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The 'Paper Park Index': Evaluating Marine Protected Area effectiveness through a global study of stakeholder perceptions

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ABSTRACT

Governments around the world are increasingly committed to reaching terrestrial and marine conservation goals. But achieving such commitments is challenging, and conservation targets that are reached on paper, e.g., in terms of square kilometers protected, can be misleading. Designating Marine Protected Areas (MPAs) does not guarantee achieving marine conservation goals, and so-called 'paper parks,' i.e., MPAs that are legally designated but ineffective, are common. Little is known about the *de facto* protection status of the established MPAs and no studies or databases have considered local stakeholders' knowledge. Using a one-question questionnaire, we collected data on local stakeholders' perceptions of *de facto* fishing in their MPA from most of the world's maritime countries. While the level of fishing effort was generally perceived to be higher in fully 'take' MPAs than in 'no-take' or multi-zone MPAs, we show that high levels of fishing also occur in MPAs that are fully protected according to MPAtlas and the IUCN, via a new 'Paper Park Index' (PPI), which allowed the identification of 55 likely 'paper parks,' i.e., Out of all 184 MPAs studied, 49 (27%) are classified as 'paper parks', of which 11 (35%) are in 'Latin America and the Caribbean', 17 (22%) in 'Indian Ocean', and 8 (16%) in 'Southeast Asia and Oceania' regions. The 11 MPAs with the highest PPI are listed and 10 of them are shown to have been already identified as not being very protective. These results highlight the importance of different stakeholders' knowledge about the extent and type of marine protection. They also serve as an invitation to policy-makers, spatial planners, managers and the scientific community to consider local knowledge and encourage the participation of a wider group of stakeholders in policy-making, planning and management of marine spaces.

1. Introduction

Life on Earth began in the oceans, and marine ecosystems still contain most of our planet's biodiversity [1–3]. Marine ecosystems are important for our welfare [4–8], cultural heritage [9,10], economic development [11,12], coastal protection [13] and the sequestration of atmospheric carbon [14], among other services. However, marine ecosystems, particularly along coastlines, are also some of the most heavily exploited ecosystems in the world [12,15], e.g., 50 % of salt marshes, 35 % of mangroves, 30 % of coral reefs, and 29 % of seagrasses and 89 % of oyster reefs have been lost or degraded worldwide [12].

Marine and coastal ecosystems experience pressure from a growing population, increasing urbanization [12,16], climate change impacts [13,17–20] hydrocarbon extraction [21] and other sources of pollution [22–25], and recreational activities [26]. As intensive fishing and overfishing appear to increase around the world [27–32], sustainably managing coastal ecosystems at the intersections of climate change adaptation, blue economies and conservation is an increasingly complex task.

The most frequently used tool for mitigating impacts on marine ecosystems is establishing Marine Protected Areas (MPAs), which cover about 8 % of our oceans as of 2019 [33,34]. The International Union for Conservation of Nature (IUCN) uses a global categorization of protected areas based on their management objectives and defines MPAs as "*a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*" [35]. Under this definition, the primary objective of an MPA must be the conservation of nature. IUCN also uses a category system which ranges from the category *i* for strictly protected areas to *vi*, in which conservation objectives are pursued in parallel to other human uses. Each category classifies protected areas according to its management objectives [36]. The IUCN's seven categories for MPAs are as follows: *ia* – 'Strict Nature Reserve,' *ib* – 'Wilderness Area,' *ii* – 'National Park,' *iii* –

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'Natural Monument or Feature,' *iv* – 'Habitat/Species Management Area, ' *v* – 'Protected Landscape/Seascape' and *vi* – 'Protected Area with Sustainable Use of Natural Resources.'

Some researchers pointed out that IUCN management categories need to be better adapted to marine environments [37], and that more specifications are necessary for these categories to apply well to non-terrestrial ecosystems [38,39]; also, the justification of some of the effectiveness of the categorical designation, such as *v* and *vi*, has been questioned [40,41]. Additionally, the problem of mislabeling MPAs with diverse management and zoning schemes [42,43] or different agencies applying different labels to MPAs [44] leads to ill-defined conservation goals or the protection level that is intended.

Several studies have pointed out that many MPAs do not achieve their conservation goals [45,46]; many of these ineffective MPAs were politically easy to establish, but do not protect much [47,48], leading to the term 'paper parks' being coined for MPAs that are not only ineffective but appear designed to fail [49–51]. Due to the growing number of MPAs and the expansion of unrealistic and idealistic conservation targets [52], more transparent information on the *de facto* protection that they provide to marine ecosystems is necessary. Without this information, it is challenging to standardize MPA establishment, management, and monitoring, and to avoid the proliferation of 'paper parks'.

This study used elicitation of the local knowledge of different types of stakeholders about the level of fishing perceived to occur in selected MPAs to infer the *de facto* level of protection that these MPAs enjoy. We focused on fishing to assess MPAs' *de facto* protection because fishing is – by far – the most important anthropogenic impact on marine biodiversity [29,43], and also easier to assess than the impact, say, of climate change or different forms of pollution [53].

This study serves as a useful entry point for further investigation into how much and in which way our oceans are protected. The information gathered from the different stakeholders using a one-question questionnaire via personalized email helps analyze marine conservation targets while offering a replicable and systematic methodology to identify discordances between MPAs' official categories and *de facto* protection levels. The question questionnaire sent by email is a unique method to collect and generate data that are easy to manage and assess. This one question questionnaires also helps to understand and assess how stakeholders from different socio-ecological regions share information and collaborate with scientists.

This study was performed to test several hypotheses. The first was that we would obtain a high response rate because of the simplicity of the questionnaire, but the response rate for fishers (or their professional organizations) would be low. The second, more important hypothesis was that the perceptions of fishing levels in various MPAs would differ across stakeholder groups, with the most optimistic answers (low fishing levels) being provided by government civil servants and more pessimistic answers from NGOs' staff.

