Well-being outcomes of marine protected areas

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Abstract

Marine protected areas are advocated as a key strategy for simultaneously protecting marine biodiversity and supporting coastal livelihoods, but implementation can be challenging for numerous reasons, including perceived negative effects on human well-being. We synthesized research from 118 peer-reviewed articles that analyze outcomes related to marine protected areas on people, and found that half of documented well-being outcomes were positive, and about one-third were negative. No-take, well-enforced, and old marine protected areas had positive human well-being outcomes, which aligns with most findings from ecological studies. While on balance larger marine protected areas improved ecological conditions, smaller areas improved human well-being. Most studies focused on economic and governance aspects of well-being, leaving social, health, and cultural domains understudied. Well-being outcomes arose from direct effects of marine protected area governance processes or management actions, and from indirect effects mediated by changes in the ecosystem. Our findings illustrate that both human well-being and biodiversity conservation can be improved through marine protected areas, yet negative impacts commonly co-occur with benefits.

Main text

Many countries have committed to establishing 10% of their marine waters as marine protected areas (MPAs)[1,2] to stem biodiversity declines and safeguard related ecosystem services[3,4]. While conservation effectiveness of MPAs has been demonstrated through ecological studies[5,6], many MPAs have social goals and outcomes that are less well understood[7]. Understanding how human well-being may be affected by MPAs is important for ethical reasons with potential

implications for biological outcomes. MPAs that support positive human well-being are also more likely to achieve their conservation goals because they are more acceptable, desirable, and supported by local communities[8-10]. This, in turn, can increase compliance[11]. Human well-being is an important end goal, with co-benefits for conservation goals and policies (e.g.[12-15]). Ensuring that positive human well-being outcomes are associated with implementation and maintenance of MPAs is thus important for acceptance and effectiveness.

Worldwide, increasing establishment of MPAs[16] has stimulated research on well-being outcomes of MPAs, with a substantial increase in studies in the last decade (Figure S1). The most recent synthesis of impacts of MPAs on human well-being (hereafter "well-being outcomes"), published a decade ago, focused only on fishing communities due to data constraints[7]. That study found that MPA establishment tends to improve food security and empower local fishing communities, but that effects vary depending on the social and governance context[7,17]. Since this synthesis was conducted, there have been numerous case studies (Supplementary References) that document a broad array of positive and negative social outcomes from MPAs. Given the commitment by countries to establish MPAs[16], understanding their effects on well-being outcomes is crucial.

We performed a systematic literature review on the well-being outcomes of MPAs (Tables S1, S2). We examined social, health, culture, economic, and governance domains of human well-being[18], and added an environment domain since environmental health is fundamental to human well-being and vice versa (Table S1). Governance as a well-being outcome refers to the experience of local people with the quality of governance processes – including actors such as empowerment, participation, conflict management and accountability[19]. Our analysis allows us to answer questions critical for assessing well-being outcomes of MPAs. Where and how are well-being outcomes of MPAs studied? What domains of human well-being are included in

scientific studies? Are well-being outcomes consistent across different groups of people (i.e. stakeholders)? What factors influence whether positive or negative outcomes are perceived or experienced? Finally, what well-being outcomes co-occur?

Data on human well-being outcomes of MPAs

We identified 118 peer-reviewed articles (Supplementary References, Figure S1) that investigated an existing MPA or MPAs, and included information about the measured or perceived impact(s) of the MPA(s) on people (108 articles with quantitative or directional data). The relevant articles studied 121 MPAs distributed globally (Figure 1a), containing 267 observations of stakeholders (i.e., some articles studied multiple stakeholders, as defined in the source paper), each of which described one or more well-being outcomes of MPAs (i.e., 606 data points of well-being outcomes). Coastal communities referred to residents in coastal towns rather than more specific groups such as fisheries or tourism, and recreation was defined as non-extractive personal activities (e.g., diving, kayaking). 75% of stakeholder data involved fisheries; of those, 76% were about artisanal and small-scale fisheries, 15% about industrial fisheries, and 9% about recreational fisheries, but the sample sizes were too small to analyze by disaggregated fisheries categories. Further disaggregation, while not provided in the papers, might highlight additional biases in studies (e.g., gender, ethnicity)[20]. Most MPAs with relevant data were from Asia (especially the Philippines) and Europe, with a fairly even distribution of MPA size and age categories. The most common types of MPA governance were state-led and community-based, followed by co-managed. Several study designs were used, with those asking stakeholders for their perceptions of social change being the most common, followed by studies before and after MPA establishment, and studies using control-impact design (e.g., inside and outside of MPAs). The least common study type was the before-after control-impact design (Figure 1b).

78

79 **Domains of human well-being considered in MPA studies**

80

81 All domains of well-being were mentioned at least once in every paper, whether as the focus of
82 study, or in the discussion (Figure 2). Economic, governance and environment categories were
83 most prevalent, often the focus of assessment. Social, health, and cultural domains received
84 much less attention, usually in the form of a cursory mention in the discussion. The category
85 mentioned most frequently was economic livelihoods, in which we included fisheries catches
86 and catch per unit effort (CPUE). Categories of cultural diversity and mental health received the
87 least attention. We posit that the uneven consideration of categories is due to a combination of
88 the societal importance placed on economic outcomes, and the challenges in measuring social,
89 health, and cultural domains. Ten variables across four domains had enough quantitative
90 information to be further analyzed for outcomes (Figure 3): income, number of users, CPUE,
91 catches, cost of activity (only mentioned in relation to fishing regarding increasing fuel costs
92 when distance to fishing grounds increased), stakeholder rights to inform resource management
93 (hereafter “resource control”), stakeholder support for the MPA, change in spatial use patterns
94 (hereafter “spatial change”), conflict, and community involvement (Table S1).

95

96 **Well-being outcomes of MPAs**

97

98 Overall, there were more positive (51%) than negative (31%) well-being outcomes reported in
99 the literature (Figure 3, Table S3). Shifts in the numbers of users differed between stakeholder
100 groups, with more increases for tourism and recreation, and more decreases for fisheries (Table
101 S4). The most positive well-being outcomes of MPAs related to community involvement (76%
102 positive), CPUE (73%), and income (65%). The most negative outcomes manifested through
103 increasing costs of activities (100%, though only 13 instances, all related to increased cost of

fishing), and conflict (79%). We interpreted increased conflict as a negative well-being outcome, although conflict is not necessarily negative. Debate and to some extent, conflict, is recognized as a critical element of democratic governance and procedural justice[21], often providing space for a diversity of voices, including those of minority groups[22]. The most ambiguous outcomes (i.e., no change, or could not be interpreted as negatively or positively affecting people) occurred with shifting spatial usage patterns – mostly of fishing activities – due to the MPA.

