, and oceanographic features (including depth: protecting shallow and deep ecosystems) and selecting the appropriate distribution, scale, and protection levels. This allows conservation networks to “support transient ecological states as conditions continue to change" (Keen et al., 2024, p. 10). More generally, adaptive management mechanisms, which aim to iteratively reassess conservation measures' outcomes and readjust them accordingly, are recommended (Novaczek et al., 2017).

To this point, Maxwell et al. (2020) suggest that more comprehensive funding guidelines must play a key role in avoiding MPA conservation traps. Specifically, they see value in concentrating finances in researching conservation areas' responses to climate change, specifically through investing in decision-making tools such as systematic modelling to better predict what level of intervention is needed to adapt to bioclimatic changes (Maxwell et al., 2020). With the political dimension in mind, they also advocate for stricter regulations for the financing of MPAs from private companies, so as to better ensure these corporate interests do not overwhelm ecological goals during the MPA creation process (Maxwell et al., 2020).

Human and social concerns are also non-negligible to the success of marine conservation measures. First and foremost, a study by Novaczek et al. (2017) points to the importance of defining clear MPA management objectives and ensuring that expectations imposed on a conservation measure align with what it can provide based on its characteristics. In other words, if the expected outcomes do not align with what the conservation measure may provide, there may be a trap in that investing in this conservation measure will not lead to effective conservation outcomes.

Heck et al. (2012) warn of the risks of locating MPAs in overlapping jurisdictions, where there is uncertainty around which levels of government may do what, and call for better intergovernmental coordination in those cases. Their paper also suggests a disapproval for the compartmentalization of conservation and invites conservation managers to consider non-marine factors in designing MPAs, including industrial activities such as logging occurring on nearby land, for example (Heck et al., 2012). Additionally, it encourages them to rethink what should be allowed within MPAs, as numerous activities (fishing, boating, etc.) are found to negatively affect their conservation outcomes (Heck et al., 2012). More generally, Salomon et al. (2011) advocate for bringing fisheries management and marine conservation together, making policy suggestions involving ecosystem-based management, catch shares, and eco-certification, among other things. Therefore, decision-makers wanting to apply best practices should carefully consider these to design the most effective conservation areas.

Conversely, rather than promote intergovernmental coordination or establish a general framework for MPA decision-making, Lemieux & Gray (2020) prescribe government restructuring in the form of establishing a federal agency dedicated to managing MPAs. This, they argue, will standardize the MPAs through the single lens of conservation, rather than balance these efforts with other interests as the DFO currently does (Lemieux & Gray, 2020). This approach can also be combined with the implementation of Indigenous Protected Areas (IPAs), encouraging conservation-centred leadership to be standardized at the federal level, which is a sentiment echoed by Heck et al., who remark on the positive impacts of Indigenous involvement in MPA management (Heck et al., 2012; Lemieux & Gray, 2020).

On another matter, Bennett et al. (2017) argue that a code of conduct for MPA creation and management is needed to pursue just outcomes. Such a document would emphasize preserving marginalized stakeholders' interests in the decision-making process. However, the authors are uncertain whether abiding by this code of conduct would be mandatory or voluntary, the tradeoff being for rigorous compliance standards instead of more external input from scientists (Bennett et al., 2017).

Furthermore, Lancaster et al. (2015)'s study suggests that the lack of awareness may play an important part in MPA non-compliance among recreational fishers. In cases where people already adhere to the idea that conservation is needed, raising awareness of MPA regulations and providing clear information could help increase compliance, making MPAs more effective and decreasing the costs of enforcement. For instance, the authors suggest education and outreach, as well as enhanced signage (Lancaster et al., 2015).

Regardless of its root cause, it is good practice for efficient conservation to take non-compliance into account for area-based conservation measure design. Indeed, non-compliance may affect whether several small protected areas are preferable to a single, larger one, an age-old and recurring debate in area-based conservation (Kritzer, 2004). Indeed, Kritzer (2004) demonstrated this in his analysis of the tradeoff between promoting larval replenishment and preventing non-compliance. Multiple small protected areas may be best adapted to promote larval replenishment when larval dispersal is localized, but since non-compliance mostly occurs at the boundary of a restricted area, a single, large protected area would provide the greatest actual cover (Kritzer, 2004). This also reinforces the argument for developing a good understanding of the local ecosystem and context to ensure proper design.

