Systematic Review of Spatial Planning and Marine Protected Areas: A Brazilian Perspective

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Marine protected areas (MPAs) are essential to human well-being and usually part of spatial planning processes for managing coastal and marine areas. In Brazil, national-level spatial planning processes are still incipient. This article offers a systematic review through a comparative meta-analysis of the literature on MPAs and spatial planning based on the following questions: (I) What topics are investigated in spatial planning in MPAs worldwide? and (II) What are the advances and trends of these topics in Brazilian MPAs? Specific goals of this study are (I) to identify studies on Brazil; and (II) to compare and contrast these with studies performed elsewhere. The PRISMA report was used to select literature, with a focus on three spatial contexts (I) outside Brazil, analyzing studies from other countries; (II) in Brazil; and (III) a case study in Brazil that focuses on a sustainable-use area in northeastern Pará. Studies outside Brazil showed three major groups of themes: (I) planning and tools; (II) stakeholders; and (III) the ecology of non-human species. For the Brazilian context, studies were grouped into five major themes: (I) small-scale fishing practices and conflicts; (II) participation in protected areas; (III) technical aspects of the planning process, (IV) zoning; and (V) mapping. The local case study investigates socio-cultural sustainability and tourism. All identified studies relate to use, but have a greater focus on conservation and, especially abroad, on species and ecosystems. There are few reviews or comparative studies that could help to draw parallels between the different spatial planning settings. We conclude that synthesis work on spatial management strategies worldwide is needed, including the elaboration of frameworks to develop measures to address the widespread lack of data and spatial planning expertise. Collaborative networks of researchers and practitioners are needed for this. The novelty in our study is that it examines MPAs and spatial planning research at three spatial contexts with innovative methodologies to represent the current state of the spatial planning discourse in coastal and marine conservation.

Keywords: fisheries, marine spatial planning (MSP), spatial management, stakeholders, systematic review
INTRODUCTION

A marine protected area (MPA) is a geographical space reserved by law, considered essential to human well-being (Gubbay, 2005) and, especially, to local communities (Bennett and Dearden, 2014). The implementation of MPAs has grown worldwide (Potts et al., 2014; Leenhardt et al., 2015; Tonin, 2018) as a management strategy to conserve resources (Bennett and Dearden, 2014). However, MPAs still need to be better planned (IUCN, 2009). They have an important role in marine spatial planning (MSP) (GEF, 2012) with MSP understood as a public process for organizing the use of marine space, and pursuing social, economic, and ecological benefits (Ehler and Douvere, 2009). The relationship between MPAs and MSP is sometimes described based on geographic level: Marine protected areas represent marine spatial planning at lower levels (or smaller scales), while MSP usually refers to a higher-level process (Strickland-Munro et al., 2016). MPAs are recognized as an important element of MSP (Ehler and Douvere, 2009). Another cornerstone of MSP is zoning, which, in this study, is considered a management tool in the wider context of MSP (Dudley, 2008; Kenchington and Day, 2011). It focuses on the MSP process within (IUCN, 2012) and outside MPAs. The relationship between MSP, MPA, and zoning is clarified in Figure 1.

Thus, MSP is one element of ocean or sea use management, whereas zoning plans and other regulations are one of a set of management actions for implementing MSP (Ehler and Douvere, 2009). Whether zones are highly, moderately, or weakly regulated influences the overall protection level of MPAs (Costa et al., 2016; Horta e Costa et al., 2016). Therefore, zoning applies to the management of MPAs considering their zone classification and the International Union for the Conservation of Nature (IUCN) categories of protected areas (Dudley, 2008). It facilitates the identification of types of resource uses (Domínguez-Tejo et al., 2016), as well as challenges, knowledge gaps, and institutional difficulties in MSP (Katsanevakis et al., 2011). Zoning, MPA networks, and MSP are helpful processes for ecosystem-based, marine spatial management (Katsanevakis et al., 2011). Moreover, diverse stakeholders have emphasized the importance of including MSP as a tool to harmonize different marine uses, including renewable energy generation, aquaculture, and climate change adaptation (Lombard et al., 2019). Still, MSP is incipient worldwide (Abspoel et al., 2019) and studies on MSP and zoning are rarely published in peer-reviewed journals (Domínguez-Tejo et al., 2016), although the number of published studies is growing (Rêgo et al., 2016).