Some explanatory variables had a significant influence on well-being outcomes (Figure 4, Table S5). MPAs that were single zones, no-take, old, and had high enforcement, indicated more positive well-being outcomes than other categories (Fisher's exact tests and ANOVAs, p-value <0.05). Study design was also correlated with outcomes, with studies that ascertained stakeholders' perceptions (that did not fall into the other research design categories) more negative than those that objectively measured outcomes. While the data showed that positive well-being outcomes were more prevalent in tropical systems, the correlation was not statistically significant when considering combined outcomes (Figure 4, Table S5). When analyzing specific outcomes (e.g., income, CPUE, number of users, etc.; Table S6), some additional patterns emerged. Ecosystem type was correlated with income, CPUE, support, spatial change, and community involvement; no-take zone presence was correlated with income, support, and community involvement; and compliance was correlated with resource control, support, spatial change, and conflict; for additional correlations, see Table S6. However, sample sizes were small when disaggregating outcomes, because most studies only included one or two outcomes.

Co-occurrences of outcomes showed some interesting and unexpected patterns (Figure 5). As expected, an increase in catches correlated with an increase in CPUE. When catches increased, there was also more conflict (which we interpreted as negative), perhaps due to

uneven distribution of benefits. Some co-occurrences, despite showing significant trends, have small sample sizes and are thus difficult to interpret (catches and income; catches and number of users; Figure 5), and we emphasize that correlation does not mean causation.

Discussion

Our finding that MPAs have more positive than negative well-being outcomes across diverse stakeholder groups – similar to findings by Mascia, et al. [7] for fishers – lends credibility to the potential of MPAs to benefit both biodiversity and people. Research shows that ecologically effective MPAs require five key attributes: no-take, well enforced, old (>10 years), large (>100km^2), and isolated[5]. Similarly, we found that no-take, well enforced, and old MPAs also led to more positive well-being outcomes. However, our results indicate that small MPAs had more positive well-being outcomes than large MPAs. Certain aspects of MPA design and management may thus contribute to both positive ecological and well-being outcomes, whereas others will require trade-offs. Our findings also highlight that there are both co-benefits and trade-offs among stakeholder groups, leading to questions of equity, justice, and power.

The scientific literature on well-being outcomes of MPAs focused on relatively few indicators mostly within the economic domain, such as income earned or catches, whereas many other potentially relevant indicators in other domains were mentioned but rarely measured (see Table S1 for examples of indicator topics for all well-being categories). For instance, indicators of diet and food availability can reveal changes in health of local populations dependent on coastal resources. The fact that measurements relate to only a few well-being outcomes is important, because there is a risk that easily quantifiable indicators come to dominate the discourse about well-being outcomes of MPAs. Multidimensional aspects of well-being, notably in relation to values, are particularly difficult to quantify (e.g. power, sense of community), but can have

156 important implications for the acceptance and support of MPAs[17,23]. Without being readily
157 measurable, there is a danger these aspects of human well-being may inadvertently disappear
158 from the problem/decision-making context because they are not being measured or reported if
159 decision-makers are not part of the affected communities (e.g., state managed MPAs).
160 Furthermore, indicators can become self-perpetuating, with the rationale for using indicators
161 based on past studies. Indeed, we justified some of the indicators we quantified because they
162 were assessed in a previous study[7]. Some indicators that are easily measured, such as equity
163 (e.g., examining outcomes by race, gender, age, location, cultural group, etc.), are rarely
164 included. Thus, we encourage those studying the well-being outcomes of MPAs to combine
165 previously tested indicators (see Hicks, et al. [24]) with efforts to develop a broader set of
166 indicators that represent holistic domains of human well-being[18,25,26]. Furthermore, qualitative
167 studies are particularly important in providing explanation and context for indicators, which alone
168 cannot tell the full story[25,27].
169
170 While social scientists are increasingly called on to assess human well-being outcomes of
171 MPAs[28], MPA development and management continues to be primarily occurring without
172 consistent quantitative or qualitative monitoring of well-being outcomes[29,30]. We need to move
173 towards ensuring the long-term well-being of people and communities that depend on marine
174 systems, and develop appropriate studies and indicators to capture the multi-dimensional
175 outcomes of MPAs. Similarly, participatory processes are critical to ensure that those affected
176 by MPAs are involved in making management decisions. Social sciences can provide important
177 methodological and analytical insights for qualitative studies and quantitative monitoring,
178 regarding ways in which stakeholders frame MPAs in their own terms, and how MPAs are
179 continually mediated through cultural values and worldviews, media discourses, and perceived
180 trust in science and institutions. A shift within management agencies is starting to occur, as
181 exemplified by the recent management focus on diverse ecological and cultural values[31,32].

The process of creating MPAs, that are small, local, and managed by communities, has numerous benefits for human empowerment and well-being, notwithstanding environmental outcomes[33-35]. Two main mechanisms for well-being outcomes of MPAs were reflected in the literature: (1) direct effects of MPA governance processes or management actions; and (2) indirect effects mediated by changes in the ecosystem. Direct effects included, for example, conflicts arising during MPA planning processes, community involvement in management, enhancement or displacement of livelihoods, and limitations on access rights (e.g., displacement from fishing an area, or exclusive access for some users). Indirect effects of MPAs on well-being are generally due to recovering marine systems and included increases in catches, CPUE, and income from resource extraction. These indirect effects are influenced by the state and management of ecosystems surrounding the MPA[36]. Some aspects of well-being outcomes may arise with both mechanisms. For instance, conflict can be caused by stakeholder discussions during MPA establishment and management fora, and it can also result from new or shifting user groups in the area, or changing availability of resources.

