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Review Article

Scientiometric analysis of the capture of elasmobranchs as bycatch off the Amazon coast

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ABSTRACT

Fisheries impact aquatic resources, with many species taken as bycatch, and thus represent a global threat to many species, in prticular, the elasmobranchs. Given the lack of reliable bycatch data, this study conducted a systematic review in four scientific databases to identify publications addressing elasmobranch bycatch along the Amazon coast. Between 2002 and 2022, 27 studies were published, docummenting the bycatch 28 sharks and 14 rays species. The literature search revealed an increase in the frequency of publication after 2015, with Brazil dominating the research output, while neighboring countries contributed limited data. Most studies involved trawling, while gillnet and longline fisheries were poorly represented. Worldwide, 78.0% of sharks and 57.0% of rays are classified as threatened. The review reveals persistent problems, including deficiencies in the identification, delays in data publication, and weak monitoring and enforcement. These findings emphasize the urgent need for improved research coverage, monitoring, and conservations actions.

Keywords: Batoids; Blue Amazon; Conservation; Fishery resources; Sharks.

Análise cienciométrica sobre captura de elasmobrânquios como fauna acompanhante no litoral Amazônico

RESUMO

A pesca tem impacto sobre os recursos aquáticos, com muitas espécies capturadas acidentalmente, representando assim uma ameaça global para muitas espécies, em particular os elasmobrânquios. Dada a falta de dados confiáveis sobre capturas acidentais, este estudo realizou uma revisão sistemática em quatro bases de dados científicas para identificar publicações que abordassem as capturas acidentais de elasmobrânquios ao longo da costa amazônica. Entre 2002 e 2022, foram publicados 27 estudos, documentando a captura acidental de 28 espécies de tubarões e 14 espécies de raias. A pesquisa bibliográfica revelou um aumento na frequência de publicações após 2015, com o Brasil dominando a produção científica, enquanto os países vizinhos contribuíram com dados limitados. A maioria dos estudos envolveu a pesca de arrasto, enquanto a pesca com redes de emalhar e palangres foi pouco representada. Em todo o mundo, 78,0% dos tubarões e 57,0% das raias são classificados como ameaçados. A revisão revela problemas persistentes, incluindo deficiências na identificação, atrasos na publicação de dados e monitoramento e fiscalização fracos. Essas descobertas enfatizam a necessidade urgente de melhorar a cobertura da pesquisa, o monitoramento e as ações de conservação.

Palavras-chave: Amazônia azul; Conservação; Raias; Recursos pesqueiros; Tubarões.

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INTRODUCTION

In tropical regions, fisheries typically capture a high diversity of bycatch, due to the reduced selectivity of their gear, and the effort concentrated on the target species (Aragão et al., 2015; Bonanomi et al., 2017; Isaac & Braga, 1999; Lutz et al., 2023; Morgan & Burgess, 2005). This accidental harvesting of non-target resources is increasingly becoming a global threat to many marine species, due to the high levels of ecological impact on natural stocks (Bonanomi et al., 2017; Isaac & Braga, 1999).

Despite the diversity of the organisms that make up the bycatch, in general, very little of this resource is exploited commercially (Almeida et al., 2011; Dias-Neto & Dias, 2015), and even basic biological data are lacking for most of the organisms captured, which hampers the development of effective sustainable management measures for this resource (Guimarães-Costa et al., 2020; Passarone et al., 2019). This bycatch fauna includes several elasmobranchs that are endangered species (Charles & Kennelly, 2018; Erguden et al., 2022; Oliver et al., 2015). These species may be taken using a variety of fishing gear, although trawls, gillnets, and longlining are the principal types of rig, which have the greatest impact, albeit in different manners, according to the specific characteristics of their capture mechanisms (Aragão et al., 2015; Bonanomi et al., 2017; Cintra et al., 2015; Dias-Neto & Dias, 2015; Morgan & Burgess, 2005; Nóbrega et al., 2021; Oliveira & Frédou, 2007; Rigg et al., 2009; Silva et al., 2016).

Despite its evolutionary success, the Chondrichthyes is nowadays one of the most threatened groups of marine organisms worldwide (Dulvy et al., 2014; Dulvy et al., 2021; Moore, 2017; Pacoureau et al., 2021; Simpfendorfer & Dulvy, 2017). The biological characteristics of these fishes, including their slow growth, late maturation, and reduced fecundity, make them particularly vulnerable to exploitation by large-scale fisheries (Bonanomi et al., 2017; Dias-Neto & Dias, 2015; Erguden et al., 2022; Jorgensen et al., 2022). High rates of fishery exploitation have led to a critical decline in many elasmobranch populations around the world (Erguden et al., 2022). When available, the fishery data often present incorrect species identifications or no taxonomic information whatsoever, making it difficult to assess the true impact of fishing on this endangered fauna, particularly in the case of the bycatch (Bonanomi et al., 2017; Morgan & Burgess, 2005), which greatly hampers the difficult task of quantifying the real impact that fisheries have on this threatened fauna.

As most of the elasmobranch catch is incidental, most of the individuals captured are discarded at sea. Together, poor fishery monitoring and the misidentification of species result in a lack of understanding of the true impact of this bycatch on the fish populations (Wosnick et al., 2023).

The situation is extremely preoccupying in the case of the Amazon coast, which includes Brazil, west of the Parnaíba Delta, Guyana, Suriname, French Guiana, and the east coast of Venezuela (Awhida-Robinson et al., 2025; Guimarães-Costa et al., 2020). This region is characterized by intense fishing pressure associated with significant gaps in scientific knowledge. Most studies have focused on trawl fisheries, especially those targeting pink shrimp, while gillnet and longline fisheries are still relatively poorly understood (Silva et al., 2016; Dias-Neto & Dias, 2015). In addition, many bycatch records use only generic nomenclature (*e.g.*, dogfish, skate, shark) or imprecise taxonomic identification, which results in ineffective risk assessment and conservation strategies (Bornatowski et al., 2014; Coelho et al., 2023).

There is a major shortage of data on the composition of the bycatch taken by Amazonian fisheries, mailny off the Brazilian coast, as well as in the case of the smaller-bodied species or fish that have little commercial value (Pinheiro & Martins, 2009). The lack of any reliable identification of the species, which is common in the case of the elasmobranchs (Dias-Neto, 2011; Dias-Neto & Dias, 2015), together with the absence of continuous official fishery statistics (Isaac & Braga, 1999; Wosnick et al., 2019a; Wosnick et al., 2019b), and the limited scope of most research, which has tended to focus on shrimp trawling (Silva et al., 2016), all hamper the reliable evaluation of the actual impact of bycatch and the application of effective sustainable management measures that are relevant to the ecosystem.

The most recent update of the International Union for Conservation of Nature's Red List indicates that approximately one-third of all shark, ray, and chimaera species are threatened with extinction, with direct fishery exploitation and bycatch being considered to be the principal causes of the decline in their populations (IUCN, 2023). Given this, the systematic assessment of the scientific literature on the elasmobranchs captured in the region of the Amazon coast is extremely important for the understanding of patterns and trends. In this context, scientometric analyses provide a valuable tool for the development of public conservation policies (Qaiser et al., 2017; Sultan et al., 2023).

The general lack of data on the species captured in the Amazon region may be mitigated, at least in part, by systematic reviews of the research on elasmobranch bycatch, which can provide extremely important insights for the conservation of threatened fishery resources. The present study adopted a scientiometric approach to provide a concise overview of the elasmobranch bycatch taken by fisheries operating off the Amazon coast. The principal objectives of the study were to: quantify and characterize research patterns over time; identify the most common fisheries and data collection methods; identify the species involved and assess their conservation status and identify knowledge gaps and the potentially most lucrative directions for future research. The integration of ecological, taxonomic, and scientiometric perspectives should advance the development of effective conservation strategies for the region's elasmobranchs.

MATERIAL AND METHODS

Data collection

The systematic literature search presented here was conducted in May and June 2023 (Page et al., 2021; Rethlefsen et al., 2021), using four well-respected scientific databases—Google Scholar, Web of Science, Scientific Electronic Library Online (SciELO), and Scopus—to ensure an optimal coverage of the literature.

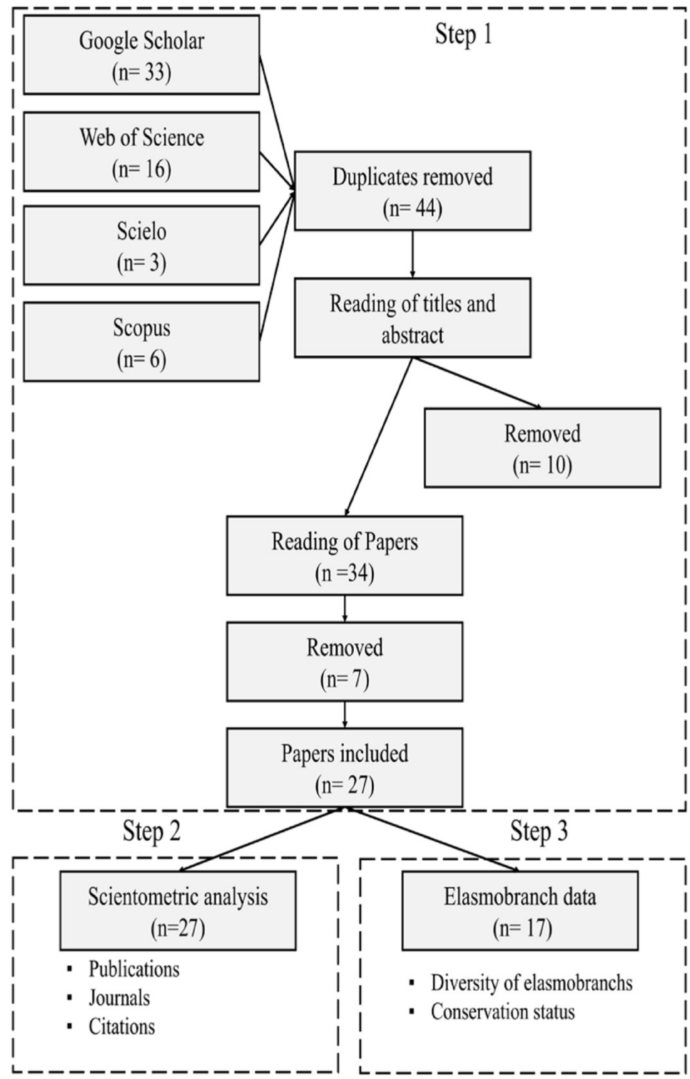
The search focused on the bycatch of the trawl, gillnet, and longline fisheries operating off the Amazon coast, specifically in Brazil, Guyana, French Guiana, Suriname, and Venezuela. The Web of Science, SciELO, and Scopus databases were selected for this survey due to their content of indexed journals of high scientific relevance at both national and international levels, while Google Scholar was included due to its enormous volume of indexed papers (Baas et al., 2020; Battisti & Salini, 2013). While limiting the search to databases of scientific papers (Google Scholar, Web of Science, SciELO, and Scopus) makes this study replicable, in comparison with other approaches—for example, for cross-referencing purposes or the identification of the personal sites of researchers—, there is a risk of missing papers that are either not indexed or simply unavailable in these databases (Molina & Cooke, 2012).