In Brazil, the Blue Amazon represents the country’s Exclusive Economic Zone (EEZ) and has an area of 5.7 million km², or approximately half of Brazil’s terrestrial area, which makes it one of the largest on the planet (Gerhardinger et al., 2018). The implementation of zoning strategies in the Brazilian EEZ is still at an early stage (Gerhardinger et al., 2019), despite existing projects that aim at the management of coastal areas, such as the Orla Project (Casemiro et al., 2018). Brazilian protected areas, inserted in the National System of Conservation Units (Brazil, 2000), are part of an important conservation strategy toward the conservation of myriad coastal and marine ecosystems, including mangroves (Pinheiro et al., 2015). Federal protected areas are divided into two main groups: strictly protected areas (17%) and sustainable use areas (83%) (MMA and ICMBIO, 2018). The goal of strictly protected areas is to preserve nature so that only indirect use, which does not involve consumption, collection, or destruction, is allowed (Brazil, 2000). The sustainable use group aims to reconcile nature conservation and direct use, allowing for the collection and commercial use of natural resources (Brazil, 2000).

One of the categories in the sustainable use group is the extractive reserve. This model pursues the participation of local stakeholders in the management of natural resources (Brazil, 2000; Partelow et al., 2018): members of traditional communities have the role of co-managers (da Silva, 2004). In the case of mangroves, for example, “mangrove civilizations” (Diegues, 1995) practice artisanal fisheries (Diegues, 2008). These are usually the main socio-economic activity in these areas (Fernandes et al., 2018), such as the Amazon macrotidal mangrove coast (Souza Filho, 2005). This coast is one of the longest (Souza Filho, 2005) and most important protected mangrove regions on the planet (Hayashi et al., 2019) and its coastal-estuarine communities depend on the mangrove ecosystem services (Eyzaguirre and Fernandes, 2018; Fernandes et al., 2018).

Despite the importance of ecosystems such as the northern mangroves, policy measures for MSP in Brazil are at an early stage (Gerhardinger et al., 2019), and the development of knowledge creation in this front remains poorly understood. In the implementation arena, the incipincy of spatial management in Brazilian MPAs is revealed by the fact that only 19% of these areas have management plans, which usually include the MPA’s zoning. Assessing the status of MSP in Brazil can help identify gaps and conservation needs in marine conservation. The development of effective management plans and zoning strategies requires systematic data, which are usually gathered by, or in collaboration with, scientific studies.

With the aim to better understand research in MPAs and spatial management in different spatial contexts, this article offers a systematic review through a meta-analysis of the literature and addresses the following questions: (I) Which...
FIGURE 1 | Relationship between key concepts in marine, area-based management. *MPA zoning, where some aspects of management are spatially identified, should be distinguished from ocean zoning, where strategies, such as MPAs, and sectoral activities are spatially regulated at higher levels. Zoning applies to the management of MPAs based on the International Union for the Conservation of Nature (IUCN) categories. The diagram is based on the literature and concepts presented in this introduction.

topics studied relating to spatial planning in MPAs have been investigated worldwide? and (II) What are the advances and trends in these topics regarding MPAs in Brazil, both considering the whole country and a case study? and (III) How do studies performed worldwide (outside Brazil) compare to those performed in Brazil? This last question aims to assess how a single country has been developing research in MPAs and spatial management and how this research differs from other countries. This helps identify common topics, successes, and challenges in spatial planning inside and outside Brazil, while also pinpointing aspects that are specific for the Brazilian context and that could dialogue with the experience of other countries with the goal to promote mutual learning and the exchange of experience.

MATERIALS AND METHODS
Spatial Contexts
Studies were categorized according to three spatial contexts (or the geographic areas analyzed): (I) outside Brazil, (II) in Brazil, and (III) in a case study MPA in north Brazil, the Caeté-Taperaçu marine extractive reserve, located in the coastal Bragantinian northeastern region of Pará (Mendes, 2005; IBGE, 2010; Figure 2). The mangrove areas in the Amazonian mangrove belt are a Ramsar Site (RAMSAR, 2018). They represent at least 57% of the mangrove coverage in Brazil, with an area of about 7,591 km² (Souza Filho, 2005). They have high biodiversity (Abdala et al., 2012) and are one of the largest continuous extensions of mangroves on the planet (Souza Filho, 2005). Caeté-Taperaçu is one of the few marine extractive reserves in the marine biome that has a zoning plan and where local research contributed to formulate the management plan (Abdala et al., 2012). This marine extractive reserve therefore offers a good case study to investigate the literature on spatial planning inside Brazil.