We found that conflict increased more often than decreased with MPA implementation. A key source of conflict identified in the reviewed literature related the reconfiguration of stakeholders' resource access, use and rights as a result of MPA implementation. For example, conflict was often related to MPA-mediated displacement of users that increased overlap in the use of marine areas. This was particularly common amongst fishers employing different gear types (e.g., [37,38]). Further, conflict was often documented in relation to MPA decision-making processes during which different stakeholder groups vie for influence and control. In many cases, this conflict occurred between local users (often fishers) and external stakeholders, including conservation organizations (e.g., [39]) and tourism operators (e.g. [40]). Given the power differentials between local users and external stakeholders (particularly in Global South

208 contexts), such processes were often documented as further marginalizing local users and
209 contributing to inequities in resource use or access[41]. However, in some cases it was reported
210 that MPA establishment was seen as a negotiation opportunity for local users to acquire or
211 solidify their rights over a marine area. For example, Cudney-Bueno et al.[42] report although
212 there was substantial conflict over the granting of access rights during MPA implementation,
213 fishers territorial access rights were strengthened through the process. Further, conflict can
214 denote debate and deliberative decision-making, essential to democratic governance and
215 procedural justice[35]. For example, Gurney et al.[41] document how conflict led to improved
216 governance, whereby MPA management group members fished together in an MPA to highlight
217 lax enforcement by government officials.
218
219 Given that MPA processes involve reconfiguring resource use and access, and typically involve
220 a number of competing stakeholder groups, conflict is likely[43]. Conflict also highlights that there
221 are commonly trade-offs among different people in MPA design and management, and that win-
222 win situations are rare and difficult to negotiate. Better understanding the nuances of conflict,
223 and managing expectations, might help inform and innovate future MPA design and
224 management processes. Collaboration between resource-users may also provide opportunities
225 for dialogue, sense-making and conflict resolution[44]. Involving the community at initial phases in
226 the policy decision-making process can promote deliberation and increase the efficiency in
227 producing workable outcomes[45,46]. However, we need to recognize that access to power is
228 uneven among stakeholders.
229
230 An interesting finding was that the design of studies affected whether well-being outcomes
231 appeared more positive or negative. Studies that measured the perceptions of stakeholders
232 (e.g., their self-assessment of impacts through surveys) were more negative than those that
233 attempted to measure objective aspects of human well-being (e.g., tracking fisheries landings

234 before and after MPA implementation). Such a discrepancy could be due to who is measuring
235 the outcome (stakeholders vs. researchers). Also, different aspects of well-being are captured
236 by subjective and objective measures, with objective measures less able to capture some
237 aspects of well-being that critically affect people, such as culture, conflict, and social relations.
238 Subjective measures do not only reflect perception; they can also be self-reports of observed
239 reality. Perceptions and self-reports clearly matter in their own right, because these can lead to
240 support for, or opposition to, conservation[19,47,48]. Thus using both objective and subjective
241 measures is essential, as they can test and lend validity to each other. Understanding why
242 results of objective measures are sometimes inconsistent with reported perceptions may help
243 identify more acceptable and robust management actions[49].
244
245 Our review revealed several research gaps that require attention. Some systems (e.g., Arctic,
246 sub-tropical) had no or very little data, and some regions (e.g., South America) and stakeholder
247 groups (e.g., recreational users) were understudied. A methodological gap was that the most
248 powerful study design – before-after-control-impact[50] – was also the least prevalent.
249 Furthermore, studies to date predominantly concerned single MPAs. As MPA networks are
250 being established, there is a need to think about assessing well-being outcomes at the scale of
251 networks, rather than single sites, which requires attention to potential mismatches between
252 ecological and social systems. Some limitations of our research are that we do not know
253 whether MPAs that have been studied are biased towards positive or negative results. We also
254 considered all indicators of well-being as important, whereas in reality some aspects will be
255 more important to stakeholders, and this will likely vary by stakeholder group. A more nuanced
256 understanding of human well-being outcomes of MPAs is critical for creating management
257 measures that benefit people and ecosystems.
258

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Figure 1. (a) Global distribution of the number of studies of MPAs by country included in the analysis, with MPAs shown in pink outline. (b) Characteristics of the studies and MPAs included in this review. Numbers in parentheses indicate the number of studies (i.e., papers) for study design (out of 118), and the number of MPAs (out of a possible 121; some MPAs had no data about some characteristics). BACI stands for before-after control-impact; S., C., and N. stand for South, Central, and North, respectively; co-mgnt is an abbreviation of co-managed.

Figure 2. Domains and categories of human well-being mentioned in studies reviewed. Env. means environmental. For the rationale underpinning our categorization scheme, see[18].Table S1 describes details about the domains of human well-being

Figure 3. Summary of well-being outcomes of MPAs. See Table S3 for interpretations of negative, positive, and ambiguous outcomes. Sums of percentages may not add up to 100% due to rounding errors. “Com. involvement” refers to community involvement. % refers to the percentage of data point that were positive, negative, or ambiguous (neither clearly positive or negative; or no change). Data points consist of all measures of well-being by stakeholder group(s) contained in the papers reviewed. See Table S3 for interpretation of positive, negative, and ambiguous.

Figure 4. Combined well-being outcomes summarized by explanatory variables. See Table S3 for interpretations of negative, positive, and ambiguous outcomes. Sums of percentages may not add up to 100% due to rounding errors. Ambiguous refers to no change or unclear directionality of change. Bolded variables are those that show significant ($p<0.05$) correlations (Fisher’s exact tests or ANOVAs) between the variable and synthesized outcomes (Table S5). For analyses by disaggregated outcomes, see Table S6.

Figure 5. Co-occurrence of select well-being outcome variables. Blue circles are scaled relative to each plot to illustrate the sample size (number inside the circle) of co-occurrences, and the grey bars indicate the sample sizes of the rows and columns. The first variable stated is shown on the x-axis, and the second on the y-axis. ** indicates Fisher's exact test $p<0.05$, *$p<0.1$.

Methods

Selecting papers: We carried out a systematic literature review in Web of Science (capturing all dates, with the first article appearing in 1973, last searched on 5 June 2018; Table S1) to identify studies that assessed the outcomes of MPAs on human well-being (hereafter well-being outcomes). We included original peer-reviewed journal articles that investigated (1) an existing MPA or MPAs, (2) included information about the measured or perceived impact(s) of the MPA(s) on people. Excluded were studies about: the impact of users on the MPA; opinion papers; modelling studies with hypothetical or predictive data; anticipated impacts; descriptive studies of fishing/tourism effort within an MPA without a temporal comparison; and review papers. Papers included the following research designs: before-after studies; control-impact (or inside-outside) comparisons; before-after-control-impact (BACI) studies; distance from MPAs; studies that assessed people's perceptions that did not fit in the other categories; and other (e.g., historical narratives, ethnographic studies).