The search parameters applied in the present study included a combination of descriptors related to bycatch, elasmobranchs, and fisheries, which were applied to the title, abstract, and keywords of the papers catalogued in each database. The search terms were a set of descriptors in both English and Portuguese, which were associated with Boolean operators (AND, OR) to refine the results. No time frame was established here for the data search, to provide a complete record of the historical development of the research in this field (Farias, 2025).

Screening, eligibility and the analysis of the data

The records obtained from the four databases were processed in three steps:

- Data filtering and their eligibility assessment;
- Data analysis using a bibliometric approach;
- Data analysis on the elasmobranchs (Fig. 1).



SciELO: Scientific Electronic Library Online.

Figure 1. Flow chart showing the process of identification, processing, and sorting of the papers analyzed in the present study.

Step 1

The papers extracted from each database were filtered based on the title and abstract of each publication, with the exclusion criteria including studies that did not focus on the specific topic addressed here, and studies that were not published in scientific journals, including monographs, theses, dissertations, books, and conference abstracts. Duplicate papers were also eliminated from the listing, and each paper was read in full to determine whether it fell within the exact scope of the research defined here.

Step 2

Following the bibliometric approach of Qaiser et al. (2017) and Sultan et al. (2023), each paper was examined to determine its bibliographic metrics, that is, its authors, title, journal, year of publication, country and institutions of affiliation, journal impact factor (JCR), and the number of authors per article, together with other details of the study, that is, the specific geographic region, sampling period, type of fishing gear (trawl, gillnet or longline), and the composition of the bycatch.

Step 3

The papers containing data on elasmobranchs taken as bycatch were selected and examined in detail to determine: the species captured, their updated scientific nomenclature (California Academy of Sciences, 2023; FishBase, 2023; Shark References, 2023; WoRMS, 2023), and the global conservation status of these species according to the IUCN's Red List (IUCN, 2023).

RESULTS

Publications, journals, and citations over the years

A total of 59 publications were identified in the four databases surveyed in the present study, with 34 of this total found in Google Scholar, 16 in the Web of Science, six in the Scopus database, and three in SciELO, covering the period between 2002 and 2022. Once the title and abstract of each scientific paper had been verified, and the duplicates had been removed, this total was reduced to 34 papers on the specific topic of bycatch in Amazonian fisheries (Fig. 1). However, seven of these 34 publications were excluded, for many reasons. To begin, four of the studies covered an area larger than the Amazon coast, without differentiating which data were from the Amazon region, while two papers were based on a compilation of data, and one presented only a comparison of the statistical tests used to analyze the data. The 27 papers that remained after the full reading of each publication identified initially form the final set of papers that were analyzed in the present study (Farias, 2025). This set of papers includes all the bycatch studies, which were analyzed, although only 17 present detailed data on the elasmobranchs.

The papers recovered by the literature search were published between 2002 and 2021 (Fig. 2), with the annual production peaking in 2019 (five papers), followed by 2016 and 2021, with four papers each. This variation in the number of papers published each year indicates a progressive increase in the research on the topic over the years. The data presented in these papers were collected between 1991 and 2018, with 2010 and 2014 being the years during which the most data were collected, followed by 2011, 2013, 2016, and 2017 (Fig. 2). These findings indicate that the sampling effort is not distributed uniformly over time, in relation to the publication of the papers.

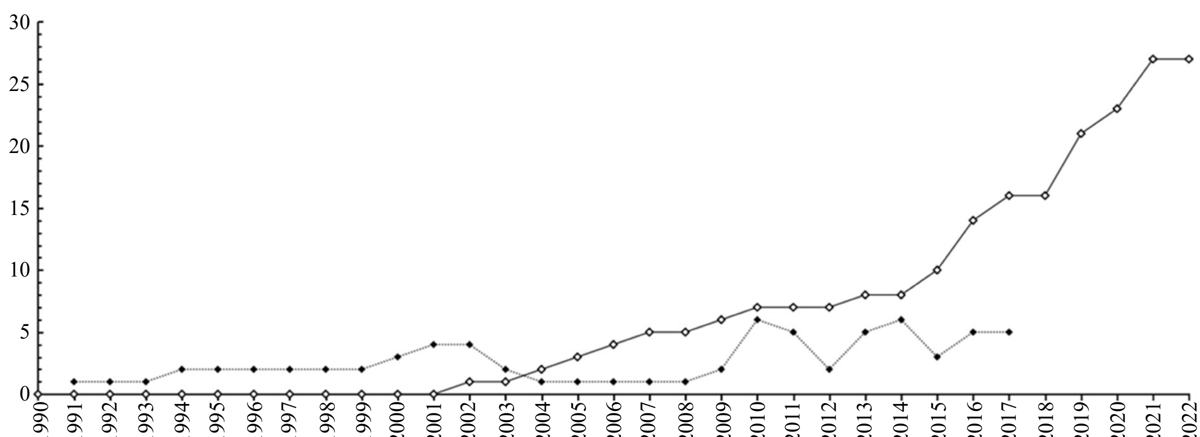


Figure 2. Cumulative frequency over time (years) of the publications on elasmobranch bycatch in the Amazon region identified in the present study, together with their respective sampling periods.

The analysis of the papers (Fig. 2) revealed a recent increase in publication rates, although there is a clear time lag in the publication of data over the past four years (2019–2022). This time lag reflects the interval between the collection of the data and the publication of the papers, which varied from one to 11 years. Only two of the seven papers that had a time lag of more than five years reported data collected over a period of more than two years (seven and 10 years of data collection). The other five papers reported data that took either one or two years to collect, despite taking six to 11 years to publish the results of the study (Farias, 2025).

The papers identified here had between two and 15 authors, with an overall mean of just under five (4.8) authors per paper. The authors publishing each paper also represented between one and 10 different academic institutions or a mean of 2.7 institutions per paper. Some of the authors also represent more than one institution (Farias, 2025). Overall, the papers analyzed here were published by researchers from 36 different institutions, with each institution being involved in between one and 13 papers, with an overall mean of 2.2 papers per institution. Between one and 31 researchers from any given institution were involved in the publication of the papers analyzed here, with just under four (3.8) per institution, on average, being involved in the publication of research on the bycatch taken by fisheries operating off the Amazon coast (Farias, 2025).

The 27 papers recovered here were published in a total of 20 different journals, of which only nine have an impact factor (IF) (Fig. 3a). These journals are *Frontiers in Marine Science* (IF = 5.247), *Brazilian Journal of Oceanography* (IF = 1.933), *Fisheries Research* (IF = 1.9), *Neotropical Ichthyology* (IF = 1.47), *Gulf and Caribbean Research* (IF = 1.1), *Latin American Journal of Aquatic Research* (IF = 1.022), *Ocean and Coastal Research* (IF = 0.885), *Boletim do Instituto de Pesca* (IF = 0.8), and Ciencias Marinas (IF = 0.5).

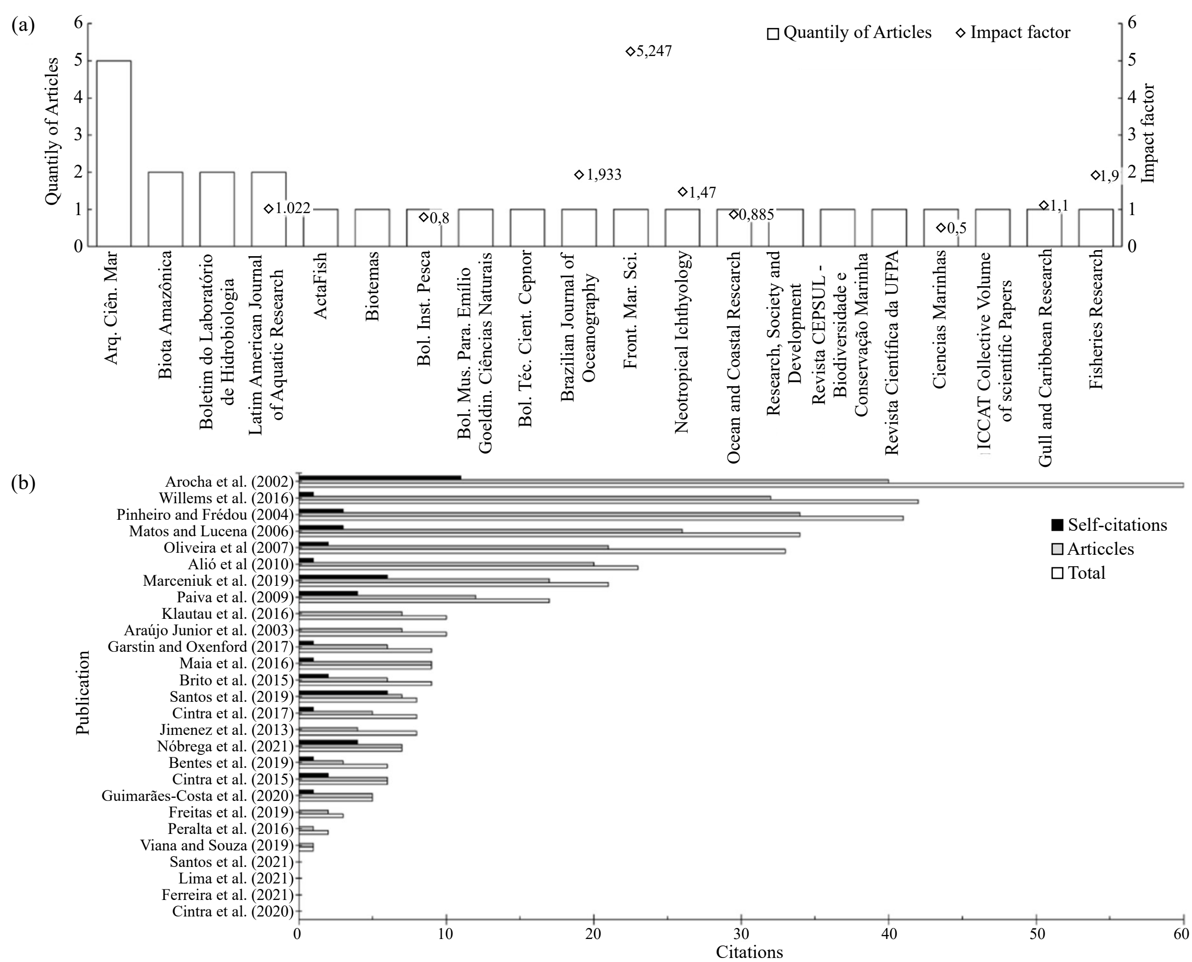


Figure 3. Relationship between the journals, impact factors, and number of citations: (a) the number of papers per journal and impact factor; (b) the total number of citations, citations of papers, and the self-citations of the research on elasmobranch bycatch off the Amazon coast.

