

# Local perceptions of spatial management indicate challenges and opportunities for effective zoning of sustainable-use protected areas in Brazil

Rebecca Borges, Annette Breckwoldt, Roberta Sá Leitão Barboza, and Marion Glaser

**Abstract:** Protected areas (PAs) are widely applied conservation instruments. Often, they are also expected to help secure livelihoods of poor subsistence, small-scale producers, making the management of PAs often dependent on community support. The usefulness of analyzing the perceptions of PAs among local users to improve the effectiveness of PA management is increasingly recognized; however, there are few studies on spatial perceptions, for example, how users perceive the PA's geographical boundaries or its zoning, and how these can be used in PA zoning. Here, we analyze how local stakeholders perceive two sustainable-use PAs on the Amazon coast, the changes they have brought about, and their current management. We identify and link the mental models of different user groups to formal conceptualizations of the PAs in legal instruments and identify mismatches related to what the PA means to local stakeholders and where it is located, which need to be considered when building a zoning plan. Because of the frequent research in our study area, we also discuss possible research fatigue in this region. We highlight the challenges and opportunities related to promoting spatial literacy and awareness-raising regarding PAs. We recommend adapting legal instruments to include diverse territorial representations and alternative management tools.

*Key words:* protected areas, co-management, zoning, Brazil, extractive reserves.

## Introduction

Protected areas (PAs) are clearly defined geographical spaces that aim for the long-term conservation of nature and its associated ecosystem services (Dudley 2008). They are widely acknowledged as important instruments to protect biodiversity and livelihoods (Laurance et al. 2012; Geldmann et al. 2015). However, they are frequently found to suffer from a lack of adequate planning (IUCN 2009). In coastal-marine ecosystems, PAs can play an important role in marine spatial planning (MSP) initiatives (GEF 2012), which are the public processes for organizing the use of marine space and pursuing social, economic, and ecological benefits (Ehler and Douvère 2009). Despite clear similarities and interactions between these tools, marine PAs and MSP are not identical conservation strategies and can be

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differentiated based on geographic level<sup>1</sup>: PAs are strategies for lower levels, while MSP usually refers to a higher-level process, such as national- or statewide initiatives (Strickland-Munro et al. 2016). Zoning is an important element of spatial planning and can be implemented both within (IUCN 2012) and outside PAs (Kenchington and Day 2011). According to the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Ehler and Douvère 2009), MSP is one element of ocean or sea use management; zoning is one example of a management action for implementing MSP. Zoning is also essential for ecosystem-based management (Douvère, 2008).

MSP has been evolving as a tool to protect ecosystems while allowing for the development of human activities (Jones et al. 2016), and, similar to other management strategies, it requires the use of a full range of evidence from across the social and natural sciences, and of multiple methods in monitoring and evaluation protocols, which can provide a more complete picture for conservation and environmental management decisions (Bennett 2016). One type of knowledge that can be used for MSP and PAs is the perceptions surveyed by local stakeholders, including the direct users of resources inside PAs. Bennett (2016, p. 4) defines perceptions as “the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome”. Perceptions can also be identified as social representations (Durkheim 2009), sensory experiences at a physiological level (Matsumoto 2009), cultural factors (Schmaus 2014), environmental representations (Silva et al. 2016), and opinions and emotions (Beyerl et al. 2016).

Research on perceptions can be used to explore the nature and magnitude of social impacts and to understand whether local people view the social impacts of conservation as just or equitable (Beyerl et al. 2016). Perceptions can also be used to assess how stakeholders view the legitimacy of governance (Glaser et al. 2018; Jimenez et al. 2019). Such insights can feed into evaluations of conservation initiatives and contribute to their long-term success (Bennett 2016). Perceptions are often dismissed as anecdotal by those arguing for evidence-based conservation, but investigating perceptions of local people can provide important insights into the social impacts, ecological outcomes of conservation, and social acceptability of environmental management (Bennett 2016; Beyerl et al. 2016).

An important aspect to consider in the investigation of perceptions related to PA management is the sense of place. According to Tuan (1977), a sense of place relates to the meaning and attachment to a setting held by an individual or group. In the case of PAs, this setting could correspond to the environment itself (e.g., mangroves) or the reserve area, the geographical space within the legal boundaries of the PA. Gooch (2003) identifies sense of place as one way of building on the existing positive impacts of catchment care groups and encouraging long-term volunteering.

The positive outcomes of acknowledging and integrating perceptions in terms of stakeholder engagement and awareness-raising about resource management are especially relevant for conservation strategies based on co-management, such as the Brazilian extractive reserves. These are sustainable-use PAs that aim to benefit both human populations and the ecosystems on which they depend (BRASIL 2000). The first decade of the extractive reserves established in the Bragança region, north Brazil (where mangroves are the most abundant ecosystems), brought about an increase in social benefits such as houses

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<sup>1</sup>Here we use the definition of scale as the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon (Gibson et al. 2000), while levels represent the points on a given scale (Cash et al. 2006; Glaser and Glaeser 2014). Level, as understood here, is often found in the literature as scale, especially in terms such as small-scale.

and other consumer goods (Partelow et al. 2018.) Prior to the establishment of PAs in the Bragança region, 83% of the rural population relied on mangrove resources for subsistence and (or) commerce, and 68% of the households derived monetary income from mangrove products (Glaser 2003). Over half of the rural population (64%) was involved in the collection and commercialization of the mangrove crab, *Ucides cordatus*. Despite the importance of mangroves in traditional local communities, this ecosystem is subject to increasing anthropogenic pressures, including deforestation and other forms of degradation, which require urgent management measures to guarantee the protection of its biodiversity and natural resources (Menezes et al. 2008).

Leading up to the creation of these PAs, there was a high level of social energy translated into collective efforts to establish co-management strategies in the region. However, around 10 years later, increasing political and economic instability caused cuts in educational, environmental, and public service expenses (Pinheiro et al. 2015). Since then, extractive reserves have experienced a considerable decrease in interest and participation by local users due to a lack of perceived benefits from participation in PA-related decision-making processes (Partelow et al. 2018). The majority of this population has a low income, limited formal education, and poor living conditions. Public sanitation, water supply, garbage collection, schools, and medical assistance are mostly inadequate and represent issues to be overcome by local authorities. In the Bragança PA<sup>2</sup>, in less than 15 years after its creation, perceptions about the purpose of the reserve appear to have shifted from managing local natural resources to obtaining individual material benefits, and local motivation for involvement has declined (Partelow et al. 2018).

Considering the fundamental importance of mangroves to local populations, as well as the challenges faced by the mangrove extractive reserves in northern Brazil, analysis of local perceptions of both the regional environment and the PA itself appears crucial to help improve PA management and, therefore, achieve successful mangrove conservation. Perceptions, in this case, may serve as tools to detect gaps in PA management and to identify the status of well-being of traditional populations and their inclusion in the participatory management of PAs with a traditional ecological knowledge approach. Although management perceptions in the Bragança PA have been investigated previously (e.g., Partelow et al. 2018), that inquiry did not focus on the spatial dimensions of management, including how stakeholders perceive the geographical space in which PAs are located, and how this space compares with their traditional resource extraction territories. Further steps to investigate this shift in perception are to disentangle the perceptions of different stakeholder groups, and to evaluate the impact of the various mental models or mind maps of PAs on specific aspects of management, such as the zoning established for the Bragança PA in its 2012 management plan.