2. Material and methods

Questionnaires are a commonly-used method to assess, advise, manage and invest in conservation [54,55]. In the present research, the questionnaire was sent as an integral part of a personalized email. This required little financial and technical resources while reaching a wide set of stakeholders around the world. However, there are some risks associated with the type and quality of the information obtained from questionnaires. Answers can depend on the time of the day when they open their emails [56] and/or be biased by the competence or background of the responders [57]. The latter is why we chose a range of stakeholders with different interests in MPAs.

The single question we asked via personalized emails concerned the level of fishing that they thought occurred in a given, explicitly mentioned MPA in their country's water, with the choices being 1, or 'no fishing,' 2, or 'light fishing,' 3, or 'moderate fishing,' and 4, or 'very intense fishing;' note that these terms were deliberately not defined further.

The benefit of choosing a one-question questionnaire within a personalized email is that people are more willing to reply to a single question, and even provide information to complete their answer. This contrasts, e.g., with the Hite Report which was based on questionnaires with over a hundred questions, and whose low response rate (8 %) generated a massive non-response bias [58]. To further reduce the non-response rate and hence non-response bias, follow-up emails were sent as recommended by the total design method of Dillman [59].

Based in part on the MPAtlas (https://mpatlas.org/) [33], we sampled at least one MPA per coastal country (n = 257). The objective was to assess countries' largest no-take MPAs, i.e., ideally an MPA with more than 90 % of its area designated as 'no-take,' or classified as Fully or Highly Protected in MPAatlas (n = 53). When this was not possible, MPAs with multiple zones were chosen (n = 11); later, they are called multi-zone (some zones of the MPA allow fishing). Otherwise, the largest MPA of that country was chosen, including some with zones categorized as Less protected/Unknown in MPAatlas (n = 150); later, for assessments, this type is called 'MPA w/fishing' (allows fishing in the entire MPA). For some MPAs, information about their zoning or prohibited activities was not available (n = 43).

The MPAs were also studied by socio-ecological region following the classification of Palomares and Pauly [60], i.e., High Arctic (n = 1), Indian Ocean (n = 40), Latin America and Caribbean (n = 82), Mediterranean and Black Sea (n = 33), North America and Greenland (n = 4), North-Western Europe (n = 40), Northwest Pacific (n = 12), Southeast Asia and Oceania (n = 33) and West Africa (n = 10), but with Antarctica added (n = 2). Note that we have considered the state of Hawaii as part of the North America and Greenland Region. The MPAs' years of establishment range from 1899 to 2020 based on the data from MPAatlas and official documents. More than 65 % of the MPAs were established over the last two decades. Specific information on countries' conservation efforts and further individual MPAs details and perceptions from the different stakeholder groups that replied to the questionnaire, can be found at www.searoundus.org [61]. The disparities in response rates among various stakeholders were an outcome of our decision to adhere to a consistent method of contact throughout the investigation [62]. This uniform approach may have impacted the response rate from the fishing community. Nonetheless, this highlights the need for alternative means of engagement with this particular demographic. Grading the reliability of perceptions is a challenging task. To enhance the reliability of our findings, we employed a diverse range of participants, thereby providing a comprehensive representation of opinions. Additionally, a word map of the studied MPAs can be found on the same website under the 'Tools & Data' menu. Each point shows the approximate location of the MPAs studied and the colours represent their size (red: <100 km^2, yellow: 100–1000 km^2, green: >1000 km^2) [62].

The IUCN category of the MPAs was sourced from ProtectedPlanet [34] and official documents such as their management plans (category iaand ib, n = 25; category ii, n = 45; category iii, n = 8; category iv, n = 58;category v, n = 24; category vi, n = 27; not reported, n = 70) of the 7IUCN management categories [36]. When this was not available the category was taken from MPAtlas [33]. The strictest IUCN categories are ia and ib ('strictnature reserve' and 'wilderness area') and the less strict is *vi* ('Protected area with sustainable use'). The IUCN categories are the widest and most global categorization system to classify protected areas. Even though the IUCN categories were not developed to relate to allowed uses within MPAs, they reflect the intent of the MPAs through their main management goals. In order to make the IUCN categories comparable to our fishing responses, the categories *ia* and *ib* are considered equivalent to our response 'no fishing,' *ii* to 'light fishing,' *iii* to 'moderate fishing' and *iv*, *v*, *vi* to 'very intense fishing' (based on [63]).

When comparing the most common responses per stakeholder group and region, there were, in some cases, ties between two adjacent fishing levels (e.g., 2 and 3, or 3 and 4). In such cases, to avoid biasing the result

toward higher fishing intensities, the lower fishing level was selected.

Within each Marine Protected Area, the average responses of the fishing intensity from the questionnaire were used to derive a 'Paper Park Index' (PPI), i.e., the difference between the average fishing intensity indicated in the responses to our questionnaire and the IUCN category level. Thus, the MPAs that present the largest difference between the official IUCN category and the average perception of fishing intensity have a high PPI and are tentatively classified as potential 'paper parks' or misfunctioning MPAs. In other words, the PPI assesses the difference between the expected conservation goals of the MPA and the perceived fishing activities within that MPA. For example, if most respondents indicated 'moderate' or 'very intense fishing' for an MPA officially designated as 'no-take,' we might be dealing with a potential 'paper park' or a misfunctioning MPA, which is at risk of being a 'paper park,' depending on the PPI scale. In contrast, if within a no-take MPA, most respondents indicated 'light fishing' or 'no fishing,' the confidence of having a *de facto* MPA is higher.