Qualitative data and analyses on human well-being: We reviewed papers that met our selection criteria for mentions of possible well-being outcomes (i.e., qualitative information). We tracked the indicators or phrases mentioned, and summarized them into slightly adapted domains and categories of human well-being reported by Kaplan-Hallam and Bennett[1] (Table S1). We used this categorization because it provided a recent review and synthesis of social impacts in conservation and environmental management and was therefore highly relevant to our study. It synthesizes several related relevant frameworks, which we also considered e.g., [2-6]. Our modifications were to add 'environment' as a domain to encompass variables relating directly to the ecological system (although we did not track quantitative data for this domain); and we added 'legitimacy' to governance domain as this is an

important component of governance[7]. Ambiguities between domains of well-being meant that some indicators could fit within multiple domains, so we made a decision about the best fit. For example, 'number of users' can represent the cultural engagement with an activity, and we associated it with the cultural domain. It could also be an indicator of economic outcomes. We graphed the number of papers mentioning each of the domains and categories to provide an overview of the prevalence for different aspects of human well-being.

Quantitative data on human well-being: We collated results of measurements (quantitative data) of the well-being outcomes of MPAs by the most refined yet independent stakeholder group possible, such that a paper could provide multiple data points relating to different levels and types of social aggregation (e.g., by village, and/or by stakeholder type, and/or fishing gear type). We collated data for variables known to be important, and that are commonly measured, as identified by Mascia, et al.[8]: number of users (e.g., number of fishers, number of tourism operators), community organization (i.e., number of active civil society organizations exclusively or primarily of that stakeholder group), income, and the fisheries-specific measure of catch per unit effort (CPUE). In addition, we tracked other variables that were commonly measured within the papers reviewed: resource control (i.e., involvement by stakeholders in governing natural resources within the MPA), support for the MPA, cost of carrying out an activity (e.g., fuel costs for fishers or tourism operators), conflict, spatial usage change of the MPA (i.e., whether and how spatial usage patterns changed, mostly relating to fishing), and fisheries-specific total catches. We obtained quantitative data from the results of the papers, and tables and figures therein, using WebPlotDigitizer (https://apps.automeris.io/wpd/) to acquire data from figures or graphs. When multiple years were tracked, we used data from the latest year (i.e., longest time since protection). When multiple species were included (e.g., CPUE for multiple species), we used the data for the species with the most catches. Given papers used different methods and measures that are not

comparable across contexts, we categorized data as increased, no change, or decreased. Some papers reported different outcomes for a single category of well-being (support: high or increased, medium or no change, low or decreased; spatial change: displacement; fishing the line; changed pattern; no change). Therefore, we interpreted these measures as illustrating predominantly positive outcomes, negative outcomes, or ambiguous outcomes (Table S3). We created a summary of the outcomes by stakeholder-MPA combinations, categorizing them as positive if only positive outcomes were found for a stakeholder group, negative if only negative outcomes existed, and tradeoff if both were described for a stakeholder group; we did not consider ambiguous outcomes in this summary.

Data on explanatory variables: We collated information provided in the papers about potential variables that might contribute to the well-being outcome of MPAs on people including characteristics of: the MPAs (country, continent, size, age), governance (community-based, co-managed, state- or NGO-managed), management (no-take or multiple use), ecosystem protected (tropical, sub-tropical, temperate). We also included the study design used in the source papers (before-after, control-impact, BACI, perception, distance from MPA, other). For the sake of visual comparisons, we classified size and age into three categories: small (<1km2), medium (1-100km2), and large (>100km2); and young (<5 years), medium (5-10 years), and old (>10 years), respectively. Where details about the MPAs were lacking, we looked up the MPA on protectedplanet.net or MPA Atlas to ascertain the size and age. Some MPAs were not listed and thus had incomplete information. To estimate the age of the MPA at the time of the study, we used the designation date and the year the study was performed. If date of data collection was not provided, we assumed data were collected the year before publication. For MPAs that have had major management changes, we used the date of the change to calculate the age, not the original MPA designation date. Similarly, when papers mentioned that implementation (i.e., management plan) was different from the date of designation, we used the date of implementation. We

categorized the stakeholder groups studied (fisheries, coastal communities, tourism, recreation, other). Where the studies provided the data, we also compiled whether the MPAs had high enforcement (yes, no), high compliance (yes, no), and clear boundaries (yes, no).

Quantitative analyses: We summarized the data by calculating the percentage of positive, ambiguous, negative outcomes for the categories of human well-being that had quantitative data (economic, governance, social, cultural). Similarly, we summarized the percentage of positive, ambiguous, and negative outcomes by stakeholder group, ecosystems, MPA characteristics, MPA locations, governance, and study design. We used Fisher's exact tests (2-tailed, for factor variables) and ANOVAs with Tukey HSD post-hoc test (for continuous variables, size and age) to assess the statistical significance of the relationship between synthesized outcomes (positive, trade-off, negative) and the explanatory variables. We also examined within categories or variables with more than two categories, but these analyses did not yield any additional insights. We used Microsoft Excel and R to visualize data, and all quantitative analyses were carried out in R[9].

We used balloon plots (in R package gplots[10]) and Fisher's exact tests to gauge co-occurrence of specific outcomes. We examined co-occurrence of economic indicators by comparing the variable with the most data (catches, n=124) to other economic variables (income, number of users, CPUE), and the two next most commonly found variables to each other (CPUE and number of users). We excluded cost of activity because of limited data points (n=13). We then repeated the analyses comparing catches to governance variables (resource control, support, spatial change) and social variables (conflict, community involvement). Small sample sizes precluded statistical analyses with multiple variables.

The data that support the findings of this study are available as supplementary materials.