Literature Selection Criteria
In May 2018, the Web of Science (WoS) database (Clarivate Analytics, 2017) was used to search for studies outside and inside Brazil and the Brazilian Digital Library of Theses and Dissertations (BDTD) was searched to obtain more studies on Brazil. In these databases the following combined terms were searched: (I) {("protected area" AND "(coastal OR marine)"), OR MPA} AND {"spatial management" OR "spatial planning"} and (II) {["protected area" AND "(coastal OR marine)"), OR {"MPA" OR "conservation unit"} AND {"spatial management" OR "spatial planning"} AND Brazil].

Criteria were adopted to filter studies that focused on the search terms (Table 1). The titles and abstracts of the retrieved articles were screened based on these criteria. The English language was selected for its broad usage in scientific publications (Drubin and Kellogg, 2012), both outside and inside Brazil. Portuguese was selected to increase the number of studies found, due to the amount of literature produced in the Portuguese language (Barata et al., 2014). Title, abstract, and keywords sections of studies in Portuguese were translated into English by the first author in order to obtain results in the English language.

Some words were analyzed as terms while others, as individual words. The words “marine protected area,” for instance, when occurring together, were analyzed as a term. When combined with other words, e.g., “marine habitats” and “study area,” these words were analyzed separately. On the other hand,

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6We used the term “conservation unit” because it is the literal translation into English of “unidade de conservação,” which is the term most frequently used in Portuguese for “protected area.”
words such as “spatial” and “management” were analyzed as separate units, because of their independent meaning and possibility to be combined with other words, forming units with different meanings, such as “spatial planning,” “protected area management,” and “management plan.”

Analyses
Overview of all Analyses Performed
The systematic literature review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guide (Moher et al., 2009; Figure 3). The qualitative and quantitative analyses were conducted after the systematization of the studies with the PRISMA report.

Quantitative Analyses
The textual content or corpus of title, abstract, and keywords sections of the selected studies was structured after the collection and compilation of all the documents. The frequency of certain key terms in the studies and similarity among these words were analyzed (Abric and Vergès, 1994; Abric, 2003). Lexicometry is a method to measure word frequency in a text (Torruella and Capsada, 2013). A semantic lexicometry analysis was performed...
FIGURE 3 | Diagram of selection and eligibility criteria, including sample sizes, using the PRISMA report. The PRISMA report was used to filter documents obtained from the databases according to the eligibility criteria.

(Wasserman and Faust, 1994; Leydesdorff and Welbers, 2011) based on the co-occurrence of words and their interrelationship of coexistence with the nodes represented in the similarity chart (Fronzetti, 2018). Proximity or connectivity is based on distance metrics (Wasserman and Faust, 1994) depending on the frequency and inter-relationship between nodes (Fronzetti, 2018). The results presented are related to the most frequent terms in each analysis, but do not necessarily exhaust all possible relationships that could be derived from the datasets.

Word clouds
Title, abstract, and keywords sections of the studies were also jointly subjected to the word cloud analysis using MAXQDA version 2018.2. Word cloud is the processing of qualitative data that are grouped and organized graphically according to word or expression frequency (Heimerl et al., 2014). Word clouds can serve as a starting point for a more in-depth analysis. Terms shown in the word clouds have a minimum frequency of three hits. Words used in the search were eliminated from the word clouds generated.

Similarity analysis
A similarity analysis shows the spring force\(^7\) and the frequency between the words through the classification of the three sections analyzed (titles, abstracts, and keywords). The textual content was evaluated using the discursive occurrences related to similarities and interlinks between the words or terms (Alexandridis et al., 2018). We used the method of graphs (Fruchterman and Reingold, 1991), based on Eades’ algorithm (Eades, 1984) and on the spring forces (Kobourov, 2012) to indicate how close or far apart terms are (Fruchterman and Reingold, 1991), how interrelated words are in the discourse (Alexandridis et al., 2018), and the salient themes of each class. Classes are connected to each other by a frequency number that shows the similarity between the words and identifies the discourse structure of the studies analyzed. This similarity analysis is related to the descending hierarchical analysis that we introduce below.