The use of multiple knowledge sources is particularly important for avoiding conservation traps. Conducting new research surveys for establishing MPAs may be expensive, and there already exists a wealth of knowledge from local communities and experts that is more readily accessible than performing research surveys (Aylesworth et al., 2017). Thus, relying on all knowledge sources available has the potential to decrease costs and increase outcomes, leading to efficient conservation. Scientists often overlook the importance of using multiple knowledge sources and instead frequently rely on their own data, leading to the trap of unsustainable conservation practices as a bulk of resources are spent researching. Local knowledge is especially important as MPAs do not follow universal rules and need tailored local solutions to prevent conservation traps (Giakoumi et al., 2018). While broader regulatory guidelines play a large role in shaping MPAs, efforts for individual MPAs will use these frameworks as a basis for their own solutions (Ban et al., 2014). Aylesworth et al. (2017) noted how certain fishing industry personnel in Thailand were skilled at identifying species and genus of seahorses, saving the researchers time and effort. These experts, while not scientifically trained, still had enough useful local knowledge about the local marine organisms and environment to pass along to conservation researchers (Aylesworth et al., 2017). Different roles within the industry were also able to provide different kinds of insights, as divers provided information about different species, and trawl captains about different genera (Aylesworth et al., 2017). All forms of stakeholder engagement can be equally valuable and contribute to efficient conservation. This demonstrates the importance of using multiple knowledge sources for preventing conservation traps, as the burden of evidence being placed on any single entity is bound to become unsustainable once factoring in all local elements needed for a self-sufficient and successful MPA.

Overall, the literature is in consensus that the current conservation strategy in Canada is prone to investing time and resources into ineffectual conservation traps due to overlapping government jurisdictions, a lack of protocol concerning balancing an MPA's ecological targets with other interests, and a hesitation to rely on scientific priorities. The common thread between suggested solutions supposes MPA-government dynamics must be revamped so that external actors have less influence, facilitating the decision-making process. The process for modifying this aspect of governance can range from high-level interventions – such as establishing a new government agency as the sole director of MPA activities – to maintaining the current structure but redefining responsibilities and metrics regarding MPA efficiency.

4. Conclusion

Effective conservation policies are critical to safeguard marine species and halt biodiversity loss. Unfortunately, despite its current efforts to protect marine ecosystems, Canada has continued to observe biodiversity loss in its waters. In this paper, we have identified four main factors that have negatively impacted efficient conservation strategies in Canada, one related to biological concepts and three related to socioeconomic concepts. We have elucidated these four factors in an effort to raise awareness of challenges that conservationists and policymakers can expect to face when developing marine conservation policy. We have also endeavoured to outline some key ways to avoid and mitigate these issues.

Though the literature exemplifies these four factors as crucial in determining MPA efficiency, we do not maintain that they are the only ones that decision-makers may face in marine conservation policy. Future research should look to further unentangle these complex issues and to continue to address how we can facilitate effective marine conservation, both in Canada and abroad.

References

Aylesworth, L., Phoonsawat, R., Suvanachai, P., & Vincent, A. C. J. (2017). Generating spatial data for marine conservation and management. *Biodiversity and Conservation*, *26*(2), 383–399. https://doi.org/10.1007/s10531-016-1248-x

Ban, N. C., McDougall, C., Beck, M., Salomon, A. K., & Cripps, K. (2014). Applying empirical estimates of marine protected area effectiveness to assess conservation plans in British Columbia, Canada. *Biological Conservation*, *180*, 134–148. https://doi.org/10.1016/j.biocon.2014.09.037

Bennett, N. J., Katz, L., Yadao-Evans, W., Ahmadia, G. N., Atkinson, S., Ban, N. C., Dawson, N. M., de Vos, A., Fitzpatrick, J., Gill, D., Imirizaldu, M., Lewis, N., Mangubhai, S., Meth, L., Muhl, E.-K., Obura, D., Spalding, A. K., Villagomez, A., Wagner, D., … Wilhelm, A. (2021). Advancing Social Equity in and Through Marine Conservation. *Frontiers in Marine Science*, *8*. https://doi.org/10.3389/fmars.2021.711538

Bennett, N. J., Teh, L., Ota, Y., Christie, P., Ayers, A., Day, J. C., Franks, P., Gill, D., Gruby, R. L., Kittinger, J. N., Koehn, J. Z., Lewis, N., Parks, J., Vierros, M., Whitty, T. S., Wilhelm, A., Wright, K., Aburto, J. A., Finkbeiner, E. M., … Satterfield, T. (2017). An appeal for a code of conduct for marine conservation. *Marine Policy*, *81*, 411–418. https://doi.org/10.1016/j.marpol.2017.03.035

Cardador, L., Brotons, L., Mougeot, F., Giralt, D., Bota, G., Pomarol, M., & Arroyo, B. (2015). Conservation Traps and Long-Term Species Persistence in Human-Dominated Systems. *Conservation Letters*, *8*(6), 456–462. https://doi.org/10.1111/conl.12160

Fisheries & Oceans Canada. (2023). *Canada's Fish And Seafood Trade in 2023: Overview*.

