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# Tracking the Debate Around Marine Protected Areas: Key Issues and the BEG Framework

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**Abstract** Marine conservation is often criticized for a mono-disciplinary approach, which delivers fragmented solutions to complex problems with differing interpretations of success. As a means of reflecting on the breadth and range of scientific research on the management of the marine environment, this paper develops an analytical framework to gauge the foci of policy documents and published scientific work on Marine Protected Areas. We evaluate the extent to which MPA research articles delineate objectives around three domains: biological-ecological [B]; economic-social[E]; and governance-management [G]. This permits us to develop an analytic [BEG] framework which we then test on a sample of selected journal article cohorts. While the framework reveals the dominance of biologically focussed research [B], analysis also reveals a growing frequency of the use of governance/management terminology in the literature over the last 15 years, which may be indicative of a shift towards more integrated consideration of governance concerns. However, consideration of the economic/social domain appears to lag behind biological and governance concerns in both frequency and presence in MPA literature.

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## Introduction

Regulation of fishing activity is not a new phenomenon. Fogarty and others (2000) cite the fourteenth century state prohibition of harmful dredging in certain UK marine areas so as to protect mussel and oyster beds for example, while protected areas (PA) of one sort or another have long been viewed as an integral component of fisheries management. Similarly in the Pacific, traditional authorities made extensive use of PA to safeguard valuable marine resources during certain fishing seasons (Johannes 2000). However, the first formal scrutiny of PA as a potential management tool dates to 1957—after Ray Beverton and Holt (1957) observed that the inaccessibility of North Sea fishing grounds due to the presence of mines in the aftermath of World War II had resulted in an unexpected increase of cod and related stocks in the vicinity. Their age-structured model in fact suggested no-take reserves were 'unhelpful in management' terms (Pitcher and Pauly 1998, p. 3), as (i) such reserves merely caused fishing effort to be concentrated into a reduced 'unrestricted' zone, and (ii) fish movements were not confined to the no-take zone—thus dissipating the expected benefits of the strategy. Instead, fleet and gear controls were favoured as first-best solutions to the overfishing issue (Guénette and others 1998, p. 251).

Nevertheless, as fishing intensity grew during the following decade, and marine ecosystems became ever more heavily exploited, the ineffectiveness of such effort controls induced the international community to review the governance of marine areas. The 1958 Geneva Conventions on the Law of the Sea established an international legal framework

for the protection of living marine resources, and these were supplemented by the Ramsar Convention (1971—covering Wetlands of International Importance), the UNESCO World Heritage Convention (1972) and the UNEP Regional Seas Programme (1974). The latter developed action plans which also emphasized the regional protection of living marine resources—the first of which entered into force in the Mediterranean in 1978. Paralleling these developments, the World Conservation Union (IUCN) convened the first conference on Marine Protected Areas (MPAs) in Tokyo in 1975, recommending the establishment of a representative and effectively monitored global system of MPAs (IUCN 1976). As Noël and Weigel (2007, p. 237) acknowledge, conservation was the primary driver behind MPA formation at the time, as the areas slated for recognition—coral reefs, mangroves, and salt-water plants—were argued to play critical roles in the marine biological cycle.

In the 1980s the emphasis began to change as management considerations and the realisation that PAs could satisfice multiple goals came to the fore. The IUCN initiated a series of workshops at the Third World Congress on National Parks in Indonesia which culminated with the timely publication of the highly influential *Marine and Coastal Protected Areas: A Guide for Planners and Managers* (Salm and Clark 1984). Now, MPAs were less viewed as small isolated refuges entrusted with pursuing strictly conservationist ends, but as a fundamental element in national and regional policies of coastal zone management (Allison and others 1998; Halim and Morcos 1995). Tourism/eco-tourism and recreational activities were now often accepted as legitimate endeavours within the proscribed zone (Agardy 1993; Gossling 1999), and MPAs were "increasingly being considered to be an important complement to existing fisheries management regimes" (Martin and others 2007, p. 22). Furthermore, while the *1992 Convention on Biological Diversity* (CBD) reinforced the conservationist philosophy of MPAs by committing the 168 signatories to conserve biological—including marine and other aquatic eco-system—diversity, the ratification of the *UN Convention on the Law of the Sea* (UNCLOS) in 1994 not only permitted nation states to establish 200 nautical mile exclusive economic zones (EEZ), but also facilitated the creation of MPAs outside national territorial [3 nautical mile] waters—with the proviso that international navigation rights were unaffected.

These factors combined to prompt a rapid escalation in the number of recognised MPAs. In the space of 25 years (1970–1995), the number of MPAs grew ten-fold—from 118 to 1,306 (Kelleher and others 1995). Barely a decade later the number had leapt to 6,289 with the governments of the United States (773 MPAs), Canada (574), Sweden (489), Australia (414) and the United Kingdom (377) in the forefront of MPA designation (www.MPAglobal.org). Most recently, the outgoing administration of George W. Bush created three new Pacific marine sanctuaries (the Marianas Marine National Monument, the Rose Atoll Marine National Monument, and the Pacific Remote Islands Marine National Monument) covering nearly 200,000 square oceanic miles (MSNBC, 6 January 2009). This growth in MPAs has been matched by a corresponding surge in the academic literature—an 'allintitle' search for 'marine protected area [or areas]' on GoogleScholar on 1st June 2009, for example, produced a sharply ascending number of 'hits' as the decades progress (4 between 1970 and 1980, 134 between 1981 and 1990, 2,310 between 1991–2000, and 11,020 in the current decade—excluding articles in this issue—to date). However, the major portion of this literature adopts an ecological analytic, underlining Lubchenco and others premise that: "The goal of marine reserves is to ensure the persistence of the full range of marine biodiversity—from gene pools to populations, to species to whole ecosystems (2006, p. 6)." Hoagland and others (1995, p. 2) lament, that the number of papers applying economic approaches to analyse marine reserve decision-making is 'remarkably' small, was re-iterated a decade later by EMPAFISH (2006, p. 1), while Jentoft and others (2007, p. 615) bemoans the fact that social benefits are viewed of secondary importance—and are oft-described in generalised terms.

The present article then seeks to ascertain the extent to which (Biological/ecological, Economic/social and Governance/management (henceforth BEG domains) considerations have informed –or been addressed—in published research on the MPA theme. In a sense then, this is a first step towards both redressing and extending Willis (2003, p. 101) "plea for researchers to apply the same rigour to examination of the fisheries-related efficacy of marine reserves as they would apply to other environmental effects studies." The following section of the paper therefore seeks to identify, in effect, the requisite BEG elements one would expect published articles on specific PAs to address. Section three combines these three domains into the BEG framework—while Section 4 applies the framework by reviewing the extent to which these domains are reflected in a number of selected articles on MPAs across the last 15 years. A conclusion explains how the adoption of such a framework "may facilitate the step-by-step assessment of MPAs in the context of [future] fisheries management (Charles and Sanders 2007, p. 312)".

## (Marine) Protected Areas: Biological/Ecological, Economic/Social and Governance Considerations

Rather fortuitously, a recent publication by FAO (2007) provided cogent insights into how some of these BEG considerations impact upon the design, implementation and

success of PAs across the globe. These insights, in conjunction with the managerial guidelines proffered by Salm and Clark (2000), Ward and others (2001) and Sobel and Dahlgren (2004) provide a useful starting point for identifying the different disciplinary considerations which influence the creation, operation and evaluation of PAs and which, by extension, we would expect to be acknowledged in the literature.

## PAs: The Biological and Ecological Considerations

Biological and ecological considerations can be sub-divided into two constituent elements—an ex-ante justification for the creation of the PA (What is it that makes the PA so 'special' as to require its legal and juridical protection?), and an ex-post evaluation of the benefits (both intrinsic and extrinsic) of extending PA status.

