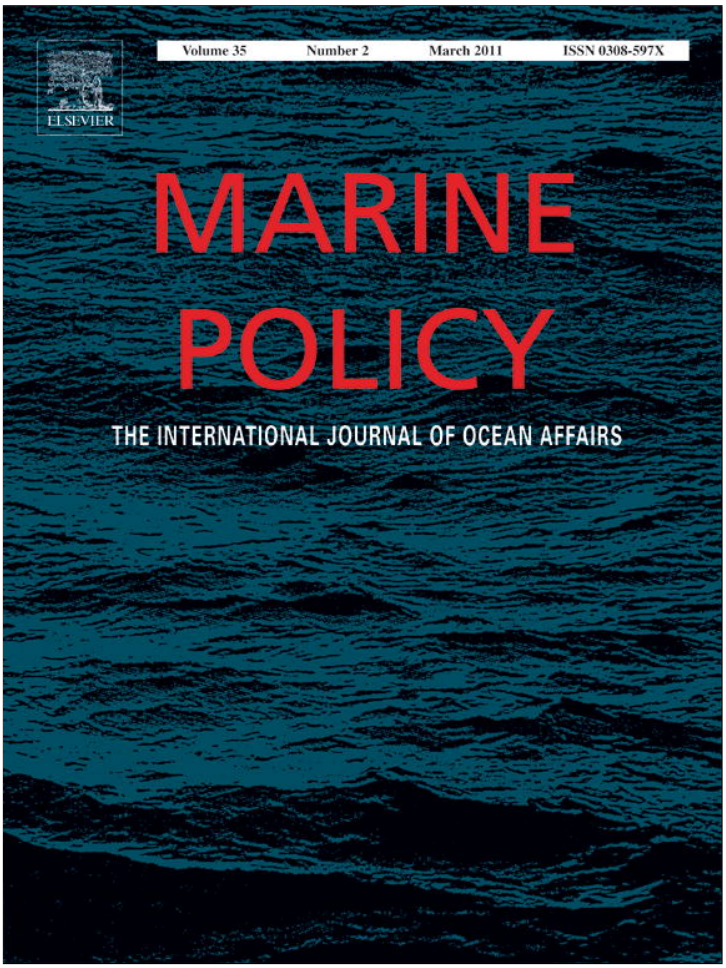

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Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning

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ABSTRACT

A blind faith in the ability of MPAs to counteract loss of biodiversity is fraught with risk, especially when MPAs are poorly planned and when the consequences of establishing MPAs are not adequately thought out. MPA shortcomings are categorized as one of five main types: (1) MPAs that by virtue of their small size or poor design are ecologically insufficient; (2) inappropriately planned or managed MPAs; (3) MPAs that fail due to the degradation of the unprotected surrounding ecosystems; (4) MPAs that do more harm than good due to displacement and unintended consequences of management; and (5) MPAs that create a dangerous illusion of protection when in fact no protection is occurring. A strategic alternative, which fully utilizes the strengths of the MPA tool while avoiding the pitfalls, can overcome these shortcomings: integrating marine protected area planning in broader marine spatial planning and ocean zoning efforts.

1. Introduction

Marine protected areas (MPAs) are arguably one of the most powerful tools available to combat ever-increasing over-exploitation of marine resources and degradation of ocean habitats. However, a blind faith in the ability of MPAs to counteract loss of biodiversity and services does not serve the marine management or conservation community well, especially when MPAs are poorly planned and when the consequences of establishing MPAs are not adequately thought out. At the same time, an unconscious but significant bias towards certain biomes (rocky nearshore environments of the temperate zones, coral reefs in the tropics) means that MPAs are heavily concentrated on only certain kinds of biodiversity, with huge swaths of ocean ecology – such as within the pelagic domain of the high seas – seemingly ignored [1].