Based on Google Scholar, the older papers tended to have the most citations overall, and even when the citations in monographs, books, and book chapters are excluded, this pattern is virtually unchanged, which implies that these types of publication have little influence on the number of times a paper is cited (Fig. 3b). The only exceptions were the papers published by Arocha et al. (2002), Oliveira and Frédou (2007), and Willems et al. (2016), which were cited 20, 12, and 10 times, respectively, in monographs, books, and book chapters. A similar overall trend was also observed in the number of self-citations, that is, older papers tended to be self-cited more frequently. Given that, Arocha et al. (2002) were self-cited 11 times, Marceniuk et al. (2019) and Santos et al. (2019) on six occasions, and Nóbrega et al. (2021) and Paiva et al. (2009) four times each.

Types of fisheries and data collection procedures

Two of the 27 papers identified here reported data for three different types of fisheries, while all the others focused on only a single type. Overall, trawling featured in 22 (68.8%) of these 32 reports, followed by gillnetting (five papers), longlining (four papers), and one case of rod-and-line fishing.

Trawling is also predominant in the papers published by the different countries included in the data compiled here (Fig. 4a), although Guyana and Suriname are each represented by only a single study (of trawling, in both cases). We did not retrieve any articles from French Guiana, probably because of specific limitations in the analytical approach (see Material and Methods; Farias, 2025). In the specific case of the papers identified on the fisheries of the east coast of Venezuela, there was also a predominance of trawling. While the studies were more varied in Brazil, there was still a predominance of trawling (17 of the 26 occurrences), followed by gillnetting (five occurrences), longlining (three), and one case of rod-and-line fishing (which was only recorded in Brazil).

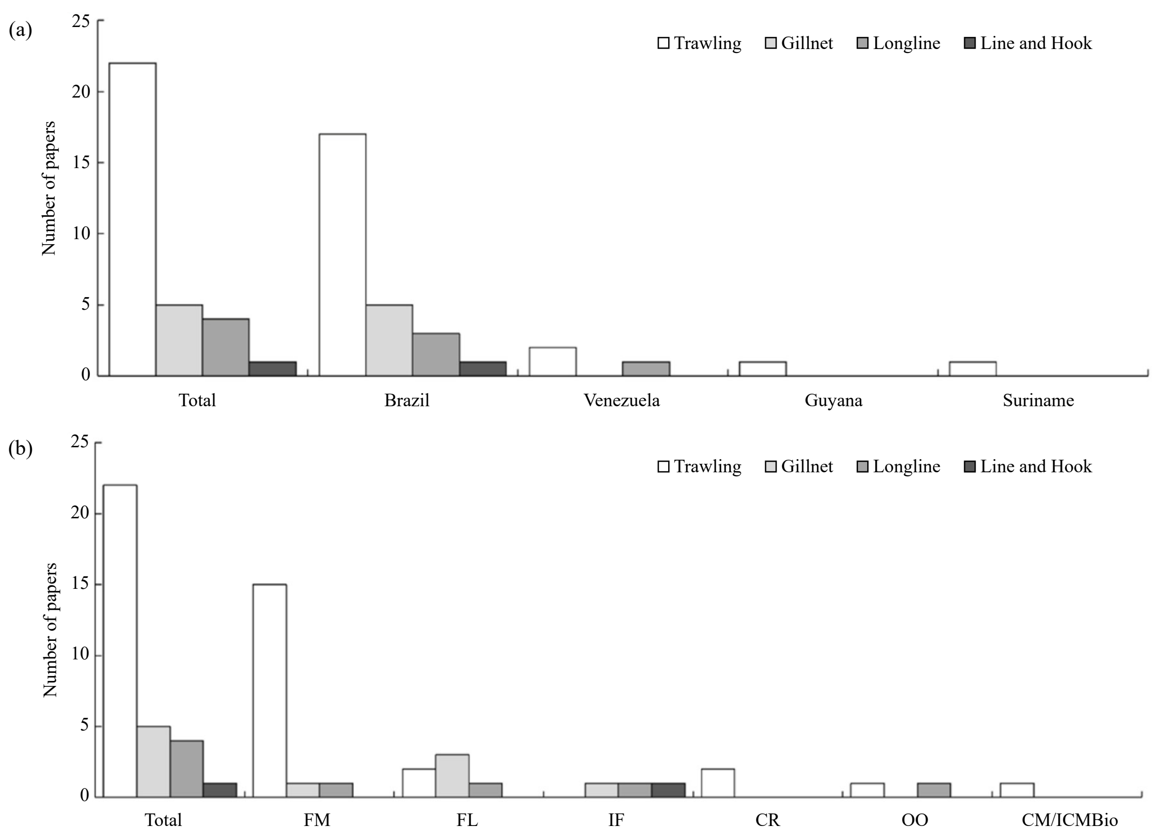


Figure 4. Relationship between the types of fisheries, country, and data collection methods: (a) types of fisheries per country; (b) types of fisheries per data collection method—fishery monitoring (FM), fishery landings (FL), interviews with fishers (IF), catch records (CR), onboard observers (OO), and cruise monitored by Centro Nacional de Pesquisa e Conservação da Biodiversidade Marinha do Norte/Instituto Chico Mendes de Conservação da Biodiversidade (CM/ICMBio).

Considering the 31 reports, there was also a predominance of data obtained through fishery monitoring (17 papers), including four papers published by the Centro Nacional de Pesquisa e Conservação da Biodiversidade Marinha do Norte (National Center for Research and Conservation on the Marine Biodiversity of Northern Brazil—CEPNOR), while two involved vessels equipped with devices used to exclude turtles from capture, and in one case, a vessel equipped with turtle exclusion devices/bycatch reduction devices. The other reports involved fishery landing data (seven cases), interviews with fishers (three), catch records (two), onboard observers (two), and a CEPNOR research cruise (Fig. 4b).

Elasmobranchs captured

A problem with the data obtained during the present study was the fact that some scientific names were outdated, that is, while they were valid at the time of the publication of the paper, more recent taxonomic reviews have reformulated their nomenclature, which required the names of five rays and one shark to be updated here (Farias, 2025). Based on the content of the papers analyzed here, which presented detailed elasmobranch capture data, a total of 28 species of shark were identified in the respective studies, representing 12 genera, nine families, and five orders (Farias, 2025). In the case of the rays, there were 14 species, 10 genera, eight families, and five orders (Farias, 2025). However, a degree of uncertainty was encountered in many cases, with the imprecise classification of specimens leading to the identification of sharks only to family, in one case, or genus, in three cases, as well as the generic term "cação," in one case (Farias, 2025). A similar scenario was observed in the case of the rays, with the specimens being identified only to family in one case, genus in two cases, and the generic "arraia" or "raia" in two cases (Farias, 2025).

The present study revealed that the Brazilian Amazon coast is the region with the greatest diversity of elasmobranch bycatch, with 26 species (14 sharks and 12 rays), followed by Venezuela, with 22 species (all sharks). Only nine species (one shark and eight rays) were recorded in Guyana, and five species, all rays, in Suriname. These differences are at least partly related to the much larger number of papers from Brazil (22) identified in the literature search, in comparison with Venezuela (four papers), and Guyana and Suriname, each with only one paper.

Elasmobranchs and the different types of fisheries

The data compiled here indicate that longline fisheries captured 24 species of shark belonging to nine families, while the trawlers captured 10 species from three families, and gillnets, three species from three families (Fig. 5a). In the case of the rays, the data indicated that the trawlers captured 14 species belonging to eight families, while the gillnet and longline fisheries each captured only a single species of ray (Fig. 5b). The greater diversity of elasmobranchs captured by trawlers in the present study may be accounted for by factors such as the reduced selectivity of the trawl nets, and the much larger number of papers (22) that focus on trawling, in comparison with gillnetting (five papers), and longlining (four).

Most of the capture data from the trawl fisheries were derived from the monitoring of vessels (15 papers), which avoided the potential bias and underestimates caused by discarding unwanted catches at sea. By contrast, the gillnet data were obtained primarily by the monitoring of catch landings (three papers) and interviews with fishers (one paper), which would have been completely vulnerable to potential bias due to the discarding of specimens at sea. The longline studies were based on records of landings, interviews with fishers, the monitoring of vessels, and onboard observations, with each method being employed in a single paper.

Conservation status

The data from the present study indicate that the conservation status of the shark species taken as bycatch off the Amazon coast (Fig. 6) was even more preoccupying than the global scenario, given that the IUCN classifies 78% of the species as threatened—five (17.8% of the total) of these species are classified as critically endangered (CR), seven (25%) as endangered (EN), and 10 (35.7%) as vulnerable (VU), with five (17.8%) classified as near threatened (NT), and one (3.5%) as least concern (LC). A similar situation was observed in the rays, with 57% of the species being classified as threatened (CR + EN + VU).

The IUCN classifies three batoids species (21.4% of the total) as CR, three (21.4%) as EN, and two (14.2%) as VU, with four (28.5%) being classified as NT and one (7.14%) as LC (Fig. 6). One batoid species (7.14% of the total) was classified as data deficient. Despite being classified as threatened, these species continue to be captured and discarded, and any decrease in the captures of sharks and rays will tend to reflect a decline in the populations rather than the results of any fishery management efforts (Davidson et al., 2016; Leite Júnior et al., 2023).