Thus, the PPI of an MPA is simply defined as the difference between the mean fishing level perceived by stakeholders in a specific MPA and its official IUCN management category (already simplified to 4 categories: *i*, *ii*, *iii*, and *iv* +). MPAs with a PPI index between 0 and 1 are considered 'potential paper parks' and greater than 1 'likely paper parks.' Plots and visuals have been generated as a combination of the resulting graphs using R version 4.1.1 and Adobe Illustrator.

3. Results and discussion

Within the study, 3027 different persons were contacted and including follow-ups, a total of 4023 emails were sent. Of the 3027 contacts, 40 % (1241) replied to our email and 27 % (814) provided an answer to the one-question questionnaire. Because about 100 persons were asked about more than one MPA, the total number of usable responses to our questionnaire was 1107. The graphs and assessments in this section present the 1107 responses from the stakeholders who replied and shared their perceptions of the *de facto* protection status of the MPAs they were asked about. Considering local perceptions is important to differentiate *de facto* MPAs from 'paper parks.' Here, we present results by stakeholder groups, regions and some individual MPAs with the highest index of PPI.

3.1. Stakeholders responses

One of our hypotheses was that we would obtain a high response rate because of the simplicity of the questionnaire; this hypothesis is verified, as of the stakeholders who replied to our personalized email, 66 % provided us with the fishing level of the MPA they were asked about. The overall response rate (Table 1) was higher for academics (37 %), followed by civil servants (29 %) and NGOs (23 %). These numbers were difficult to gather, considering that in recent years people are less willing to participate in online surveys and they rather prefer telephone or face-to-face contact [64]. This can be explained by the rise of unsolicited e-mails and the ill will caused to potential respondents [65]. Moreover, in our study, we did not pre-notify or send invitations via email, which provides an increased response rate. However, a simple design can also boost the response rate [66].

The second part of our first hypothesis is also confirmed, as the fishers (and/or their organization) had a low response rate (6 %) than all other stakeholder groups. Surprisingly, however, journalists have an even lower response rate (4 %). Both for regions in the Global North and South, the pattern is similar, i.e., academics have the highest response rate (42 % and 34 %, respectively) followed by civil servants (30 % and 29 %, respectively) and NGOs (15 % and 28 %, respectively). The lowest response rates recorded were fishers (8 % and 5 %, respectively) and journalists (5 % and 3 %, respectively).

In general, considering all the regions covered (Table 1 and Fig. 1), the most common responses among the five types of stakeholders were the central categories, i.e., 'light fishing' (chosen more commonly by fishers, civil servants, and journalists) and 'moderate fishing' (by academics and NGOs). This resulted in 'light fishing' being the most

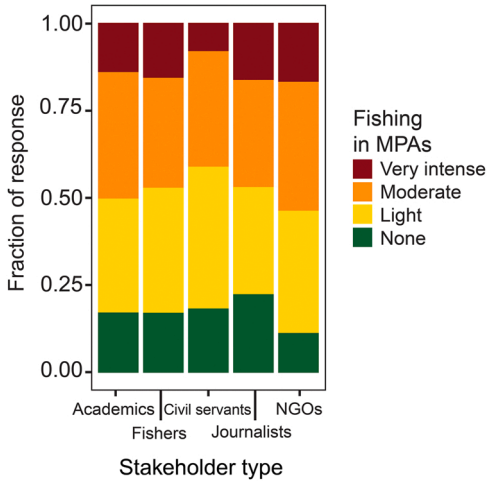

Fig. 1. The proportion of responses (n = 1107) regarding the status of MPAs perceived by different stakeholder groups. The responses proportions were roughly similar among the five types of stakeholders, 'light fishing' and 'moderate fishing' being the most commonly assigned labels.

Table 1
Overview of the number of emails sent and received and the most common answers provided by stakeholders and regions. Replies show the number of replies/amount of emails sent and the most common response level (Cr) reported, which is encoded with a number being 1 = no fishing, 2 = light fishing, 3 = moderate fishing and 4 = very intense fishing. Note that Antarctica was not considered in the Global South assessment due to the lack of residents.

\\	Academics		Fishers		Civil servants		Journalists		NGOs		Total	
Regions	Replies	Cr	Replies	Cr	Replies	Cr	Replies	Cr	Replies	Cr	Replies	Cr
A) Antarctica	7/11	1	0/4	-	1/6	1	3/10	4	1/5	1	12/36	1
B) High Arctic	2/4	2	0/2	-	2/6	2	1/6	2	2/6	1	7/24	1
C) Indian Ocean	68/179	3	13/78	4	36/146	3	7/115	4	83/137	2	207/655	3
D) Latin America and Caribbean	102/275	3	13/118	3	99/254	2	10/232	3	70/202	3	294/1081	3
E) Mediterranean. and Black Sea	54/159	3	7/68	2	40/102	2	4/109	3	24/76	3	129/514	2
F) North America and Greenland	9/20	1	1/6	1	12/27	1	2/25	2	1/15	2	25/93	1
G) North-Western Europe	86/220	3	24/137	2	62/177	3	14/121	4	31/89	4	217/744	3
H) North-Western Pacific	17/49	2	0/14	-	6/23	2	1/34	1	1/6	1	25/126	1
I) Southeast Asia and Oceania	53/164	2	9/42	3	42/163	2	7/79	2	37/118	2	148/566	2
J) West Africa	14/39	2	3/22	3	21/62	2	0/33	-	5/28	3	43/184	2
Global North (B,E,F,G,H)	168/452	3	32/227	2	122/335	2	22/295	4	59/192	4	403/1501	2
Global South (C,D,I,J)	237/657	3	38/260	3	198/625	2	24/459	3	195/485	3	692/2486	2
Total (A-J)	**412/1120**	**3**	**70/491**	**2**	**321/966**	**2**	**49/764**	**3**	**255/682**	**3**	**1107/4023**	**2**

common response and perception within the studied MPAs (36 %), followed closely by 'moderate fishing' (35 %), 'no fishing' (16 %) and 'very intense fishing' (13 %). For regions in the Global North and Global South, the pattern is similar 'light fishing' (33 % and 37 %, respectively), 'moderate fishing' (32 % and 37 %, respectively), 'no fishing' (19 % and 14 %, respectively) and 'very intense fishing' (16 % and 12 %, respectively).