Without wishing to undermine the efforts of MPA planners and managers, whose efforts must be lauded, this paper highlights potential risks inherent in careless MPA designation. These risks or shortcomings are of five main types: (1) MPAs that by virtue of their small size or poor design are ecologically insufficient; (2) inappropriately planned or managed MPAs; (3) MPAs that fail due to the degradation of the unprotected surrounding ecosystems; (4) MPAs that do more harm than good due to displacement and unintended consequences of management; and (5) MPAs that create a dangerous illusion of protection when in fact no protection is occurring. These shortcomings are discussed in detail and with examples, after which is posed a strategic alternative that fully utilizes the strengths of the MPA tool while avoiding many of the pitfalls.

2. Categories of shortcomings

2.1. Mismatch of MPA scale to issue and context

MPAs that are too small or are poorly designed with respect to the conservation problems they were created to address are unlikely to attain the goals, which justified their designation. One problem is the uncritical application of models developed for terrestrial systems to the marine environment, which differs from land in terms of structure, scale, dynamism, and connectedness [2,3]. One can argue whether the terrestrial and marine ecosystems exhibit a difference in kind or in degree see [4], but regardless, the wholesale application of tools and methods developed for use on land to address unsustainable use of the sea is bound to falter or even to fail.

Large protected areas can help to overcome the issues arising from the very large spatial scales in which most marine ecosystems operate. However, large MPAs are not always categorically better. Such MPAs may not be feasible in much of the world and may include large no-take areas created without consideration of management in the surrounding areas. For instance, the declaration of the Papahānaumokuākea National Monument in the Northwest Hawaiian Islands (NWHI) was viewed as an unqualified

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success by some environmental groups, but may also be seen as a lost opportunity to put in place a large, zoned multi-use MPA like the Great Barrier Reef Marine Park. Fish originally caught offshore from reefs in deep waters, but within the monument boundaries by long line operations, may be sourced from unsustainable fisheries in the western Pacific countries, and flown in for the Hawaiian market with a higher carbon footprint than before. The zoning as a sanctuary rather than monument could have resulted in very large no-take areas, and sustainable fishing zones away from fragile coral reefs.

Another set of problems arise concerning MPAs used for species conservation. When areas are designated to protect marine megafauna under the impetus of public affection towards charismatic species, without a solid theoretical foundation [3], or when MPAs are created without calibrating protected area size and design to match the home ranges of the species the protected area is intended to protect, MPAs can fall short. Furthermore, MPAs are rarely designed to ensure connectivity with nearby MPAs, even when such other areas are necessary to enhance the conservation status of target species, and to meet the ecological requirements of such species through different life history stages [5]. Below, we present specific examples of MPA designations that fail to guarantee the conservation of the species they were intended to protect.

The vaquita (*Phocoena sinus*), a small porpoise endemic to the northern Gulf of California, Mexico, with only a few hundred individuals surviving today, is one of the world's most endangered mammals [6]. The species is threatened to a great extent by unsustainable mortality levels caused by intense gillnet fishing carried out in its core habitat, a mere 2200 km^2. This is a case in which an MPA correctly designed and effectively managed could have very effectively addressed the single threat undermining the species' survival. Unfortunately, a Biosphere Reserve created in 1993 to protect the vaquita fell short of its target because its boundaries were designed in such way as to leave 40% of the species' greatly reduced core habitat outside of it [6]. As a result, the species, which was originally classified as vulnerable in IUCN's Red List, continued declining and was upgraded to endangered in 1991 and to critically endangered in 1996 [6].

A voluntary whale sanctuary approx. 1000 km^2 wide was established by Canada's Department of Fisheries and Oceans (DFO) in the Gully, the largest submarine canyon off the coast of eastern Canada, to minimize the risk of ship collisions with the region's cetaceans, in particular with northern bottlenose whales, *Hyperoodon ampullatus*, which are particularly frequent in the area [7]. Mariners crossing the sanctuary are alerted through the "Notices to Mariners" about the natural value of the Gully and recommended that the area should be avoided when possible; guidelines are also offered for minimizing hazards to whales when navigating through the area. Based on extensive cetacean surveys conducted in the Gully and surrounding waters, [7] recommended that the DFO voluntary sanctuary be significantly extended, with a formally established MPA having a core protection zone based on depth and bounded by the 200-m isobath, and an additional 10-km buffer zone defined around the core to provide protection from activities having further-reaching effects, such as noise, dredging, and chemical pollution. To date these protections have not been established, and the Gully closure thus falls short of meeting its conservation objectives.