To better understand local perceptions regarding the meanings related to PAs and sense of place, especially for community-based and cooperative PA management, we investigated the perceptions of local stakeholders in two extractive reserves in the Bragança region. We also analyzed the possible implications of these perceptions for the development of spatial management plans and, in particular, zoning strategies. Given the extensive record of research in the region, mainly done through surveys and interviews, we extended our analysis to include local perceptions of previous scientific research and examined how often our respondents had been surveyed. Local research is crucial because research institutions in the region have a strong connection

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<sup>2</sup>This PA is officially called Reserva Extrativista Marinha de Caeté-Taperacu: <https://www.icmbio.gov.br/portal/unidadesdeconservacao/biomas-brasileiros/marinho/unidades-de-conservacao-marinho/2107-resex-marinha-de-caete-taperacu>

to stakeholders while helping shape management policies for these two PAs. Specifically, we aimed to identify stakeholder perceptions regarding the meanings of the PAs, the geographic spatial aspects of these areas, and the existing zoning plan, their perceptions of PA management outcomes, and their possible behavior toward future spatial management efforts.

## Materials and methods

### Study areas

The study area encompasses mangroves and nearby waters in the municipalities of Bragança (2092 km<sup>2</sup>) (IBGE 2019a) and Tracuateua (934 km<sup>2</sup>) (IBGE 2019b), in Pará, northern Brazil (Fig. 1).

Both Bragança and Tracuateua have each a PA of the category extractive reserve (or RESEX, from REServa EXtrativista, or extractive reserve in Portuguese). As part of a national PA system, the RESEX category aims to promote sustainable management of resources to maintain local livelihoods while supporting biodiversity conservation (BRASIL 2000). In addition to the two extractive reserves in our study site, 16 other reserves currently protect ~6637 km<sup>2</sup> of forest along the mangrove belt in northern Brazil (Hayashi 2018). At the time of the creation of the RESEXs, in 2005, local populations were highly dependent on mangrove resources. In the Bragança extractive reserve, the adjacent rural socio-economic impact area of 130 km<sup>2</sup> had about 15 000 people, who derive most of their livelihood from the mangrove resources (Glaser 2003).

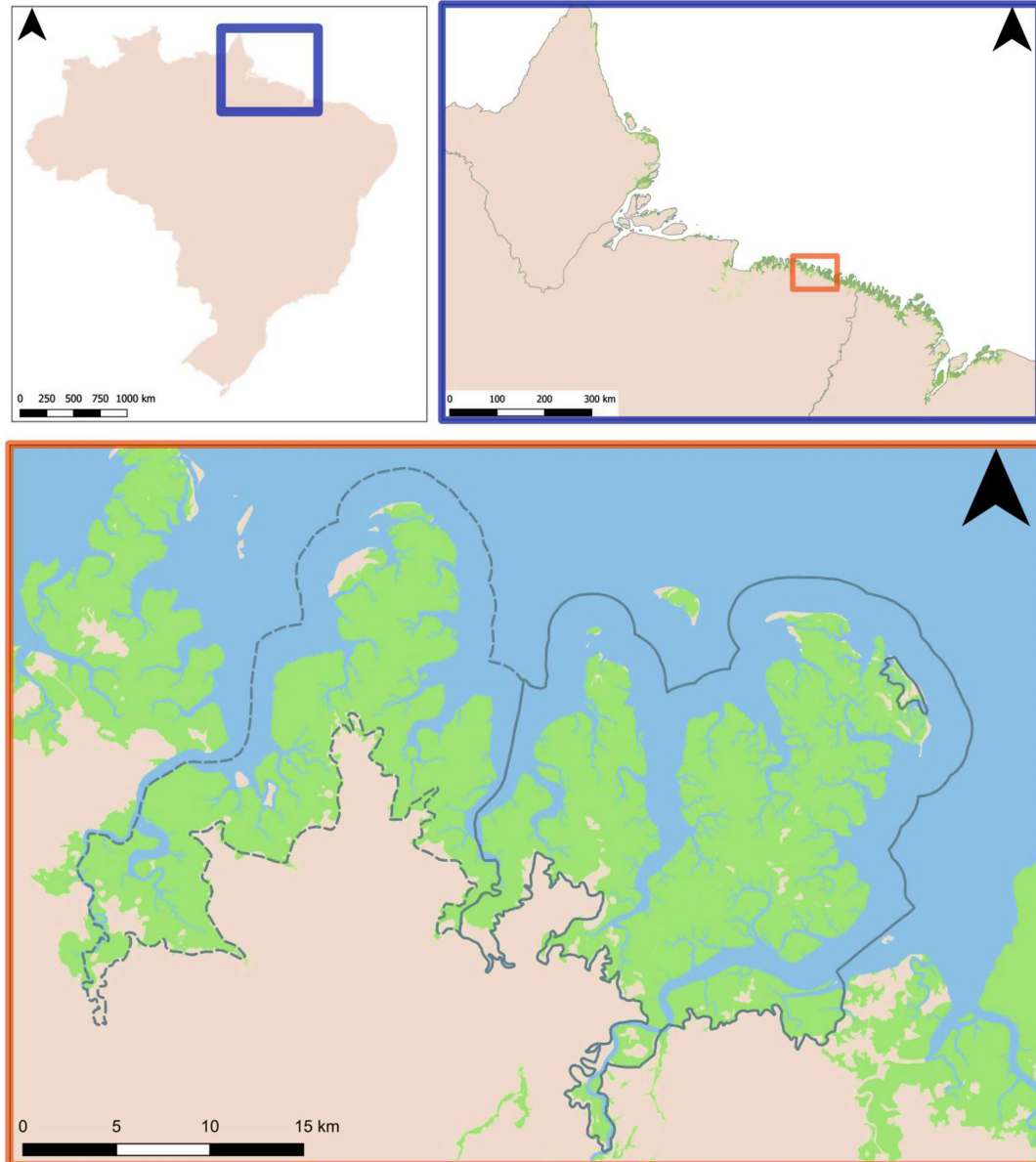
### Surveys and interviews

We implemented two approaches to questioning respondents. One was a quick survey about management with randomly selected informants in the most populous village in the Bragança PA. The other was a more thorough, semi-structured interaction with key informants, some of which were drawn on a map. Key informants were initially selected among well-known local leaders and other stakeholders active in the management of both the Bragança and Tracuateua PAs and, after the first few interviews, by snowball sampling (Johnson 2014). Surveys and interviews were conducted between October 2016 and March 2018. A total of 226 local actors were interviewed, of whom 135 were key informants (87 in Bragança and 48 in Tracuateua) and 91 were randomly selected informants (in Bragança only).

The interview/survey focused on management strategies, problems, and conflicts faced in the region. At the end of the questionnaires/surveys, we asked about research itself, whether it was perceived as beneficial, whether results came back to interviewees (as concrete benefits or merely as results communication), and whether the interviewee had been previously interviewed. Table 1 lists the questions that were asked.

Regarding questions related to locations and places, replies by key and randomly selected informants are presented in the results section separately. This was done because, for key informants, these questions were asked in combination with other questions that involved drawing replies on a map, while randomly selected informants replied only to an oral survey. This might have affected replies; for instance, key informants might have been prompted to talk about geographical places and give place-based replies due to the presence of a map, whereas randomly selected informants tended to give broader replies.

**Fig. 1.** Study areas with the delimitations of the PAs Caeté-Taperaçu (in the municipality of Bragança, to the east) and Tracuateua (in the municipality of the same name, to the west). Maps produced using QGIS 3.2. Data sources: ICMBio (2019), IBGE (2019c), NaturalEarth (2019), and Giri et al. (2011).



