Improving human well-being outcomes in marine protected areas through futures thinking

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Summary

Marine protected areas (MPAs) are an important tool to protect marine biodiversity that can have substantial impacts on human well-being. However, such social impacts are rarely considered proactively. Proponents must work collectively and proactively to better understand and communicate future well-being impacts, while co-creating lasting solutions prior to MPA development and iteratively during ongoing management.

Area-based marine conservation is growing

Effective marine conservation and management is needed to reduce declines in marine biodiversity, and to minimize the potential repercussions of depleted oceans for human well-being (e.g., loss of livelihoods, food insecurity, diminished cultural heritage)[1]. One prominent recommendation for maintaining the oceans' abundance and biodiversity is to reduce extractive activities, like fishing and mining, within an expanded global network of marine protected areas (MPAs). Well-sited, protected, and managed MPAs have been shown to support recovery of depleted species, protect species at risk, and increase biomass of fished species[1]. However, MPAs have also been documented to have adverse social impacts, especially where they limit access to resources, facilitate the dispossession of coastal communities, or reassert colonial dynamics and challenge national sovereignty[2,3]. New global targets have committed countries to significantly expand MPA coverage within their marine and ocean environments. The recent adoption of the Kunming-Montreal Global Biodiversity Framework by the Parties to the Convention on Biological Diversity (CBD Decision 15/4) aims to increase global MPA coverage from 8.1% to at least 30% by 2030. With the number and geographic extent of MPAs

worldwide continuing to expand rapidly, there is a concern that people dependent on the ocean are disproportionately impacted, and that those impacts are rarely considered prior to MPA establishment.

People who rely on the oceans the most for livelihoods and food – e.g., small-scale fishers, Indigenous Peoples, and coastal communities – often bear the cost of increasing protections. Examples of negative effects can include displacement from fishing grounds, crowding in the spaces that remain open, increased conflict, and higher costs of fishing when having to travel further[4]. For instance, in the Bay Islands, Honduras, the Indigenous Garifuna community stated that the Natural Marine Monument Archipiélago Cayos Cochinos led to "criminalization of the Garifuna fishing activity", and increased conflict with the Navy that enforced MPA regulations[5]. Impacts of MPAs can also extend beyond local coastal communities, for example when large-scale MPA establishment becomes political, involving sovereignty claims and disputes, with impacts that intersect with broader and more diverse populations[3]. Impacts are especially concerning when MPAs are imposed on people, with no consideration of, or consultation in relation to potential future impacts to their lives and livelihoods[6]. With approximately 40% of the global population living in coastal areas, expanding MPAs to cover 30% of the oceans will have significant impacts on human well-being. Therefore, there is a need to better understand and communicate future well-being impacts, while co-creating lasting solutions prior to MPA development and iteratively during ongoing management.

Additional focus on MPAs and human well-being needed

While most research to date on MPAs has focused on ecological effects[1], there is a growing emphasis on better assessing and understanding their effect on human well-being[2,4]. Case studies are an important approach to document human well-being outcomes, and such case studies have shown that MPAs can have both positive and negative impacts on people[4] (Figure 1). Negative effects are particularly prevalent in the short term because benefits associated with ecosystem recovery (e.g., increased catches, income) take time to accrue. However, two key challenges remain. First, human well-being is often vaguely defined and unclearly conceptualized, commonly focusing only on easily measurable indicators such as income, catches, or catch per unit effort[4]. Yet human well-being is a multi-dimensional concept[7] that is hard to capture because an individual, or a collective, can define their well-being in diverse, nuanced, and intersectional ways[8]. Not capturing such diversity – e.g., in terms of age, culture, ethnicity, gender, and engagement within a specific fishery – can result in missing impacts of MPAs. For example, while the establishment of an MPA in Zanzibar, Tanzania, reported significant benefits to tourism actors, the MPA displaced other user groups such as female seaweed farmers who were not involved in the decision-making process[9].