Descending hierarchical analysis
We used the Descending Hierarchical Analysis (DHA) to classify terms in descending order by lexical category (Reinert, 1990). The hierarchical dendrogram is based on the Euclidean distance between words in the text (Fruchterman and Reingold, 1991). It also evaluates the degree of association between the classes of each word (Ratinaud and Marchand, 2012). Since only one document was found for the local case study, this document was incorporated into the Brazilian context for this specific analysis. Three important parameters for interpretation were used: (I) similarity, which refers to the concurrence between the words that are similar; (II) proximity, which indicates the distance between the words (Fruchterman and Reingold, 1991); and (III)

\(^7\)Spring force is used in network social theory to measure the distance between objects in a text. In this study, the distance between words/terms shows the relationship of meaning in the discourse.
frequency, which explains the interrelation between the words in all documents (Ratinaud, 2009; Alexandridis et al., 2018).

The distance between the classes was analyzed using the DHA and a dendrogram chart, where the percentage indicates how many words/terms belong to each class. The words were analyzed using the “advanced lexical search” tool in MAXQDA. More on MAXQDA is explained in section Software Used.

Specific topics approached in each study were identified, including the referenced bibliography. The qualitative categorization was based on the search terms, according to hits (number of times the search term was found) and to the number of documents where these search terms were found. Search terms relate to frequent topics in the literature on MSP and MPAs. A list of search terms was created based on the authors' familiarity with the literature on these two topics.

Software Used
Two software packages were used for the analyses: MAXQDA and Iramuteq (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires) (Table 2). These tools were used to represent the structure of discourse on spatial planning studies in order to map the studies and their scientific cognitive structure through the landscape of bibliometric cartography (van Raan, 1996). The analyses were selected from each package based on the availability of each analysis and the easiness of interpretation of the visualized results.

MAXQDA is a license-based tool that uses the coding of data as a starting point for qualitative and mixed-methods analyses (Oliveira et al., 2016). Iramuteq is an open-access, qualitative analysis tool which is not based on the codification of texts but rather analyzes segments of the texts through tests such as the descending hierarchical classification, the similarity analysis, and word clouds (Souza et al., 2018). It offers different ways of statistically analyzing qualitative data (Ramos et al., 2019), since it is developed in the Python language and uses functionalities provided by the statistical software R (Souza et al., 2018).

The textual corpus was analyzed through coded segments of the documents using MAXQDA. An analysis of the frequency of the codes used in relation to the contexts was produced, as well as a lexical search on study topics (section Word clouds). MAXQDA was also used to code studies selected for the content analysis into thematic categories (section Similarity analysis).

Additionally, Iramuteq was used to analyze the textual corpus derived from the publications (Ratinaud, 2009). This tool produces a statistical map of a textual corpus from the frequency of words or lexicometry analyses based on chi-square statistics (Ratinaud, 2009). The titles, abstracts, and keywords sections of the studies were analyzed in the Iramuteq for each of the spatial contexts considered. Table 2 shows the analysis performed by database search and spatial contexts, highlighting the software used for each analysis.

Although some databases have interesting analytical tools such as the tree maps and bar charts on WoS, the programs we used here have a wider range of descriptive and inferential statistical tools to analyze qualitative data. MAXQDA, for example, is considered user-friendly, while Iramuteq is intuitive (Oliveira et al., 2016). The word cloud analysis, for instance, a way of presenting the frequency of the words in the documents, was carried out with MAXQDA due to its more appealing presentation of the results.

RESULTS
Quantitative Analyses
General Characteristics
Initially, the search yielded one, 28, and 190 studies for the local case study, for studies in, and outside Brazil, respectively. After applying inclusion and exclusion criteria, a total of 111 studies were selected. A total of 111 studies were selected, 16 in Brazil, and one for the local case study, respectively. After applying inclusion and exclusion criteria, a total of 111 studies remained to be analyzed, with publication years ranging from 2003 to 2017 (Table 3).

Word Frequency Clouds
The frequency of the words in the title, abstract, and keywords of each study was analyzed (see Data Sheet 1). Studies outside Brazil (Figure 4A) most frequently contain the word “conservation,” “species,” “fisheries,” and “fishing.” In the titles

| Search terms | Search database | Number of studies | Analysis | Software | Spatial context(s) analyzed |
|--------------|----------------|------------------|----------|----------|-----------------------------|
| (1) and (2)  | WoS and BDTD   | 128              | Quantitative analyses | MAXQDA   | Outside and in Brazil, plus the local case study |
| (1) and (2)  | WoS and BDTD   | 48               | Qualitative analysis  | –        | Outside and inside Brazil, without the case study |

WoS, Web of Science; BDTD, Biblioteca Digital Brasileira de Teses e Dissertações.
of the Brazilian studies (Figure 4B), the terms most frequently mentioned are “conservation,” “environmental,” “fishing,” “local,” and “use.” The local study (Figure 4C) has among its most frequently mentioned terms “tourism,” “extractive reserve,” and “Caeté-Taperaçu,” which are all terms directly related to the protected area that is the research site for this specific study. Some words observed with greater frequency (larger size) are similar for studies outside and in Brazil, such as “conservation” and “fishing,” while the local case study leans toward “sustainability” and “sustainable.”