Methods references

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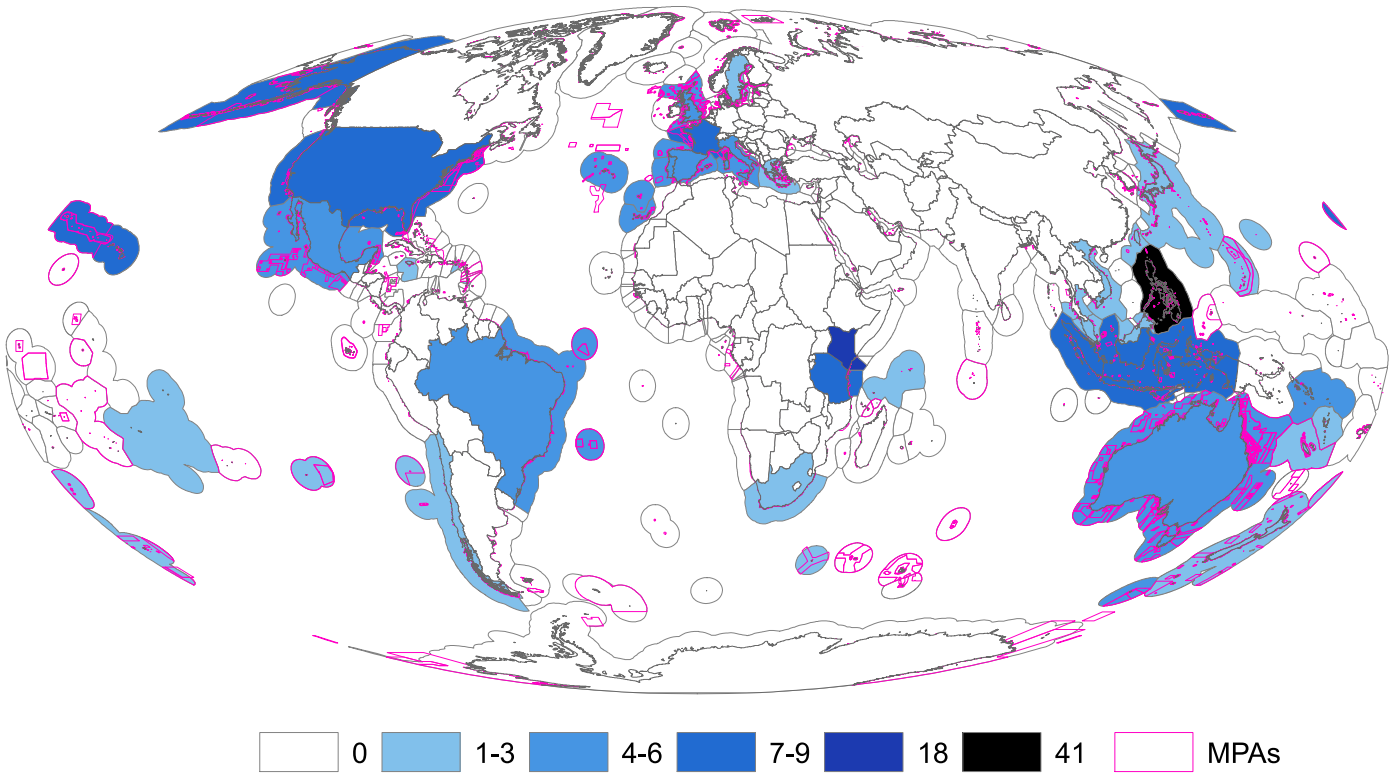
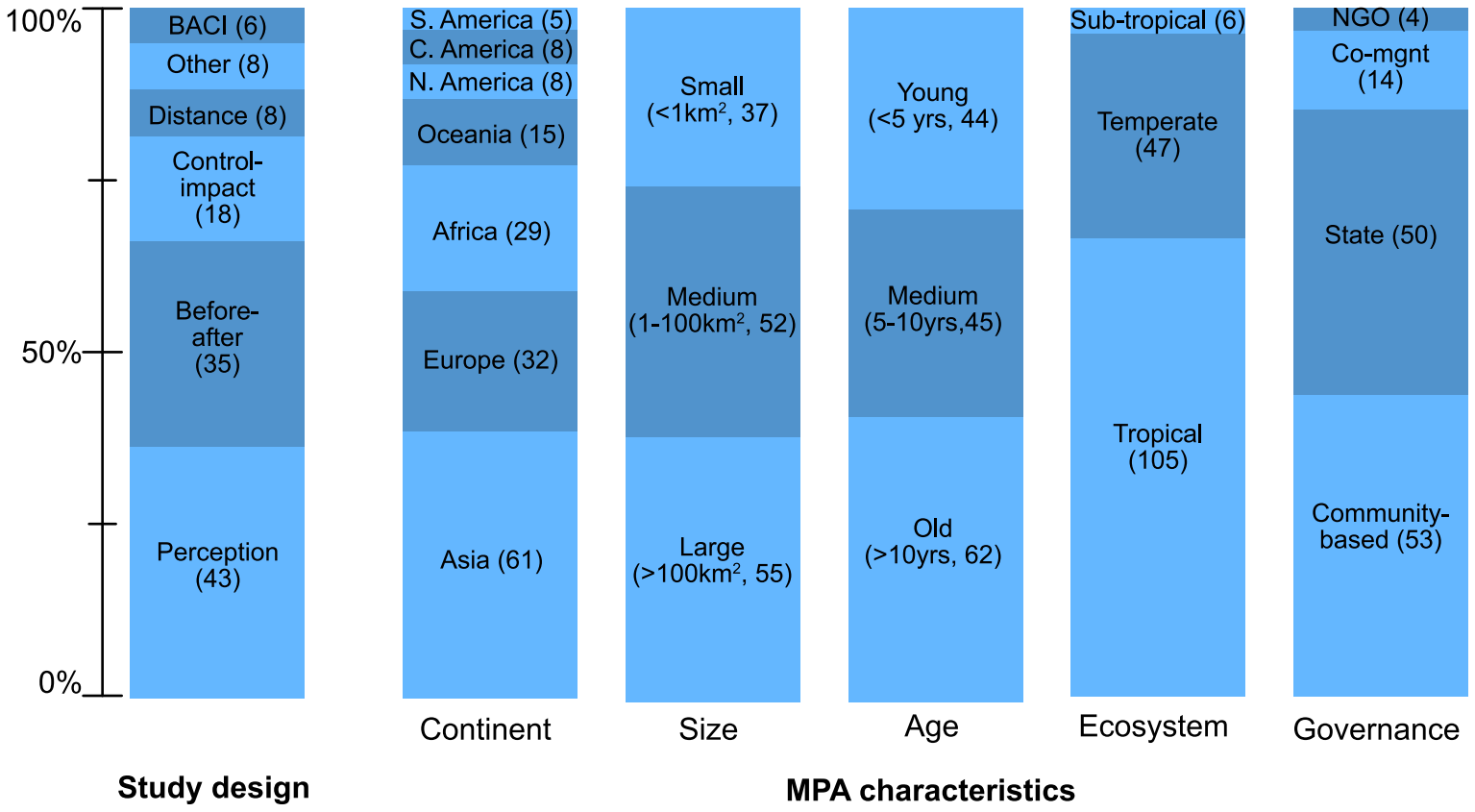