### Selection of interviewees<sup>3</sup>

In this study, we included key informants, who are the local stakeholders who are currently or have long been involved in the co-management of PAs. These include users

<sup>3</sup>The words interviewees, respondents, and informants are used interchangeably and refer to those people who were present in the surveys and interviews.

**Table 1.** Perception-related questions asked and stakeholders targeted, by protected area (PA).

Question*	Group targeted	PA
What is RESEX?	Key informants and randomly selected respondents	Tracuateua and Bragança
Where is the RESEX?	Key informants and randomly selected respondents	Tracuateua and Bragança
How is the management of the RESEX currently performing?	Key informants and randomly selected respondents	Tracuateua and Bragança
Are there different areas or zones inside the RESEX?	Key informants	Bragança <sup>‡</sup>
Have you ever been interviewed before about the RESEX?	Key informants and randomly selected respondents	Tracuateua and Bragança
Is the RESEX well-researched?	Key informants and randomly selected respondents	Tracuateua and Bragança
Is research a good thing?	Key informants and randomly selected respondents	Tracuateua and Bragança
Does research somehow return <sup>†</sup> to the communities?	Key informants and randomly selected respondents	Tracuateua and Bragança

\*Although they were asked in this order, these questions were immersed in a longer questionnaire that included questions on other topics.

<sup>†</sup>Return of research was understood by respondents as both or either (i) concrete, positive policy measures that were implemented based on local research; and (or) (ii) the sharing of research results with local communities where the research was conducted.

<sup>‡</sup>Only the PA in Bragança has a management plan with zoning, so only these informants were asked about current zones.

(mostly fishers) who are or have been part of the management council, who have acted as local environmental monitors, or who were part of the social movement that led to the creation of the PAs. These users are locally seen as community leaders<sup>4</sup>. Another group of resource users who are often included in local perception studies are knowledgeable users, who have first-hand experience with resource extraction and conservation practices in the region, both traditional and government-led practices. Key informants are also staff at local environmental organizations (governmental and non-governmental) and university researchers, who have closely worked with or studied the management of the PAs, including environmental analysts who work at ICMBio, the federal organization that manages<sup>5</sup> the PAs in the region.

Since we were interested in the perceptions of management by the broader population who live in the impact area of the PAs, we investigated not only the perceptions of local people who are already involved with the co-management of PAs, but also of those who are rarely included in the discussions related to management or even aware of management instruments and processes. For this purpose, we also included another stakeholder group, which we called randomly selected informants. These people are normally excluded from surveys in the region, although they live either inside the PA or in the buffer zone<sup>6</sup>. These were selected through a semi-randomized house selection process in the most populous villages of the municipality of Bragança. These surveys provide important insights into the wider local perceptions of PA management. This group of informants usually replied in a short and direct manner so that one perception was

<sup>4</sup>The categorization as leader is somewhat complicated. According to our field experience, some of these stakeholders are self-attributed leaders, while some of them are seen as leaders by only part of their communities. Disputes for local leadership inside communities are not rare.

<sup>5</sup>The areas actually have a managing council, but an employee of ICMBio is the head of the council, so this employee is known as protected area manager.

<sup>6</sup>According to Brazilian legislation, buffer zones are established in the PA's zoning plan, as part of the management plan. For PAs which did not have a management plan, the buffer zone extends from 2 to 3 km from the outer limits of the PA, depending on what kind of activity is to be approved by the PA's management (CONAMA 2010).

associated with each reply. The randomly selected informants were surveyed only in one municipality (Bragança), and these surveys, contrary to those with key informants, did not involve a map.

For most of the questions analyzed, we display the results jointly for the two PAs, except when (i) we focused on the randomly selected informants, who were only interviewed in the Bragança PA; (ii) we ask about the current management/zoning plan, which currently only exists for the Bragança PA; or (iii) for the question about the current management of the PAs, for which the negative perceptions seem to be stronger for the Bragança PA (see Results section).

Based on these two selection methods, informants from the two PAs were grouped into (i) randomly selected informants ( $N = 91$ ) and (ii) key informants ( $N = 135$ ). Key informants were further divided into (i) academia members ( $N = 18$ ); (ii) administration employees ( $N = 9$ ); (iii) knowledgeable users, indicated by other respondents because of local knowledge about nature and traditional practices ( $N = 81$ ); and (iv) community leaders ( $N = 27$ ).

It is important to highlight that this characterization is not clear-cut because informants often fit in more than one category. Especially considering the different questions, informants would reply by “putting on different hats”. For example, professors would reply as technical experts to questions that refer to their areas of expertise. Administration employees, who were often community leaders or academics, replied to questions related to management as administrative employees, but as researchers or direct users to other questions. For this reason, informants were categorized differently depending on the question asked.

#### Data processing

We used MAXQDA Plus 2018.2 to perform a predominantly qualitative analysis of the interviews. Answers were recorded anonymously, and the informants could not be individually identified in any published material.

#### Ethics and research authorization

We followed the Code of Ethics adopted by Brazilian universities. Accordingly, participants in the study were informed about the purpose of the questionnaire/survey, as well as data use and diffusion. We obtained verbal consent from the participants prior to conducting the questionnaire/survey. Answers were recorded anonymously, and individual informants could not be identified in published materials or other publicly available records. Whenever possible, we also recorded personal contact information to facilitate the restitution of results to the participants. This restitution activity started with an awareness-raising project and will continue following the conclusion of the project, which was funded by the Rufford Foundation through its small grants program. The research was approved by ICMBio (Sisbio process number 36427147).

#### Categorization of replies to the questions asked to local stakeholders

A comprehensive list of the questions is shown in [Table 1](#). In this section, only some questions are explained in detail. These are the questions for which we present the quantitative results.

#### What is RESEX?

Replies were categorized as follows: (i) does not know and (or) has never heard about it (ii) an area; (iii) something related to mangroves; (iv) something related to fisheries; (v) an organization/association; (vi) something related to the management and (or) sustainable use of resources; (vii) something related to nature conservation; (viii) something related to

reserve and (or) extractivism; (ix) a provider of financial and (or) material benefits; (x) an instrument for the protection of local population; and (xi) other definitions.

#### *Where is the RESEX?*

We chose four categories for the replies to the question about the location of the RESEX: (i) does not know; (ii) an area; (iii) a specific point (e.g., an address); and (iv) the headquarters of the users' association (This last category refers to those informants who mentioned a specific point but stated clearly that they were aware they were referring to the association and not really to the location of the RESEX.). This question was analyzed separately for key informants and randomly selected informants, since the latter were not asked while being shown a map.

#### *Are there different areas or zones inside the RESEX?*

The responses to this question were categorized into (i) yes (when the informants stated that they were aware of different zones, as described in the zoning plan); (ii) no (when the informants stated that there are no different zones and the area is uniformly managed); and (iii) unclear (when informants stated that they were aware of the different areas, but they actually mentioned other aspects, such as ecological features or spatial use patterns). This question was not asked to randomly selected informants.

The answers to these three questions helped us build mental models to investigate the aforementioned shift in perception in the two PAs since their creation. We define a mental model as a small-scale representation of external reality (Craik 1943), a similar but less rich representation of the world (Johnson-Laird 1983). On the different possible orientations of mind maps of the human–nature relations see Glaser (2006) and Glaser et al. (2021).

#### *How is the management of the RESEX currently performing?*

We chose five categories for the perceptions of management: (i) negative (when only negative aspects are mentioned); (ii) rather negative (when an overall discredit or disapproval is conveyed by the informants, even though positive aspects are also mentioned); (iii) neutral (when no clear inclination can be distinguished); (iv) positive (when only positive aspects are mentioned); and (v) rather positive (when an overall trust in or approval of the PA management is conveyed by the informants, even though negative aspects are also mentioned).