In the north-western portion of the Mediterranean Sea, an international MPA known as the Pelagos Sanctuary was established in 1999 by a treaty among France, Italy, and Monaco. The Sanctuary was designated to encompass the permanent Ligurian oceanographic front, which sustains critical habitat for all the cetacean species regularly found in the Mediterranean Sea [8]. The placement of the borders of the Sanctuary resulted from a decade of negotiations among the three nations, in which political considerations (e.g., ensuring that the territorial waters included within the Sanctuary were equitably subdivided between Italy and France) prevailed over ecological considerations (i.e., encompassing within the sanctuary cetacean critical habitat appropriately). As a consequence, a large zone of low cetacean density comprised between Corsica and the Italian mainland was included, whereas a large portion of important pelagic cetacean habitat, to the west of Corsica, was left outside. The final plan leaves very important habitat for a number of cetacean species (e.g., fin whales, sperm whales, striped dolphins, Cuvier's beaked whales) to the west and to the south–east of the Sanctuary unprotected from high risk activities such as naval exercises and seismic prospecting. In effect, Pelagos Sanctuary provides protection to relatively low value areas, while higher value areas (from a marine mammal perspective) have been left out because management of those areas would be more difficult.

The need for integrating conservation action on land and at sea is particularly evident in the case of marine turtles: efforts to protect nesting grounds on land are insufficient to warrant population's survival if fishery-caused mortality at sea is significant. Leatherback turtles (*Dermochelys coriacea*) nesting in the Las Baulas Marine Park in Costa Rica declined precipitously during a 15-year monitoring period (from 1988–89 to 2003–04), in spite of an increased proportion of hatchlings produced from deposited eggs as a result of *in situ* conservation action [9], because of the very high mortality of adult females as fisheries' bycatch [10]. Decline in nesting has been documented to be much greater than 80% in most of the populations of the Pacific [11]. As argued by [10], recovery of leatherback turtles cannot be achieved by increasing hatchling production alone because of the high mortality caused by fisheries; pelagic and coastal fishing practices that impact leatherbacks must be changed or eliminated urgently if conservation of the species is to be achieved. Even in Australia's Great Barrier Reef Marine Park – a marine protected area encompassing some 344,400 km^2 – sea turtles are not afforded adequate protection because some critical habitats fall outside the administrative authority of the park [12,13].

2.2. Inappropriate planning or management processes

Many papers and textbooks have been written on processes for MPA planning and operations, and many others have catalogued failures in meeting management objectives when these MPA processes are not followed. This paper does not review these analyses, but rather points to common inadequacies that could well be overcome if MPA creation were embedded in a larger strategic planning effort, as detailed in the final section of this paper.

A far-too-common phenomenon that dooms many an MPA to failure is insufficient involvement of stakeholders in the planning process—either because too few stakeholders were engaged with underrepresentation of certain stakeholder groups, or because the stakeholders were brought in too late in the planning process [14]. User groups have demonstrated a vociferous opposition to MPAs when they have no buy-in; stakeholder engagement can generate that buy-in, as can transparent participatory planning processes.

Another common failure of MPAs in meeting the objectives for which they were established is the result of inadequate attention to compliance. Creating management regimes that do not take into consideration enforcement requirements or potential for compliance are known to fail the world over [e.g., 15]. Under this category falls missteps in the planning process that include: (1) not understanding what drives use of ocean space and resources (and what therefore needs to be addressed in order to ensure compliance with

regulations); (2) insufficient engagement of users in the planning process, as described above; (3) inadequate budgeting of resources for surveillance and enforcement; and (4) establishing an MPA in a place where the logistical challenges of trying to ensure compliance are too daunting.