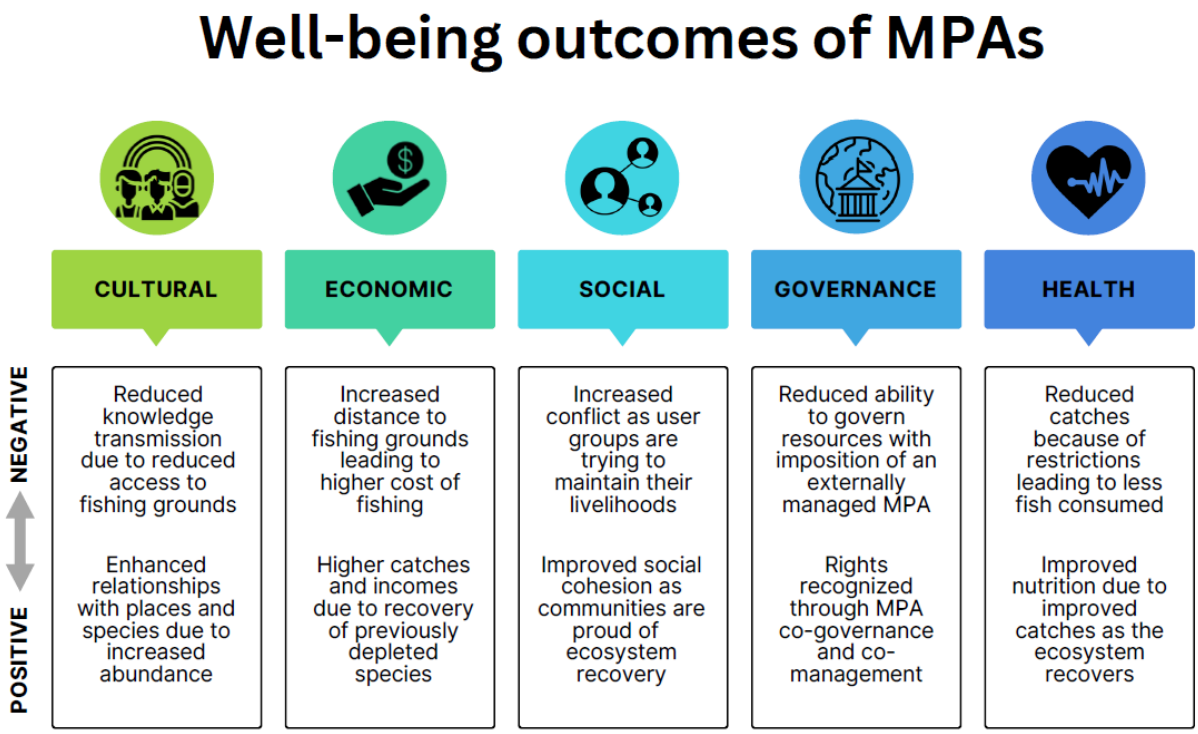

Figure 1. Potential well-being outcomes of marine protected areas, which can range from negative to positive. Examples are taken from Ban et al. (2019)[4].

The second challenge is that to date human well-being impacts have largely been studied retroactively[1]. While studies about past impacts are essential in building our understanding of human well-being outcomes of MPAs and adaptive management, much less attention has been paid to approaches of anticipating future impacts of proposed MPAs. Considering future impacts is necessary for such impacts to be fully understood by those who will be affected, in order to decide if and how MPAs are established and managed, including mitigations to potential adverse effects. Importantly, the CBD Kunming-Montreal Global Biodiversity Framework calls for a human-rights based approach. To achieve this, the free, prior, and informed consent of Indigenous Peoples, small-scale fishers, and other rights- and stakeholders is essential, and it is vital to envision and transparently communicate plausible well-being impacts to the various groups during the MPA planning process, prior to implementation – yet these considerations are currently rarely implemented in MPA planning. Further, seldom is the question raised whether those affected can cope with the short-term harms of MPA implementation while awaiting expected long-term benefits, or if so, whether long-term benefits outweigh the short-term harms[1].

Approaches for considering alternative futures

Planning for an uncertain future, like developing and implementing an MPA and addressing its future well-being impacts, is an ongoing process of learning, acting, and reflecting through time. To understand the diversity of ways that people think about their own and their community's well-being, we need to develop planning approaches that are open to those diverse views. This means including the material (what people can acquire, do and be), relational (how people are connected to one another and the natural environment), and subjective (how people are thinking and feeling) aspects of well-

being[10], as well as cultural, economic, social, governance, and health dimensions[4]. To encompass these many aspects of well-being, we use a broad definition: "a state of being with others and the natural environment where human needs are met, where one can act meaningfully to pursue one's goals and where one enjoys a satisfactory quality of life"[8]. This definition emphasizes the place-based, evolving nature of human well-being, while highlighting the concept's flexibility as a better multidimensional measure than conventional economic approaches alone[10].