The analysis of the responses to the questions presented above was based on simple percentages of hits of perceptions (each time a perception is mentioned during the interview) divided by the total number of perception hits on one specific aspect, for example, management performance. Therefore, perceptions were recorded throughout the interview, not only when a specific question was asked.

#### *Perception of previous research*

The results related to the last three questions in Table 1, which are about the research done in the region, are presented at the end of the Results section in a qualitative manner, in connection with the results for the question “Have you ever been interviewed before about the RESEX?” (The replies to this question were categorized simply into yes and no.) Together, the replies to these four questions shed light on how local stakeholders perceive research done in the region up to the point of our research.

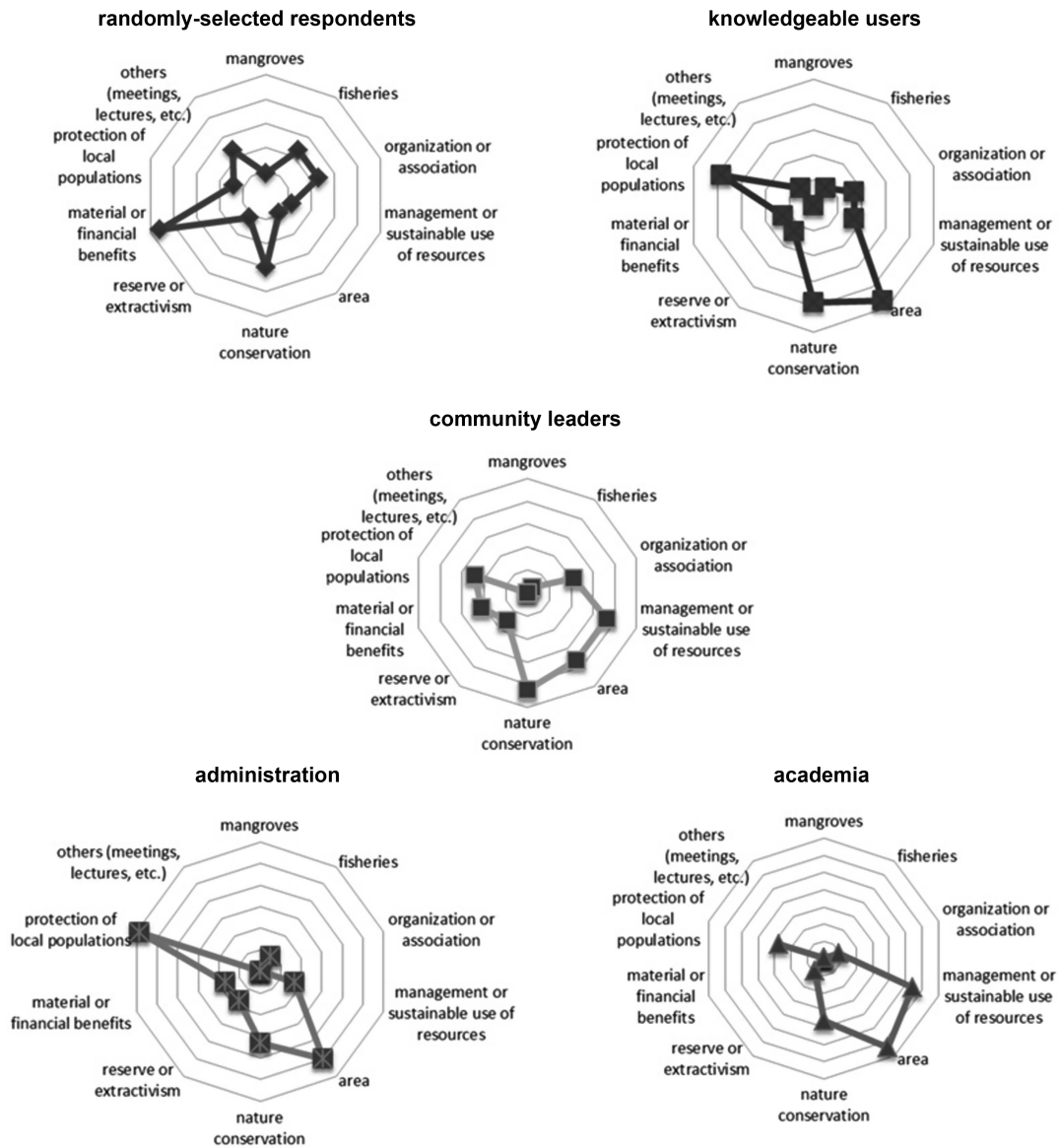
## **Results**

### **What is RESEX?**

Approximately 19% of the interviewees did not know what the RESEX was or had never heard about it (16% were randomly selected informants and 3% were knowledgeable users).



**Fig. 2.** Perceptions about what the RESEX is, by informant group, excluding the replies “did not know” and “never heard of”. Categories of responses not represented in these graphs were associations with research, teaching, and awareness-raising, meetings and lectures, prohibitions, and corruption, which were only mentioned by randomly selected informants (totaling 11% of the perceptions captured for this group) and by community leaders (4% of this group’s perceptions).



The remaining 140 informants expressed various perceptions related to the RESEX (Fig. 2), totaling 246 different perceptions (according to our categories), as shown in Table 2. Note that the same informant might have given more than one reply, that is, one perception category of reply, to this question.

Regarding the mental model of the PA (or stated perceptions represented by the response types), Fig. 2 shows that the association of the name RESEX with a geographic area

**Table 2.** Number of perceptions about what the RESEX is for each perception category, by informant group, excluding the replies “did not know” and “never heard of”.

Perception category	Administration	Randomly selected informants	Knowledgeable users	Academia	Community leaders	Total
Others (e.g., meetings, lectures)	0	10	0	0	2	12
Mangroves	0	4	0	0	0	4
Fisheries	1	10	1	0	2	14
Reserve or extractivism	2	5	5	1	3	16
Organization or association	0	10	7	1	4	22
Management or sustainable use of resources	2	5	12	6	4	29
Nature conservation	4	13	14	4	9	44
Material or financial benefits	2	20	7	0	3	32
Protection of local populations	7	6	8	3	9	33
Area	6	4	12	7	11	40
Total	24	87	66	22	47	246

(“area” in the graphs) was relatively low: 5%, 18%, 23%, 25%, and 32% of the perceptions captured among randomly selected informants, knowledgeable users, community leaders, administration employees, and academics, respectively.

Most of the randomly selected informants did not have at the forefront of their concept of the reserve the idea that the RESEX is a geographical space. This can be at least partly related to the fact that the PA is colloquially known only by its acronym (RESEX), which, to most informants, seemed to rather represent a program other than an actual area (the terms in Portuguese does mention the word “area”, which might partially explain this mental model). Although the question “What does RESEX stand for?” was not directly asked, we had the impression that many direct resource users (represented by the groups of community leaders, knowledgeable users, and randomly selected informants) did not know what the acronym RESEX means.