### Similarity Analysis

Five classes compose the words for studies outside Brazil (Figure 5), where the most frequent words are “plan,” “management,” and “conservation.” The term “marine protected area” should be read as one single word, while “spatial” and “management” are two different words that have a relationship to one another. On the one hand, “marine protected area” is related to “stakeholder,” “process,” “plan,” and “network.” On the other hand, “management” is related to the “spatial,” and “ecosystem.” This group (yellow) is related to the red group, i.e., the studies on spatial management relate to the benefits of the fishery activity. The distance values between the words, based on frequency, can be found in Data Sheet 2.

Five classes compose the words of the studies in Brazil (Figure 6). These studies discuss more frequently “conservation,” “management,” and “environmental.” The words “social” and “participation” (yellow group) have a greater proximity value with “conservation” of “biodiversity” in Brazil. On the other hand, the most frequent word in the lilac class, “management,” is related to “relationship,” while “conflict” is related to “area” and “zone” in the red class. “Brazil” is connected, in a direct way, to “biodiversity,” and in an indirect way, to “participation” and “social.”

Brazilian studies also bring the term “conflict” in combination with “fish” and zone. “Management” and “plan” relate to “local” and “knowledge,” while also including, but apparently with smaller frequency, “social” and “participation.”

Unlike the other two contexts, the analysis of similarity of the one relevant study on the local case study presents only three classes (Figure 7). The structure of the discourse in this study presents the word “tourism” (green group) as most frequently occurring and also as related to “extractive reserve” (blue group). “Caeté-Taperaçu” is an “extractive reserve.”

### Descending Hierarchical Analysis (DHA)

For studies outside Brazil (Figure 8A), three classes were identified, the Brazilian studies (including the local case study) (Figure 8B) present five classes.

The words in class 1 (44%) are closest to those in class 2 (16.6%), and these two classes are significantly different from class 3 (39.4%) The results of the statistical analyses can be found in Data Sheet 2. The red and green classes, e.g., “management” ($\chi^2 = 47.28$, $p = 0.0001$), “conservation,” “plan,” “initiatives” ($\chi^2 = 105.2$, $p = 0.0001$), and “stakeholder” refer to the management dimension of spatial planning research. The blue class, e.g., “fish,” “population,” “species,” “abundance,” and “model,” refers to the biological and ecological dimensions of the spatial planning research on MPAs.

Studies in Brazil form different classes of terms and words (Figure 8B). The green class, e.g., “practice,” “alternative,” and “fisherman” are closest to red class, e.g., “conflict,” “fisher,” and “actor.” The brown class, e.g., “protect” and “participation” are closest to blue class, e.g., “project.” The lilac class contains words such as “legal,” “development,” and “GIS.”

All the classes are interrelated in varying degrees, for example, classes 3 and 1, which relate to social dimensions. Classes 2 and 4 are closely related to one another and also relate to management, while class 5 relates to the zoning, for example, by using GIS tools to establish zones.

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**TABLE 3** | Studies selected.

|               | Local | In Brazil | Outside Brazil | Total |
|---------------|-------|-----------|----------------|-------|
| Number of studies after exclusions |       |           |                |       |
| WoS           | 0     | 5         | 111            | 116   |
| BDTD          | 1     | 11        | 0              | 12    |
| Total         | 1     | 16        | 111            | 128   |

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*Geographic Information System (GIS).*

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Borges et al. Spatial Management in Marine Protected Areas

FIGURE 5 | Similarity analysis of studies outside Brazil, showing the formation of five classes of words/terms. The numbers represent the proximity between one word and a second word which is closest to the first one. The number indicates the distance between the words overall, showing their relationship in terms of proximity to each other. These words are interconnected by frequency, based on the theory of graphs and networks. The colors represent the classes, which were established according to the proximity of the words in the texts. Also, the largest words are the most frequently mentioned in the studies. This similarity analysis is related to the DHA in Figure 8.