Flores-Tolentino, M., Beltrán-Rodríguez, L., Morales-Linares, J., Rodríguez, J. R. R., Ibarra-Manríquez, G., Dorado, Ó., & Villaseñor, J. L. (2021). Biogeographic regionalization by spatial and environmental components: Numerical proposal. *PLOS ONE*, *16*(6), e0253152. https://doi.org/10.1371/journal.pone.0253152

Giakoumi, S., McGowan, J., Mills, M., Beger, M., Bustamante, R. H., Charles, A., Christie, P., Fox, M., Garcia-Borboroglu, P., Gelcich, S., Guidetti, P., Mackelworth, P., Maina, J. M., McCook, L., Micheli, F., Morgan, L. E., Mumby, P. J., Reyes, L. M., White, A., … Possingham, H. P. (2018). Revisiting "Success" and "Failure" of Marine Protected Areas: A Conservation Scientist Perspective. *Frontiers in Marine Science*, *5*. https://doi.org/10.3389/fmars.2018.00223

Government of Canada. (2023, December 8). *Canada's 2030 National Biodiversity Strategy*. https://www.canada.ca/en/environment-climate-change/services/biodiversity/2030-nature-strategy.html

Government of Canada. (2025, July 15). *About federal marine conservation tools* [Government]. Fisheries and Oceans Canada, Public Affairs, Digital and Creative Services. https://www.dfo-mpo.gc.ca/oceans/protection-conservation/tools-outils/index-eng.html

Heck, N., & Dearden, P. (2012). Local Expectations for Future Marine Protected Area Performance: A Case Study of the Proposed National Marine Conservation Area in the Southern Strait of Georgia, Canada. *Coastal Management*, *40*(6), 577–593. https://doi.org/10.1080/08920753.2012.727728

Heck, N., Dearden, P., & McDonald, A. (2012). Insights into marine conservation efforts in temperate regions: Marine protected areas on Canada's West Coast. *Ocean & Coastal Management*, *57*, 10–20. https://doi.org/10.1016/j.ocecoaman.2011.11.008

Iacarella, J. C., Burke, L., Clyde, G., Wicks, A., Clavelle, T., Dunham, A., Rubidge, E., & Woods, P. (2023). Monitoring temporal and spatial trends of illegal and legal fishing in marine conservation areas across Canada's three oceans. *Conservation Science and Practice*, *5*(6), e12919. https://doi.org/10.1111/csp2.12919

Keen, L. H., Stortini, C. H., Boyce, D. G., & Stanley, R. R. E. (2024). Assessing climate change vulnerability in Canadian marine conservation networks: Implications for conservation planning and resilience. *FACETS*, *9*, 1–15. https://doi.org/10.1139/facets-2023-0124

Kritzer, J. P. (2004). *Effects of Noncompliance on the Success of Alternative Designs of Marine Protected‐Area Networks for Conservation and Fisheries Management*. *18*(4), 1021–1031.

Lancaster, D., Dearden, P., & Ban, N. C. (2015). Drivers of recreational fisher compliance in temperate marine conservation areas: A study of Rockfish Conservation Areas in British Columbia, Canada. *Global Ecology and Conservation*, *4*, 645–657. https://doi.org/10.1016/j.gecco.2015.11.004

Lancaster et al. (2017). Aquatic Conservation: Marine and Freshwater Ecosystems. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *37*(4), 813. https://doi.org/10.1002/aqc.2736

Langhammer, P. F., Bull, J. W., Bicknell, J. E., Oakley, J. L., Brown, M. H., Bruford, M. W., Butchart, S. H. M., Carr, J. A., Church, D., Cooney, R., Cutajar, S., Foden, W., Foster, M. N., Gascon, C., Geldmann, J., Genovesi, P., Hoffmann, M., Howard-McCombe, J., Lewis, T., … Brooks, T. M. (2024). The positive impact of conservation action. *Science*, *384*(6694), 453–458. https://doi.org/10.1126/science.adj6598

Lemieux, C. J., & Gray, P. A. (2020). How Canada "hamburger manufactured" its way to marine protected area success and a more effective and equitable way forward for the post-2020 conservation agenda. *Journal of Environmental Studies and Sciences*, *10*(4), 483–491. https://doi.org/10.1007/s13412-020-00627-4

Lotze, H. K. (2021). Marine biodiversity conservation. *Current Biology*, *31*(19), R1190–R1195. https://doi.org/10.1016/j.cub.2021.06.084