According to Roessger et al. [67], more than half of MPAs in European waters experience more intense fishing than their surrounding areas, with average trawling intensity 1.4 times higher [68]. This would imply that the biomass and abundance of fish are – at best – similar to non-protected areas [69]. However, the results from our questionnaire have 'light fishing' as the most common fishing level within MPAs in the Global North.

By region, the responses were diverse among the different stakeholder groups (Table 1). For the regions of 'Antarctica,' 'North America and Greenland,' 'Northwest Pacific,' and 'High Arctic' the most common response was 1, i.e., 'no fishing'. Among the stakeholder groups, NGO staff selected more often 'moderate fishing' (37 %), while for the rest of the stakeholders, the most common response category was 'light fishing' (fishers 44 %, civil servants 41 %, academics 36 % and journalists 31 %). The least common category in all the studied stakeholders was 'very intense fishing' (academics 16 %, journalists 16 %, fishers 13 % and civil servants 8 %), except for NGOs for which 'no fishing' was the least common category (11 %). The proportions of the responses among stakeholders are similar but the interesting point is the less common extreme answers 'very intense' among civil servants and 'light fishing' among NGO staff (Fig. 1). For government civil servants, the odds of a higher reported perceived fishing level were 0.675 times that of other stakeholders, i.e., government officials reported lower fishing levels than other stakeholder groups. This suggests that our second hypothesis, about government civil servants being more optimistic than other stakeholders, while NGOs seem to be more pessimistic.

This result corresponds with the observation that civil servants often work in settings lacking feedback or monitoring mechanisms, and thus provide responses that do not question their employers' efforts. On the other hand, NGO staff will tend to be more critical [70] and in most cases, are used to monitor progress around the issues for which they are campaigning. Therefore, they would rather highlight than ignore deficiencies. "NGOs are considered to have smaller bureaucratic apparatus than governments, more efficient decision-making processes and ability to adapt relatively quickly to changing situations through strategic alliances" [71]. Moreover, NGOs usually have the tools to expose national and international abuse [72]. However, sometimes, specific NGOs can be perceived as prioritizing their own interests over the public good and other stakeholders' views [71–73], which affects the credibility of the entire environmental NGOs sector and its causes [74].

The low response rates we obtained from fishers may stem from their being skeptical about both MPAs and online questionnaires [75–77]. However, as we had to contact some fishers through their organizations, the low response rate may to some extent represent the organizations rather than the individual fishers' lack of interest. Thus, the responses from this group of stakeholders may have reflected 'official' positions, similar to civil servants. However, the answers of the fishers differ between the Global North and South, with the southern regions being more critical (45 % indicating 'moderate fishing') than the northern regions (44 % indicating 'light fishing'). As for the journalists, their slightly higher proportion of responses with 'no fishing' and lower proportion of 'very intense fishing' may be due to being more influenced or in contact with information from official statements by the governments' civil servants.

We believe that the answer behind our respondents selecting the central categories more often is not because of a lack of knowledge or a riparian MPA (almost 70 % of the selected MPAs were coastal), but because: (i) there is a behavioral tendency to select responses that are not extreme [78,79] and (ii) some of the respondents might find it difficult to select a category for a relatively new MPA (over 65 % of the studied MPAs were established only within the last two decades).

3.2. Comparison between stakeholders' responses, official MPA categories and MPA types

Fig. 2 shows the responses of MPA stakeholders about the level of fishing in different types of MPAs. Fig. 2A, with the IUCN categories, shows the fraction of responses with 'no fishing' and 'light fishing' decreases as the IUCN category increases. MPAs category *i* allow less extractive and recreational activities than higher categories. The proportion of 'no fishing' and 'light fishing' is respectively as follows: 31 % and 48 % (*i*), 17 % and 42 % (*ii*), 12 % and 40 % (*iii*), 17 % and 33 % (*iv*), 11 % and 23 % (*v*), and 12 % and 42 % (*vi*). For 'moderate fishing' the percentages are 18 % (*i*), 28 % (*ii*), 44 % (*iii*), 32 % (*iv*), 50 % (*v*) and 41 % (*vi*).

As illustrated in Fig. 2A, it is difficult to determine if the match between the official protection level and the perceived level of fishing occurred because our respondents replied to the questionnaire with the official category in mind or not, even though we asked them only about their perception. We think this may have been the case for the civil servants, but it seems unlikely for the other groups, as for many MPAs, the official IUCN category is usually not known publicly.

Fig. 2B shows the responses of MPA stakeholders about perceived levels of fishing in different types of MPAs. This comparison generated clearer associations between perceived levels of fishing and MPA types. Thus, 'No-take' MPAs received almost 50 % 'light fishing,' followed by 26 % 'no fishing.' 'Multi-zone MPAs' were perceived as exposed to 'light fishing' (37 %), 'moderate fishing' (36 %) and 'no fishing' (23 %). Finally, 'MPAs w/fishing' were perceived as being exposed to 'light fishing' (32 %); 'moderate fishing' (39 %), 'and 'very intense fishing' (17 %). In general, fishing effort was perceived to be higher within 'MPAs w/fishing' than in no-take or multi-zone MPAs.