### *Location and Size*

Clearly habitat quality and configuration are key ex-ante considerations when establishing PAs, although the literature suggests that—historically at least—planning was more ad hoc than systematic (Stewart and others 2003). To combat such failings, Salm and Clark (2000) propose a series of eight ecological criteria to help in the MPA selection process (Table 1).

Clearly the criteria mentioned in Table 1 are not mutually exclusive—Diegues (2008, p. 40ff), for example, details how the creation of the Mandira Mer estuarine reserve south of São Paulo in Brazil not only restricted oyster-rearing in the estuary to a small group of 25 families whose ancestors date back to the eighteenth century (productivity under the Salm terminology above), but said activity "may actually enhance the biodiversity and productivity of the mangrove"—one would presuppose that one (ideally more) of these ecological considerations which underpin the case for establishing of a specific PA would be cited in the associated literature.

Our primary expectation then is that the literature does not only specify the location and size (LOC) of the PA, but also gives an indication as to the ecological rationale (RAT) for its creation. While the former is often explicit, the latter is frequently expressed in a variety of ways. Chuenpagdee and others (2002), for example, note that the San Felipe MPA off the Yucatán peninsula in Mexico is an 'important nursery ground for lobsters, groupers and other species', Nsiku (2001, p. 132) acknowledges that the Lake Malawi National Park was the only protected lacustrine environment in Africa and 'protected a cross-section of species in the cichlid family', while Kepulauan Seribu Marine National Park in Indonesia was relatively rich in biodiversity, but faced 'continued degradation of both the ecosystem and environmental resources' due to the relative impunity of transgressors (Fauzi and Buchary 2002, p. 169ff).

### *PA: The Intrinsic Benefits*

A second expectation is that the literature comments upon the bio-ecological benefits resulting internally (i.e: within the PA) from the designation of a PA. Unfortunately, as Ward and others (2001, p. 89) note however, these benefits are normally evaluated with respect to an (often adjoining) unprotected area with a similar habitat—rather than a pre-PA/post-PA comparison, which 'would provide the most convincing evidence of a reserve effect.' This caveat notwithstanding, Grafton and others (2005, p. 164) suggests these benefits may take the form of reduced mortality (RM), and/or reduced environmental or habitat damage (REHD).

Bohnsack (1998, p. 299), for example, notes the importance of protecting the physical habitat [REHD] from fishing gear and other anthropogenic impacts (such as pollution and sewage discharge), some of which derive from outside the PA in question. Boersma and Parrish (1999, p. 299) detail the plethora of chemical pollutants that threaten the marine environment and, while acknowledging that PAs can perhaps reduce point sources of such pollution by regulating

**Table 1** Selecting a MPA (ecological criteria)

1. *Biodiversity (b)*: the variety of ecosystems, habitats, communities and species contained in the MPA.
2. *Naturalness (n)*: the lack of degradation or disturbance of the area encompassed within the MPA.
3. *Dependency (d)*: the degree to which a species depends on the area enclosed (or an eco-system is reliant upon the ecological processes occurring therein).
4. *Representativeness (r)*: the degree to which the MPA typifies a habitat type, ecological process, biological community, geological feature or other natural characteristic.
5. *Uniqueness (u)*: the degree to which the MPA is unique (i.e.: harbours endangered species, highly distinctive ecosystems etc.).
6. *Integrity (i)*: is the actual/proposed MPA en effective, self-sustaining ecological entity?
7. *Productivity (p)*: the extent to which productive processes within the MPA produce benefits for species/human community.
8. *Vulnerability (v)*: susceptibility of the MPA to natural and anthropogenic activities.

*Source*: Salm and Clark (2000, pp. 92–93)

discharge—they cite the case of the US levying higher penalties on vessels found guilty of dumping within National Marine Sanctuaries—as waterborne pollutants can travel wide distances, full eradication of the threat to PAs is impossible. Grigg (1994) investigated how sewage discharge (and fishing pressure) affected the coral ecosystems and reef fisheries off Hawaii—with Brown and others (2001), noting MPAs [case of Buccoo Reef Marine Park in Tobago] are often obliged to take measures to curb faecal flows. On the other side of the globe, Turner and others (1999) examined how trawling and dredging led to loss of habitat structure in New Zealand and Australia, before cautioning that MPA's should not be seen as a panacea in isolation from 'conventional management approaches'. Moreover, such efforts to REHD may not always be successful. Jones and others (2004), for example, discovered that despite the creation of four MPAs in Papua New Guinea, habitat degradation—specifically the sharp deterioration in live coral cover—saw a 75% decline in species abundance over the period 1996–2003. Ensuring REHD—even within a PA—is clearly no easy task.

Reduced mortality (RM) or, to consider the other side of the coin, increased abundance within the PA has driven the research agenda of a (rapidly growing) number of studies. Bohnsack (1998, p. 300) found strong scientific support for an increased; abundance of the [overfished] stocks, spawning stock biomass and density within the PA, and an enhanced spawning potential and fecundity—though the incremental contribution of PAs to egg and larval production and accelerated stock recovery post-collapse is less well documented. A subsequent meta-analysis (Halpern 2003) encompassing 89 studies confirmed this, revealing a higher biomass (+90%), greater densities (+63%), organism size (+80%) and biodiversity than for the control areas for the majority (90>%) of MPAs reviewed. Two publications—by Ward and others (2001) and the US based National Research Council (2001)—review a swathe of papers, categorising the effects of reserves in terms of their impact upon biomass, age-size-fecundity of species, and stock abundance, and provide useful starting points for generating a prescriptive list of what one might habitually expect to find in the PA literature vis-á-vis RM. Botsford and others (2007, p. 114) however report that not only does an examination of research outputs suggest that 'large-bodied, long-lived top predators respond slowly to protection', but that other species can also have slower recovery rates, causing structural shifts in the PA species inventory.

Aggregating such considerations with the research of Boersma and Parrish (1999: Table 3) allows us to identify a spectra of population and community-level effects affecting the resident species [RM] and the physical habitat [REHD] of the PA (Table 2), effects that we would expect to be captured within the supporting PA literature (particularly that purporting to adopt a bio-ecological framework). Why these effects are occurring is a rather more difficult question to answer (Botsford and others 2007, p. 122)—and requires insights into larval production and dispersion. The latter also raises the question of whether researchers assess the spillover effects of PA creation.

### *PA: The Extrinsic Benefits*

PAs are also expected to generate external or extrinsic benefits beyond the delineated boundaries of the PA. As adult biomass within the reserve increases in both size and volume, both larvae and stock are likely to seep/spillout into surrounding waters (Polachek 1990). However, while over a decade ago Boersma and Parrish (1999, p. 297) noted that outmigration of fish stocks from PAs had 'rarely been quantitatively assessed', 10 years on Murawski and others (2008) was still able to assert that scientific questions regarding the nature and magnitude of MPA edge and spillover effects remained unresolved. This was reflected at a 2007 *European Symposium on MPAs as a Tool for Fisheries Management and Ecosystem Conservation*—a gathering of 397 marine scientists where 255 papers were presented, yet only a 'few presentations described large-scale offshore MPAs that had resulted in documented