#### Where is the RESEX?

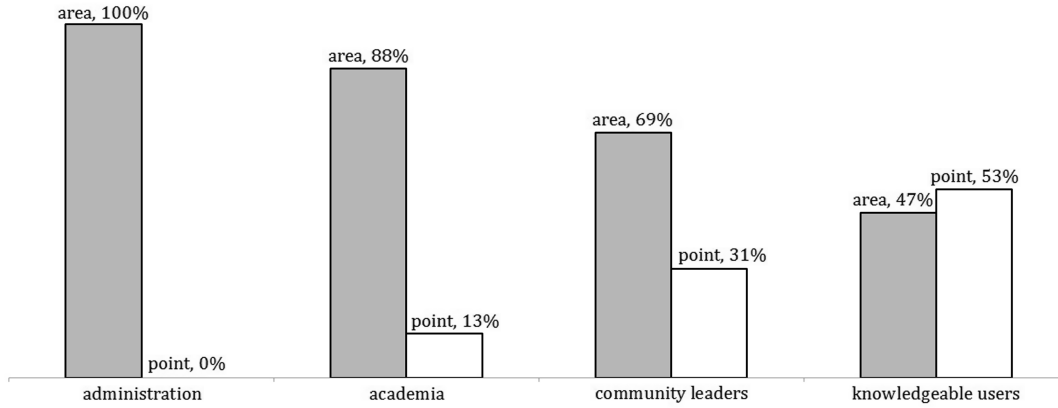
Regarding the key informants who replied to this question ( $N = 63$ ), only 4% who replied to this question said that they did not know where the RESEX was located, while ~6% explicitly associated the question with the headquarters of the users’ association.

The remaining 90% of the key informants (56 respondents) indicated either the concept of an area for the location of the RESEX or a specific point, such as an approximate address or a specific building (Fig. 3). The address was that of a building where the headquarters of the users’ association was located in Bragança. The numbers are similar but not the same when pooled from the total of perceptions registered and from the total of replies registered since one reply could contain multiple perceptions. This distinction highlights that some replies were ambiguous and contained both perspectives. Three groups view RESEX as an area (administration, academia, and community leaders), whereas similar proportions of knowledgeable users expressed one of the two perceptions.

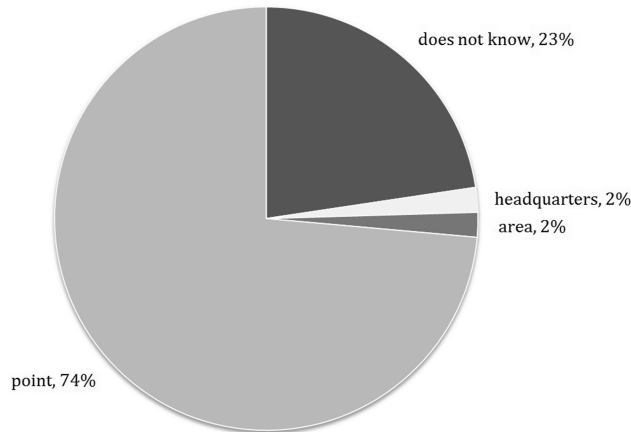
Considering only the randomly selected informants (in Bragança), we show below all the replies obtained (Fig. 4).

Randomly selected informants rarely perceived the RESEX as an area. Most of them mentioned a specific address to represent the location of the RESEX. Almost a quarter said that they did not know where the RESEX was. A few of them mentioned the headquarters of the users’ association as well; however, differently from the majority mentioned above,

**Fig. 3.** Perceptions about where the RESEX is located by informant group, for the key informants. The percentages are pooled from the total number of perceptions registered ( $N = 63$ ), excluding the replies “I do not know” and the ones who explicitly mentioned the headquarters of the users’ association.



**Fig. 4.** Perceptions about where the RESEX is located, for the randomly selected informants. The percentages are pooled from the total number of replies, that is, interviews registered ( $N = 53$ ), including those who replied “I do not know”, who mentioned an address (point), who mentioned a geographical area (area), and who explicitly mentioned the headquarters of the users’ association (headquarters).



these informants explicitly mentioned that they were referring to the users’ association and not to the RESEX.

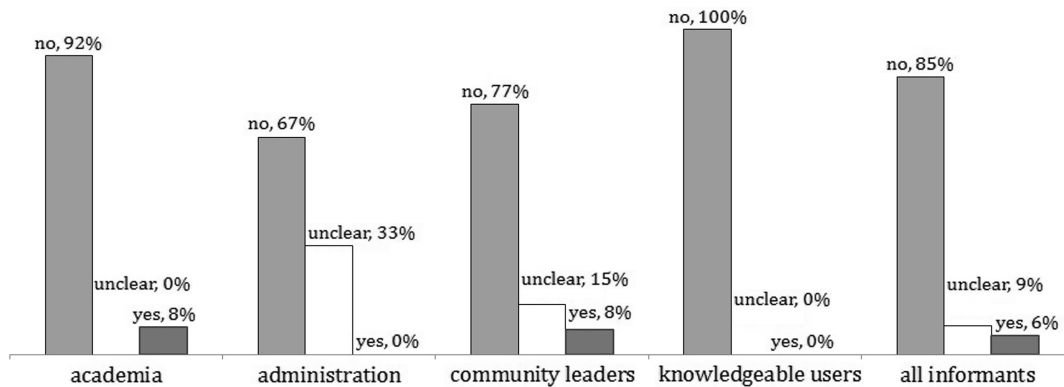
The reason why these informants mostly mentioned an address could be related to an immediate association of the question where, to a specific point on a map, which cannot be given to the PA itself. However, they could have been referring to the headquarters of ICMBio, the federal organization who manages the PAs in the region<sup>7</sup> or, most likely, to

<sup>7</sup>The areas actually have a management, deliberative council, but an employee of ICMBio is the head of the council, so they are known as protected area managers.

**Fig. 5.** The headquarters of the local users' association (Bragança PA). Google Maps Street View. -1.0341246, -46.7726674, Bragança, Pará. Image captured in August 2012, from ©2020 Google <https://goo.gl/maps/CB7ubvBefx8MmGfK9>.



**Fig. 6.** Knowledge about the existence of the current zones in the management plan of the Bragança PA by informant group, in relation to the number of interviews in each informant group. This question was not asked to randomly selected informants.



the headquarters of the users' association. This is possibly also largely influenced by the fact that the name RESEX is painted on the façade of the building where the association's headquarters are located (Fig. 5).

#### Are there different areas or zones inside the RESEX?

If the area and borders are poorly understood by locals, so are the zones defined in the management plan. Regarding the existing zoning in the Bragança PA, about 85% of the informants did not know about the current zoning of the Bragança PA (Fig. 6). Only certain academics and community leaders were aware that this management instrument existed (~6% of the interactions), although none of the interviewees could roughly identify the zones on the map used during the interviews. The numbers shown are not based on a count of informants, but rather on a count of interactions (one individual interview or one focus group interview). When the managers were asked about the reasoning behind the establishment of the zones, none could explain it. They also said that zoning probably needed updating.

**Table 3.** Perception related to protected area (PA) management performance, by informant group.

Informant group	Did not reply	Does not know	Rather negative situation	Rather positive situation	Neutral (neither positive nor negative)	Positive situation	Negative situation	Total
Randomly selected informants	3	20	5	2	0	4	19	53
Administration	1	0	0	1	0	1	4	7
Knowledgeable users	0	4	8	2	1	2	10	27
Community leaders	0	2	7	0	0	0	14	23
Academia	0	2	5	0	1	0	5	13
Total	4	28	28	5	2	9	55	131

### How is the management of the RESEX currently performing?

For this question we obtained overall 131 replies (Table 3). All interviewed stakeholder groups perceived the management situation of both PAs as either negative or rather negative (Fig. 7). The negative perception, however, was proportionally higher among knowledgeable users (49% and 29% for negative or rather negative, respectively) and community leaders (52% and 32% for negative or rather negative, respectively).

Considering only key informants, this negative or rather negative perception of management is observed for both PAs, although more strongly for the Bragança PA (58% and 27% for negative or rather negative, respectively, of all key informants, as opposed to 32% and 29% for negative or rather negative, respectively, of key informants from Tracuateua) (Fig. 8).