Drawing on examples from related fields, because MPA-specific studies are sparse, we here identify three approaches that are particularly promising in taking a future-oriented approach to understanding well-being outcomes of MPAs for both shorter (~ 5 years) and longer terms (multiple future generations): quantitative prediction, forecasting change, and future interactions and dynamics (Figure 2; see Table S1 for more details on these approaches).

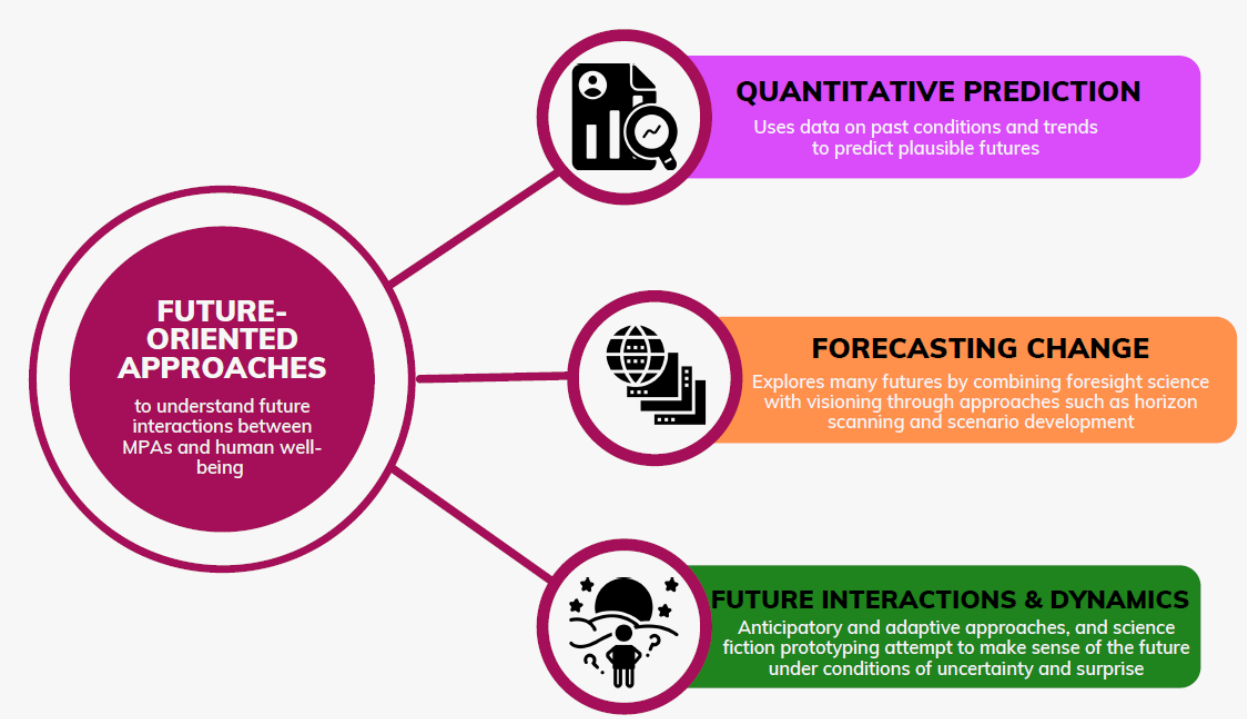

Figure 2. Approaches for considering alternative futures. See Table S1 for details on each approach and additional citations.

Quantitative prediction

Quantitative modeling approaches can be useful to predict and understand plausible futures based on past data. Quantitative modeling is evidence-based, and is common in biological and physical sciences (e.g., to project fish stocks[11]). It can similarly be used to estimate social impact, vulnerability, and risk to gauge the possible magnitude of change, sensitivity to change, and resilience to changes[12]. For example, quantitative models of MPAs that estimate social impact could use data from past human well-being assessments from existing MPAs to predict potential future effects for proposed MPAs (e.g., changes in income, catches, nutrition). They can also link estimates of well-being to changes in the ecosystem (e.g., 1-to-10-year projections of fisheries catches[11]) through social-ecological systems models[12], while quantifying uncertainty. The explicit participation and engagement of diverse actors in this approach can help to include diverse visions of the future. However, operationalizing quantitative

models requires data, yet data on human well-being are usually limited to a few indicators[4]; whereas important place-based indicators and context-specific variables, such as culturally relevant understandings of well-being and the future, are often missing. Furthermore, quantitative prediction methods assume that past changes can predict future ones, and that changes in one MPA are applicable to others, which may not always be the case.