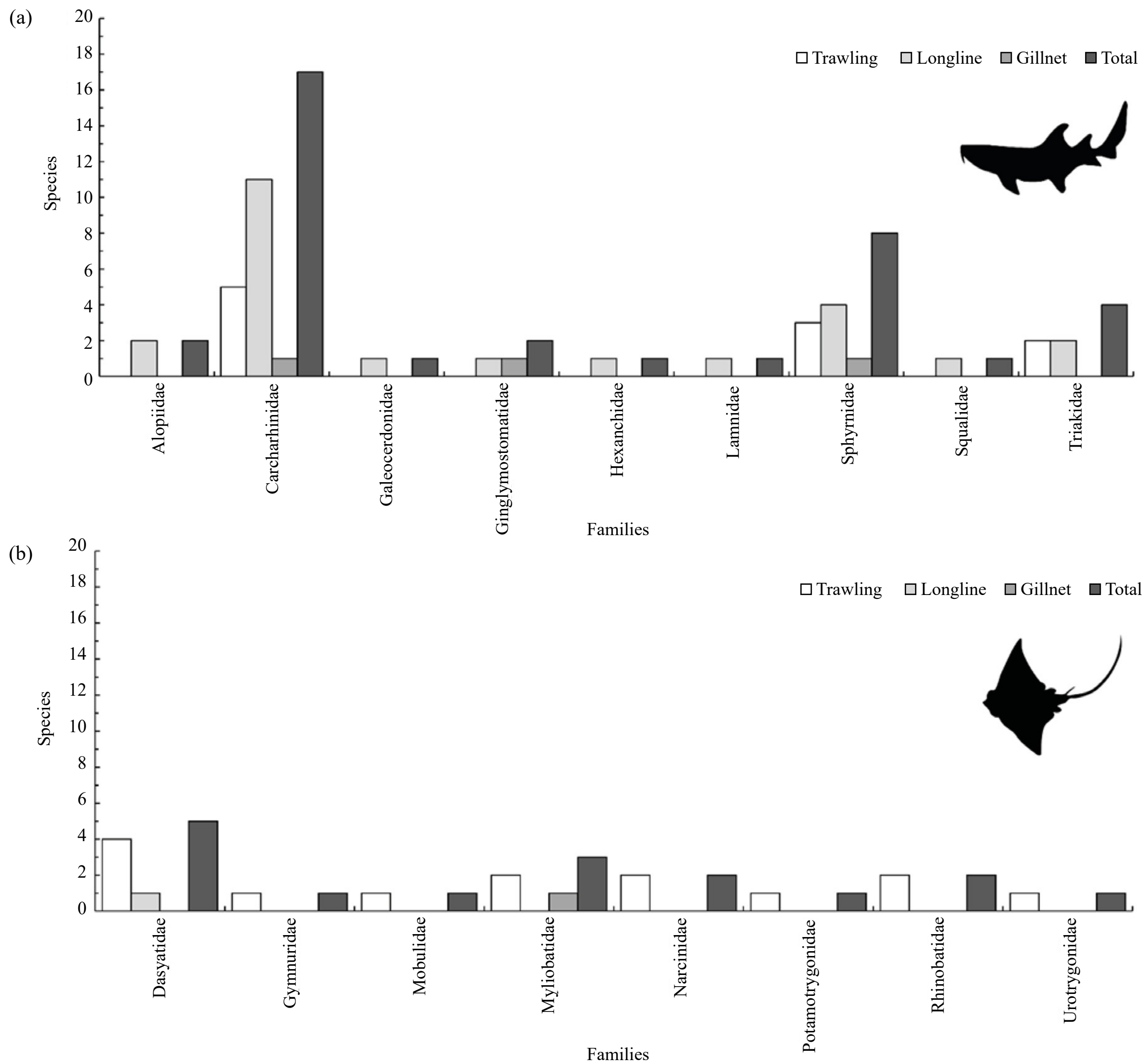


Figure 5. Number of elasmobranch species captured per family and type of fishery: (a) sharks; (b) rays.

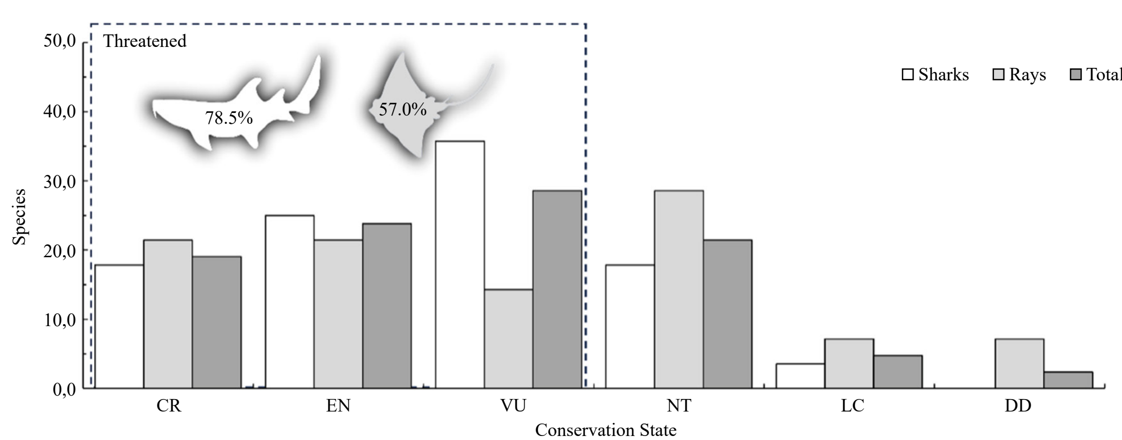


Figure 6. Conservation status of the elasmobranch species assessed here, as classified by the International Union for Conservation of Nature: critically endangered (CR), endangered (EN), vulnerable (VU), near threatened (NT), least concern (LC), and data deficient (DD).

DISCUSSION

Analysis of the publications

The assessment of the impact on the species taken as bycatch off the Amazon coast is still a major challenge, due to the time lag between the collection of the field data and their publication. In the present study, time lags of up to 11 years were observed between the collection and the publication of the data. Given this, the data on the impacts of bycatch do not reflect the current fishery scenario, but rather, past events. This time lag compromises significantly the potential for the identification of the species that are most affected by bycatch in the present day, which impedes the accurate assessment of the contemporary impacts of fishing on regional biodiversity (Thomaz & Mormul, 2014; Wosnick et al., 2023).

Two possible explanations for this time lag may be: slow science, which is simply that a relatively long period of time is necessary for the researchers to analyze their data and produce high quality manuscripts (Casadevall & Fang, 2015; Thomaz & Mormul, 2014), and progressive submission, which consists of the initial submission of the manuscript to a periodical with the highest possible impact factor and, when it is rejected, submitting it to a journal with a lower impact factor, and so on to periodicals with progressively lower impact factors, until the manuscript is accepted for publication (Chapman et al., 2019; Han et al., 2020). While relatively common, both these practices can result in significant delays between the collection of data and their eventual publication, which hampers the immediate application of the data to the development of effective conservation and management policies.

These two approaches may not only reflect a quest for a broader interdisciplinary approach and more diverse expertise, which would improve the quality of the publication, but also a strategy that aims to increase academic output through multiple co-authorship (Chapman et al., 2019) or even a systematic institutional policy of providing incentives for collaborations and partnerships. In general, papers with more authors tended to involve more institutions, which implies that the inclusion of co-authors from other institutions may be an important contribution to the publication process. This trend is consistent with the policies of research institutions and funding agencies that support the establishment of collaborations as a criterion for scientific performance assessment and funding support provision (Loyola et al., 2012; Waltman et al., 2013).

However, the delays in the publication of these fishery data cannot be attributed solely to neglect on the part of the researchers, given that the configuration of the fishery management agencies, fishery institutes, and universities is incompatible with the complexity of the scenario in Brazilian waters, particularly off the Amazon coast. This sector of the Brazilian littoral presents a number of challenges, including its enormous area and its local features, such as the large numbers of fishers operating in the region, the diversity of vessels employed by the local fisheries, which often use multiple types of fishing gear, the countless clandestine fishing ports, the reduced effectiveness of the local fishery monitoring, and the lack of both financial and human resources for this monitoring (Gonçalves Neto et al., 2021; Jimenez et al., 2019; Jimenez et al., 2021). In addition to these factors, local researchers face several practical difficulties, including the accumulation of professional commitments and reduced potential for the consolidation of research groups, given that there are few opportunities for the recruitment of the human resources trained by these groups (Hanson et al., 2024). The typical challenges of publishing a paper, such as the delays in the submission of the manuscript and the review process, editorial bottlenecks, and impractical publishing fees, all contribute to the time lag, which limits the communication of invaluable data important for this vulnerable field of research (O'Donnell et al., 2010; Taşkın et al., 2022).

The IF of a journal is generally seen as an indicator of the potential influence of the papers the journal publishes, in terms of the number of times each paper is cited in other publications over the years (Casadevall & Fang, 2015; Chapman et al., 2019; Han et al., 2020). However, other variables, such as the academic status of the authors and their institutions, and the practice of self-citation, may also influence the final number of citations of any given paper. In addition to being, potentially, anti-ethical, self-citation influences the total number of citations of a paper, which can contribute to its academic performance (Eisenlohr et al., 2014; Waltman et al., 2013).

The fact that more than half of the journals in which the papers were published do not have an IF indicates a tendency for the authors to prioritize the number of papers published, rather than their quality. This strategy, while understandable from the perspective of the pressure to publish exerted on researchers by the academic system, may compromise the relevance and the potential influence of the papers published on bycatch in the Amazon region (Casadevall & Fang, 2015; Thomaz & Mormul, 2014). Alternatively, authors should prioritize the publication of their research findings in periodicals with a high IF, to ensure the quality, visibility, and scientific impact of their work (Casadevall & Fang, 2015; Waltman et al., 2013), which would ultimately contribute to their potential for receiving resources for further research in the same field (Loyola et al., 2012).

In addition, publication in periodicals of greater impact has direct implications for the capacity of the researcher to obtain funding, given that funding agencies tend to apply multiple criteria for the evaluation of projects, taking into consideration not only the number of papers published, but also their quality and the impact of the journals in which they are published (Loyola et al., 2012; Thomaz & Mormul, 2014). In this case, more selective publishing strategies that emphasize the quality of the papers should not only strengthen the scientific content of the studies on the bycatch of the Amazon coast, but also improve the chances of funding for further research.

Even so, several considerations must be taken into account for the assessment of studies published on the fisheries of the Amazon coast, given the environmental and structural characteristics of the region. The adoption of the IF as the standard for the evaluation of the quality of a publication appears to have been assimilated by local Brazilian researchers following the recent consolidation of graduate programs and the refinement of Brazilian policies for the assessment of the quality of scientific publications over the past 25 years (Cirani et al., 2015; Pascuci & Fishlow, 2023). From this perspective, in fact, the available fishery data, which are historically fragile, are often not robust enough to be acceptable for the most qualified scientific journals (Gonçalves Neto et al., 2021). This emphasizes the importance of the papers published in less well-respected journals, in addition to the journals published by the main local research institutions, which are known as bulletins (*boletim* or *boletín*, in Portuguese and Spanish, respectively), *i.e.*, *Arquivos de Ciências do Mar*, *Boletim do Museu Paraense Emílio Goeldi*, *Boletim* Técnico-*Científico do CEPNOR*, *Boletim do Laboratório de Hidrobiologia*, *Boletín de Investigaciones Mariñas y Costeras*, which provide an important outlet for the results of the region's research groups.

Elasmobranch bycatch in different types of fisheries

Globally, research mainly tends to focus on three types of fisheries—trawling, gillnetting, and longlining. Each of these different types of fisheries imposes a distinct set of impacts on the marine biota, depending on the features of their harvesting mechanisms and their selectivity (Aragão et al., 2015; Bonanomi et al., 2017; Cintra et al., 2015; Dias-Neto & Dias, 2015; Mcauley et al., 2007; Nóbrega et al., 2021; Oliveira & Frédou, 2007; Rigg et al., 2009; Silva et al., 2016; Soykan et al., 2008).

Trawling results in the capture of a high diversity of elasmobranchs, but also involves the rejection and discarding of a large part of the bycatch due to its lack of commercial value or the small size of the fish, with typically more rays than sharks being captured, due to the association of the former with the bottom substrate and coastal shelves (Clarke et al., 2018; Garcés-García et al., 2020; Oliver et al., 2015; Santos et al., 2016; Silva Júnior et al., 2013).

Longline fisheries are the main source of elasmobranch catches (Bonanomi et al., 2017), although there is under-representation in the longline fisheries that target non-pelagic habitats, given that the deep-swimming sharks are normally returned to the sea dead (Bonanomi et al., 2017; Oliver et al., 2015), resulting in an underestimate of the mortality rate of the discarded species (Braccini & Waltrick, 2019). The pelagic sharks are not subject to such under-representation because they are retained for the extraction of byproducts, such as the fins, meat, liver, and skin (Fernandez-Carvalho et al., 2015).

Among these three more common fishing methods, trawling is the main focus of research into bycatch, which emphasizes the need for the systematic monitoring of catches at sea, given that records obtained from the fishery landing data are subject to a bias that may underestimate the total bycatch, because most species with no economic value are thrown overboard before reaching port (Chaves, 2021; Márquez-Farias, 2005).