Recently, suggestions about compatible uses for each category were published [80], and previous studies suggest that an increased variety of uses lead to greater pressure and intensity of uses [43]. Hence, we expected a lower fishing intensity where the main MPA goals reflect higher protection, i.e., in the strictest IUCN categories. The overall level of protection of an MPA and the zoning type thus makes a difference in how effective an MPA will be perceived to be. The level of protection and zone type is important to achieve tangible conservation objectives.

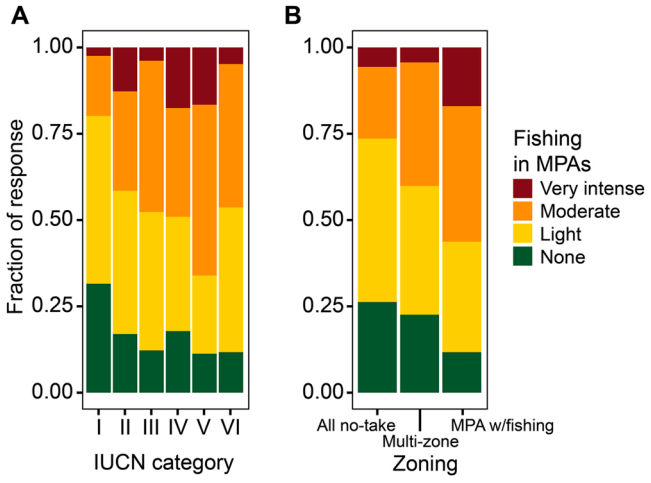

Fig. 2. Fraction of responses (n = 965) per IUCN category (A) and (n = 827) per MPA zoning type (B). Note (in A) the relationship between the strictest IUCN categories (*i* and *ii*) and the proportion of 'no fishing' responses. Similarly, note (in B) that no-take MPAs have a higher proportion of 'no fishing' responses than the multi-zone (some zones of the MPA allow fishing) and the 'MPA w/fishing' (i.e. MPA with fishing, which allows fishing in the entire MPA).

A meta-analysis [81] showed that after a few years of protection, fish biomass was restored in no-take areas, but not in multi-zone or unprotected areas.

3.3. Analysis of responses by regions

The responses among the different regions did not differ substantially, except for the High Arctic, which was associated with lower perceived fishing levels (Fig. 3). Even though there are no substantial differences in the overall 'no fishing' response between the Global North and South, there are regions in the Global North with a high response rate for 'no fishing,' i.e. 'North America and Greenland' (68 %), 'High Arctic' (57 %) and 'Northwest Pacific' (40 %).

In the Global South, the 'no fishing' category was no frequent, and neither was the 'very intense fishing' category, which did not receive more than 5 % of the response in any region (Fig. 3). In contrast, in the Global North, the proportion of 'moderate' and 'very intense' responses vary between 0 % and 38 % and 0–21 % respectively.

'North America and Greenland,' 'Antarctica,' the 'High Arctic,' and the 'Northwest Pacific' show similar response patterns with a predominance of 'no fishing' (68 %, 58 %, 57 % and 40 %, respectively). The predominance of 'no fishing' in these MPAs may be a result of ongoing marine conservation efforts [82–84], even though marine spatial planning for the US share of the Arctic Ocean seems to lag behind [82]. The Pacific, whose waters are crisscrossed by migrating tuna and other large pelagic fishes [85] is known for high levels of illegal, unreported and unregulated (IUU) fishing [86–88] and stronger institutions should be developed for better fisheries management [89] with greater efforts on monitoring, control, and surveillance (MCS) at national and international level [90]. The comparatively low percentage of 'no fishing' is likely linked to poor regulation and monitoring of fisheries in many parts of the Pacific, including poorly managed EEZ and very large scale MPAs [91].

The response patterns (Fig. 3) are similar within the regions of 'Latin America,' 'North-Western Europe' and the 'Indian Ocean'. Among the Mediterranean and the Black Sea, West Africa and Southeast Asia and Oceania, the response patterns are also similar: 'no fishing' has a low proportion (<1–16 %) but 'light fishing' is the highest (3–40 %). In West Africa, the fisheries resources are strongly exploited by foreign distant-water fleets through fishery cooperation agreements that usually do not meet the declared objectives of cooperation for local development and reduction of poverty [92]. The overexploitation of marine resources by third countries catalyzes misconduct, e.g., fishing in no-take areas of MPAs, which may potentially explain the low share of responses for 'no fishing' in the regions of West Africa and Southeast Asia and Oceania.

Of the 184 MPAs in our study that have an assigned IUCN management category or a scientific framework for categorizing MPAs, only 9 % had an average perceived fishing level that matched the IUCN management category, i.e., a PPI of zero; Out of all 184 MPAs studied, 49 (27%) are classified as paper MPAs (Fig. 4) of which the majority are in 'Latin America and the Caribbean' (17, 35%), in 'Indian Ocean' (11, 22%), and in 'Southeast Asia and Oceania' (8, 16%) regions. No paper parks were found in the 'High Arctic' and 'North America and Greenland' regions.

Table 2 lists the top 11 likely 'paper parks' (PPI >1), of which 5 are listed as 'fully protected' in the MPAtlas. 10 of these MPAs have available liter-ature that supports their identification as 'paper parks' (See Table 2). The only MPA for which we have not found information that supported our findings was the *Terres Australes et Antarctiques Françaises* ('strict marine protection zone').