Forecasting change

Another useful, forward-looking approach combines foresight science (also called foresighting) with visioning the future through, for example, horizon scanning and scenario development. Whereas quantitative models use past data to predict the future, forecasting explores many futures, and more explicitly addresses uncertainty by anticipating and understanding potential future developments, trends, and challenges. An advantage of foresighting over quantitative prediction is that forecasting is not dependent on data where something has occurred, and hence can include "shock" events (e.g., a pandemic affecting tourism in an MPA). Forecasting uses a diverse range of analytical and visioning tools to understand the past and present in order to anticipate future possibilities[13]. A hypothetical example is illustrative: imagine a proposed MPA, where implementers want to gauge how the MPA combines with other factors to affect well-being. They can use horizon scanning to draw on expert opinion to identify emerging issues that could affect the MPAs, identifying, for instance, submerged artificial light fisheries[14] as a potential threat to species recovery inside the MPA. They might also use scenario development, through participatory processes that engage marginalized groups in future thinking (e.g.,[15]), to construct plausible narratives of alternative futures[16]. Scenarios might include pessimistic outlooks, where fishing closures of the MPA interact with fishing developments outside the MPA that prevent recovery and cause fish stocks to collapse, resulting in the most vulnerable groups suffering malnutrition and preventing transfer of local knowledge because being on the water fishing is no longer viable. Scenarios can also consider an optimistic future, for example, marginalized groups becoming involved in MPA management, providing employment opportunities and allowing for more self-determination, enabling species recovery (which can be modeled through quantitative methods), and improving all aspects of the well-being of communities near the MPA. Such foresighting techniques can guide MPA planning and management to mitigate possible negative well-being outcomes and enhance positive outcomes. However, while foresighting techniques are flexible, inclusive, and collaborative in nature, they require substantial participant engagement, which can be both time consuming and expensive.

Future interactions and dynamics

Additional approaches can put more emphasis on potential interactions and dynamics in the future that affect human well-being in the context of MPAs, and that are harder to capture with modeling predictions and forecasting. For example, anticipatory and adaptive approaches to MPA management attempt to make sense of the future under conditions of uncertainty and surprise. Such approaches recognize the need for flexible conservation strategies and use iterative processes of decision-making where management strategies are adjusted in response to new and emerging information. Fiji's Locally Managed Marine Network provides a promising example of a community-based adaptive co-management system where protected area boundaries and management rules are motivated by the need to enhance management effectiveness and future resilience[17]. For instance, science-based guidance and community consultation were used in the MPA network in the Kubulau District, Fiji, to adjust the pre-existing MPA boundaries and management rules to enhance effectiveness and improve resilience to climate change. Another useful approach is science fiction prototyping[18]. Science fiction prototypes are short works of fiction, grounded in scientific fact and crafted for the purpose of starting a conversation about the implications of change and the future. Such creative

approaches can envision both likely and remotely possible futures, including interactions and dynamics that are too complex and uncertain to include through quantitative predictions. They can focus on any or all aspects of well-being outcomes, including exploring the intersectionality of impacts, and be made realistic through storytelling, perhaps combined with artistic illustrations of such futures. For example, short stories could focus on how coastal residents of a specific age, ethnicity, religion, and gender would fare if a MPA is established, thereby allowing for exploration of specifics of human well-being that are not usually included in other approaches.

Embrace transparency and equity in marine conservation

With MPA establishment poised to continue until 30% of the oceans are protected, people's well-being will be affected, especially that of vulnerable coastal marine-reliant communities. It is imperative that MPA practitioners and scientists use participatory future-oriented approaches to anticipate and mitigate potential negative well-being impacts, and foster more equitable decision-making and distribution of benefits and risks within and among groups, communities, countries, and generations. This can be part of a co-governance strategy, which can then inform how MPAs are implemented and governed inclusively in the long-run. Importantly, this would include local input in determining if MPAs are established at all if adverse effects cannot be mitigated.