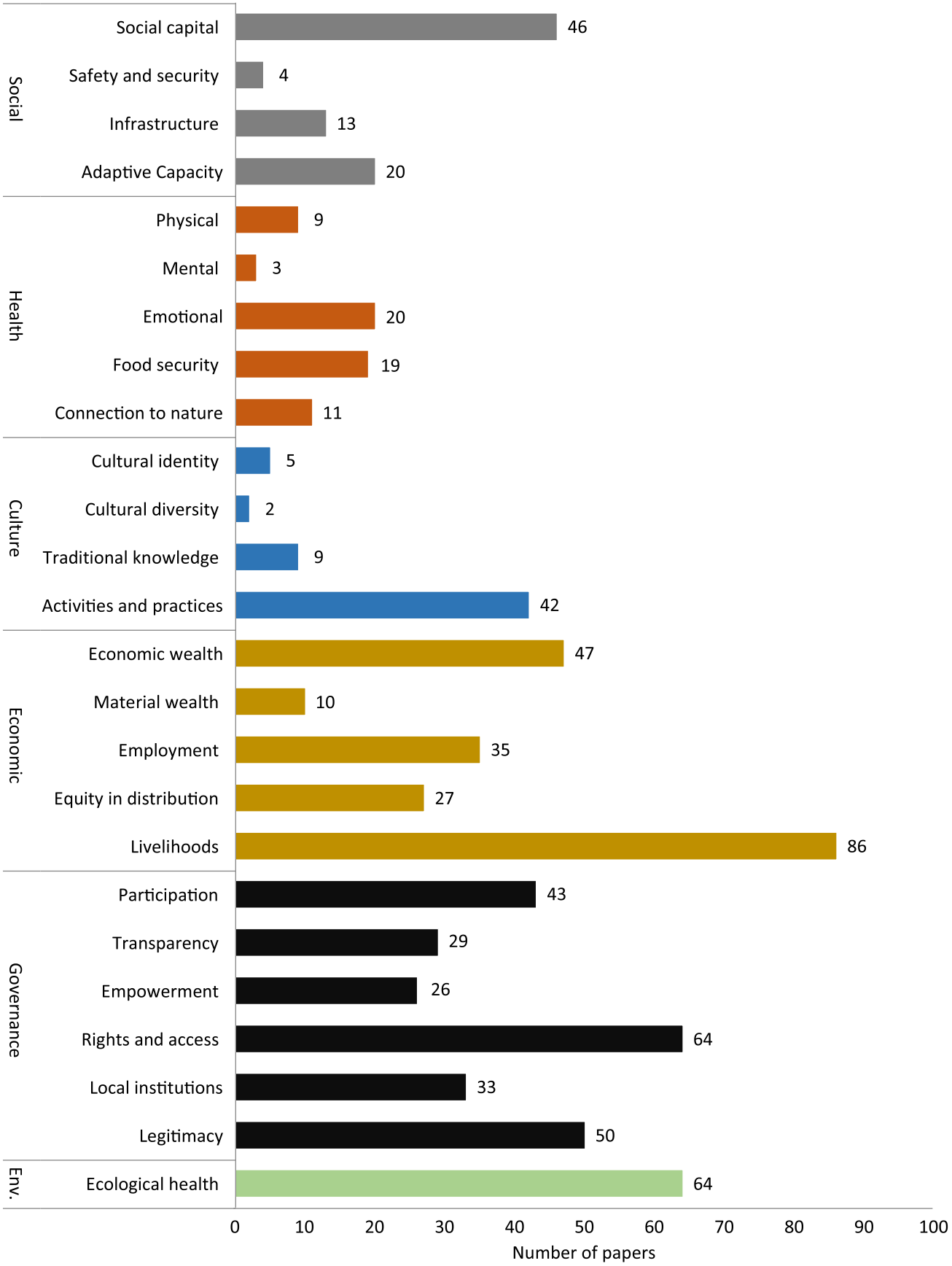
10 Warnes, G. R. *et al.* Various R Programming Tools for Plotting Data. (https://cran.r-project.org/web/packages/gplots/gplots.pdf, Online, 2016).