Frequency of Topics Through Lexical Search
The lexical search identified the terms related to fisheries as the most frequent ones for studies both outside (7,382 hits in 111 studies searched, or an average of ∼66 hits/study) and in Brazil (5,877 hits in 16 studies searched, or an average of ∼367 hits/study), as well as for the local case study (110 hits for one study searched). Other high frequency terms can be found in Table 4.
Furthermore, the lexical search identified missing research topics (Table 5). Further details on the results for this analysis can be found in Data Sheet 3.
FIGURE 6 | Similarity analysis of studies in Brazil (local case study excluded). The numbers represent the proximity, expressed as the distance between the words based on frequency and similarity. The largest words are the most frequently mentioned. These words are interconnected by frequency, based on the theory of graphs and networks. The colors represent the classes, which were established according to the proximity of the words in the texts. This similarity analysis is related to the DHA in Figure 8.

DISCUSSION

This systematic review identifies studies on spatial planning in MPAs and, specifically, compares and contrasts studies performed outside and in Brazil. We identified studies related to spatial management in different spatial contexts and provide a combination of systematic review and meta-analysis, with a qualitative and quantitative approach (Impellizzeri and Bizzini, 2012). A list of all titles can be found in Data Sheet 2, as well as the context of each study, the database where it was found, and its original language.

The Context Outside Brazil

The relationship between ecological and socioeconomic aspects is evidenced by the connection of spatial planning to fishing. Research on MPAs involves aspects of networks, planning, design, and stakeholders. Spatial management in general, not necessarily linked to protected areas, relates to issues of scale, tools, and approaches, and, as expected, to MSP. Species and habitats are related to distribution and range, probably due to the importance of their distribution for MSP and zone in general, with a focus on coral reefs. The term “conservation” is usually linked to biodiversity.

Some studies focus on spatial prioritization. One study introduces a framework for spatial prioritization as an alternative to conservation planning tools (Teh et al., 2013). This study specifically mentions zoning strategies, such as the implementation of no-take zones (Mangubhai et al., 2015; Martin et al., 2015). Other studies rely on prioritization software. One of them uses Marxan to build a new zoning plan for...
the current MPAs in the Canary Islands and highlights the need for a rezoning of these areas (Martín et al., 2015). Marxan is an algorithm designed to help decision-makers find solutions to conservation planning problems (Ball et al., 2009). Marxan also assisted the distribution of biodiversity, for example, defining zones of fish conservation as an important tool for spatial planning success of MPAs (Haupt et al., 2017). Another study uses Marzone with socioeconomic criteria and concludes that the final zoning plans recognize community use and governance of resources, maximize equity and access to traditional fishing grounds, and better support long-term food security and livelihoods of local communities (Mangubhai et al., 2015). Marzone is a prioritization tool in the Marxan family. It allows for geographic areas to be assigned to specific zones, each with its own set of actions, objectives and constraints (Ball et al., 2009). Besides algorithms such as Marxan and Marzone, spatial modeling can also be used as a planning tool (Pillans et al., 2014).

Spatial modeling of seabirds also serves to represent areas of intensive use and is applied to identify solutions for MSP and spatial management of MPAs (Perrow et al., 2015). Conservation of pelagic biodiversity, for example, needs innovative methods to reach conservation targets related to marine planning, such as modeling of data in a temporal context (Grantham et al., 2011). Such modeling should integrate supporting processing.
such as links to nearby systems and their elements (Guidetti et al., 2013). The spatial-temporal modeling of corals showed the areas with the highest conservation priority to be included in MPA planning (Makino et al., 2014). Spatial planning is also a topic in studies on historical modeling with climatic projections in space-time scenarios to identify the changes and disturbances of an MPA (Levy and Ban, 2013). The changes and vulnerability of the exclusive economic zone through spatial analysis are also important to the decision making in risk management (Katsanevakis et al., 2011). Therefore, MPA management includes modeling studies that identify the resilience of ecosystems to climate change by identifying the priority and exclusion zones for spatial planning in the future (Davies et al., 2016). Connectivity strategies for seabird conservation indicate that MPAs are valuable tools for conservation and that spatial protection should be included in the complexity of such systems (Yorio, 2009).