**Table 2** PA: Population and community-levels effects on species resident in the PA

| |
|---|
| Population Effects |
| *Abundance (A)*—Have there been [Are there] changes in the abundance of the focal species? |
| *Individual Size and Age (S&A)*—Is there evidence that focal species are (now) living longer and/or growing larger? |
| *Biomass (B)*—Has the total mass [including spawning stock] of the focal species changed within the designated site? |
| Community-Level Effects |
| Predators and Higher Trophic Species (P)—Has the presence (density) of predatory species changed? |
| Richness (R)—Has the number and genetic diversity of species changed? |
| Community Structure (C)—Has the balance between predator and prey changed (due to [de/in]creased size, abundance, and diversity of upper trophic-level species? |
| Habitat Complexity (H)—Has the nature of the physical habitat changed? |

benefits in the forms of spillover of fish' (Hoffmann and Pérez-Rufaza 2008, p. 3). There are some exceptions however. Chapman and Kramer (1999) and Ashworth and Ormond (2005), for example, found few spillover effects across MPA boundaries in Barbados and Southern Sinai respectively. In the former case no direct evidence of emigration from the reserve into the neighbouring area was uncovered, while in the latter case research disclosed reverse migration into the MPA from adjacent fished areas where population densities were higher. Conversely, Christensen and others (2008), using an MPA scenario simulation for sandeel in the North Sea, calculated that larval export increased the total yield in the southern North Sea by 16%, with a 'characteristic spillover range of 100 km'. Pérez-Rufaza and others (2008, p. 252) examined fish and larval dispersion around the 270 hectare Cabo de Palos-Islas Hormigas MPA off southeast Spain and, in contrast, cautioned that adult fish migration only occurred up to 10 km from the MPA boundary—with the effects most pronounced within the first 2–3,000 metres (although egg and larval dispersion was likely over larger distances). The same MPA was included (along with five further MPAs) within the EU BIOMEX project, studies from which (Goñi and others 2008; Harmelin-Vivien and others 2008) have concluded that spillover effects were in evidence, but within a much more limited range—within 700–1,000 metres of the MPA perimeter in the case of lobster and mullet, and up to 2,500 metres in the case of scarids. Earlier work by Kelly and others (2001) while lending support to this thesis with regard to spiny lobster movements into and out of the CROP MPA in Northern New Zealand, also noted gendered differences in migration patterns over the year (male lobsters tended to exit the reserve after the mating season finished in May, females relocated outside the MPA during September and October—the egg-laying season).

Less acknowledged in the literature, although nonetheless of some merit when calculating the biological/ecological spillover effects, relates to the way that the PA also delivers non-fishery benefits—such as the maintenance/enhancement of wider habitat complexity, species diversity, community [trophic] complexity and the populations of fishing affected species (Ward and others 2001, p. 131). This is particularly important, for example, in instances where the PA's ecosystem is rather unique (u) or where it hosts endangered species (d), and sees the PA assuming the role of safeguarding the system/species for posterity—an 'insurance buffer' in Ward and others's parlance against the destruction (natural or anthropogenic) of comparable ecosystems elsewhere.

Acknowledgement of these extrinsic effects, at a minimum then, should provide insights into Spillover (S)—the movement of adult fish out of the PA (case of the EU BIOMEX project alluded to above); Larval Export (LE)—the dispersion of larvae outside the PA confines (see Christensen and others above), and Insurance (INS)—recognition of the role of the PA as a unique ecosystem refuge/refuge for endangered species.

In biological/ecological terms, PA literature can therefore be evaluated in terms of whether—and the extent to which—it comments upon; (i) location and size of PA [two components], and the (ii) intrinsic benefits [three components] and (iii) extrinsic benefits [three components] associated with its creation. A full biological/ecological checklist is given at Appendix.

## PAs: The Social and Economic Considerations

While few would disagree with Ward and others's acknowledgement (2001, p. 128) that evaluations should include; whether local economies have been augmented, economic opportunities enhanced and/or diversified, and whether the quality of life of the majority of stakeholders has improved, actually quantifying the socio-economic outcomes consequent upon PA creation is no easy task. Whitmarsh and others (2003, p. 37), for example, highlight three assessment (profiling, impact analysis and benefit assessment) procedures that could be employed, procedures that can, in turn, by reviewed using twelve distinct techniques. Moreover, there is also the question of the time frame involved (Russ and others 2004)—ecological and economic paybacks are likely to be low in the immediate aftermath of PA creation, but will accumulate with time providing the PA has been effectively designed and governance mechanisms function. Mascia (2004, p. 175) provides a useful starting point however, by suggesting that socio-economic performance of PAs can be decomposed into efficiency, equity and more generalised socio-cultural considerations.

### *PA: Efficiency Considerations*

In efficiency terms PAs, if they are adjudged to be successful, should contribute to an aggregate increase in total economic value (**TEV**). While clearly many PA are 'no-take'—and in some instances 'no-dive' or entry—zones, catches/human activity should swiftly dwindle to zero within the catchment area, the premise is that Spillover and (in the longer-term) Larval Export will lead to increased compensatory catches in adjacent fishing areas. Yamasaki and Kuwahara (1990), for example, found enhanced snow crab catches in the waters surrounding a PA in Kyoto Prefecture (Japan) 5 years after its creation. However, as some studies have shown (McClanahan and Kuanda-Arara 1996; Johnson and others 1999; Murawski and others 2008), enhanced catches may coincide with increased

fishing effort along PA boundaries due to a combination of 'push' (as fishers whose traditional fishing grounds fell within the 'no-take' PA were now expelled) and/or 'pull' (as fishers whose traditional fishing grounds were more distant relocated to the outskirts of the PA so as to reap the expected spillover effects) factors. Goñi and others (2008, p. 171), for example, note gradients of CPUA and CPUE (catch per unit area—and effort) extended up to 2.5 kilometres outside the six Mediterranean MPAs studied for certain fishing tactics/techniques. Such spatial redistribution will affect operating costs (EMPAFISH 2006, p. 9)—as not only will greater distances need to be travelled to fish (Wilcox and Pomeroy 2003), but it may also take longer to locate the target in unfamiliar waters (Ramos 1992) and engender a switch in fishing technique (Kelly and others 2001, p. 112). As a consequence, while absolute catches (AC) provide an indication of the (principal) direct use value associated with PA creation, there is an expectation that the literature will also examine the aggregate impact upon total fishing effort (TFE) and costs (TFC). This is important as Hannesson notes (1998), for increased fishing effort in areas adjacent to the PA may well fully dissipate the additional rent created.

In some instances, other *extractive use values* (EUV) may be on offer—Becker and Choresh (2006, p. 114—citing original work by Ruitenbeek and others [1999]) quantify the global bio-prospecting worth of Montego Bay Marine Park in Jamaica. In addition, consideration should be given to the impact (or potential impact) upon *non-extractive direct use* (NEU) values. Alcala (2004, p. 13), for example, notes how dive shops built in two resorts following the creation of Apo Island Marine Reserve in the Philippines were generating net revenues of US$35,000 p.a. in the mid-1990s. In the CINMS, the most important NEU value was whale-watching—accounting for 62% of all recreational activity within the reserve confines according to Leeworthy and Wiley (2003)—with the estimated annual worth to the local economy ascending to US$20 million plus (Pendleton 2004, p. 10/1). Taylor and Buckenham (2003, p. 26ff) also identify a plethora of NEUs following the establishment of MPAs in New Zealand—the number of water taxi operators increased, and opportunities to kayak and swim with seals have emerged—with a concomitant knock-on effect upon the provision of accommodation (hotel and camping) in the vicinity. Costs in terms of overcrowding, a lack of parking and increased litter have also transpired. Two further words of caution however. First, such activities may well have emerged with time in these areas, even in the *absence* of PA status. Second, the growth of these activities may simply be a consequence of the 'displacement' from other areas—and not incremental growth of such activities. These possibilities should thus be factored into any economic analysis of the non-extractive use benefits accruing from MPA creation.

Although the TEV concept also embraces indirect use values (IUV—or 'ecological function' values—benefits that support other economic activities), option values (OV—the benefits [to current non-users] from accessing the area some future date), bequest values (BV—the value of conserving the area for the benefit of future generations) and existence values (EV—the value [to a non-user] of ensuring the area remains in its current pristine condition), somewhat understandably—given their more intangible nature, such values have historically been more omitted than admitted within the literature on PAs (c.f. Subade 2007: Table 1). One exception to this was the study by Turpie and others (2006) on the MPAs along the Garden Route Coast of South Africa. Using a contingent valuation approach with 381 respondents and offering a one-off payment 'to prevent the worst scenario [no protection] from coming about', the authors inferred an EV of R238 million (US$23.4 million), a value that would 'increase with added protection' (2006, p. 33). Samonte-Tan and others (2007, p. 330) research upon the Bohol Marine Triangle in the Philippines not only computes the IUV attributable to nursery and habitat protection [US$61,383 p.a.—extrapolated from fish landings data], but the EV [US$169,674—the cost of the protective seawall required to conserve the area], and the OV and BV combined [US$125,703—the biodiversity value based upon WTP and past cost-benefit studies of mangroves].