Despite the growing advocacy for MPAs among user groups, resistance to some forms of management, especially the establishment of large no-take reserves, still lingers. MPA management strategies can be viewed as an attempt to police the local community, which may preclude getting the community to support the protected area. This can be especially the case when MPAs are viewed as being imposed on locals by "outsiders" [16]. Trouble arises most frequently when MPA practitioners do not recognize that the systems they are managing and studying include people and their sometimes unique cultures. Cultural parameters are especially important to consider in areas having significant populations of indigenous peoples with traditional connections to the marine environment [17,18]. Attempts to limit access to these resources, especially fishing rights, have the potential to disrupt the socio-economic stability of coastal communities and result in conflict among user groups with competing interests over the same limited resources. Although the scientific evidence supporting more restrictive access management strategies may be strong, access restrictions are not likely to last long without significant stakeholder support [19–21]. And because conflict resolution mechanisms are rarely built into MPA and reserve implementation schemes, the potential for having such perceptions and attitudes derail the establishment of protected areas is great [14,22].

Lack of information, or the perception that not enough attention has been given to the displacement problem, can be a big factor in the success or failure of an MPA initiative, at least as far as public or user group acceptance is concerned. Perceptions that an MPA or reserve unfairly singles out a particular user group can also affect compliance and potential for criminal activity, and therefore lead to the necessity for increased enforcement investment [23]. Lingering distrust can complicate or even derail MPA planning processes, such as occurred in the early California Marine Life Protection Act planning process and the in the Channel Islands, California National Marine Sanctuary [24]. Even when governments acknowledge the potential for displacement and study ways to compensate fishers for lost revenues, as is the case with Australia and New Zealand, fishers remain distrustful because their collective perception is at odds with that of decision-makers.

Non-compliance commonly occurs when people do not understand (or have not been told) the reasons for restrictions. Many people very willingly abide by the rules when they recognize it is in their own self-interest to do so, for instance when fishing cooperatives develop their own self-regulations that point them towards sustainability [25]. One of the great shortcomings of government agencies and NGOs alike has been failing to communicate how MPAs can meet multiple objectives and steer things towards sustainability. Instead, an 'us-versus-them' attitude is often the norm, and the result is failure after conservation measures are not been embraced by the many legitimate users of the marine environment [26]. Enforcement may be more readily accepted, especially in cases like open access waters where the "anything goes" rules precede management, when people understand why regulations exist and for whose benefit.

In sum, even the best laid MPA plans will not result in more effective management or conservation if the capacity to carry out the essential elements of management does not exist. At a bare minimum these elements include: education and outreach, surveillance and monitoring, enforcement, performance monitoring and evaluation, and adaptive design of MPA boundaries and regulations as information increases and/or environmental conditions change (adaptive management).

2.3. Failure due to degradation of the unprotected surrounding ecosystem

By their very nature, MPAs are islands of protection. When the sea in which these islands of protection sit is degraded, the MPAs themselves are at risk of no longer being able to meet their objectives. The most obvious example of this is the impact of toxics pollution from afar, which eventually crosses MPA boundaries and begins to damage the species and ecosystems inside. But equally likely are other impacts caused by the degradation of the surrounding area, through noise pollution, eutrophication effects, ecological imbalances resulting from resource extraction, etc. Habitat loss in associated ecosystems can also influence the health and productivity of target ecosystems, such as occurs when mangrove is deforested and coral reef species lose mangrove-associated nursery grounds [27]. Degradation and habitat loss is the norm; most marine areas around the world suffer from a combination of these factors all occurring cumulatively over time.

A small scale example of the inability of marine protected areas to conserve habitat and species when the area outside the MPA is allowed to become degraded is the sad case of Buck Island National Park in St. Croix, US Virgin Islands. The site was first designated in 1948 to protect what was considered "one of the finest marine gardens in the Caribbean Sea", the centerpiece of which was a robust stand of elkhorn coral (*Acropora palmata*) and associated reef species. The initially small site was expanded to a 71 km^2 protected area when it was declared a Marine National Monument by President John F. Kennedy in 1961 and further expanded by President William J. Clinton in 2000. Today, the elkhorn reef is essentially denuded, with mortality of all the large branching corals having occurred from a combination of environmental degradation, related white band and black band disease effects, and natural catastrophes. Living coral cover has decreased and macroalgal cover has increased, and the algal-covered ghosts of once magnificent and vibrant elkhorn corals are a stark reminder of the consequences of management failure.