As the results show that research on MPAs outside Brazil emphasizes aspects of MPA stakeholder participation and design. The coastal and marine zone planning process should apply diversified initiative strategies such as stakeholder inclusion to achieve MPA management objectives (Fox et al., 2013) and spatial modeling which includes expert opinion successfully allows the identification of areas for conservation (Wedding et al., 2013).

To do this, it is necessary to include the contributions of the stakeholders in the MPAs by analyzing the conflicts among the different sectors and their interests (Lieberknecht and Jones, 2016). For example, a study addresses the evaluation of stakeholder policies and stakeholder views and concerns to verify the MPA's management effectiveness and establish MPA networks (Lu et al., 2014). In another study, a conflict analysis was carried out and the spatial modeling in the MPAs helped the implementation of MPAs (Pecceu et al., 2016). The effectiveness of protected areas can be boosted by creating a network which has population representation as a design principle (Ban et al., 2014).

Some studies specifically focus on zoning. On the one hand, MPA zoning requires integrating socio-economic and cultural factors to obtain support from communities during implementation. On the other hand, spatial prediction models include zoning studies of biodiversity distribution to represent areas of high conservation need (Schmiing et al., 2014) and to identify areas of conservation priority for interconnected land-sea planning (Klein et al., 2012). In addition, multi-criteria spatial analysis is used to define areas and minimum and maximum sustainability through the socioeconomic evaluation of activities such as fish farming in the MPA (Dapueto et al., 2015). Bio-economic models are used to verify the spatial management
The Brazilian Context

The similarity analyses show that, in Brazil, “social” and “participation” are closely related to “conservation” and “biodiversity.” This is not found in studies outside Brazil. Two studies approach the topic of stakeholder participation (Prestrelo and Vianna, 2016; Ribeiro, 2017), including possible conflicts that emerge in the context of a protected area (Martins, 2012; de Andrade and Soares, 2017). This highlights the importance attributed to local knowledge for the management plan of protected areas. MPAs in Brazil strongly relate to conservation and biodiversity. It also shows that research in Brazil gives some degree of emphasis to sustainable use of resources. The theme “participation” is a frequent one probably because of a political atmosphere that was favorable to, and reflected demands for, an increased social participation of myriad political actors in the management of protected areas. MPA zoning is reported as well as with general regulations of an MPA (de Andrade and Soares, 2017), are also analyzed. Perceptions of users regarding the number of hits (appearances) for the group of search terms, considering all contexts together.

| Group rank | Search terms | # of hits | International context | National context | Local context |
|------------|--------------|-----------|-----------------------|-----------------|--------------|
| 1          | “fishery” “fisheries” “pesca” “pesqueir” “pescaria” | 13,369    | 7,282                 | 5,877           | 110          |
| 2          | “protected area” “area” protegida “unidade” de conserva | 3,408     | 2,123                 | 1,232           | 53           |
| 3          | “zon”       | 2,908     | 2,072                 | 817             | 19           |
| 4          | “rede de unidades” “rede de áreas” network “redes de unidades” “redes de áreas” | 1,964 | 1,924 | 37 | 3 |
| 5          | “biodiversity” “biodiversidade” | 1,856 | 2,072 | 817 | 22 |

The search term groups include words in English and their counterparts in Portuguese.
including climate change into the planning of protected areas through a gap analysis of marine protected areas (Magris et al., 2015). One study assesses issues in protected area management (Gerhardinger et al., 2011), while other studies include fisheries management (Costa et al., 2016; Prestrelo and Vianna, 2016) and fish biology (Costa et al., 2016).

**Local Case Study**

The local case study approaches the topics of socio-cultural sustainability and tourism in the Caeté-Taperaçu marine extractive reserve (Freitas, 2013). This study was the only one found in the searched databases. This study addresses the application of tourism on Ajuruteua beach, which is in the buffer zone the Caeté-Taperaçu marine extractive reserve (Abdala et al., 2012). The management plan is a tool of great importance for the inclusion of tourism in this protected area, comprising the support of other stakeholders starting from the formulation of policies to guarantee the participation of the communities (Freitas, 2013). The study also highlights that the study area, a marine extractive reserve, has an important sociocultural dimension. This is expected since management programs in marine extractive reserves are directed at resource sustainability, environmental protection, knowledge, participatory management, and operation of the reserve (Abdala et al., 2012).

In contrast to the national and global contexts, the case study paper does not mention the connection between fishing and spatial planning. It rather emphasizes sustainable use and communities and focuses on the relationship between tourism and the local communities.