Elasmobranch bycatch and its effects

The impacts of bycatch from commercial fisheries represent a severe threat to marine species throughout the world, given the reduction of the stocks of many species, which also impacts ecosystem function. The elasmobranchs are especially vulnerable, due to their slow growth, late maturation, and limited fecundity, which reinforce the need to prioritize the conservation of this group (Bonanomi et al., 2017; Dulvy et al., 2017; Vooren & Klippel, 2005), with the resolution of the bycatch problem being a priority for the conservation and management of many elasmobranch species (IUCN, 2023; Wosnick et al., 2023).

The decline of shark and ray populations because of fishery pressure is derived primarily from the capture of reproductive females, and immature individuals, such as neonates, yearlings, and juveniles (Vooren & Klippel, 2005). Both processes have disproportionate impacts on the productivity of these species, which reduces the potential for the long-term recruitment of stocks (Adams et al., 2018; Vooren & Klippel, 2005). These impacts may be further aggravated by the exploration of breeding grounds and areas of recruitment, in which the capture of pregnant females or juveniles may be relatively frequent (Adams et al., 2018; Wosnick et al., 2023).

Even when the animal is discarded or released, its survival depends on a series of factors, such as the physiology of the species, the stress of the capture process, the tolerance of stress, the lesions suffered during capture and handling, the changes in ambient temperature, the time of exposure to the air, and the management of the specimens (Bonanomi et al., 2017; Braccini & Waltrick, 2019; Chaves, 2021; Molina & Cooke, 2012; Raoult et al., 2019; Wosnick et al., 2019a). The effects of these factors are concentrated into two specific moments: when the fish are brought on board, with mortality being determined by the type of gear, the time of exposure of the fish to the air, and the species involved, and the period following the release of the fish, which can be affected by the stress of the capture, the physiology of the fish, lesions, and behavioral alterations (Ellis et al., 2017). The factors that have lethal consequences for the bycatch species, leading to an increase in mortality, include long periods of exposure to the air, high levels of handling stress, the capture of deepwater species (physiological trauma), and profound lesions caused by entanglement in the fishing gear (Braccini & Waltrick, 2019; Ellis et al., 2017). The size of the species is also important, given that smaller species tend to suffer higher mortality rates, which may further increase with the time of exposure to the fishing gear (Braccini & Waltrick, 2019; Morgan & Carlson, 2010).

In addition to the lethal consequences of being taken as bycatch, there are sublethal effects of passing through the capture process, such as behavioral alterations, that is, a reduction in the capacity of the fish to forage or avoid predators, as well as impacts on the growth and reproduction of the animals released alive (Chaves, 2021; Leite et al., 2020; Molina & Cooke, 2012; Wilson et al., 2014). The latter impact is the most preoccupying, since any effect on reproduction, eventually, impacts recruitment (Finotto et al., 2021; Leite et al., 2020; Wilson et al., 2014).

The sublethal effects of this process range from physiological disturbances (Raoult et al., 2019; Wilson et al., 2014), lesions caused by the contact with nets or entanglement with the gear (Wilson et al., 2014) to premature births or the abortion of young resulting from the stress of the interaction between gravid females and the fishing gear, which can compromise the fecundity or reproductive capacity of the females (Adams et al., 2018; Wosnick et al., 2018). These effects may impact both the performance of the individual and population dynamics. The physiological responses of elasmobranchs to the stress of capture have been well documented, and include a reduction of aerobic capacity, an increased susceptibility to disease, and a reduction in growth rates (Cameron et al., 2023; Molina & Cooke, 2012; Wosnick et al., 2023). Behavioral changes may include alterations in foraging efficiency, a reduced capacity for the avoidance of predators, and the interruption of migratory or reproductive behaviors, which can all reduce the physical fitness of the individual, and its survival potential, even when the fish are released alive (Leite et al., 2020; Wilson et al., 2014).

Abortion or induced birth is a frequent occurrence in the pregnant females of many elasmobranch species when captured by fisheries (Adams et al., 2018). In addition to the immediate loss of reproductive potential, the stress may cause a long-term loss of fecundity, which compromises the subsequent reproductive cycles. Adams et al. (2018) and Finotto et al. (2021) concluded that the type of fishing gear, the intensity of the stress experienced during handling, and the later stages of gestation all influence the probability of a miscarriage.

While few data are available on the sublethal effects of bycatch, further studies would provide valuable insights into the post-release survival of these fish, and the factors that contribute to poor capture conditions (Dapp et al., 2016; Finotto et al., 2021; Wilson et al., 2014). The considerable impact of bycatch on the elasmobranchs reinforces the need for the implementation of effective conservation measures for the affected species, mainly because most of these taxa are threatened on some level, at a global scale.

Conservation status

It is extremely important to determine the conservation status of the non-target species, especially the case of the elasmobranchs, which are subject to high mortality rates (Ferrette et al., 2019; Santos et al., 2023). The IUCN classifies threatened species in three categories: CR, EN, and VU, which are important guidelines for the development of effective conservation strategies and the management of natural resources (Rodrigues et al., 2006). The data deficient category represents the main challenge for conservation planning, given that the lack of data on the biology, ecology, and life history of a species limits the potential for a reliable understanding of the threat degree (Bland et al., 2014; Bland et al., 2015; Dulvy et al., 2021; Jorgensen et al., 2022). In the case of the elasmobranchs, recent scientific advances have permitted a reduction in the number of data deficient species, which has nevertheless resulted in an increase in the number of threatened taxa (Dulvy et al., 2021; Gross, 2019; Simpfendorfer & Dulvy, 2017). Globally, 32.6% elasmobranch species are classified as threatened (CR + EN + VU), including 36% of all ray species, 31.2% of the sharks, and 7.7% of the chimaeras (Dulvy et al., 2021). The global ongoing decline in the populations of oceanic sharks over the past century has been due primarily to the continuous growth of fishery pressure (Pacoureau et al., 2021).

Identification of the species captured

The failure of both industrial and artisanal fisheries to identify the species of elasmobranchs they capture is a chronic problem that hampers fishery management and the monitoring of legally protected species (Bornatowski et al., 2014; Cashion et al., 2019). The typical use of generic ethnocategories (in Portuguese), such as "cação" (dogfish), "tubarão" (shark), and "raia" or "arraia" (ray), tends to obscure the actual diversity of the taxa, in terms of the number of biological species, despite the use of more specific terms, such as "spotted ray," "snouted ray" or "sandpaper dogfish" (Barbosa Filho et al., 2021; Coelho et al., 2023; Medeiros et al., 2022).

Two other factors also contribute to the incorrect identification of the elasmobranch species captured by fisheries: the fact that many individuals are landed without the head or tail (Coelho et al., 2023; Pinhal et al., 2009), or the pectoral fins, in the case of the rays, and the lack of a thorough and meticulous analysis by investigators and fishery managers that enables the reliable identification of the species caught (Coelho et al., 2023). It is fundamentally important to align the knowledge of scientists and fishery managers with the fishers' one, to establish a species-specific identification system for the animals captured (Coelho et al., 2023), as well as training onboard observers and landing monitors to obtain a more accurate identification of the main elasmobranchs taken as bycatch (Bornatowski et al., 2014).

Overall, the findings of the present study reinforce the urgent need for studies with more reliable taxonomic definitions of the species of sharks and rays taken as bycatch, to facilitate the definition of the species captured and the correct labeling of the species of commercial value, as a prerequisite for effective fishery management (Baeta et al., 2010; Bornatowski et al., 2014). For elasmobranch species that cannot be identified reliably on the basis of traditional morphological criteria or when the specimens are landed without certain body parts, molecular markers, such as Cytochrome C Oxidase Subunit I (COI) and NADH Dehydrogenase Subunit 2 (NADH2), are useful diagnostic tools for their identification (Bornatowski et al., 2014; Ferrette et al., 2019; Guimarães-Costa et al., 2020; Leite Júnior et al., 2023; Vella et al., 2017). However, this approach is inviable for large numbers of individuals, and it does not provide an instantaneous identification of the species, either on board the vessel or at the landing point.

Reduction of the bycatch

Modern technology provides several options for reducing the bycatch of shrimp fisheries by modifying the trawl nets. One option is the deployment of exclusion grilles at the entrance to the bag (Medeiros et al., 2013), while separating panels or grilles associated with a funnel can direct the shrimp into the net, while the fish and other aquatic organisms are detoured to escape windows in the upper part of the net (Dias-Neto & Dias, 2015; Medeiros et al., 2013). These devices can be employed easily, and provide a number of advantages for the fishers, such a reduction in the work needed to bring the catch onboard and a decrease in the time needed to sort the catch, while also reducing the bycatch and increasing the catches of the target species, which tend to be less affected by the devices (Guanais et al., 2015; Medeiros et al., 2013).

In Brazil, shrimp trawler operations have been legally obliged since the 1990s to employ turtle exclusion devices and bycatch reduction devices, following the Food and Agriculture Organization's recommendations (FAO, 2019). Guanais et al. (2015) and Medeiros et al. (2013) demonstrated that these devices can reduce the bycatch of large-bodied non-target species without affecting the shrimp harvest. Research off the Amazon coast has also confirmed a reduction in the bycatch of turtles and large teleosts, although the evidence on elasmobranchs is still inconclusive (Aragão et al., 2015; Dias-Neto & Dias, 2015).

Effective measures for the reduction of the bycatch taken by longline fisheries are also needed urgently. These measures include the use of nylon lines in the dropper loop of the paternoster to facilitate the escape of sharks (Leite Júnior et al., 2023; Vooren & Klippel, 2005) and the use of circular hooks that are less likely to capture sharks, in comparison with the traditional J-shaped hooks (Fernandez-Carvalho et al., 2015; Vooren & Klippel, 2005). The use of circular hooks has been tested in several tropical and subtropical fisheries, and has been shown to reduce the onboard mortality, not only of elasmobranchs, but also of other non-target species taken as bycatch (Godin et al., 2012). In Brazil, regulatory measures exist for the use of circular hooks, but only in the case of tuna and swordfish fisheries (Brasil, 2017).

The temporary closure of fishing grounds may also be an effective alternative for the reduction of the bycatch, as observed in the case of pelagic longline fisheries in South Africa (Grantham et al., 2008), although it is important to note that the shift in effort to areas adjacent to the fishing grounds that had been closed temporarily tended not to reduce the bycatch. When supported by the fishers and combined with continuous monitoring, this type of measure can provide a valuable fishery management tool (Davidson et al., 2016; Grantham et al., 2008).

The size of the mesh of gillnets can be modified to reduce the bycatch (Vooren & Klippel, 2005). A few studies have shown that the size of the mesh has a significant influence on the selectivity of the nets in terms of the size of the species captured (McAuley et al., 2007). In Brazil, there have been several initiatives to optimize mesh sizes and implement strategies for the rapid release of fish taken as bycatch (Leite Júnior et al., 2023; Wosnick et al., 2023).

The use of magnets to mitigate the capture of elasmobranchs proved to be potentially useful in experimental assays, given that the magnetic field was shown to scare off elasmobranchs without provoking any reaction in other groups of organisms (Richards et al., 2018; Rigg et al., 2009).