### Perception of previous research

Figure 9 shows that, apart from academics and randomly selected informants, the majority of the respondents had been interviewed at least twice or even several times about the PA before our survey in 2016, especially among community leaders, one of whom even replied, “Yes, actually way too many times.”

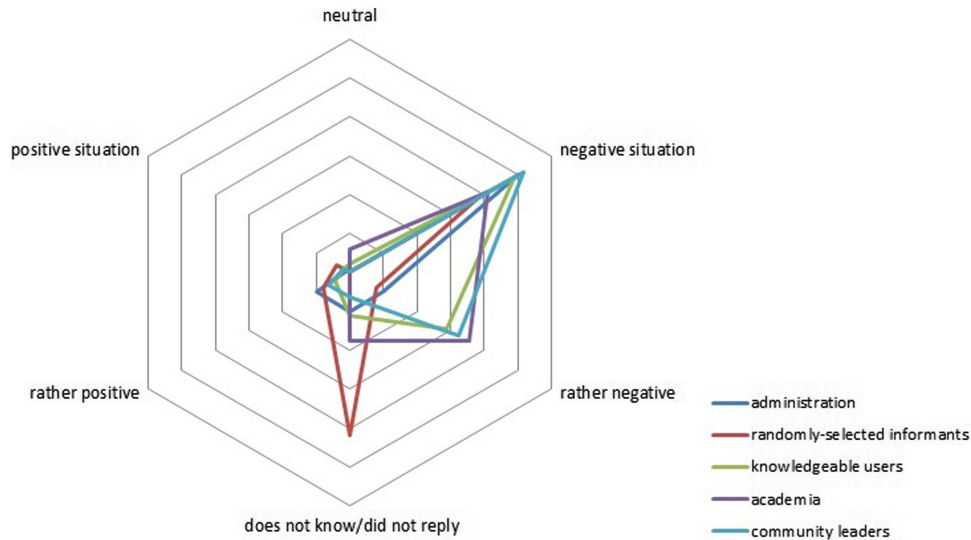
One respondent from the randomly selected informants group seemed to associate the surveys to which we referred to our question with bureaucratic aspects related to the management of the PA. They replied, “Yes, there used to be a lot of [interviewers] like that. I used to even pay [the membership fee] to the RESEX. They used to have a lot of meetings [...] There was also this IDATAM<sup>8</sup>, a lot of people participated, but it was all a scam. Some people say that [these projects] don’t even exist anymore [...]. Another reply showed a possible mix-up with monitoring by management or regulating authorities: “No, it is the first time [that I am being surveyed]. For some time during the time when we cannot fish crabs<sup>9</sup> there comes the research. The researcher goes to the port.”

This fatigue and a general sense of disbelief in research can be directly identified in some of the replies. Around 76% of the respondents who replied to the question “Does research somehow return to the communities?” stated that the research did not return to the communities interviewed. A former president of the users’ association said, “Almost nothing [of the research done comes back]. If it did, the communities would understand how to improve things.” Another community leader replied, “Little [from research] has had an effect, because sometimes [researchers] do the research and do not come back.” A RESEX

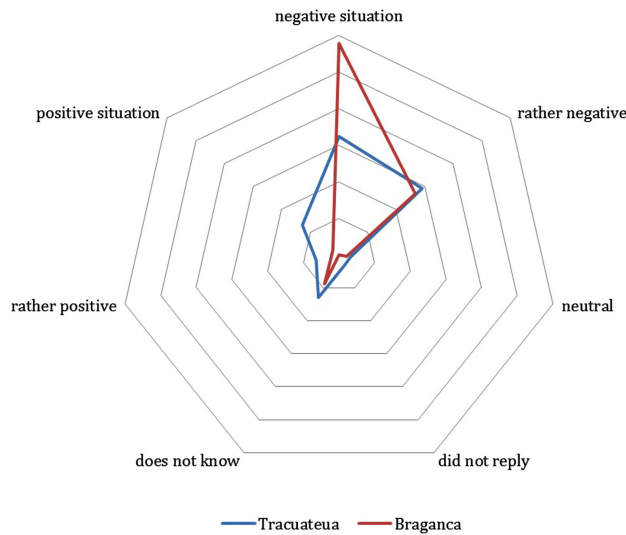
<sup>8</sup>IDATAM is the Institute for Development and Technical Assistance in the Amazon. This institute conducted interviews and workshops related to fisheries in the region for several years.

<sup>9</sup>When crabs reproduce, crab fishing is prohibited in the state of Pará. This temporal closure runs for ~5 days per month, from January to April. The exact dates are usually calculated and released some weeks in advance.

**Fig. 7.** Perceptions of the protected area (PA) management performance (in 2016) by informant group. The results are shown together for both PAs analyzed.

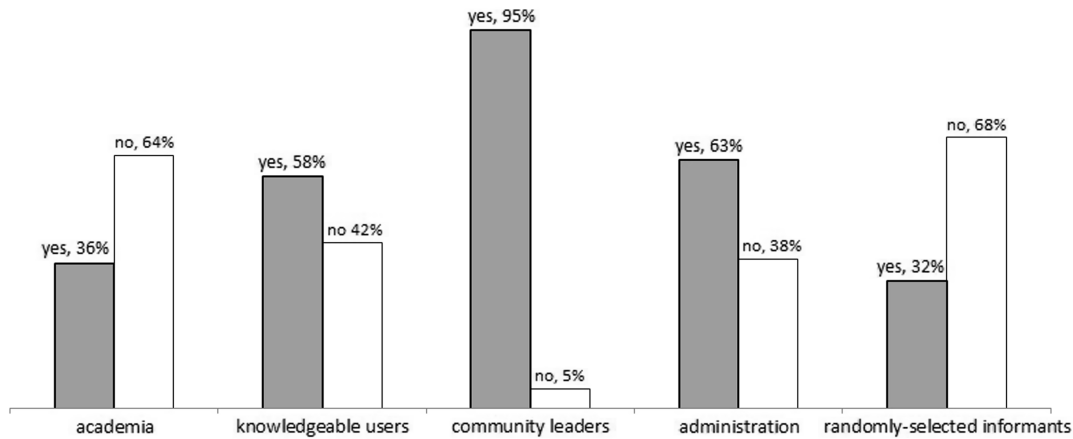


**Fig. 8.** Perceptions of protected area (PA) management, by PA, only for key informants.



manager confirmed, “Very little [of the research comes back]. Sometimes the university has feedback for the management.” A local user complained, “[The communities] do not know what happened to the research because [the researchers] come to the communities, but we do not see the results. They do not come back to bring the results. [...] They come, do an interview, and do not bring the results. All of them from UFPA<sup>10</sup>.” Randomly selected informants also detected this lack of restitution: “All of [the researchers] that have ever come here, none of them ever came back. They take the results and go away.”

**Fig. 9.** Percentage of each respondent group that had been surveyed or interviewed before.



Even researchers themselves acknowledged this deficiency in providing feedback and bringing about positive change through research: “There is no restitution, not to the communities, not to public authorities. When there is some feedback, it does not have a broad representation to change policies. [...] Generally, researchers do not go back to the communities.”

## Discussion

For the Bragança PA, a better understanding of environmental representations (or perceptions) has been used to assess PA success and could be an instrument to improve mangrove governance (Eyzaguirre 2017). In this study, we expanded the investigation of local perceptions to include spatial aspects, such as how users perceive the PA’s geographical boundaries, its zoning, and even previous research done in the region, and how these could connect to PA management.