**Spatial Planning and Management: Comparing the Different Contexts**

In Brazil, only two studies recommend zoning in protected areas. While MSP in Brazil is still incipient, we suspect that there are many non-peer-reviewed studies on this topic that are not published in peer-reviewed journals. Such studies in the gray literature were not captured in this study, but will be further analyzed in an upcoming paper. This makes the spatial planning experiences in Brazil less visible to academia and is probably what caused the low number of publications for our local study case. Studies outside and in Brazil deal with “use,” but have a greater focus on “conservation,” and especially abroad, on “species” and “ecosystems.” There are few reviews or comparative studies (26 and 8% of the studies outside and in Brazil, respectively). Such studies would help to draw parallels between the different settings where spatial planning is being evaluated or taking place. This work could be undertaken by one or several collaborative network(s) of researchers and practitioners.

In mangrove ecosystems, for instance, studies on MSP are still incipient, although zoning studies on MPAs, in general, are growing around the world (Rêgo et al., 2016). Brazil is somewhat ahead of the international field: 34 and 50% of the analyzed studies have a focus on spatial management, outside and in Brazil, respectively. Among the studies that deal with the topic of zoning inside a given protected area 23% are outside and in Brazil 31% inside Brazil.

We found only one study for our local MPA related to MSP and management, although the Amazonian coastal area is considered the most protected mangrove region on the planet (Hayashi et al., 2019). This is unexpected, given the high number of studies in the region of this MPA and the fact that it is one of the few MPAs that has a zoning plan. For example, one study is related to the co-management and institutional resilience to assess the adaptations of social-political changes in a MPA (Partelow et al., 2018). Our findings underline that zoning in Brazil is still in its early stages, especially in the blue economy-related marine zoning (Gerhardinger et al., 2019).

**Limitations**

The absence and presence of publications on spatial planning were affected by the language of search. That is, the Portuguese language was a key factor in the search for studies in Brazil, while English influenced the search for studies both in and outside Brazil. The English language could have overrepresented the number of studies and made others invisible (Mongeon and Paul-Hus, 2016). Although the growth of publications in Brazil has been evident since 2002, Brazilian publications still have little presence abroad due to the language barrier (Barata et al., 2018). Authors in research areas such as the social sciences and humanities publish mainly in Portuguese, although in some areas it is disregarded as a language of knowledge dissemination (Solovova et al., 2018). Similarly, the keywords could have directed the search to find studies on spatial management and protected areas in the contexts studied, but not studies related to planning effectiveness.

**CONCLUSIONS**

There are few reviews or comparative studies, especially regarding zoning within protected areas, which can help to draw parallels between the different local, national and international settings where spatial planning is being evaluated or taking place. Areas of research on spatial planning are highlighted. When related to MPA research, a strong influence of fisheries is detected. This study used three spatial contexts to assess the status of MSP worldwide and relate it to Brazil. The novelty about this study is the comparison with the reality in Brazil, where “conservation is not on the forefront of spatial planning alone, but rather accompanied by related social aspects, such as “participation” and “user perceptions.”

The methods applied in this study can be replicated elsewhere in order to verify the state of MSP in different countries and they are not necessarily restricted to the coastal and marine realm. The integration of the analyses shown here is an innovative way to present data in a systematic review and can be used to compare and contrast a given issue for different spatial and institutional levels and contexts. This gap could be addressed through a collaborative network of researchers and practitioners.

**DATA AVAILABILITY STATEMENT**

No datasets were generated or analyzed for this study.
AUTHOR CONTRIBUTIONS

RB conceptualized the research, searched and compiled the studies analyzed, performed the MAXQDA analyses, and wrote the manuscript. IE searched and compiled the studies analyzed, performed the Iramuteq analyses, and wrote the manuscript. MG helped restructure the manuscript and discuss the results. All authors contributed to the article and approved the submitted version.

FUNDING

RB is grateful to CNPq for the scholarship to perform the doctoral research (Process 290055/2014-8). IE is grateful to Laboratório de Ecologia de Manguezal (LAMA) and Organization of American States (OAS) for providing scholarship for postgraduate studies in Brazil. The authors are grateful to the University of Bremen for providing financial support for this open-access publication.

ACKNOWLEDGMENTS

We thank the reviewers for valuable comments on the manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fmars.2020.00499/full#supplementary-material
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