Future perspectives for the conservation of the elasmobranchs

The progressive increase in coastal population densities, overfishing, and the exportation of elasmobranch meat contribute to the ongoing decline in the stocks of these animals (Davidson et al., 2016), although one major difficulty that limits the assessment of the impact of fisheries on shark and ray populations is the fact that only a very small proportion of the catch is identified to species (Santos et al., 2023). Reliable fishery statistics covering ample spatial and temporal dimensions are essential to ensure the adequate management of sustainable fisheries and the conservation of species (Bornatowski et al., 2014; Davidson et al., 2016; Santos et al., 2023).

The mitigation of the capture of specific species as bycatch is hampered by the multiple specificity of the fisheries (Silva Júnior et al., 2013), which can only be resolved by monitoring the elasmobranch bycatch of commercial fisheries, and conducting research focused on the elaboration of a database on this bycatch, as well as establishing effective measures of sustainable management and conservation strategies for the species (Bonanomi et al., 2018; Dias-Neto, 2011; Dulvy et al., 2021). These efforts would be complemented by the release of bycatch immediately after its capture as an important measure when other mitigatory strategies are not effective, emphasizing the importance of the participation of the fishers in resolving this question (Molina & Cooke, 2012; Vooren & Klippel, 2005). However, very few data are available on the survival rates of released bycatch for most fisheries (Bonanomi et al., 2017).

It is necessary studies that approach the basic ecological and biological aspects of the species captured, such as their life cycle (Bonanomi et al., 2018; Passarone et al., 2019; Silva Júnior et al., 2013), to cover gaps in the information on the life history, ecology, abundance, and distribution of the species (Jorgensen et al., 2022). More detailed studies of the impact of post-release mortality would also be fundamentally important (Molina & Cooke, 2012). As bycatch likely has significant demographic impacts on the species captured, there is an essential need for a better understanding of the interactions between elasmobranchs and the different types of fisheries (Bonanomi et al., 2017).

CONCLUSION

The findings of the present study have revealed advances in the research on the elasmobranch bycatch off the Amazon coast, while also exposing certain asymmetries and knowledge gaps. The scientific output on this subject increased gradually from 2015 onward, reflecting the growing preoccupation with the conservation of the region's rays and sharks. Even so, there were a considerable concentration of studies in Brazilian waters, and a predominance of research on trawl fisheries, with few data on gillnets and longlines. This reduces the representativeness of the available data and highlights the need for more ample and integrated research efforts that reinforce networks of collaboration, and improve the professional standing of scientists and the infrastructure of research institutions.

Two main measures are necessary to support a more precise and reliable assessment of the impact of fishing fleets on Amazonian fishery resources, particularly the populations of sharks and rays: the more precise identification of the species taken as bycatch by these fisheries, which can be achieved by the more systematic monitoring of the vessels during their operation and the monitoring of landings, and investments in the collection of more up-to-date data, to eliminate existing knowledge gaps, and provide more reliable information on the biological features of the elasmobranch species fished in the region, including their exploitation as a commercial resource and the release of bycatch.

CONFLICT OF INTEREST

Nothing to declare.

DATA AVAILABILITY STATEMENT

The data is available at https://doi.org/10.5281/zenodo.18100700

AUTHORS' CONTRIBUTIONS

Conceptualization: Farias, T.S., Nunes, J.L.S., Rodrigues Filho, L.F.S.; **Formal Analysis:** Farias, T.S.; **Writing — original draft:** Farias, T.S., Nunes, J.L.S., Rodrigues Filho, L.F.S.; **Writing — review & editing:** Farias, T.S., Nunes, J.L.S., Sales, J.B.L., Rodrigues Filho, L.F.S.; **Data curation:** Farias, T.S.; **Project Administration:** Farias, T.S.; **Validation:** Nunes, J.L.S., Sales, J.B.L., Rodrigues Filho, L.F.S.; **Supervision:** Nunes, J.L.S., Sales, J.B.L., Rodrigues Filho, L.F.S.; **Final approval:** Farias, T.S., Nunes, J.L.S., Sales, J.B.L., Rodrigues Filho, L.F.S.

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DECLARATION ON USE OF ARTIFICIAL INTELLIGENCE TOOLS

We declare no use of artificial intelligence tools.

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REFERENCES

Adams, K. R., Fetterplace, L. C., Davis, A. R., Taylor, M. D., & Knott, N. A. (2018). Sharks, rays and abortion: the prevalence of capture-induced parturition in elasmobranchs. *Biological Conservation*, 217, 11-27. https://doi.org/10.1016/j.biocon.2017.10.010

Almeida, O., Rivero, S., & Androczevecz, S. (2011). Espécies exploradas pela indústria pesqueira na Amazônia, In J. M. P. Silva & C. N. Silva (eds.), *Pesca e territorialidades: contribuições para a análise espacial da atividade pesqueira* (pp. 27-38). GAPTA/UFPA.

Aragão, J. A. N., Cintra, I. H. A., & Silva, K. C. A. (2015). Situação da pesca de camarões na plataforma continental amazônica. *Acta of Fisheries and Aquatic Resources*, 3(2), 61-76.

Arocha, F., Arocha, O., & Marcano, L. A. (2002). Observed shark bycatch from the Venezuelan tuna and swordfish fishery from 1994 through 2000. *ICCAT Collective Volume of Scientific Papers*, 54(4), 1123-1131.

Awhida-Robinson, A. K., Torres-Hernández, E., Pérez-Rodríguez, R., Piñeros, V. J., Solís-Guzmán, M. G., Angulo, A., Simões, N., Lasso-Alcalá, O. M., Monroy, M., & Domínguez-Domínguez, O. (2025). Influence of the Great Amazon Reef System and Pleistocene sea-level drops on the phylogeography of Haemulon aurolineatum (Haemulidae). *PeerJ*, 13, e19415. https://doi.org/10.7717/peerj.19415

Baas, J., Schotten, M., Plume, A., Côté, G., & Karimi, R. (2020). Scopus as a curated, high-quality bibliometric data source for academic research in quantitative science studies. *Quantitative Science Studies*, 1(1), 377-386. https://doi.org/10.1162/qss_a_00019

Baeta, F., Batista, M., Maia, A., Costa, M. J., & Cabral, H. (2010). Elasmobranch bycatch in a trammel net fishery in the Portuguese west coast. *Fisheries Research*, 102(1-2), 123-129. https://doi.org/10.1016/j.fishres.2009.10.016

Barbosa Filho, V., Luiz, M., Ramires, M., Mourão, J. S., Rosa, R. S., Alves, R. R. N., & Costa-Neto, E. M. (2021). Ethnotaxonomy of Sharks by Expert Fishers from South Bahia, Brazil: Implications for Fisheries Management and Conservation. *Ethnobiology & Conservation*, 10. https://doi.org/10.15451/ec2021-08-10.02-1-12

Battisti, F., & Salini, S. (2013). Robust analysis of bibliometric data. *Statistical Methods & Applications*, 22, 269-283. https://doi.org/10.1007/s10260-012-0217-0

Bland, L. M., Collen, B. E. N., Orme, C. D. L., & Bielby, J. O. N. (2014). Predicting the conservation status of data-deficient species. *Conservation Biology*, 29(1), 250-259. https://doi.org/10.1111/cobi.12372

Bland, L. M., Orme, C. D. L., Bielby, J., Collen, B., Nicholson, E., & McCarthy, M. A. (2015). Cost-effective assessment of extinction risk with limited information. *Journal of Applied Ecology*, 52(4), 861-870. https://doi.org/10.1111/1365-2664.12459

Bonanomi, S., Brčić, J., Colombelli, A., Notti, E., Pulcinella, J., & Sala, A. (2017). Fisheries bycatch of chondrichthyes. In L. F. da S. Rodrigues Filho & J. B. L. Sales, editores. *Chondrichthyes: Multidisciplinary approach* (pp. 39-62). IntechOpen. https://doi.org/10.5772/intechopen.69334

Bonanomi, S., Pulcinella, J., Fortuna, C. M., Moro, F., & Sala, A. (2018). Elasmobranch bycatch in the Italian Adriatic pelagic trawl fishery. *PloS One*, 13(1), e0191647. https://doi.org/10.1371/journal.pone.0191647

Bornatowski, H., Braga, R. R., & Vitule, J. R. S. (2014). Threats to sharks in a developing country: the need for effective simple conservation measures. *Natureza & Conservação*, 12(1), 11-18. https://doi.org/10.4322/natcon.2014.003

Braccini, J. M., & Waltrick, D. (2019). Species-specific at-vessel mortality of sharks and rays captured by demersal longlines. *Marine Policy*, 99, 94-98. https://doi.org/10.1016/j.marpol.2018.10.033

Brasil (2017). Ministério do Meio Ambiente (MMA). *Portaria nº 74, de 13 de fevereiro de 2017*.

California Academy of Sciences (2023). *Eschmeyer's Catalog of Fishes*. California Academy of Sciences Retrieved from https://www.calacademy.org/scientists/projects/eschmeyers-catalog-of-fishes

Cameron, L. W., Roche, W. K., Beckett, K., & Payne, N. L. (2023). A review of elasmobranch catch-and-release science: synthesis of current knowledge, implications for best practice and future research directions. *Conservation Physiology*, 11(1), coad100. https://doi.org/10.1093/conphys/coad100

Casadevall, A., & Fang, F. C. (2015). Impacted science: impact is not importance. *MBio*, 6(5), 10-1128. https://doi.org/10.1128/mbio.01593-15

Cashion, M. S., Bailly, N., & Pauly, D. (2019). Official catch data underrepresent shark and ray taxa caught in Mediterranean and Black Sea fisheries. *Marine Policy*, 105, 1-9. https://doi.org/10.1016/j.marpol.2019.02.041

Chapman, C. A., Bicca-Marques, J. C., Calvignac-Spencer, S., Fan, P., Fashing, P. J., Gogarten, J., Guo, S., Hemingway, C. A., Leendertz, F., Li, B., Matsuda, I., Hou, R., Serio-Silva, J. C., & Stenseth, N. C. (2019). Games academics play and their consequences: how authorship, h-index and journal impact factors are shaping the future of academia. *Proceedings of the Royal Society B*, 286(1916), 20192047. https://doi.org/10.1098/rspb.2019.2047

Charles, A. G., & Kennelly, S. J. (2018). Bycatches of endangered, threatened and protected species in marine fisheries. *Reviews in Fish Biology and Fisheries*, 28, 521-541. https://doi.org/10.1007/s11160-018-9520-7

Chaves, P. D. T. (2021). Bycatch: causes, impacts, and reduction of incidental captures. In W. Leal Filho, A. M. Azul, L. Brandli, A. Lange Salvia & T. Wall (editors), *Life Below Water*. Encyclopedia of the UN Sustainable Development Goals (p. 1-11). Springer. https://doi.org/10.1007/978-3-319-71064-8_73-1

Cintra, I. H. A., Paiva, K. S., Klautau, A. G. C. M., & Silva, K. C. A. (2015). Da captura incidental de *Manta birostris* (Chondrichthyes, Mobulidae) em pescaria industrial de camarão-rosa na plataforma continental amazônica. *Revista CEPSUL-Biodiversidade e Conservação Marinha*, 4(1), 1-4. https://doi.org/10.37002/revistacepsul.vol4.5071-4

Cirani, C. B., Campanario, M. A., & Silva, H. M. (2015). A evolução do ensino da pós-graduação senso estrito no Brasil: análise exploratória e proposições para pesquisa. *Avaliação*, 20(1), 163-187.