### Spatial perceptions

When asked to locate the PA most of the stakeholders who are usually involved in PA management and research (administration, academia, and community leaders) mentioned an actual area instead of an address. On the other hand, the percentage of association of the RESEX with a point (or an address) was high among randomly selected informants, who are rarely directly involved in the PA’s management processes. Regarding knowledgeable users, no clear predominant perception could be identified. During the fieldwork, we observed only a few visual indications of the existence of PAs, especially near areas where local users live or extract resources and areas visited by tourists (Fig. 10). This lack of geographical indications could contribute to the fact that respondents rarely perceive the spatial aspects of PAs.

Previous research has shown that local stakeholders (most of whom were also part of this study as key informants) have a strong connection with the local environment, especially with the mangroves (Eyzaguirre 2017). This shows that a sense of place already exists, at least for people who are usually involved in PA management. The missing link

<sup>10</sup>The acronym for Universidade Federal do Pará, or Federal University of Pará, which is the university with a campus and several research projects in the area.

**Fig. 10.** Partially destroyed signs near the outer limits of the protected areas (PAs).



does not seem to be about bringing a sense of place to the concept of the PA, that is, the RESEX, but rather about bringing the RESEX concept to the sense of place that already exists, giving it a place-based dimension, which would strengthen the connection to the local mangroves and to the environment in general and help foster participation in local management processes.

Partelow et al. (2018) identified that a lack of clear communication about the purpose of the RESEX and associated development programs contributed substantially to why perceptions shifted in the region. The information flow between all stakeholders was deficient and influenced by disputes over political influence. We found that bringing into local management the ideas embedded in the concept of an area for protection (or, in Portuguese, *área de proteção*) could help serve as a bridge concept, connecting the many dimensions of mangroves (and nearby ecosystems) to the many aspects of management related to a RESEX (including the material benefits that are part of the necessary improvement of local people's lives). Figure 11 helps clarify this bridging property of the term area for protection.

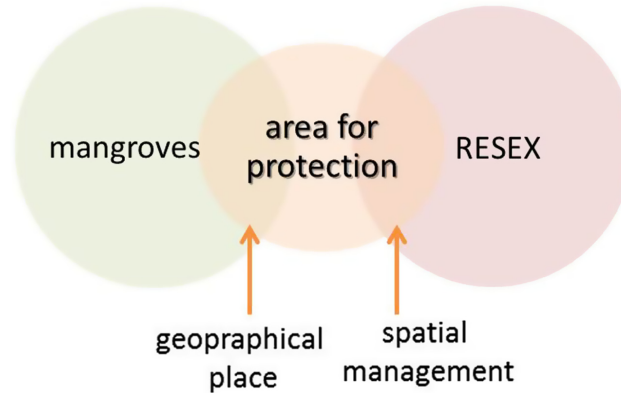
Our analysis of perceptions shows that most interviewees knew nothing about the spatial management of the reserves per se, with about 85% of the informants unaware of the current zoning of the Bragança PA. This could obstruct stakeholders' participation in co-management because their spatial perceptions of the RESEX differed from those of PA management authorities and from the representation of the PA in legal instruments and formal management or research meetings.

The zoning of the Bragança PA was first established in the management plan in 2012 through participatory processes. However, the methods used to define the zones were not thoroughly explained in the management plan. An option would have been a prioritization exercise, using only the participatory mapping data or other data resources, and different ways of including or excluding inputs and feedback from local stakeholders. The consultancy company responsible for the elaboration of the plan did not exist anymore (during our fieldwork in 2019) and therefore could not be contacted. In addition, the original GIS shapefiles (with the results from the mapping workshops and other spatial data presented in the management plan) were not delivered to ICMBio and therefore were not available for consultation. This hinders a re-analysis of the data in the management plan and makes an update more difficult.

Lack of knowledge about zoning and lack of implementation of the spatial management instruments seem to be correlated, although it is difficult to determine cause–effect relations. The causes for these problems could be a lack of effective communication and



**Fig. 11.** Conceptual diagram of area for protection as a bridging concept between the ideas of mangroves and RESEX. Note that this does not represent an area-based, physical conceptualization, since in our protected areas (PAs), for example, all mangroves are geographically inside the RESEXs.



awareness-raising channels between PA management authorities and local stakeholders (Partelow et al. 2018). In addition, there is widespread spatial illiteracy among the different stakeholder groups. In the case of local resource users, a lack of familiarity with the use and interpretation of geographical maps is associated with very basic formal education of the local population (IBGE 2019a). This map-related illiteracy contrasts with a better formal cartographic understanding by administration and academic informants, who were usually aware of the area dimension of the PA and had some experience using the kind of maps that were presented along with the interview questions.

Not only is the implementation of spatial management strategies difficult due to these perception differences, but also the possibility of changing these strategies, such as with an inclusive participatory update of the PA zoning, as recommended in the management plan (Abdala et al. 2012). Although promoting spatial literacy among the different stakeholder groups and translating and disseminating myriad perceptions, policy measures, and research results is important to allow for wider participation and engagement, legal instruments should also be adapted to incorporate local mental models of the PA.

This is especially relevant in the context of highly dynamic ecosystems co-managed by local populations, such as Brazil's Amazonian mangrove forests. For instance, focusing on local place names rather than their exact location taken by a GPS device would help users to better locate these areas. Incorporating place names also helps to deal with the strong temporal dynamics of these mangrove areas. Concrete examples are the so-called emburatauas, areas that require special conservation measures because they are nursery areas to many fish species (Barboza and Pezzuti 2012). These deeper portions of the rivers are also known to change their location over time, so working with the concept rather than with GPS coordinates would make more sense in this context. Focusing on local place names while planning and implementing management strategies connects better to the sense of place of involved local stakeholders and can, therefore, catalyze further and wider involvement and enhance stewardship of nature conservation in these two PAs.

#### Perceptions of management performance

The management performance of both PAs was mostly perceived as negative or rather negative for both PAs, but more strongly for the Bragança PA. Local leaders' negative perceptions about PA management might relate to a state tutelage created by the PAs, in

which local conflicts, which were previously solved through local mechanisms, are now handed over to state agencies, such as ICMBio (Narahara 2014). This loss of autonomy could, therefore, contribute to distrust and general disbelief in the institution of the PA.

Our analysis also investigated the perceptions of current PA management performance and how these perceptions relate to the material gains provided by PAs. All stakeholder groups perceived the management performance of both PAs as, at least, rather negative. Furthermore, informants with the most information and involvement had the most negative views. For the Bragança Reserve, it has been argued that the material gains offered by the RESEX shifted the focus of RESEX members from environmental management concerns to issues related to financial and other material benefits and political advantages (Partelow et al. 2018). As early as the time of the release of the management plan, in 2012, users' expectations regarding the RESEX had already been found to be mainly related to material gains, and less than 3% of the users had expectations related to the environment and monitoring (da Silva Junior et al. 2014). These authors have shown that local attention to environmental protection cannot be detached from worries related to working conditions and general quality of life for local populations.

Since 2015, however, Brazil has seen a political-economic crisis that led to budget cuts not only to the PAs but also to other subsidies important to the livelihoods of local users, most of whom live in poverty (Castilho et al. 2017; Partelow et al. 2018). With severely reduced subsidies to both PAs and their local members, local perceptions of the PAs and their management became more negative, as reported by the respondents. This change in perception was also identified in the Bragança PA by Partelow et al. (2018), who found that local residents started perceiving the RESEX as a government social aid program. Another source of dissatisfaction with PA management is related to disputes over the control of the association's management board (Partelow et al. 2018) and other positions. At the time of our fieldwork, the PA managers (i.e., ICMBio officers) had recently been replaced in both PAs, and there were intense struggles over the leadership of the RESEX members' organization.