At the opposite end of the size spectrum is the case of the Great Barrier Reef Marine Park (GBRMP) in eastern Australia. No review of MPA efforts can avoid mention of this large, complex, and hugely successful marine protected area—held up as the world's most prominent example of the benefits of using MPAs to conserve species, habitat, and uses of the environment that are sustainable. However, early in the history of the GBRMP, a lack of consideration of context put the reefs of this highly valued region at risk. The Great Barrier Reef Marine Park Authority (GBRMPA) originally had very little influence over land use in adjacent Queensland. Large scale agriculture, including sugar cane production, leached large amounts of nitrates and phosphates into streams and the nearshore ocean. This in turn caused eutrophication and algal overgrowth in some areas. The GBRMPA recognized this shortcoming and amended its policies to create a management system, which could begin to engage the State of Queensland, and the outcome seems to be improvement in overall ecosystem health—though some of the condition of corals may be attributable to the most robust reefs being selected for the highest protection status in the initial zoning of the park [28].

Marine protected areas and other local management measures are important, but they cannot alone act to protect ecosystems from the damaging effects of human activity within and outside of areas [29–31]. Not considering the context in which oases of protection sit essentially means putting the conservation or management investment at risk: not only are marine biodiversity and ecosystem services compromised but also the time and resources spent protecting an area that no longer remains protected are wasted. This is highly inefficient in economic terms, and also may act to lessen the confidence of the public and decision-makers in our ability to manage marine areas generally.

2.4. MPAs that cause damaging displacement and other unintended consequences

Most MPAs limit fishing, whether commercial or recreational; restrictions on fishing activity include limiting extraction by season or place, regulating gear types, establishing catch limits, and controlling the development of aquaculture. Any of these restrictions carries with it the consequence of moving effort from one place to another—a phenomenon known as displacement. Displacement itself is poorly defined and few empirical studies have quantified the impacts of fisheries closures that cause displacement in fisheries, and it is but one type of unintended consequences. This section outlines several different types of displacement and other unintended consequences of MPA establishment and regulation, as well as issues of perception and how these play into the potential effectiveness of MPAs as a management tool.

Thus one major concern with MPAs, and especially no-take fisheries reserves, is the effect that closure of an area will have on the user groups and the surrounding environment [32]. Some argue that since reserve designation is rarely done with buy-back programs or other measures that would result in reduced fishing effort, fishing boat displacement will sometimes lead to effort becoming concentrated in smaller areas, causing conflict and ecological harm [33]. Such costs can be avoided by programs that facilitate alternative livelihoods or provide compensation for lost rights, but usually the funds to support such corollary programs are not available.

There are potential economic, social, and environmental or ecological consequences of displacing effort, especially if the area closures are not made to be synergistic with other fisheries management measures [34]. Putting all the eggs in the marine reserves basket and banking on spillover is much like single species fisheries management, in which the lack of a comprehensive or holistic approach doom many fisheries management efforts to failure. This is not only because the management intervention of creating a closed area may be too narrow in focus, but also because fisheries closures do incur real costs that are too often overlooked, fueling perceptions or misconceptions that impede future conservation efforts [26]. Unfortunately, though many of the possible costs of fisheries displacement are widely anticipated each time a reserve designation comes up for discussion, there are few analytical studies that actually quantify displacement impacts [35], or the tendency for MPA edges to act as a magnet for fishing effort—a particularly serious problem in open access regimes and for relatively small community-based MPAs [36]. The following few paragraphs summarize the types of impacts that are predicted to occur due to displacement.