### *PA: Equity Considerations*

Equity considerations, in the Mascia (2004) framework, involve not just the monetisation of the benefits (costs) accruing from MPA creation and operation but also the identification of how these benefits/costs are split between the different stakeholder—existing and new entrant—groupings (STAKEBEN/LOSS). Andrianarivo and others (1999, p. 36) similarly shows how the establishment of the Nosy Atafana Marine Park in Madagascar benefitted the four village communities located within the Park (who were permitted to engage in artisanal fishing activities on specified days) at the expense of migrant fishermen who had traditionally fished in the vicinity (this unfortunately prompted a relocation of effort to—and increased evidence of overfishing in—the adjacent Masoala Marine Park). It is not just actual benefits/costs, but also perceived benefits/costs that matter for, as Pollnac and Pomeroy (2005), Pollnac and others (2001a, b), and Christie and others (2009) acknowledge, if certain fishers/stakeholders *feel* marginalised by the PA legislation, they can be just as antagonistic to PA management efforts as those who are materially prejudiced.

In the case of the creation of 'no-take' reserves, transfers are likely to be to the immediate detriment of consumptive

resource users (principally fishers) whilst advantaging non-consumptive resource use groupings. In some instances, non-consumptive resource users—case of recreational divers in the CINMS reserve off California—may also lose out.

Quantification of losses in this manner allows the Kaldor-Hicks criterion to be brought into play—and compensatory [COMP] measures to be adopted so as to correct the negative distributional consequences that may arise from MPA creation/extension. In the case of the Great Barrier Reef Marine Park, for example, the 2004 rezoning exercise which extended the area closed to commercial fishers from 4.5 to 33% was accompanied by a structural adjustment package which compensated 181 stakeholders in six different fisheries to the tune of A$31.6 million via a licence buy-out programme (FERM 2007, p. 2/3). In a similar vein, the closure of Glacier Bay (Alaska) to commercial fishing was matched with a US$5.5 million federal compensation package to acquire the permits of nine Dungeness crab fishers—although it seems "the compensation package for Glacier Bay is probably not a good example of what commercial fishers should expect if marine reserves are created elsewhere in Alaskan waters (Alaska Department of Fish and Game 2002, p. 21)." While the nature of these buy-outs are best interpreted as lump-sum wealth (to atone for future forgone income streams) compensation packages, Niesten and others (2008) report an income scheme whereby local communities have forgone harvesting sea-cucumbers and other resources in the Solomon's Arnavon islands provincial protected area in exchange for salaries to patrol the area and participate in the monitoring of sea-turtle nests. Equally, as EMPAFISH (2006, p. 17) note, the compensatory measures may not be direct money transfers, but 'support in kind'—oriented, for example, to developing alternative fishing activities (provision of boats/gear to target new species in new locations) and/or supporting the redeployment of fishers into alternative occupations (tourism). By and large however, the reporting of such COMP schemes (if indeed they exist) is, unfortunately, more the exception than the rule in much of the MPA literature to date.

### *Sociocultural Considerations*

Mascia (2004, p. 179) suggests the impact of MPAs upon the sociocultural dimension can be evaluated through a variety of performance measures which may, depending upon the sociocultural policy objectives of the particular MPA in question, include; (changes in) employment levels, crime rates, alcoholism and domestic violence rates—although Pomeroy and others (2007, p. 158) note that that no known research to date has examined the impact of MPA creation upon these latter three factors. Furthermore, MPA creation and evolution may foster demographic change in the community—stimulating stakeholder entry and/or exit (geographic or occupational migration)—with particular ethnic, age, gender and/or religious groups being empowered (or disempowered) as a consequence. Walley (2004), for example, documents how the creation of the Mafia island Marine Park in Tanzania caused women in neighbouring communities to develop alternative livelihood strategies (including seaweed farming, shell collection and factory work) which not only enhanced their status, but the income so generated reduced household reliance upon fishing activity—with the added bonus that the incidence of dynamite dynamite-fishing declined. In contrast, the Californian Department of Fish and Game acknowledges how, in retrospect, its policy of MPA creation over the period 1950–1999 effectively disempowered certain ethnic groups through their 'de facto exclusion … from intertidal areas (2004, p. 1).'

The personal and communal is important too—and changes in resource access rights that are occasioned by MPA establishment are also likely to affect individual, household or community wellbeing (in non-income terms) too. Sanchirico and others (2002, p. 12), for example, suggest occupational risk may increase if fishers are displaced from their traditional fishing grounds—and are obliged to voyage to unfamiliar waters in vessels unsuited for the task. Pollnac and others (2001a, b; Pollnac and Poggie 2006)—although not referring directly to MPAs—talk of the satisfaction derived from undertaking fishing activities, while Tonge and Moore (2007) discuss variations in satisfaction across different visitor segments in the case of the Swan Estuary Marine Park in West Australia. In the case of the Queensland Coral Fishery community 'illbeing' is gauged in terms of the number of DPIF ministerial letters (5 or more trigger a review of the fishery) received relating to sustainability concerns within the fishery (QPIF 2009), while Pollnac and others (2001a, b) suggest community wellbeing in the Visayas MPA in the Philippines is 'reflected in the nutritional status of its children'.

In conclusion, while we side with Mascia insofar as we feel the sociocultural dimension associated with MPA creation merits recognition in the literature even if, as Mascia acknowledges (2004, p. 179), '[they] have not been well studied', we do not wish to be overly prescriptive here. Thus, we suggest literature should simply be scrutinised for evidence that sociocultural (SOCCUL) issues relating to MPA creation have been acknowledged—rather than being didactic, and asserting which are the pertinent sociocultural considerations we expect to see embraced.

## PAs: The Governance and Management Considerations

PAs are legal constructions, created by government (or other agencies) for the purpose of regulating human

activity in specific geographical areas. Law—or law-like phenomena—provide the means for creating the contours of a PA and also ensure its functioning; they constitute an important part of the governance framework. But governance is more than law alone: governance is the aggregate of mechanisms utilized for steering the development and continuance of PAs in space and time. Christie and White (2007) therefore refer to PAs as "management interventions that are spatially organized."

Evaluating the performance of PAs on the governance/management plane has two dimensions (Pollnac and others 2001a, b; Christie and others 2009). First, an enquiry into the PAs internal governance structure, and second, an enquiry into its nesting in broader governance environments. We first the latter dimension first, and then consider how the internal governance structure could be evaluated.

### *The Governance Environment*

Jentoft and others (2007, p. 617) note that PAs "are not established in a vacuum and do not start with a clean slate." Instead PAs are inevitably nested in larger institutional environments, with which there is (or is not) a measure of 'fit'. The nature of its institutional embedding, particularly, but not only in the realm of government, has been assumed to affect its functioning in various ways.

Cicin-Sain and Belfiore (2005) point out that if PAs are managed in isolation, they are vulnerable to negative exterior developments such as pollution, overfishing and destruction of habitats. For this reason these authors argue that "protection of coastal and marine areas […] needs to be integrated into spatial development strategies for larger areas"(2005, p. 862). Although Cicin-Sain and Belfiore express a preference for the framework of Integrated Coastal Management (ICM), the issue of policy coherence is in fact a larger one. IUCN-WCPA (2008, p. 19) therefore emphasize that PA management should relate to sectoral institutions in fields such as watershed management, fisheries, tourism and maritime transportation. Others emphasize the need for vertical and horizontal linkages among policy cycles at different scale levels (Fanning and others 2007).