(a)

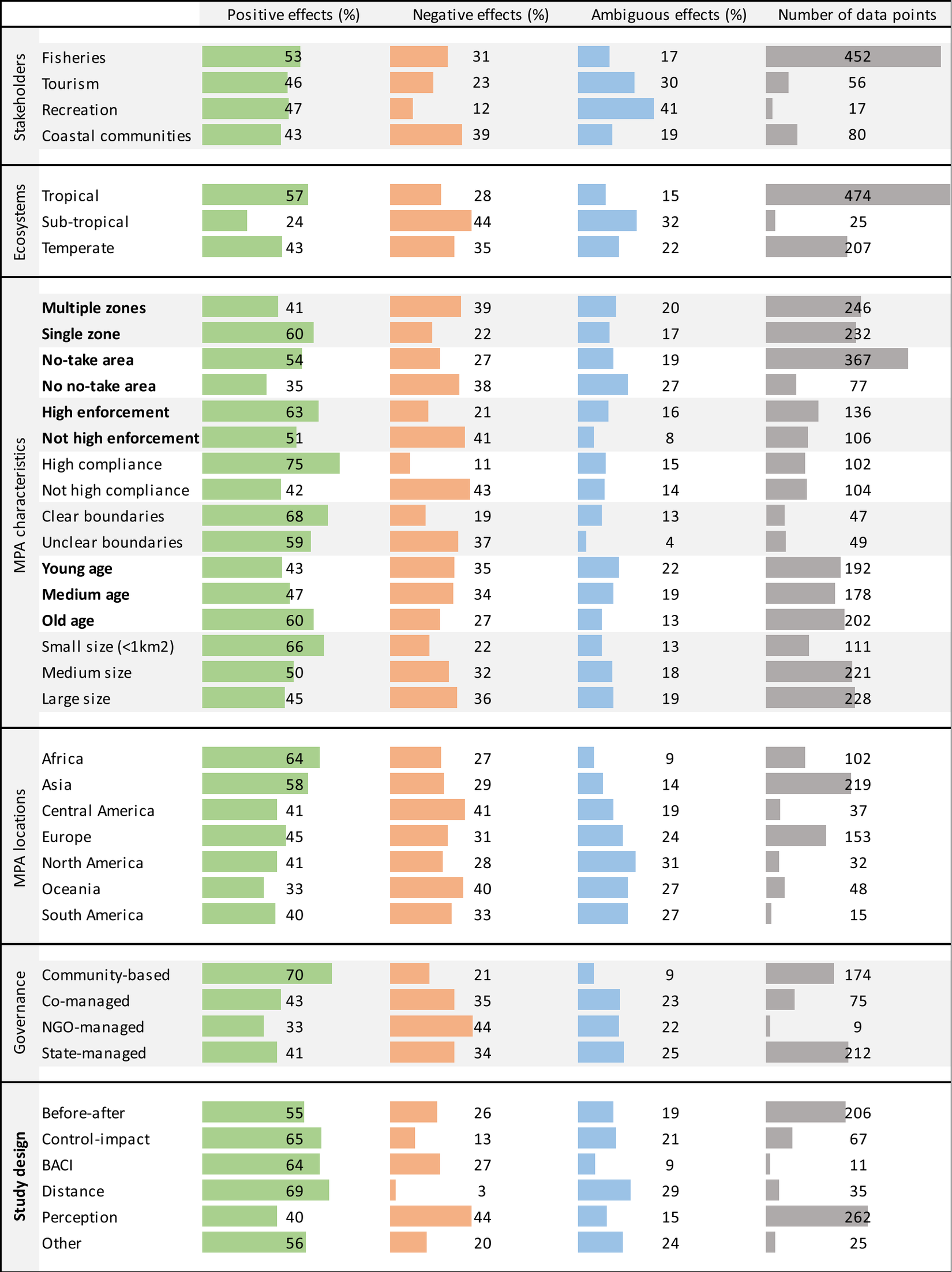

0
1-3
4-6
7-9
18
41
MPAs

(b)

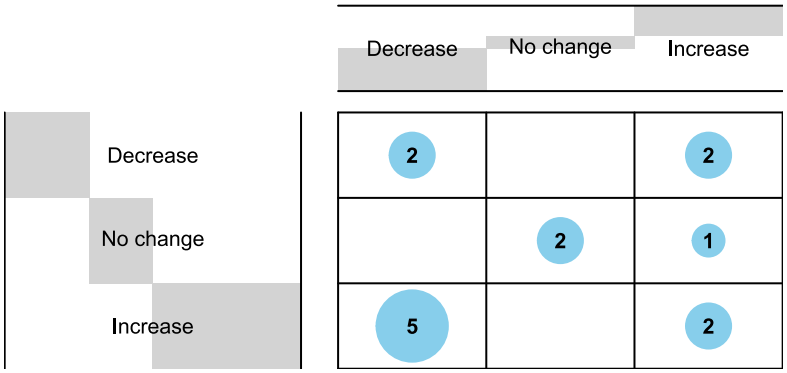

100%
50%
0%
BACI (6)
Other (8)
Distance (8)
Control-impact (18)
Before-after (35)
Perception (43)
S. America (5)
C. America (8)
N. America (8)
Oceania (15)
Africa (29)
Europe (32)
Asia (61)
Small (<1km², 37)
Medium (1-100km², 52)
Large (>100km², 55)
Young (<5 yrs, 44)
Medium (5-10yrs,45)
Old (>10yrs, 62)
Sub-tropical (6)
Temperate (47)
Tropical (105)
NGO (4)
Co-mgnt (14)
State (50)
Community-based (53)
Continent
Size
Age
Ecosystem
Governance
Study design
MPA characteristics


Social
Social capital
46
Safety and security
4
Infrastructure
13
Adaptive Capacity
20
Health
Physical
9
Mental
3
Emotional
20
Food security
19
Connection to nature
11
Culture
Cultural identity
5
Cultural diversity
2
Traditional knowledge
9
Activities and practices
42
Economic
Economic wealth
47
Material wealth
10
Employment
35
Equity in distribution
27
Livelihoods
86
Governance
Participation
43
Transparency
29
Empowerment
26
Rights and access
64
Local institutions
33
Legitimacy
50
Env.
Ecological health
64
0
10
20
30
40
50
60
70
80
90
100
Number of papers

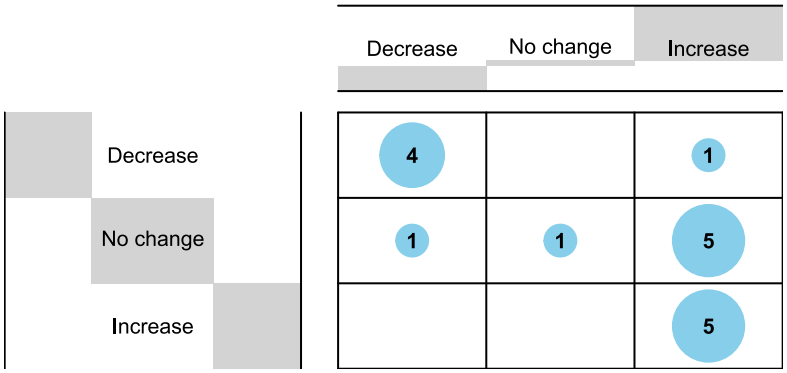

Positive effects (%)
Negative effects (%)
Ambiguous effects (%)
Number of data points
All combined
51
31
17
606
Number of users
44
34
22
59
Income
65
16
20
51
CPUE
73
11
17
66
Catches
61
20
19
124
Cost of fishing
0
100
0
13
Resource control
58
34
8
38
Support
61
33
6
83
Spatial change
22
25
52
67
Conflict
15
79
5
78
Com. involvement
76
3
21
34


Positive effects (%)
Negative effects (%)
Ambiguous effects (%)
Number of data points
Stakeholders
Fisheries 53 31 17 452
Tourism 46 23 30 56
Recreation 47 12 41 17
Coastal communities 43 39 19 80
Ecosystems
Tropical 57 28 15 474
Sub-tropical 24 44 32 25
Temperate 43 35 22 207
MPA characteristics
Multiple zones 41 39 20 246
Single zone 60 22 17 232
No-take area 54 27 19 367
No no-take area 35 38 27 77
High enforcement 63 21 16 136
Not high enforcement 51 41 8 106
High compliance 75 11 15 102
Not high compliance 42 43 14 104
Clear boundaries 68 19 13 47
Unclear boundaries 59 37 4 49
Young age 43 35 22 192
Medium age 47 34 19 178
Old age 60 27 13 202
Small size (<1km2) 66 22 13 111
Medium size 50 32 18 221
Large size 45 36 19 228
MPA locations
Africa 64 27 9 102
Asia 58 29 14 219
Central America 41 41 19 37
Europe 45 31 24 153
North America 41 28 31 32
Oceania 33 40 27 48
South America 40 33 27 15
Governance
Community-based 70 21 9 174
Co-managed 43 35 23 75
NGO-managed 33 44 22 9
State-managed 41 34 25 212
Study design
Before-after 55 26 19 206
Control-impact 65 13 21 67
BACI 64 27 9 11
Distance 69 3 29 35
Perception 40 44 15 262
Other 56 20 24 25