Displacement would not be a factor were it not for the increased time and fuel costs of getting to new, presumably farther areas, and the costs associated with learning where new fisheries grounds are or learning new techniques. In theory, these costs could be countered by increased productivity, such that better yields in new areas would compensate fishers for the losses incurred by closing certain fishing grounds [37]. One means of potentially increasing productivity is to use reserves targeting spawning stock or nursery areas to create enough production that spillover occurs outside reserve boundaries. If stock levels become higher, search costs are lower, all else being equal—a phenomenon known as the stock effect [38].

Spillover has not been demonstrated to the same degree as increased production inside reserves [18], but much current scientific research is aimed at determining the extent to which spillover indeed occurs [39,40]. Since fishers may soon learn to fish the line – i.e. fish close to reserve boundaries to take advantage of high catches – they can quickly counteract any spillover effect [41], though interestingly this has not yet occurred in the Georges Bank scallop fishery where fishing the line has been done with great intensity [42]. However, there remain reasons to doubt whether reserves can produce the kind of spillover necessary to overcome both costs from physical displacement and perceptions of fishers that they are being unfairly restricted from historic, traditional, or most productive fishing grounds. Such congestion externalities also have social and ecological consequences, such as abandoning even successful small scale community-based MPAs.

The crowding of boats into smaller (and sometimes farther) areas outside no-take reserves has the potential to increase competition and conflict [33]. Often these measures create conflict in fisheries that already are ripe for conflict due to naturally decreasing yields (i.e. those brought about by climate changes) or other issues arising from over-capitalization, decreased environmental health, or breakdowns in social institutions or governance mechanisms [14]. Paradoxically, the increase in steam time needed to get to new locations outside the closed area is expected to lead to a tendency of fishers to want to invest in greater capital in increased fishing capacity, at a time when many fisheries managers are looking to decrease fishing effort and thus control overcapitalization [38]. This has not only economic consequences, but also social ones in that fisheries management is less able to do its job, and fishers may become even more unwilling to play by the rules.

If it is assumed that the new restrictions on fishing brought about by an MPA or reserve are not matched by some other effort reduction, the lack of such exogenous management decisions creates opportunities for overexploitation to continue [36]. The ecological consequences of overexploitation in turn can be not only stock reduction but also impaired recruitment, selection for smaller sizes of individuals, reduction in genetic diversity, and trophic imbalances [43,44]. Clearly effort displaced to depleted stocks would need to be dealt with more restrictively than effort displaced to less than fully utilized stocks [45]. While potential displacement of effort may also be offset by the potential beneficial effects caused by increased production and spillover from the proposed MPAs [46], many fishers are reluctant to accept this premise on the basis of modeling or the few existing case studies alone [34]. Because displacing effort to areas farther offshore or more difficult to reach might lead to investment in greater capital, these ecological impacts could be actually worsened if the protected area measure is not coupled to some form of effort reduction [38,47]. However, there is little evidence of this having occurred in real life situations. Fishing effort reduction is particularly difficult in contexts such as Asia where marine resources are a critical part of food security for the poorest segments of society and in which few economic alternatives exist. Open access regimes are well entrenched and social surveys of artisanal fishers in the Philippines show strong opposition to reduced fishing effort without alternatives to fishing or clear rules that allocate any benefits from reduced fishing effort (Christie, unpublished data). Efforts to reduce fishing effort in the Philippines are underway, but will require long term commitment and creativity to overcome initial resistance [48]. It has taken a concerted effort over three decades for coastal management and MPAs to become common in the Philippines, a similar time horizon is likely necessary for fishing effort reduction and widescale spatial planning [49]. The lack of information that could provide policy makers with a starting point from which to evaluate potential effects on fisheries outside reserves and to anticipate what types of specific management actions (if any) might be required to mitigate the effects of displacement precludes a substantive discussion of this issue [46].

A perhaps more troubling ecological consequence is the unintended consequence of shifting effort from sink areas to source areas [50]. Such a displacement of effort could have dramatic impacts on future recruitment in the wider area, including within

the reserve boundaries itself. However, as before, evidence for this actually having occurred is lacking in the published literature.