A lobster fishery that is very important at a national level occurs in the National Park of Archipiélago Los Roques, Venezuela, with underreported catches taken from the restricted zones, including the poaching of sea turtles and a recreational fishery of bonefish (*Albula vulpes*) [93]. Queen conch, *Strombus gigas*, was also suffering heavy exploitation in the

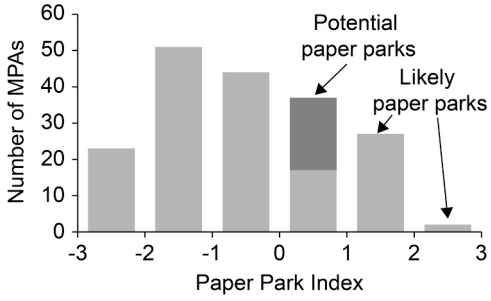

Fig. 4. 'Paper Park Index' (PPI) assessment of the 184 Marine Protected Areas (MPAs) included in this study that were assigned a category either by the IUCN management category system or a scientific framework, allowing the identification of 11 MPAs with a high PPI. These are most likely 'paper parks,' as documented in Table 2.

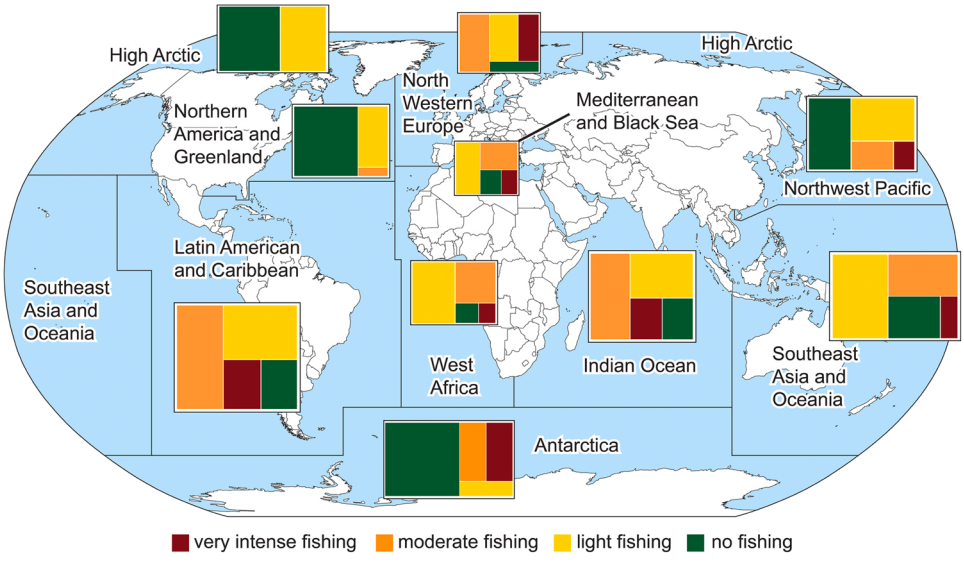

Fig. 3. Worldwide assessment of the *de facto* protection of MPAs, as estimated by the perception by local stakeholders (all groups combined) of the level of fishing they are subjected to, by the 9 broad regions with roughly similar ecologies, economies and cultures as defined in Palomares and Pauly [60], with Antarctica added. The Global North regions are High Arctic (HA), Mediterranean and Black Sea (MB), North America and Greenland (AG) and North Western Europe (WE). The Global South regions are Antarctica (AN), Indian Ocean (IO), Latin America and Caribbean (AC), Northwest Pacific (WP), and West Africa (WA).

Table 2
MPAs with the highest value of the 'paper park index' (PPI). A greater value indicates a higher PPI (more confidence to be a *de facto* 'paper park'). IUCN levels are the official designation of the MPAs as provided to Protected Planet [34] by the country. The MPAtlas levels are from www.mpatalas.org [33] and * means that the fishing protection level was obtained using the MPA Guide or 'Regulation-Based Classification System Assessment' [43].

MPA	Country	Region (Fig. 3)	IUCN level	MPAtlas level	PPI	Source
Archipiélago Los Roques National Park	Venezuela	AC	ii	Less protected	2	p,q
Terres Australes et Antarctiques Françaises	TAAFs / France	AN	ia	Fully protected*	2	-
Misool Marine Reserve	Indonesia	AO	-	Fully protected*	1.5	i,j,k
Nijhum Dweep	Bangladesh	IO	ii	Fully protected	1.5	m,n,o
Pulu Keeling	Cocos Islands	IO	ia	Fully protected	1.4	r,s
Cu Lao Cham Hoi An Biosphere Reserve	Vietnam	AO	ia	Not protected	1.4	b,c,d
Desertas Islands	Portugal	WE	ia	Less protected	1.3	e,f
Gizilaghaj National Park	Azerbaijan	IO	ii	Less protected	1.3	g,h
Nazca-Desventuradas Marine Park	Chile	AC	ia	Fully protected*	1.3	l
Ciénagas del Catatumbo	Venezuela	AC	ii	Less protected	1.2	a
Yumurtalik lagoons	Turkey	MB	ii	Less protected	1.2	t

p,q: [90,91]; i,j,k: [92–94]; m,n,o: [95–97]; r,s: [98,99]; b,c,d:[100–102]; e,f: [103,104]; g,h: [105,106]; l: [107]; a: [108]; t: [109]
Source: Source refers to references of accounts supporting the identification of an MPA as a 'paper park.'

area [94].

In the Raja Ampat MPA network and vicinities of the Misool MPA, there are grouper and anchovy fisheries [95] and the decline of those stocks is being affected by the use of non-selective fishing gears [96,97]; harmful fishing methods need to be prohibited [98].

Nijhum Dweep plays an important role in the local and national fisheries of Bangladesh [99]. With the number of households in the area increasing, fishing has intensified [100], especially the use of long seine nets set with poles along the shoreline [101].

In Pulu Keeling, i.e., in the Cocos (Keeling) Islands, administered by Australia, trolling is allowed, but poaching is a known issue [102]. Recreational and subsistence fishing are widespread around the atoll [103].