Given the potential shortcomings of each future-oriented approach, there is no single best approach, method, or tool to understand future impacts. All future-oriented MPA wellbeing impact assessments should consider a diversity of approaches together, including diverse modes of participation and community engagement to enable inclusive visions of the future, and to plan for future trade-offs associated with MPAs. For example, scientists and local communities can work together via *'future interactions and dynamics'* approach to obtain an array of place-based anticipations and uncertainties about specific MPA implementations; with such information, they could then leverage *'forecasting change'* approach to develop relevant future scenarios; and adopting *'quantitative modelling'* approach can generate tangible and comparable potential future effects to assist local policymakers to design and deploy inclusive MPA measures, which will benefit the nature and people in both short- and long-term. Ultimately, understanding future well-being impacts, especially those on the marginalized and vulnerable communities, requires engaging with the politics of who sets the rules, which social values dominate, and whose knowledge will be used in decision-making. The application of participatory and co-designed future-oriented approaches can assist countries and the marine conservation community in fulfilling its human rights obligation for free, prior, and informed consent of Indigenous Peoples, small-scale fishers, and other rights- and stake-holders and in pursuing greater social equity as MPAs increase in coverage at a global scale.

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Author Contributions

Initial conceptualization and workshop design DMB and NCB; All authors contributed through workshop participation and paper conceptualization; main manuscript writing by DMB, redrafting by NCB, with input and advice from all authors throughout.

Declaration of Interests

The authors declare no competing interests.

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Supplementary Materials

Table S1: Summary of approaches that can be applied to understand the future interactions between marine protected areas (MPAs) and human well-being, with detailed reference list.

Future Oriented Approaches	Summary	Examples of Data Collection Techniques	Examples of Applications	Examples of References
Quantitative prediction	Quantitative models often use past data to help describe the social-ecological conditions and trends to predict plausible futures. Approaches can include risk, social and vulnerability assessments, statistical modeling, prediction, and forecasting. Approaches can provide valuable insight into projected change within social and ecological systems to limit uncertainty. Yet, when used alone modeling approaches can miss important context specific and place-based indicators important to understand the social system.	Models informed by environmental, ecological, or economic data, including: surrounding the biophysical, biogeochemical, and the physical environment; Species occurrence and species richness data; Fish catch data; Biomass assessments; Stock assessments.	Habitat suitability models; Predictive modeling of fish stocks; social impact analysis; Risk assessments; Marine spatial Planning (MSP).	[1-9]
Forecasting change	Systematic approach to generate future possibilities for planning and management by drawing upon a variety of analytical and other tools. This approach can make use of multiple tools and collaborative processes to provide insight about the future by understanding past and present events.	Tools include: horizon scanning, forecasting, scenario-planning, and statistical modeling.	CSIRO Ocean Futures program; the EU Horizon 2020 CERES project; Future Seas 2020 initiative.	[10-13]
	Forecasting often uses scenarios, approaches that generate alternative plausible storylines under conditions of environmental, social, and economic change. There is no single unifying approach to scenario development. Qualitative in orientation and iterative. Scenarios can be predictive (i.e. what will happen); normative (i.e. what one	Participant workshops used to determine time horizons, identify key challenges, and drivers of change. Methods can also include, listening posts, kitchen table discussions,	Shared Socio-Economic Pathways; UNEP Global Environmental Outlook; the CBD Global Biodiversity Outlook; the Millennium	[14-23]

	would like to happen); or exploratory (i.e. what the future could be). Participatory and narrative scenarios use storytelling and description to portray the future, allowing participants to explore a range of social, economic, and environmental challenges.	backcasting, open houses, and visioning workshops.	Ecosystem Assessment, Future Seas 2030.	
Future interactions and dynamics	Approaches other than quantitative prediction and forecasting can explore more nuances of how interactions and dynamics might play out. For example, science fiction prototypes are short works of fiction used for scenario development, grounded in scientific fact and crafted for the purpose of starting a conversation about the implications of change and the future. Are often iterative in nature.	Narrative scenario development.	Radical Ocean Futures.	[23-25]
	Both anticipatory and adaptive approaches to management are closely related to foresight and foresight science. Anticipation can be generally understood as the formal and informal processes that attempt to make sense of the future under conditions of uncertainty. Both adaptive management and adaptive governance have been proposed as learning-based approaches that can enable conservation to address uncertainty and complexity within a system.	Participatory scenario building and quantitative simulation modeling.		[26-32]

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