Closely related to the above is the issue of institutional nesting, whereby institutions are defined as including both rules and organizations. Thus the organizational structure and rule systems implemented by PAs should 'fit' in larger entities, much like "Chinese boxes—institutions existing within a sequence of institutions" (Jentoft 2007a, p. 141). Ostrom (1990, p. 101) arrives at a similar conclusion. One of the design principles she identifies for the management of common pool resources is that institutions are all "organized in multiple layers of nested enterprises." Approaching the issue from another side, Christie and White (2007) argue that "MPA implementation requires supportive legal and jurisdictional frameworks", noting somewhat ominously that this is "a relatively rare condition around the world."

But PAs are also a part of a political context (Charles and Wilson 2009, p. 12), in which politicians make decisions that affect a PA in one way or another. Whether this is a desirable condition is up for debate. Jentoft (2007b, p. 673) for example muses that "I have heard scientists say that fisheries management could work much better if politicians would stay away", but concludes that "we need more politics in fisheries management, not less." Whatever one's opinion might be, it is clear that PAs require long-term political support and legitimacy in order to be successful. IUCN-WCPA (2008, p. 83) thus argues that: "political awareness and support are fundamentally important throughout the process of developing and implementing a MPA network." We would thus expect the PA literature to consider the governance environment (GE)—specifically the wider policy, institutional and political setting, and (ideally) to comment on the extent to which this environment is conducive to the performance of the PA in question.

PAs also have a temporal environment (TE), which consists of their history of origin as well as visions of the future. Chuenpagdee and Jentoft (2007) argue that the manner in which PAs are brought about contributes in large measure to their subsequent governability, some actions and events detracting from (and others adding to) present performance. Special attention therefore needs to be given to past path dependency, and the manner in which a PA's history influences its current functioning. The temporal environment of governance also includes the extent to which governing agents have developed—and communicated—a vision for the short- and long-term future of the PA. The credibility and legitimacy of this vision is argued (Jentoft and others, 2007) to influence the extent to which stakeholders subscribe to the rules imposed by a PA authority.

Consequently, we expect that the literature makes reference both to the manner in which the PA was established—as well as the clarity (and stakeholder acceptability) of plans for the future of the PA (the 'vision').

### *Internal Governance Structures*

The manner in which PAs are governed internally also has a critical impact on their ultimate performance. Five dimensions of internal governance (IUCN-WCPA 2008; Ostrom 1990) are particularly important in this respect: (i) decision-making arrangements, (ii) resource use rules, (iii) monitoring and enforcement systems, (iv) sustainable financing and (v) conflict resolution mechanisms.

First, decision-making arrangements (DMA). Interactive governance theory (Kooiman and Bavinck 2005) distinguishes three modes of decision-making with regard to resource use: self-governance (whereby resource users devise their own management system), hierarchical governance (in which an outside agent such as government sets the rules) and co-governance (in which there is some form of partnership in rule-making between resource users and outside agents). Christie and White (2007) apply a similar schema to MPA management, arguing that context determines the most appropriate choice. They also point out the role of other actors than government, such as traditional authorities, and private entities. Needless to say, power is a crucial aspect of decision-making (Jentoft 2007c; Jones 2009).

Much debate surrounds the issue of participation of resource users in PA decision-making. Charles (2001, p. 237) is adamant: "Experience has shown that the imposition of MPAs without broad consensus is a recipe for failure." He therefore argues that it is crucial to "undertake consultation, design, implementation and monitoring of the MPA using participatory processes." Pomeroy and Berkes (1997) note, however, that user participation can vary on a scale from being consulted to being fully in charge (c.f. Pollnac and Pomeroy 2005). We expect that the literature provides an indication of the decision-making arrangements applied within the PA—and in particular, how (and the extent to which) different stakeholders participate in decision-making.

Second, resource use rules (RUR). PA managers apply a variety of rules to structure the appropriation of environmental services in the geographically bounded areas under their jurisdiction. Within these areas, PAs often include a core region or closed area (in which restrictions are strict), and a buffer region (with a more relaxed regulatory regime and multiple-use activities).

Rules applying to PAs take two forms, rules that restrict access and rules that dictate what (and the corresponding quantity) that can be extracted (cf. Schlager and Ostrom 1993). Access rules define the conditions under which entrance is permitted, relating to persons, modes, and times. Extraction rules define the kind of activity which entrants are allowed to engage in and the environmental services gained. While many of the rules in MPAs relate to fishing activity (as this is often a common practice in the oceanic space slated for PA status), supplementary rules may relate to the extraction of minerals or fuelwood, or relate to tourist-type activities (such as dive schools for example). Consequently, we expect that the literature delineates the various access and extraction rules applied in PAs.

The world abounds with rule systems, which are neither adhered to or enforced (Pollnac and others 2001a, b; Christie and others 2009). Compliance has therefore become a major field of study (Hauck 2008) as institutional support for monitoring and compliance (M&C) purposes is limited. IUCN-WCPA (2008, p. 97) points out that: "monitoring and evaluation provide the foundations for learning lessons and adaptive management of the MPA network" (cf. Charles 2001). The same source (pp.100) noted a series of practical reasons for defective enforcement of rules in PAs, arguing that: "one solution for enforcement problems is considerable involvement by local communities and other stakeholders in conservation projects." It stands to reason that literature therefore discusses the extent to which a monitoring framework is in place.

Creating and maintaining PAs requires substantial funding (PAFUN) and this should be recognised in the literature. IUCN-WCPA (2008, p. 88) argues therefore that "a financially sustainable MPA network should be able to meet, on a continuing basis, the initial and recurring costs needed to achieve its objectives." A resilient financial strategy should always embrace a portfolio of complementary revenue sources as well as cost-effective management approaches. Such revenue sources may include funds derived from governments and NGOs, grants from private institutions, but also locally generated income, with funds for capital investment often being obtained from different sources rather than recurring expenses.

In her seminal volume 'Governing the commons' (1990), Ostrom includes the availability of low-cost conflict resolution mechanisms (CRM) among her design principles for long-enduring common pool resource institutions. As in any other societal field, conflict is a recurring theme in PA governance, taking place at various scale levels and between different categories of actors (such as users, outsiders, and officials). Provisions for their just and effective resolution are therefore of eminent concern, if the PA is to be maintained over time.

In governance/management terms then, PA literature can therefore also be evaluated in terms of whether—and the extent to which—it comments upon; (i) the governance environment [two components], and (ii) internal governance structures of the PA [five components]. A full governance and management check-list is given at Appendix.

## Methods

The BEG framework is operationalised by drawing on the preceding literature review so as to identify seven issues across each of the three domains (biology-ecology, socio-economic, governance-management)—which we would expect the MPA literature to address in some way or other. In the case of the biological/ecological domain, these embrace considerations such as whether the PA has led to reduced stock mortality/increased abundance, and/or

reduced environmental or habitat damage, or perhaps induced spillover or larval export effects. Socio-economic components include identifying whether the literature being interrogated computes estimates of changes in total catches and/or fishing effort—and the degree to which PA creation has engendered the growth of new non-extractive activities, besides identifying how the benefits have been shared among different stakeholders. The governance-management domain captures whether the literature examined details considerations such as resource-use rules, decision-making arrangements and conflict resolution mechanisms within the PA, as well as the funding and local institutional environment.