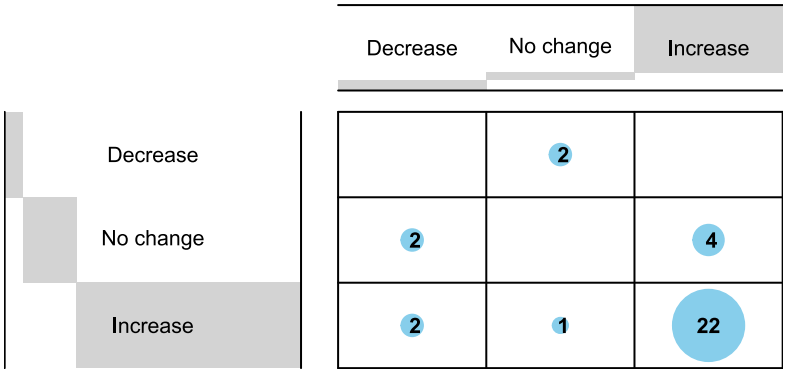
Catches vs Income*



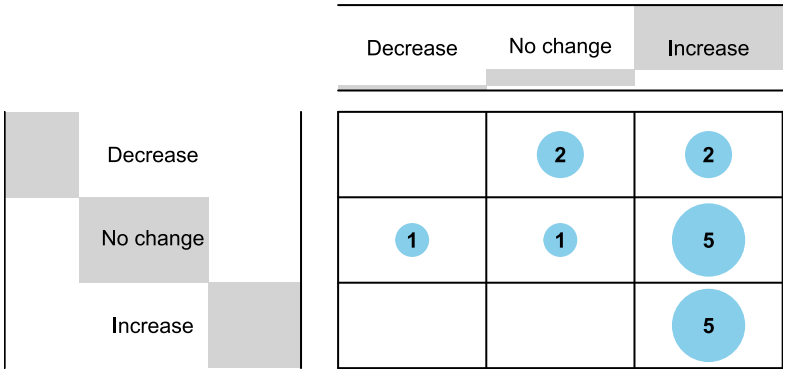
Catches vs number of users**



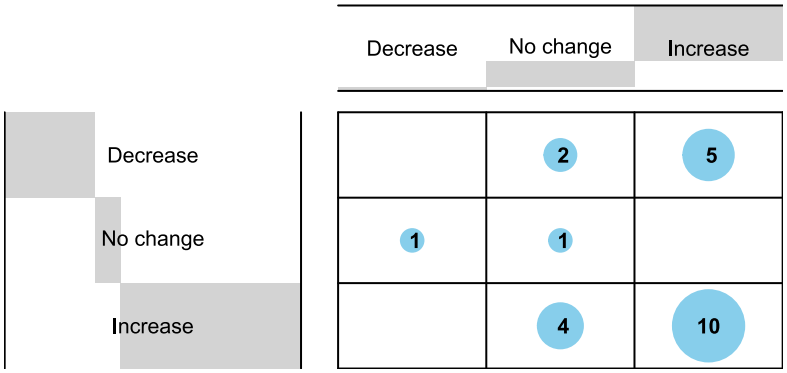
Catches vs CPUE**



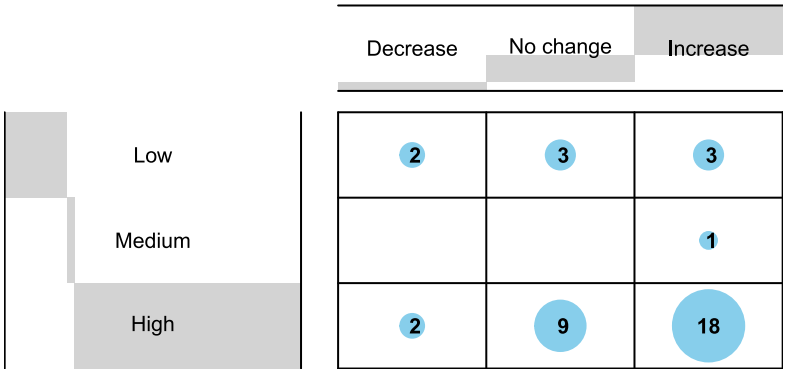
CPUE vs number of users



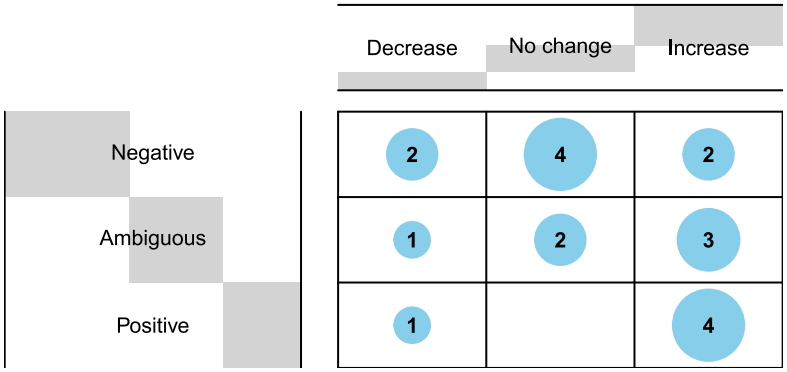
Catches vs Resource control



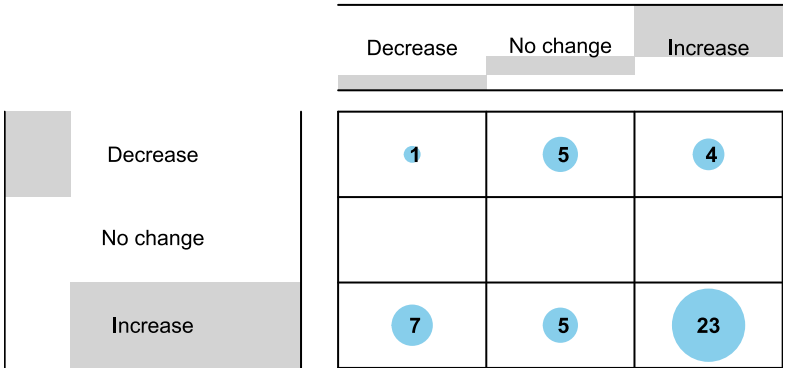
Catches vs Support



Catches vs Spatial change



Catches vs Conflict*



Catches vs Community involvement