Bennett and Dearden (2014) also found that perceptions of governance and management processes in marine PAs in Thailand were generally negative. As in our case study, these perceptions indicate the need to build trust and improve the relationship between PA governance and management bodies and local communities. This would improve management and governance processes and support successful socio-economic and conservation outcomes through increased popular support and better compliance (Bennett and Dearden 2014). Stakeholder participation is increasingly being sought and embedded into environmental decision-making processes, from local to international scales (Stringer et al. 2006; Beyerl et al. 2016), including spatial planning efforts (Ruiz-Frau et al. 2015; Strickland-Munro et al. 2016).

Participation is believed to increase public trust in the final decisions taken and to encourage an active civil society if participatory processes are perceived to be transparent and consider conflicting claims and views (Richards et al. 2004; Glaser et al. 2021). In the case of co-management strategies, such participatory processes can help in the pursue of social and ecological objectives (Cinner et al. 2012).

Understanding local environmental perceptions enables managers to connect with different stakeholders, informs public debate about resource management, identifies issues surrounding local governance of marine resources, and other possible applications to environmental management (Beyerl et al. 2016; Walker-Springett et al. 2016). Local perceptions therefore clearly influence how individuals facilitate and support or undermine conservation initiatives and outcomes, which makes perception studies important for shaping conservation interventions (Bennett, 2016). Perceptions can also indicate the social acceptance of a PA and help monitor governance (Leleu et al., 2012). Our analysis of current

perceptions of the two co-managed PAs in our study can help shape policy measures to increase local users' participation in management. This is because acceptance has been shown to improve when local people (fishers) are directly involved in PA management (Leleu et al. 2012). This indicates that promoting participation could create a virtuous circle of involvement–acceptance–involvement, which is vital for effective co-management.

Environmental changes, coping strategies, and social processes are perceived differently by individual stakeholders. Once in place, the specific responses to such challenges might be considered efficient by some, yet completely unsuccessful by others (Beyerl et al. 2016). In our case, a negative or rather negative perception is shared by all groups in both PAs examined, which stresses the need for further investigation of these perceptions and urgent measures to integrate them in PA management, including planning and evaluation strategies.

### Management and previous research

During the interviews, we perceived a lack of clarity by local users (all key informants, except academia and administration staff) regarding research and monitoring and management-related surveys. That is because academia, NGOs, public authorities, and the PA management have been conducting many surveys with fishers and households in general. This is reflected in the high percentage (76.5%) of local, direct users who had already been interviewed (considering only knowledgeable users and leaders and excluding randomly selected informants). These surveys do not seem to have contributed, in a transparent way, to finding ways to link local users to the development and implementation of PA regulations<sup>11</sup>. This may have contributed to the observed fatigue and lack of hope in terms of receiving concrete benefits or even just being informed about the results of the surveys.

Potential negative effects might include a generalized distrust in research and researchers and a lack of motivation to participate not only in the many research and monitoring initiatives in the region but also in PA management and other political arenas. Following Bennett (2016), we argue that researchers need to extend their focus from pure knowledge generation to include communicating results, deliberating on possible courses of action and their outcomes, and identifying possible concrete steps to improve conservation outcomes.

### Conclusions

In this study, we have linked the mental models projected by different user groups to formal conceptualizations of PAs in legal instruments and identified mismatches that need to be considered when building a zoning plan. These include how local users perceive and change their perceptions of the essence of a PA and its main goals, and how PAs are formally established in legal instruments. Our research contributes to the analysis of place meaning, which, according to Stedman (2008), receives less attention than the already poorly tackled place attachment aspect of the concept of sense of place.

While mangroves are places where key aspects of the sense of place can be identified, such as attachment and meanings, the mental model by local users regarding what the

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<sup>11</sup>There have been exceptions to this lack of retribution by local research projects. For example, the MADAM (Mangrove Dynamics and Management) project, which ran from 1995 to 2005, distributed a bulletin, every two months for the better part of the duration of the project, informing local communities about research news. This material was able to engage families in discussions about the research being done in the region. Even though we realized during the interviews that local people still remember the MADAM project, this specific initiative of reporting on research results seems to have been forgotten by the communities and not repeated by researchers. It is noteworthy, however, that the MADAM project, contrary to most other research projects in the region, was long-lasting, well-funded, and multidisciplinary since its conception.

PAs mean is disconnected from the concrete elements of the geographical space (e.g., the mangrove forests). An enriched sense of place, which connects the ecosystems with existing, formal conservation instruments, seems to be key to improving the connection between local inhabitants and their environment and would therefore motivate stakeholders to participate in co-management processes. By better understanding the meanings attributed to important elements of conservation, such as a PA, we can find ways to strengthen the connection between local people and the instruments they have acquired to actively participate in environmental management.

A direct output for conservation is our recommendation that zoning strategies consider user perceptions, especially when, as in our case study, the geographic limits and zones are hardly known or acknowledged by local users. In such circumstances, spatial regulations should not assume that users can easily identify PA boundaries or zones in PA, the delineation of which they are not involved in. Spatial literacy and awareness of the PAs need to be promoted, and legal instruments need to be adapted to allow for the inclusion of more diverse territoriality representations and unusual management tools, such as spatially and temporally dynamic gear-restricted zones.

Because of a long, extensive research record in this region, we also observed a possible fatigue toward surveys among local stakeholders. The perception that results do not return to respondents in the form of feedback or concrete improvements in management, or even that survey questions are unrelated to local priorities, could lead to mistrust and reduce the incentives for co-managing the PA. Awareness-raising and the return of research results in generally accessible forms could curb the effects of research fatigue and of the perceived failure of management efforts. In fact, communication in general should be enhanced between local users, managing authorities, and academia, so that limitations in the interpretations of and subsequent compliance with spatial regulations can be better understood and overcome.

Despite the negative aspects identified in the management of the PAs, it is important to point out that (i) co-management in coastal areas is a recent development in Brazil. Stakeholders and the institutions involved are developing new tools and methods in a continuous learning-by-doing process that has been largely hindered by an anti-science and anti-environment government with traces of authoritarianism and strong neoliberal economic directives; and (ii) this study involved populations in situations of high socio-economic vulnerability with poor access to basic rights, such as clean water and food sovereignty, as well as public sanitation and health services. It is understandable, therefore, why local and national authorities do not prioritize spatial literacy or conservation awareness, especially considering the dominant structure of education, which focuses on the formation of the labor force, and the widespread cosmology among management authorities of a supposed separation between nature and society. While it is true that the institutionalization of the Brazilian RESEXs has not been flawless, their creation has been shown to bring about material benefits, such as housing and fishing equipment, for the local populations (Partelow et al. 2018), as well as to help protect the Amazonian mangroves (Hayashi 2018), which could have possibly succumbed to practices that negatively impacted northeastern mangroves, such as shrimp farming (de Lacerda et al. 2019).

Future studies are needed on the spatial aspects of PA management and the role of local perceptions in spatial management. Challenges and caveats of assessing and applying local perceptions also need to be investigated, although we believe that these generally do not outweigh the possibilities to improve conservation and management that are opened up by research involving perceptions. Since humans are central in this kind of research, it needs to be planned so that respondents understand and identify with the goals of the research and have realistic and explicitly discussed expectations in terms of the returns to

them from the new knowledge to be created. Expanding this investigation to further PAs can also help elucidate whether the issues found in the Bragança case are an exception or the rule for the extractive reserve model in Brazil.

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