The literature selected for analysis using the BEG framework was identified using google scholar, and spanned the 15-year period between 1994 and 2009 (see Appendix for a list of (30) analyzed articles). As many articles prior to 1994 are presently not available in pdf format through google scholar, this dictated the time frame available for analysis. A time frame of 5-year cohorts was selected so as to ascertain whether the BEG framework could identify trends in changing discourse. Articles were retrieved according to the search term 'Marine Protected Area' as an 'exact phrase' to be located 'anywhere in the article' and were downloaded in 5-year cohorts; for each cohort, ten highly cited MPA articles—as produced by Google Scholar—were analyzed. The presence and frequency of each component (or search term) in each article was recorded using the pdf search engine, which was supplemented by a quick visual check as to the accurate interpretation of the term in the context of surrounding text. Terminologies were expanded upon in order to capture the range of words used to describe similar phenomena. Hence in the biology domain, for example, 'Rationale' was expanded to include the search terms 'create', 'establish', 'MPA design' and 'network'. Reduced damage to habitat was similarly extended to include 'biodiversity', 'protection', and 'habitat' etc.

Evaluation of the literature was a four stage process. First, each article was reviewed to determine whether each of the specific components given in Appendix is satisfactorily addressed (Yes/No) from a BEG perspective. Second, all affirmative answers are then summated for each of the three domains—B, E and G (maximum score = 7, range 0–7 for each domain). Third, these are then reproduced in the form of an illustrative triangle (see Figures in the following section). In the unlikely event that an article fails to address *any* of the issues within all domains, then the locus reduces to the inner triangle. On the contrary, if all issues are addressed across all domains the locus equates to the outer triangle. In practice, most articles will fall somewhere in-between, with the ensuing BEG triangle giving an indication of the extent to which the literature under interrogation addresses each domain. Finally, we generated frequency data to provide an additional indication of the depth of engagement with a concept/terminology, and to avoid reliance solely on the presence or absence of terms in an article.

## Results

Figure 1 displays the presence or absence of the BEG domains in the three cohorts of reviewed articles

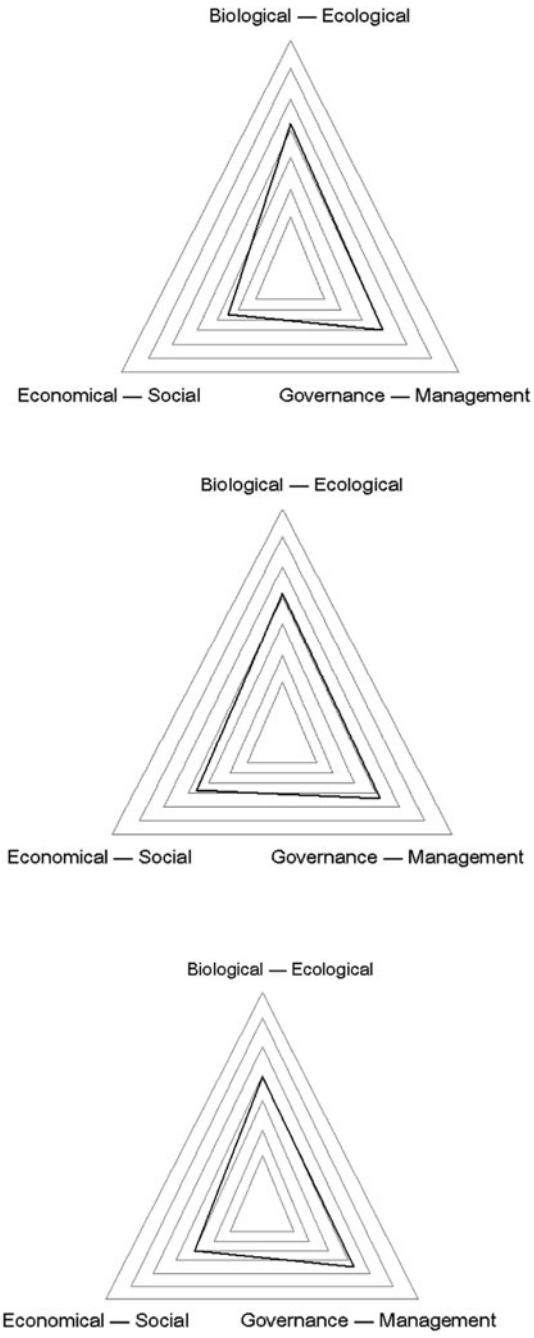


**Fig. 1** BEG triangle (1994–1999); BEG triangle (1999–2004); BEG Triangle (2004–2009)

(1994–1999; 1999–2004; 2004–2009), with 10 articles analysed per cohort.

The dominance of the biological-ecological domain in all three cohorts supports the commonly held perspectives of a dominance of biological analysis in MPA research (Hoagland and others 1995) and the subordination of social aspects of MPAs to a 'secondary importance' and generalized nature (Jentoft and others 2007) as were discussed in the introduction to this paper. However, two caveats are warranted. First, the diversity of different terminologies and expressions that can be used to express highly related phenomena make the identification and counting of search terms a potentially inaccurate process. Hence it is important that an extended menu of search terms is employed to counter this. Second, the growing recognition of the need for interdisciplinarity in work and praxis connection has led to some overlap between domains. For example, the domain of 'governance/management'—which fares well in the BEG triangles above—could equally point to the idea that management of MPAs is a universal and broadly recognized aim and rationale behind MPA research. Thus while management itself may not be the focus of the article per se, most articles, even those with a highly specialized biological focus, may well make some reference to 'better management' as part of its theoretical raison d'être. Many articles also signal the importance of 'social' or 'economic' aspects of MPAs—without going into any depth of discussion. Hence, the mere presence of terms does not necessarily indicate the presence of substantive discussion or consideration of the topic.

To counter this latter criticism we propose the basic BEG triangle is supplemented by examining the frequency with which terms are mentioned in the article under consideration, reasoning that the more frequently a term is used, the greater the likelihood of an in-depth discussion of that particular component in the article. Figure 2 thus displays the average frequency of search terms within each of the BEG domains across the three cohorts ($n = 30$). In accordance with results from the BEG triangles, there is a strong frequency of biological/ecological terminology, with economic/social considerations lagging behind. Articles with a biological focus can often mention social and economic factors (which are therefore present), but low frequency highlights that these are not dealt with in any depth. For example, McNeill (1994) is interested in the selection and design of marine protected areas in Australia and has a high score for Biological/ecological terms (108) but a much lower score of (12) for economic/social terms, which focussed on economic values. The Governance domain (17) is higher as aspects of political acceptance, legalisation and management effectiveness are substantially addressed in the paper.

The analysis of frequency of terminologies progresses the capacity of the BEG framework to tackle broad and common concerns such as governance within the MPA literature. For example, White and Courtney (2002) have a clearly interdisciplinary paper titled "Experience with Marine Protected Area Planning and Management in the Philippines". As one might expect, frequency of terms are well distributed across the three domains (B = 88, E = 59, G = 220). Compare this with Hooker and others (1999) whose article is focussed on MPA design and benefits to cetaceans (B = 49, E = 3, G = 1). This is not to argue that all MPA research should have an element of engagement across all BEG domains; specific research projects which remain within one domain make important contributions to MPA science. However, given that interdisciplinary, and integrated, approaches to marine conservation are highly advocated (Costanza and others 1998; Cicin-Sain and Belfiore 2005), it would be useful to apply the BEG tool to track the progression of inter-disciplinary research efforts over time.