Closed areas could conceivably displace fishers not only physically but also into new types of fisheries. Shifting fishing pressure onto new stocks or new species can create increased competition and conflict in the fishery, and raise the potential for overexploitation of resources outside the MPA [51]. As with the physical displacement of fishers into new areas, the displacement of fishers into new fisheries carries with it the potential for economic, social, and ecological costs.

2.5. MPAs that create illusions of protection

While it is not the intention of any marine park planner or management agency to deliberately mislead the public, the public can indeed be misled into thinking MPAs are doing their job when in fact they are not. According to [52], the large number of marine protected areas (MPAs) in the Caribbean (over 100 in the year 2000) gives a misleading impression of the amount of protection the reefs and other marine resources in this region are receiving; the same is true for many other parts of the world. Such problems with perception can cloud the public trust and make it more difficult for management agencies and conservationists to use MPA designations in the future [26,47].

Some of these perception problems can be overcome by clarity in semantics: calling a spade a spade, as it were. This draws attention to ongoing efforts to clarify definitions of various categories of protected areas, as has been happening under the aegis of the International Union for the Conservation of Nature (IUCN). The designation of "whale sanctuaries" across entire EEZs of nations, though signaling the best intentions to value and protect marine mammals, is but one example of calling something a protected area when in fact it is not, given that such designations do not imply the provision of specific management activities.

Even when MPAs offer true protections to habitat or species, they may not be true to the cause of marine conservation, if they were designated to protect a site facing little threat (what is often referred to as going after the low-hanging fruit). This wrong focus, with energies and resources invested on pressures that are mildly threatening (e.g., low level tourism, diver damage), diverts attention and resources from efforts to address real threats (e.g., bycatch, noise, habitat degradation) or more highly threatened areas in which management is more difficult to tackle.

3. Lessons learned: how to use knowledge about shortcomings constructively

Marine protected areas in all their myriad forms are a terrific conservation tool, but planners should be cautious about shortcomings because failures of MPA planning and management result in wasted resources, skepticism about MPAs, and lost opportunities.

The current situation is that vast areas of the open ocean are currently unprotected, despite their biogeographic, ecological and conservation values. Existing protected areas have often failed in their protection by a combination of factors, including lack of local support and non-compliance with regulations inside their borders, and ongoing impacts outside their borders. Moreover, most existing MPA systems do not ensure connectivity among coastal sites, and between coastal and offshore locations crucial to maintaining populations of mobile species and vital connections between local ecosystems. A paucity of MPAs in the High Seas suggests that use of the MPA tool in areas beyond national jurisdiction is fraught with difficulty [53]. Several target and threatened species use areas that are too large to be effectively protected in single reserves; existing reserves do not function as networks because they are too far apart and fail to represent important offshore foraging and breeding grounds; they also fail to recognize important processes originating offshore that provide linkages between coastal areas. Finally, reserves cannot address the full suite of stressors affecting marine populations and ecosystems.

A solution is within reach, which could well leverage the attention and money which has heretofore been spent trying to protect discrete and rather small sites. This solution requires a larger vision: to develop strategic, comprehensive, coordinated planning efforts for large ocean and coastal regions. Such an ambitious vision could be supported by robust and targeted management within discreet areas, e.g. MPAs, marine reserves, and conservation areas. Such MPAs may individually solve localized, species-specific, or habitat—specific conservation problems, but the sum total of protected areas within the context of a wider strategic marine plan does much more, potentially driving effective ecosystem-based management.

One important tool to deliver such strategic plans is Marine Spatial Planning. Marine spatial plans that utilize existing information on key areas needing protection, support sustainable development and management of marine resources overall, and are both adaptive and tailor management to existing resource use could set in motion much more effective and efficient management regimes than what we have seen to date. Coordinated, regional plans are not only necessary because of the large scale over which the dynamics of key ecosystem processes, resource markets, and governance processes occur, but also likely more efficient and cost-effective (e.g., [54]). Marine spatial planning does not stand alone, rather it is related to and will emerge from existing management frameworks and tools. Frameworks such as integrated coastal management [55,56] and ecosystem-based management [57] are essential to consider and build from [58]. Field management efforts such as the Coral Triangle Initiative, large marine ecosystem programs [59–61], and country-level ecosystem-based management programs [48] provide rich examples from which to develop lessons.