In the Biosphere Reserve of Cu Lao Cham Hoi An, Vietnam, illegal fishing consists mainly of the operations of foreign trawlers and the use of explosives [104–106]. Tourism in the area has also increased, which is accompanied by greater consumption of seafood leading to increased fishing [105].

In Desertas Islands, Portugal, there is a purse seine fishery for small pelagics, tuna fishing with pole and line and drifting longline [107]. Young seals in the area are killed by a local fishing gear called 'covo' [108].

Even though the Gizilaghaj National Park appears difficult to access, it is documented as a place that suffers overfishing and poaching due in part to disputes over the waters of the Caspian Sea between Azerbaijan and Iran [109,110].

In the Nazca-Deventuradas MPA, in the Chilean EEZ, foreign vessels have violated the protected area [111] and/or are operating around it [112]. Moreover, local fishers are concerned about the illegal and harmful practices of industrial fishers, which impact tuna stocks [113].

In Ciénagas del Catatumbo (or: Juan Manuel National Park), Venezuela, there is fishing in the MPA [114]. Even though fishing is prohibited in the National Park, subsistence activities are not regulated [114].

In the Yumurtalik lagoons, along the Mediterranean coast of Turkey, there are fish traps at different sites and fish stocks have declined due to fishing [115]. In general, there is an urgent need for management strategies that protect the catchment area of Mediterranean lagoons, and the productive zones of these sensitive ecosystems [116].

Thus, it appears that the PPI proposed here can detect MPA, based on stakeholder perceptions, which have been documented in the literature, not to fulfil their purpose of protecting marine biodiversity, and which thus, may be considered to be 'paper parks'. In other words, the PPI reflects a difference between what is expected by the specific MPA goals and what is apparently happening in that MPA. This difference is a proxy of a potential 'paper park' or a misfunctioning MPA. As the differences between the responses of the stakeholders' responses and the IUCN status become smaller, i.e., when the PPI declines, there will be an increase in the probability that MPAs would be misidentified as 'paper parks.' Thus, we recommend that, as done here, only high values of the PPI be taken as indicative.

4. Conclusions

The disconnect between official protection status on paper and the perception of fishing level or intensity evidenced by our study underlines the importance of regularly monitoring MPAs conservation outcomes. Monitoring and control are preconditions for well-implemented MPAs that can help protect marine biodiversity [91].

Next to consider is an even broader sample of MPAs per country and interviewed stakeholders, especially fishers and journalists, who exhibited a lower response rate in all the studied regions. Future research should match the results presented here with quantitative fisheries data to either support the findings or aid the identification of blind spots in official fishery statistics. Additional analyses may also compare local perceptions with the regulation-based classification system for MPAs [43], which is used in the Blue Parks criteria and MPA guide. Additional nuances of perceived fishing intensity, such as the level of artisanal or subsistence fishing compared to industrial fishing should also be explored, but are challenging and bias-prone depending on the different stakeholder groups.

All in all, the perceptions of fishing in this study facilitate the identification of 'paper parks' or areas that need attention because local stakeholders are perceiving fishing to occur that are not compatible with the official status of a specific MPA. Of the 184 MPAs in our study that have an IUCN management categoryor a scientific framework for categorizing MPAs, 27 % are likely and potential 'paper parks'. The results highlight the importance of different stakeholders' knowledge about the extent and type of marine protection. This also serves as an invitation to policy-makers, spatial planners, managers and the scientific community to consider local knowledge and encourage the participation of a wider group of stakeholders in policy-making, planning and management of marine spaces.

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CRediT authorship contribution statement

V.R. and D.P. conceptualized the research idea of emailing various stakeholders around the world about their perception of the fishing level within select MPAs. V.R developed the scientific methodology and collected and analyzed the data from stakeholders, while D.P supervised all the steps of this research. V.R wrote the first draft, which D.P. edited. Both authors have read and agreed to the published version of the manuscript.

Data availability

The MPA data produced by this research is directly accessible on *Sea Around Us* under the 'Tools & Data' tab on the toolbar (http://www.seaaroundus.org/data/#/mpa).

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Institutional Review Board Statement

This study was performed under the approval of UBC's Office of Research Ethics (# H19–03029, November 29, 2019) for studies involving humans.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Update

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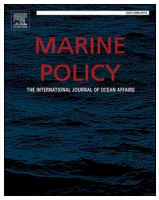

Corrigendum

Corrigendum to "The 'paper park index': Evaluating marine protected area effectiveness through a global study of stakeholder perceptions" [Mar. Policy 151 (2023) 105571]

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The authors regret to inform that due to small sign errors, a few numbers in the paper have changed. The changes (highlighted in bold) are detailed as follows:

- On page 1, highlights:
  Instead of: *Of the 184 MPAs in this study that have an IUCN management category, 30 % are likely 'paper parks.'*
  It should be: *Of the 184 MPAs in this study that have an IUCN management category* ***or a scientific framework for categorizing MPAs, 27 %*** *are likely 'paper parks.'*
- On page 1, abstract (line 11).