Clarke, T. M., Espinoza, M., Chaves, R. R., & Wehrtmann, I. S. (2018). Assessing the vulnerability of demersal elasmobranchs to a data-poor shrimp trawl fishery in Costa Rica, Eastern Tropical Pacific. *Biological Conservation*, 217, 321-328. https://doi.org/10.1016/j.biocon.2017.11.015

Coelho, K. K., Rincon, G., Bandeira, A. M., Barbosa-Filho, M. L., Wosnick, N., Brito, R. M., Nunes, A. E. O. P., & Nunes, J. L. (2023). Fisher ethnotaxonomy for elasmobranchs captured along the Brazilian Amazon Coast. *Ethnobiology Letters*, 13(1), 79-99. https://doi.org/10.14237/ebl.13.1.2022.1819

Dapp, D. R., Huveneers, C., Walker, T. I., Drew, M., & Reina, R. D. (2016). Moving from measuring to predicting bycatch mortality: predicting the capture condition of a longline-caught pelagic shark. *Frontiers in Marine Science*, 2, 126. https://doi.org/10.3389/fmars.2015.00126

Davidson, L. N., Krawchuk, M. A., & Dulvy, N. K. (2016). Why have global shark and ray landings declined: improved management or overfishing? *Fish and Fisheries*, 17(2), 438-458. https://doi.org/10.1111/faf.12119

Dias-Neto, J. (2011). *Proposta de Plano Nacional de Gestão para o uso sustentável de elasmobrânquios sobre-explotados ou ameaçados de sobre-explotação no Brasil*. Ibama.

Dias-Neto, J., & Dias, J. D. F. (2015). *O uso da biodiversidade aquática no Brasil: uma avaliação com foco na pesca*. Ibama.

Dulvy, N. K., Fowler, S. L., Musick, J. A., Cavanagh, R. D., Kyne, P. M., Harrison, L. R., Carlson, J. K., Davidson, L. N. K., Fordham, S. V., Francis, M. P., Pollock, C. M., Simpfendorfer, C. A., Burgess, G. H., Carpenter, K. E., Compagno, L. J. V., Ebert, D. A., … & White, W. T. (2014). Extinction risk and conservation of the world's sharks and rays. *elife*, 3, e00590. https://doi.org/10.7554/eLife.00590

Dulvy, N. K., Pacoureau, N., Rigby, C. L., Pollom, R. A., Jabado, R. W., Ebert, D. A., Finucci, B., Pollock, C. M., Cheok, J., Derrick, D. H., Herman, K. B., Sherman, S. C., Wright, W. J. W., Lawson, J. M., Walls, R. H. L., Carlson, J. K., Charvet, P., … & Simpfendorfer, C. A. (2021). Overfishing drives over one-third of all sharks and rays toward a global extinction crisis. *Current Biology*, 31(21), 4773-4787. https://doi.org/10.1016/j.cub.2021.08.062

Dulvy, N. K., Simpfendorfer, C. A., Davidson, L. N., Fordham, S. V., Bräutigam, A., Sant, G., & Welch, D. J. (2017). Challenges and priorities in shark and ray conservation. *Current Biology*, *27*(11), R565-R572. https://doi.org/10.1016/j.cub.2017.04.038

Eisenlohr, P. V., Tavares, J. R., Oliveira, S. L., Santos, A. O., Valadão, M. B. X., Bilce, J. M., Roberto, R. L., Castro, H. B., Zaratim, E. C. P., Lima, S. L., Santos, A. J., Silva, A. P. G., Lima, L. B., Melo-Santos, K. S., Figueiredo, J. D. S., Santos, L. M., Pereira, F. C., ... & Reis, S. M. A. (2014). Thinking better about high-quality science: A look at some ethical flaws and productivity evaluation. *Brazilian Journal of Biology*, 74(4), 1009-1010. https://doi.org/10.1590/1519-6984.17413

Ellis, J. R., McCully Phillips, S. R., & Poisson, F. (2017). A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, 90(3), 653-722. https://doi.org/10.1111/jfb.13197

Erguden, D., Kabasakal, H., & Ayas, D. (2022). Fisheries bycatch and conservation priorities of young sharks (Chondrichthyes: Elasmobranchii) in the Eastern Mediterranean. *Zoology in the Middle East*, 68(2), 135-144. https://doi.org/10.1080/09397140.2022.2051916

Farias, T. S. (2025). Scientiometric analysis of the capture of elasmobranchs as bycatch off the Amazon coast [Data set]. Zenodo. https://doi.org/10.5281/zenodo.18100700

Fernandez-Carvalho, J., Coelho, R., Santos, M. N., & Amorim, S. (2015). Effects of hook and bait in a tropical northeast Atlantic pelagic longline fishery: Part II—Target, bycatch and discard fishes. *Fisheries Research*, 164, 312-321. https://doi.org/10.1016/j.fishres.2014.11.009

Ferrette, B. L. D. S., Domingues, R. R., Rotundo, M. M., Miranda, M. P., Bunholi, I. V., Biasi, J. B., Oliveira, C., Foresti, F., & Mendonça, F. F. (2019). DNA barcode reveals the bycatch of endangered batoids species in the southwest Atlantic: implications for sustainable fisheries management and conservation efforts. *Genes*, 10(4), 304. https://doi.org/10.3390/genes10040304

Finotto, L., Walker, T. I., & Reina, R. D. (2021). Prolonged alteration of neonate traits following maternal exposure to fishing-capture stress during late pregnancy in a chondrichthyan species. *Frontiers in Marine Science*, 8, 631798. https://doi.org/10.3389/fmars.2021.631798

FishBase (2023). *Portal*. FishBase. Retrieved from https://www.fishbase.se/search.php

Food and Agriculture Organization (FAO). (2019). *Bycatch reduction devices (BRDs) in shrimp trawl fisheries: Technical guidelines for testing and implementation*. FAO Fisheries and Aquaculture Technical Paper. FAO.

Garcés-García, K. C., Tovar-Ávila, J., Vargas-Trejo, B., Chávez-Arrenquín, D. A., Walker, T. I., & Day, R. W. (2020). Elasmobranch bycatch by prawn trawls in the Gulf of California: First comprehensive analysis and the effect of fish escape devices. *Fisheries Research*, 230, 105639. https://doi.org/10.1016/j.fishres.2020.105639

Godin, A. C., Carlson, J. K., & Burgener, V. (2012). The effect of circle hooks on shark catchability and at-vessel mortality rates: A global synthesis and meta-analysis. *Fish and Fisheries*, 13(4), 429-439.

Gonçalves Neto, J. B., Goyanna, F. A. de A., Feitosa, C. V., & Soares, M. O. (2021). A sleeping giant: the historically neglected Brazilian fishing sector. *Ocean & Coastal Management*, 209, 105699. https://doi.org/10.1016/j.ocecoaman.2021.105699

Grantham, H. S., Petersen, S. L., & Possingham, H. P. (2008). Reducing bycatch in the South African pelagic longline fishery: the utility of different approaches to fisheries closures. *Endangered Species Research*, 5(2-3), 291-299. https://doi.org/10.3354/esr00159

Gross, M. (2019). Stop the global slaughter of sharks. *Current Biology*, 29(17), R819-R822. https://doi.org/10.1016/j.cub.2019.08.043

Guanais, J. H. G., Medeiros, R. P., & McConney, P. A. (2015). Designing a framework for addressing bycatch problems in Brazilian small-scale trawl fisheries. *Marine Policy*, 51, 111-118. https://doi.org/10.1016/j.marpol.2014.07.004

Guimarães-Costa, A., Machado, F. S., Reis-Filho, J. A., Andrade, M., Araújo, R. G., Corrêa, E. M. R., Sampaio, I., & Giarrizzo, T. (2020). DNA Barcoding for the assessment of the taxonomy and conservation status of the fish bycatch of the northern Brazilian shrimp trawl fishery. *Frontiers in Marine Science*, 7, 566021. https://doi.org/10.3389/fmars. 2020.566021

Han, R., Zhou, B., Huang, Y., Lu, X., Li, S., & Li, N. (2020). Bibliometric overview of research trends on heavy metal health risks and impacts in 1989–2018. *Journal of Cleaner Production*, 276, 123249. https://doi.org/10.1016/j.jclepro.2020.123249

Hanson, M. A., Barreiro, P. G., Crosetto, P., & Brockington, D. (2024). The strain on scientific publishing. *Quantitative Science Studies*, 5(4), 823-843. https://doi.org/10.1162/qss_a_00327

International Union for Conservation of Nature (IUCN) (2023). *The IUCN Red List of Threatened Species*. Retrieved from https://www.iucnredlist.org/

Isaac, V. J., & Braga, T. M. P. (1999). Rejeição de pescado nas pescarias da região norte do Brasil. *Arquivos de Ciências do Mar*, 32(1-2), 39-54.

Jimenez, É. A., Barboza, R. S. L., Amaral, M. T., & Lucena Frédou, F. (2019). Understanding changes to fish stock abundance and associated conflicts: Perceptions of small-scale fishers from the Amazon coast of Brazil. *Ocean & Coastal Management*, 182, 104954. https://doi.org/10.1016/j.ocecoaman.2019.104954

Jimenez, É. A., Gonzalez, J. G., Amaral, M. T., & Lucena Frédou, F. (2021). Sustainability indicators for the integrated assessment of coastal small-scale fisheries in the Brazilian Amazon. *Ecological Economics*, 181, 106910. https://doi.org/10.1016/j.ecolecon.2020.106910

Jorgensen, S. J., Micheli, F., White, T. D., Van Houtan, K. S., Alfaro-Shigueto, J., Andrzejaczek, S., Arnoldi, N. S., Baum, J. K., Block, B., Britten, G. L., Butner, C., Caballero, S., Cardeñosa, D., Chapple, T. K., Clarke, S., Cortés, E., Dulvy, N. K., … & Ferretti, F. (2022). Emergent research and priorities for shark and ray conservation. *Endangered Species Research*, 47, 171-203. https://doi.org/10.3354/esr01169

Leite, R. D., Wosnick, N., Giareta, E. P., & Freire, C. A. (2020). Evidence of dystocia in a free-ranging cownose ray *Rhinoptera bonasus* (Elasmobranchii, Rhinopteridae). *Boletim do Laboratório de Hidrobiologia*, 30(2), 1-6. https://doi.org/10.18764/1981-6421e2020.13

Leite Júnior, N. D. O., Wosnick, N., Sêga, L. A., Duarte, D. V., Fiedler, F. N., Bornatowski, H., Lana, F. O., Azevedo, V. G., Barreto, R., & Montealegre-Quijano, S. (2023). A captura incidental de elasmobrânquios no Brasil. *PAN Tubarões: primeiro ciclo do plano de ação nacional para a conservação dos tubarões e raias marinhos ameaçados de extinção* (pp. 171-195).