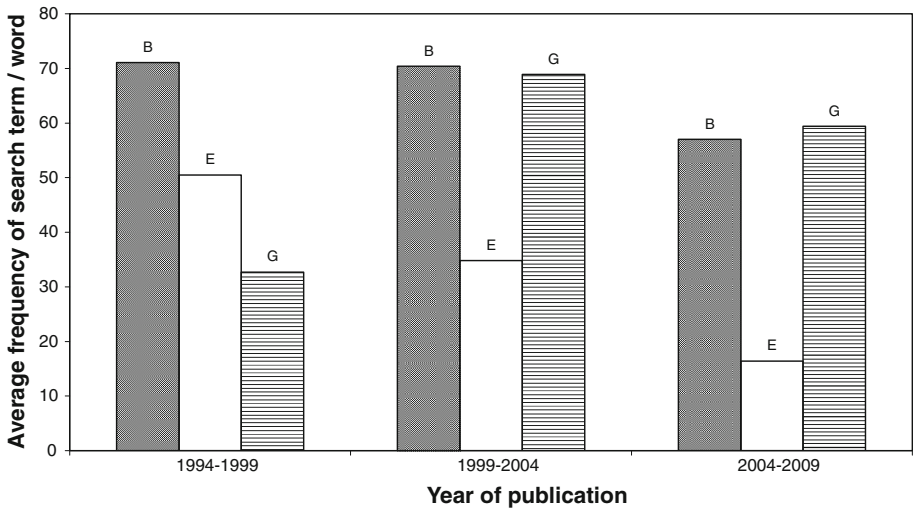


**Fig. 2** Average frequency of search terms from BEG domains in reviewed articles

Analysing, and contrasting, the contents of each 5-year cohort, the resulting BEG frameworks (Fig. 1) seem to indicate strong biological-ecological domains in the literature in all three cohorts, with a particularly weak presence of the socio-economic domain in the earliest and latest cohort. Reviewed articles in the earliest cohort (1994–1999) tended to emphasize the design of MPAs (McNeill 1994), the rationale and viability of marine parks as a precautionary approach to conservation (Lauck and others 1998) or conservation of a single species (Davis and Banks 1997), reflecting [perhaps] the failure to embrace an ecosystem approach, an approach which has gained greater currency in more recent years (Arkema and others (2006). The middle cohort (1999–2004) revealed several reflective papers on the effectiveness of MPAs (Jameson and others 2002) with discourse around the limitations of MPAs as a solution (Boersma and Parrish 1999, Agardy and others 2003)—which understandably opened space for a broader consideration of social and economic factors, and their implication for effective governance. There remains a focus on social and economic implications of MPAs in the most recent cohort (2004–2009) with well cited references such as Christie (2004) explicitly drawing out the conflict between social and biological implications of MPAs. International policy development is also reflected in the latest literature, with reference to the establishment of global networks of Marine Protected Areas (Mora et al. 2006).

## Conclusion

Willis (2003, p. 97) have suggested the raison d'être of many papers on MPAs is "advocacy for the establishment of marine reserves in parts of the world that lack them, rather than real attempts to contribute to the science of the field." As a consequence, the notion that marine reserves can be effective management tools, while intuitive, is often presented as established fact (p.98). Yet work by Kelleher and others (1995), for example, casts real doubt upon this and suggests widespread managerial shortcomings—as less than 31% of the MPAs they surveyed met their stated goals. This failure to meet stated goals can be due to a variety of factors; stock recruitment limitations (Doherty and Fowler 1994), displaced fishing effort concentrating around the peripheries of the reserve (Parrish 1999), data and information shortcomings in the pre-MPA period (Bohnsack 1998; Hall 1998), as well as social factors such as disparities in the sharing of benefits, the absence of conflict resolution mechanisms and the failure to ensure effective stakeholder participation (Christie and others 2003, p. 22). The question raised by Le Quesne (2007) whether "flawed MPAs [are] any good or just a new way of making old mistakes?" is therefore pertinent. Perhaps a similar question could be asked of the burgeoning literature on MPAs: 'Are papers advocating MPA formation based on sound biological/ecological, economic/social and/or governance/management research and/or principles'?

The aim of this paper was to thus devise a framework that could be used to evaluate the extent to which MPA research and policy documents delineate objectives around these three domains, as a first step to evaluating the above question. The biological-ecological domain of our BEG framework considered aspects of MPA design and biological success, including size/location, reduced fish mortality, improved habitat quality, and spill over effects such as larvae dispersal. The economic/social category included costs, fishing effort, extractive and non extractive use values, aspects of social or cultural change and equity considerations. The governance category analysed aspects of decision-making, management, rules and monitoring, and factors such as funding and recuperation costs. An analysis of frequency (Fig. 2), shows that the use of governance terminologies in the MPA literature have increased over time, an increase which may be indicative of a shift towards more integrated consideration of governance concerns to accompany biological ones. However, the economic/social domain still lags behind, which is concurrent with observations from the social scientists in the literature (see discussion in the introduction). This could reflect a deeper divide in MPA science and amongst MPA scientists, between natural scientists, who focus on biological aspects and are increasingly concerned with effective management, and social scientists who focus on social, cultural and economic domains of MPA, but remain disconnected from biological fisheries science (Weinstein and others 2007; Barnes and McFadden 2008).

Integrated and inter-disciplinary approaches to MPA management are frequently cited as a key for success (Arkema and others 2006) and, as such, it would be pertinent to have a tool that could track—and assess—progress in working towards a more complete and holistic MPA research and policy agenda. Identification of gaps in the literature could also help to direct attention to particularly neglected areas, thereby enabling a more balanced availability of evidence across social, economic, governance, biological and ecological domains. That said, the application of text-based analysis through key term searches is fraught with difficulty, largely due to the complexity of language and multiplicity of meaning and interpretation. Highly instructive in this regard was a conference key note speech entitled 'what do the social sciences do for fisheries policy?' by Daniel Pauly (2006). Pauly noted that his google search combining the terms 'anthropology' 'sociology' with 'fisheries' produced very low numbers of hits compared to searches using

'economics' or 'ecology' and fisheries—and led him to ask whether this indicated a lack of input from the social sciences in fisheries research and policy. Clearly, had a wider range of terms (such as 'governance', 'management', 'culture', 'society', or 'property') been applied in the search, Pauly's results and subsequent conjecture may have been different. The language can get in the way.

This is clearly problematic in the current context—as even the term MPA is, in itself, complex in definition—having numerous meanings ranging from no-take to multiple-use areas, and their creation can be driven by a fragmented mix of legislation and policy rationale. Despite this, the fact remains that the burgeoning literature in the area, and the sheer scope of access to large article data sets and skilful internet search engines, makes content analysis an appealing and potentially productive analytic method. However, given—as we have stressed—the limitations of quantifying language, it is imperative that visual checks are also used to underpin research of this type.

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## Appendix

See Tables 3 and 4.

**Table 3** The BEG Framework

| Domain | Variable | Acronym | Descriptor |
|---|---|---|---|
| Biological-ecological | 1. Location/size | LOC | Physical location and size ($km^2$ or otherwise) of MPA is identified |
| | 2. Ecologic rationale for creation | RAT | Reference/allusion made to one or more of the criteria identified in Table 1 (*b*, *n*, *d*, *r*, *u*, *I*, *p or v*) |
| | 3. Reduced mortality | RM | Population and community-level effects—as noted in Table 2 (A, S&A, B, P, R, C or H)—subsequent to MPA creation are acknowledged |
| | 4. Reduced environmental or habitat damage | REHD | Are changes in physical habitat (and reasons for) identified |
| | 5. Spillover | S | Evidence of adult fish moving out of MPA into adjacent waters |
| | 6. Larval export | LE | Evidence of larvae dispersion outside the confines of the MPA |
| | 7. Insurance | INS | Acknowledgement of non-fishery benefits arising from MPA creation (MPA provides 'insurance' against destruction of comparable ecosystems elsewhere) |
| Socio-economic | 1. Absolute catches | AC | Is mention made of how absolute catches (inside and outside MPA area) changed? |
| | 2. Total fishing effort/ costs | TFE, TFC | Is mention made of how total fishing effort and/or costs have changed following formation of the MPA? |
| | 3. (Other) extractive use values | EUV | Is mention made of any other extractive activities now occurring within the confines of the MPA? |
| | 4. Non-extractive use values | NEU | Has MPA creation engendered the expansion/creation of dive-shops and other non-extractive activities? |
| | 5. Other values | IUV, OV, BV, EV | Are ancillary benefits—such as indirect use,option, bequest and existence values recognised (and quantified)? |
| | 6. Equity considerations | STAKEBEN/ LOSS, COMP | Is comment made upon which stakeholder groupings have benefited—or lost out—as a consequence of MPA creation, and are any compensatory schemes in place? |
| | 7. Socio-cultural change | SOCCUL | Is comment made upon any socio-cultural changes—demographic change, changes in holistic wellbeing, attainment of socio-cultural policy objectives—occurring as a consequence of MPA formation |
| Governance-management | 1. Governance environment | GE | Is the MPA 'nested' within the wider policy, institutional and political setting |
| | 2. Temporal environment | TE | Is allusion made to the origins of the MPA—as well as future visions |
| | 3. Decision-making arrangements | DMA | Are explanations provided as to how the MPA is governed, and by whom? |