While regional planning is critical, effective implementation of resource management always happens at the local level in some form. Balancing the dynamics of regional and local planning and implementation is essential to success and will evolve distinctly in each context. Comparatively, empirical studies demonstrate the following factors to be essential to successfully scaling up management in a manner that considers balancing local and extra-local dynamics: leadership development, awareness raising, institutional reform, conflict resolution, adaptation, and ongoing evaluation [49].

To realize the goals, marine spatial planning (MSP) should include, at a minimum, five elements:

1. Identification of priority areas, using robust analysis of existing information and databases;
2. development of scenarios to help decision-makers and multilateral agencies weigh trade-offs and choices in creating various sorts of MPA networks that span both coastal regions and open ocean areas;
3. analysis and evaluation of current legal and institutional frameworks and potential decision-making governance structures needed for comprehensive ocean zoning; and
4. creation of regional ocean zoning plans that capitalize on existing protected areas and resource management, take into account what is known about priority areas for conservation, and elucidate appropriate areas for the wide range of marine uses.
5. linking of regional ocean zoning with national and local management efforts in a manner that strengthens all levels of management.

Many question whether a zoning plan for a dynamic ocean environment, and one occurring in a global commons, can be effective, or even feasible. However, the ability of management agencies to educate and inform, and for users to understand and comply with regulations, is often underestimated. It is probably wrong to think that marine stakeholders, particularly people who live by the sea (figuratively as well as literally) cannot comprehend complex spatial management regimes; maritime peoples have abided by complicated rules of who can do what where and when, and succeeded in doing so for centuries. And modern technology allows very complex spatial management to be graphically presented in real time—i.e. on the screens of the GPS that many commercial and recreational users have on their boats today. Vessel monitoring systems (VMS) also allow surveillance today at levels not possible a decade ago, and is becoming increasing inexpensive and attainable even in poor contexts. Furthermore, MSP is a natural extension of practices that are already very well developed in many parts of the world, including integrated coastal management and multi-use MPA management.

Skepticism about MSP is fueled by the perception that commons property regimes cannot be considered as analogous to the mosaic of private and public property that exists on land. Furthermore, important and powerful actors such as the military or well-financed industries may resist integrated marine spatial planning and the limitation on access that it may impose [62]. However, a recent review of ocean zoning efforts undertaken under the rubric of MSP suggest that a large proportion of coastal countries are overcoming these challenges and bringing the full suite of stakeholders to the planning table [63].

The marine spatial planning process, coupled to ocean zoning efforts, can create an unprecedented framework for synthesizing information on the sea's ecology, resources, ecosystem services, uses and values, and the threats to all of the above. Any zoning plan that results from analysis of such synthesized information serves to highlight what is known about marine biodiversity, the efficacy of existing management, and future research needs to enhance management effectiveness.

MSP provides the opportunity for communities which have given up fishing grounds for more effective management to be able to capture broader benefits accruing from effective management of the wider ecosystem. In one-off MPA situations, such communities do not necessarily derive the benefits from spillover, yet make the sacrifice of giving up fishing areas and spending time enforcing the MPA [36].

MSP planning processes can also serve to support managers and government officials attempting to reconcile objectives for multiple uses of ocean space and resources. In addition, MSP can put adaptive management into practice by establishing management systems with built in monitoring and legislated periodic amendments to zoning can ensure that management measures will be maximally effective in adapting to changing conditions.

Marine spatial planning, fully utilizing ocean zoning within which strategically planned MPAs are embedded, allows MPA shortcomings to be overcome in order to better safeguard the ocean worldwide and the lives of those who depend upon it.

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