Instead of: i.e., *30 % of our total sample. Most of them are located in the regions of 'Latin America and the Caribbean' (31 %), 'Southeast Asia and Oceania' (25 %) and 'Indian Ocean' (20 %).*

It should be: ***Out of all 184 MPAs studied, 49 (27 %) are classified as 'paper parks', of which 11 (35 %) are in 'Latin America and the Caribbean', 17 (22 %) in 'Indian Ocean', and 8 (16 %) in 'Southeast Asia and Oceania' regions.***

- On page 2, under material and methods (right column).
  Instead of: *The IUCN category of the MPAs was sourced from ProtectedPlanet*

  [34] and official documents such as their management plans (category ia

  and ib, n = 25; category ii, n = 45; category iii, n = 8; category iv, n = 58;

  category v, n = 24; category vi, n = 27; not reported, n = 70) of the 7

  IUCN management categories [36]. The strictest are ia and ib ('strict

  nature reserve' and 'wilderness area') …
  It should be: *The IUCN category of the MPAs was sourced from ProtectedPlanet*

  [34] and official documents such as their management plans (category ia

  and ib, n = 25; category ii, n = 45; category iii, n = 8; category iv, n = 58;

  category v, n = 24; category vi, n = 27; not reported, n = 70) of the 7

  IUCN management categories [36]. ***When this was not available the category was taken from MPAtlas [33].*** *The strictest* ***IUCN categories*** *are ia and ib ('strict*

  nature reserve' and 'wilderness area') …
- On page 3, under material and methods (last paragraph of that section).
  Instead of: *In the PPI index, values above 0 are assumed to identify potential 'paper parks.' Plots and visuals have been generated as a combination of the resulting graphs using R version 4.1.1 and Adobe Illustrator.*
  It should be: ***MPAs with a PPI index between 0 and 1 are considered 'potential paper parks' and greater than 1 'likely paper parks.'*** *Plots and visuals have been generated as a combination of the resulting graphs using R version 4.1.1 and Adobe Illustrator.*

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- On page 5, under the 3.3. Analysis of responses by regions, second paragraph.
  Instead of: *the 'no fishing' category was frequent*
  It should be: *the 'no fishing' category was* ***no*** *frequent*
- On page 5, under the 3.3. Analysis of responses by regions, above Figure 3.
  Instead of: *Of the 184 MPAs in our study that have an assigned IUCN manage-*

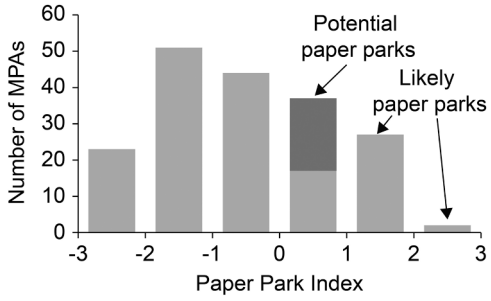
  ment category, only 9 % …
  It should be: *Of the 184 MPAs in our study that have an assigned IUCN manage-*

  ment category ***or a scientific framework for categorizing MPAs****, only 9 % …*
- On page 5, under the 3.3. Analysis of responses by regions, fifth paragraph.
  Instead of: *on the other hand, 30 % had a PPI greater than 0, which suggested they might be 'paper parks' (Fig. 4). The regions with the most likely 'paper parks' were 'Latin America and Caribbean' (31 %), 'Southeast Asia and Oceania' (25 %) and 'Indian Ocean' (20 %), while we failed to detect 'paper parks' in the 'High Arctic,' 'North America and Greenland,' 'Northwest Pacific' and 'West Africa'.*
  It should be: ***Out of all 184 MPAs studied, 49 (27 %) are classified as paper MPAs (Fig. 4), of which the majority are in 'Latin America and the Caribbean' (17, 35%), in 'Indian Ocean' (11, 22 %), and in 'Southeast Asia and Oceania' (8, 16 %) regions. No paper parks were found in the 'High Arctic' and 'North America and Greenland' regions.***
- On page 5, under the 3.3. Analysis of responses by regions, seventh paragraph.
  Instead of: *Los Roques, Colombia,*
  It should be: *Los Roques,* ***Venezuela,***
- On page 5, under the 3.3. Analysis of responses by regions, Before Figure 4:
  Instead of: Table 2 *lists the top 11 'paper parks' (PPI >1), of which 5 are listed as*

  'fully protected' in the MPatlas. 10 of these MPAs have available liter-

  ature that supports their identification as 'paper parks'
  It should be*: Table 2 lists the top 11* ***likely*** *'paper parks' (PPI >1), of which 5 are listed as 'fully protected' in the MPAtlas. 10 of these MPAs have available liter-*

  ature that supports their identification as 'paper parks'
- On page 5, under the 3.3. Analysis of responses by regions, Figure 4:
  Instead of the figure as it is currently.
  It should be as follows: (here add the new figure)



  .
- On page 5, under the 3.3. Analysis of responses by regions, in the caption of Figure 4:
  Instead of: … included in this study that were assigned an IUCN management category,
  It should be: … included in this study that were assigned **a category either by the** IUCN management category **system** ***or a scientific framework***,
- On page 5, the paragraph before Figure 4:
  Instead of "*In the Misool MPA, there are grouper and anchovy fisheries…*"
  It should be as follows: "*In the* ***Raja Ampat MPA network and vicinities of the*** *Misool MPA, there are grouper and anchovy fisheries…*"
- On page 6, in the caption of table 2:
  Instead of: The MPAtlas levels are from www.mpatalas.org [33] and * means that the fishing protection level was obtained using the 'Regulation-Based Classification System Assessment' [43].
  It should be as follows: The MPAtlas levels are from www.mpatalas.org [33] and * means that the fishing protection level was obtained using the **MPA Guide or** 'Regulation-Based Classification System Assessment' [43].
- On page 6, in table 2 (under the Misool Marine Reserve)
  In IUCN level: instead of ia
  It should be as follows: **-**
  In MPAtlas level: instead of Fully protected
  It should be as follows: Fully protected*
- On page 6, in Conclusions (last paragraph):

Instead of: Of the 184 MPAs in our study that have an IUCN management category, 30 % are likely 'paper parks'.

It should be as follows: Of the 184 MPAs in our study that have an IUCN management category **or a scientific framework for categorizing MPAs**, **27 %** are likely **and potential** 'paper parks'.

The authors would like to apologize for any inconvenience caused and add that none of these changes affect the main results and conclusions of this paper.