**Table 3** continued

| Domain | Variable | Acronym | Descriptor |
|---|---|---|---|
| | 4. Resource use rules | RUR | Are details provided of the rules governing access and/or what can be extracted from the MPA? |
| | 5. Monitoring and enforcement | M&E | Is mention made of the procedures deployed in instances where rule transgression occurs? |
| | 6. Funding | PAFUN | Is comment made upon how set-up and operational costs over time are to be met (including by who)? |
| | 7. Conflict resolution mechanisms | CRM | Are details provided as to how conflicts (of internal and external origin) are dealt with? |

**Table 4** Reviewed articles

| Article no. | No. cited by | Full reference |
|---|---|---|
| *Cohort 2004–2009* | | |
| 1 | 53 | Scholz, A and K. Bonzon and others (2004). Participatory socioeconomic analysis: drawing on fishermen's knowledge for marine protected area planning in California. *Marine Policy* 28 (2004) 335–349 |
| 2 | 62 | Mora, C., Andrèfouët, S., and M.J. Costello et al. (2006). Ecology. Coral Reefs and the Global Network of Marine Protected Areas. *Science* 312 (5781): 1750–1751 |
| 3 | 65 | Balmford, A., and Gravestock P et al. (2004). The worldwide costs of marine protected areas. *Proc. of the Nat. Acad. of Sciences in the USA (PNAS)*, 101 (26): 9694–9697 |
| 4 | 44 | Christie, P (2004) Marine Protected Areas as Biological Successes and Social Failures in Southeast Asia. *American Fisheries Society Symposium* 42:155–164 |
| 5 | 38 | Helvey, M (2004). Seeking Consensus on Designing Marine Protected Areas: Keeping the Fishing Community Engaged *Coastal Management* 32:173–190 |
| 6 | 36 | McClanahan, T.R and N. A. J. Graham (2005). Recovery trajectories of coral reef fish assemblages within Kenyan marine protected areas Mar Ecol Prog Series 294: 241–248 |
| 7 | 37 | Weible, C., Sabatier, P.A. and M. Lubell (2004). A Comparison of a Collaborative and Top-Down Approach to the Use of Science in Policy: Establishing Marine Protected Areas in California. *The Policy Studies Journal* 32 (2): 187–207 |
| 8 | 30 | Edgar, G.J, Bustamante, R.H., and J.M. Farina et al. (2004). Bias in evaluating the effects of marine protected areas: the importance of baseline data for the Galapagos Marine Reserve. *Environmental Conservation* 31 (3): 212–218 |
| 9 | 29 | Foale, S., and B. Manele (2004). Social and political barriers to the use of Marine Protected Areas for conservation and fishery management in Melanesia. *Asia Pacific Viewpoint* 45 (3): 373–386 |
| 10 | 33 | McClanahan, T.R., Graham, N.A.J., and J.M. Calnan et al. (2007). Toward pristine biomass: reef fish recovery in coral reef marine protected areas in Kenya. *Ecological Applications* 17(4): 1055–1067 |
| *Cohort 1999–2004* | | |
| 11 | 136 | Agardy, T., Bridgewater, P., and M.P. Crosby et al. (2003). Dangerous targets? Unresolved issues and ideological clashes around marine protected areas. *Aquatic Conserv: Mar. Freshw. Ecosyst.* 13: 353–367 |
| 12 | 87 | White, A.T, and Courtney, C.A., (2002). Experience with Marine Protected Area Planning and Management in the Philippines *Coastal Management*, 30:1–26 |
| 13 | 152 | Walters,C., Pauly,D., and V. Christensen (1999). Ecospace: Prediction of Mesoscale Spatial Patterns in Trophic Relationships of Exploited Ecosystems, with Emphasis on the Impacts of Marine Protected Areas *Ecosystems* 2: 539–554 |
| 14 | 115 | Boersma, P.D, and J.K. Parrish (1999). Limiting abuse: marine protected areas, a limited solution. *Ecological Economics* 31: 287–304 |
| 15 | 108 | Brown K., Adger, W.N., Tompkins, E., et al. (2001). Trade-off analysis for marine protected area management. *Ecological Economics* 37: 417–434 |
| 16 | 95 | Hooker, S.K, Whitehead, H., and S. Gowans (1999). Marine Protected Area design and the spatial and temporal distribution of cetaceans in a submarine canyon. *Conservation biology* 13 (3): 592–602 |
| 17 | 105 | Hyrenbach, D.K., Forney, K.A, and P.K. Dayton (2000). Marine protected areas and ocean basin management. *Aquatic Conser: Mar. Freshw. Ecosyst*. 10: 437–458 |

**Table 4** continued

| Article no. | No. cited by | Full reference |
|---|---|---|
| 18 | 80 | Walters, C., (2000). Impacts of dispersal, ecological interactions, and fishing effort dynamics of efficacy of Marine Protected Areas: How large should protected areas be? *Bulletin of Marine Science* 66(3): 745–757 |
| 19 | 76 | Jameson, S.C, Tupper, M.H., and J.M. Ridley (2002) The three screen doors: *can* marine ''protected'' areas be effective? *Marine Pollution Bulletin* 44: 1177–1183 |
| 20 | 84 | Tuck, G.N., and H.P. Possingham (2000). Marine Protected Areas for spatially structured exploited stocks. *Mar. Ecol. Prog. Ser* 192:89–101 |
| *Cohort 1994–1999* | | |
| 21 | 261 | Kelleher, G., (1996). A Global Representative System of Marine Protected Areas. *Ocean & Coastal Management*, 32 (2): 123–126 |
| 22 | 173 | Agardy, T., (1994). Advances in marine conservation: The role of marine protected areas. *Trends in Ecology & Evolution*, 9 (7): 267–270 |
| 23 | 101 | Davis, D., and C. Tisdell (1995). Recreational scuba-diving and carrying capacity in marine protected areas. *Ocean & Coastal Management*, 26 (1):19–40 |
| 24 | 82 | Jennings, S., Marshall, S.S., and N.V.C. Polunin (1996). Seychelles' Marine Protected Areas: Comparative structure and status of reef fish communities. *Biological Conservation* 75: 201–209 |
| 25 | 76 | Davis, D., and S. Banks (1997). Whale sharks in Ningaloo Marine Park: managing tourism in an Australian marine protected area. *Tourism Management*, 18 (5): 259–271 |
| 26 | 46 | Farrow, S. (1996). Marine protected areas: emerging economics. *Marine Policy*, 20 (6): 439–446 |
| 27 | 49 | McNeill, S.E (1994). The selection and design of marine protected areas: Australia as a case study. *Biodiversity and Conservation,* 3: 586–605 |
| 28 | 29 | Kelleher, G, and C. Recchia (1998) Editorial—lessons from marine protected areas around the world. *Parks (IUCN).* 8 (2): 1–5 |
| 29 | 23 | Preen, A., (1998). Marine Protected Areas and Dugong Conservation Along Australia's Indian Ocean Coast. *Environmental Management*, 22 (2): 173–181 |
| 30 | 403 | Lauck, T., Clark, C.W., and Mangel, M., et al. (1998). Implementing the precautionary principle in fisheries management through marine reserves. *Ecological Applications*, 8(1): 72–78 |

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