Luypaert, T., Hagan, J. G., McCarthy, M. L., & Poti, M. (2020). Status of Marine Biodiversity in the Anthropocene. In S. Jungblut, V. Liebich, & M. Bode-Dalby (Eds), *YOUMARES 9—The Oceans: Our Research, Our Future: Proceedings of the 2018 conference for YOUng MArine RESearcher in Oldenburg, Germany* (pp. 57–82). Springer International Publishing. https://doi.org/10.1007/978-3-030-20389-4_4

Maxwell, S. L., Cazalis, V., Dudley, N., Hoffmann, M., Rodrigues, A. S. L., Stolton, S., Visconti, P., Woodley, S., Kingston, N., Lewis, E., Maron, M., Strassburg, B. B. N., Wenger, A., Jonas, H. D., Venter, O., & Watson, J. E. M. (2020). Area-based conservation in the twenty-first century. *Nature*, *586*(7828), 217–227. https://doi.org/10.1038/s41586-020-2773-z

Mee, J. A., Otto, S. P., & Pauly, D. (2017). Evolution of movement rate increases the effectiveness of marine reserves for the conservation of pelagic fishes. *Evolutionary Applications*, *10*(5), 444–461. https://doi.org/10.1111/eva.12460

Muir, M. A. K. (2002). Integrated Coastal and Marine Management in Northern Regions: Reconciling Economic Development and Conservation. *Journal of Coastal Research*, 522–530.

Muntoni, Devillers, & Koen-Alonso. (2019). Science should not be left behind during the design of a marine protected area: Meeting conservation priorities while integrating stakeholder interests. *FACETS*, *4*(1), 472–492.

Nielsen, E. E., & Kenchington, E. (2001). A new approach to prioritizing marine fish and shellfish populations for conservation. *Fish and Fisheries*, *2*(4), 328–343. https://doi.org/10.1046/j.1467-2960.2001.00055.x

Novaczek, E., Howse, V., Pretty, C., Devillers, R., Edinger, E., & Copeland, A. (2017). Limited Contribution of Small Marine Protected Areas to Regional Biodiversity: The Example of a Small Canadian No-Take MPA. *Frontiers in Marine Science*, *4*. https://doi.org/10.3389/fmars.2017.00174

O'Hara, C. C., Villaseñor-Derbez, J. C., Ralph, G. M., & Halpern, B. S. (2019). Mapping status and conservation of global at-risk marine biodiversity. *Conservation Letters*, *12*(4), e12651. https://doi.org/10.1111/conl.12651

Pörtner, H.-O., Scholes, R. J., Arneth, A., Barnes, D. K. A., Burrows, M. T., Diamond, S. E., Duarte, C. M., Kiessling, W., Leadley, P., Managi, S., McElwee, P., Midgley, G., Ngo, H. T., Obura, D., Pascual, U., Sankaran, M., Shin, Y. J., & Val, A. L. (2023). Overcoming the coupled climate and biodiversity crises and their societal impacts. *Science*, *380*(6642), eabl4881. https://doi.org/10.1126/science.abl4881

Salomon, A. K., Gaichas, S. K., Jensen, O. P., Agostini, V. N., Sloan, N. A., Rice, J., McClanahan, T. R., Ruckelshaus, M. H., Levin, P. S., Dulvy, N. K., & Babcock, E. A. (2011). Bridging the Divide Between Fisheries and Marine Conservation Science. *Bulletin of Marine Science*, *87*(2), 251–274. https://doi.org/10.5343/bms.2010.1089

Spalding, M., Meliane, I., J. Bennett, N., Dearden, P., G. Patil, P., & D. Brumbaugh, R. (2016). Building towards the marine conservation end-game: Consolidating the role of MPAs in a future ocean. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(S2), 185–199. https://doi.org/10.1002/aqc.2686

Swan, K. D., McPherson, J. M., Seddon, P. J., & Moehrenschlager, A. (2016). Managing Marine Biodiversity: The Rising Diversity and Prevalence of Marine Conservation Translocations. *Conservation Letters*, *9*(4), 239–251. https://doi.org/10.1111/conl.12217

UNEP. (2022). *Kunming-Montreal Global Biodiversity Framework*. https://www.cbd.int/gbf

Ward, B. M., Doney, E. D., Vodden, K., & Bath, A. J. (2018). The importance of beliefs in predicting support for a South Coast National Marine Conservation Area in Newfoundland and Labrador, Canada. *Ocean & Coastal Management*, *162*, 6–12. https://doi.org/10.1016/j.ocecoaman.2017.12.021