Loyola, R. D., Diniz-Filho, J. A. F., & Bini, L. M. (2012). Obsession with quantity: a view from the south. *Trends in Ecology & Evolution*, 27(11), 585. https://doi.org/10.1016/j.tree.2012.07.016

Lutz, Í., Pinaya, W. H. D., Nascimento, M., Lima, W., Silva, E., Nunes, Z., & Bentes, B. (2023). Shark bycatch of the acoupa weakfish, *Cynoscion acoupa* (Lacèpede, 1801), fisheries of the Amazon Shelf. *Frontiers in Marine Science*, 10, 1101020. https://doi.org/10.3389/fmars.2023.1101020

Marceniuk, A. P., Rotundo, M. M., Caires, R. A., Cordeiro, A. P. B., Wosiacki, W. B., Oliveira, C., Souza-Serra, R. R. M., Romão-Júnior, J. G., Santos, W. C. R., Reis, T. S., Muniz, M. R., Stabile, G., Stephen, F., Klautau, A. G. C. M., & Montag, L. (2019). The bony fishes (Teleostei) caught by industrial trawlers off the Brazilian North coast, with insights into its conservation. *Neotropical Ichthyology*, 17(2), e180038. https://doi.org/10.1590/1982-0224-20180038

Márquez-Farias, J. F. (2005). Gillnet mesh selectivity for the shovelnose guitarfish (*Rhinobatos productus*) from fishery-dependent data in the artisanal ray fishery of the Gulf of California, Mexico. *Journal of Northwest Atlantic Fishery Science*, 35, 443-452. https://doi.org/10.2960/J.v35.m505

McAuley, R. B., Simpfendorfer, C. A., & Wright, I. W. (2007). Gillnet mesh selectivity of the sandbar shark (*Carcharhinus plumbeus*): implications for fisheries management. *ICES Journal of Marine Science*, 64(9), 1702-1709. https://doi.org/10.1093/icesjms/fsm136

Medeiros, M. C., Pinto, A. S., Santos, D. R., Martel, G., Lopes, S. F., & Mourão, J. S. (2022). Folk taxonomy and scientific nomenclature: Working together for conservation of fishery resources in Brazil. *Journal for Nature Conservation*, 68, 126214. https://doi.org/10.1016/j.jnc.2022.126214

Medeiros, R. P., Guanais, J. H. D. G., Oliveira Santos, L. O., Spach, H. L., Silva, C. N. S., Foppa, C. C., Cattani, A. P., & Rainho, A. P. (2013). Estratégias para a redução da fauna acompanhante na frota artesanal de arrasto do camarão sete-barbas: perspectivas para a gestão pesqueira. *Boletim do Instituto de Pesca*, 39(3), 339-358. https://doi.org/10.20950/1678-2305.2013v39n3p339

Molina, J. M., & Cooke, S. J. (2012). Trends in shark bycatch research: current status and research needs. *Reviews in Fish Biology and Fisheries*, 22, 719-737. https://doi.org/10.1007/s11160-012-9269-3

Moore, A. B. M. (2017). Are guitarfishes the next sawfishes? Extinction risk and an urgent call for conservation action. *Endangered Species Research*, 34, 75-88. https://doi.org/10.3354/esr00830

Morgan, A. C., & Burgess, G. H. (2005). Fishery-dependent sampling: total catch, effort and catch composition. *Management Techniques for Elasmobranch Fisheries*, (474), 182-200.

Morgan, A., & Carlson, J. K. (2010). Capture time, size and hooking mortality of bottom longline-caught sharks. *Fisheries Research*, 101(1-2), 32-37. https://doi.org/10.1016/j.fishres.2009.09.004

Nóbrega, P. S. V. D., Santos, C. R. M. D., Cordeiro, A. P. B., & Martinelli-Lemos, J. M. (2021). Invertebrates assemblage captured by a pink shrimp's fishery on Amazon continental shelf. *Latin American Journal of Aquatic Research*, 49(2), 227-241.

O'Donnell, R. P., Supp, S. R., & Cobbold, S. M. (2010). Hindrance of Conservation Biology by Delays in the Submission of Manuscripts. *Conservation Biology*, 24(2), 615-620. https://doi.org/10.1111/j.1523-1739.2009.01424.x

Oliveira, D. M., & Frédou, T. (2007). A pesca no Estuário Amazônico: uma análise uni e multivariada. *Boletim do Museu Paraense Emílio Goeldi-Ciências Naturais*, 2(2), 11-21. https://doi.org/10.46357/bcnaturais.v2i2.700

Oliver, S., Braccini, M., Newman, S. J., & Harvey, E. S. (2015). Global patterns in the bycatch of sharks and rays. *Marine Policy*, 54, 86-97. https://doi.org/10.1016/j.marpol.2014.12.017

Pacoureau, N., Rigby, C. L., Kyne, P. M., Sherley, R. B., Winker, H., Carlson, J. K., Fordham, S. V., Barreto, R., Fernando, D., Francis, M. P., Jabado, R. W., Herman, K. B., Liu, K., Marshall, A. D., Pollom, R. A., Romanov, E. V., Simpfendorfer, C. A., … & Dulvy, N. K. (2021). Half a century of global decline in oceanic sharks and rays. *Nature*, 589, 567-571. https://doi.org/10.1038/s41586-020-03173-9

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., ... & Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *British Medical Journal*, 372, n71. https://doi.org/10.1136/bmj.n71

Paiva, K. S., Aragão, J. A. N., Silva, K. C. A., & Cintra, I. H. A. (2009). Fauna acompanhante da pesca industrial do camarão-rosa na plataforma continental norte brasileira. *Boletim Técnico-Científico do Cepnor*, 9(1), 25-42.

Pascuci, L. M. & Fishlow, A. (2023). Higher Education in Brazil: Retrospective, current challenges and looking ahead. *Ensaio*, 31(119), 1-21. https://doi.org/10.1590/S0104-40362023003103775

Passarone, R., Aparecido, K. C., Eduardo, L. N., Lira, A. S., Silva, L. V. S., Justino, A. K., Craveiro, C., Silva, E. F., & Lucena-Frédou, F. (2019). Ecological and conservation aspects of bycatch fishes: An evaluation of shrimp fisheries impacts in Northeastern Brazil. *Brazilian Journal of Oceanography*, 67, 1-9. https://doi.org/10.1590/S1679-87592019029106713

Pinhal, D., Gadig, O. B., & Martins, C. (2009). Genetic identification of the sharks *Rhizoprionodon porosus* and *R. lalandii* by PCR-RFLP and nucleotide sequence analyses of 5S rDNA. *Conservation Genetics Resources*, 1, 35. https://doi.org/10.1007/s12686-009-9008-9

Pinheiro, H. T., & Martins, A. S. (2009). Estudo comparativo da captura artesanal do camarão sete-barbas e sua fauna acompanhante em duas áreas de pesca do litoral do estado do Espírito Santo, Brasil. *Boletim do Instituto de Pesca*, 35(2), 215-225.

Qaiser, F. H., Ahmed, K., Sykora, M., Choudhary, A., & Simpson, M. (2017). Decision support systems for sustainable logistics: a review and bibliometric analysis. *Industrial Management & Data Systems*, 117(7), 1376-1388. https://doi.org/10.1108/IMDS-09-2016-0410

Raoult, V., Williamson, J. E., Smith, T. M., & Gaston, T. F. (2019). Effects of on-deck holding conditions and air exposure on post-release behaviours of sharks revealed by a remote operated vehicle. *Journal of Experimental Marine Biology and Ecology*, 511, 10-18. https://doi.org/10.1016/j.jembe.2018.11.003

Rethlefsen, M. L., Kirtley, S., Waffenschmidt, S., Ayala, A. P., Moher, D., Page, M. J., & Koffel, J. B. (2021). PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. *Systematic Reviews*, 10(1), 39. https://doi.org/10.1186/s13643-020-01542-z

Richards, R. J., Raoult, V., Powter, D. M., & Gaston, T.F. (2018). Permanent magnets reduce bycatch of benthic sharks in an ocean trap fishery. *Fisheries Research*, 208, 16-21. https://doi.org/10.1016/j.fishres.2018.07.006

Rigg, D. P., Peverell, S. C., Hearndon, M., & Seymour, J. E. (2009). Do elasmobranch reactions to magnetic fields in water show promise for bycatch mitigation? *Marine and Freshwater Research*, 60(9), 942-948. https://doi.org/10.1071/MF08180

Rodrigues, A. S., Pilgrim, J. D., Lamoreux, J. F., Hoffmann, M., & Brooks, T. M. (2006). The value of the IUCN Red List for conservation. *Trends in Ecology & Evolution*, 21(2), 71-76. https://doi.org/10.1016/j.tree.2005.10.010

Santos, F. J. D. S., Silva, K. C. D. A., Bentes, B., Pereira, M. E. G. D. S., Klautau, A. G. C. D. M., & Cintra, I. H. A. (2019). A pesca de lagostas na Plataforma Continental Amazônica. *Arquivos de Ciências do Mar*, 52(2), 61-76. https://doi.org/10.32360/acmar.v52i2.41666

Santos, L. O., Cattani, A. P., & Spach, H. L. (2016). Ictiofauna acompanhante da pesca de arrasto para embarcações acima de 45 HP no litoral do Paraná, Brasil. *Boletim do Instituto de Pesca*, 42(4), 816-830. https://doi.org/10.20950/1678-2305.2016v42n4p816

Santos, R. A., Aranha, L. C., Fiedler, F. N., Vianna, M., Serafini, P. P., Salge, P. G., & Barreto, R. (2023). Monitoramento, comando e controle na pesca de elasmobrânquios ameaçados de extinção: desafios e proposições. *PAN Tubarões: Primeiro Ciclo do Plano de Ação Nacional para a Conservação dos Tubarões e Raias Marinhos Ameaçados de Extinção* (pp. 249-273).

Shark References (2023). *Portal*. Retrieved from https://shark-references.com/

Silva, L. E. O., Silva, K. C. A., Klautau, A. G. M., & Cintra, I. H. A. (2016). Composição da ictiofauna acompanhante na pesca industrial da piramutaba *Brachyplatystoma vaillantii* na plataforma continental amazônica do Brasil. *Boletim Técnico-Científico do Cepnor*, 16(1), 9-14.

Silva Júnior, C. A. B. D., Araújo, M. E. D., & Feitosa, C. V. (2013). Sustainability of capture of fish bycatch in the prawn trawling in northeastern Brazil. *Neotropical Ichthyology*, 11(1), 133-142. https://doi.org/10.1590/S1679-62252013000100016

Simpfendorfer, C. A., & Dulvy, N. K. (2017). Bright spots of sustainable shark fishing. *Current Biology*, 27(3), R97-R98. https://doi.org/10.1016/j.cub.2016.12.017

Soykan, C. U., Moore, J. E., Zydelis, R., Crowder, L. B., Safina, C., & Lewison, R. L. (2008). Why study bycatch? An introduction to the Theme Section on fisheries bycatch. *Endangered Species Research*, 5(2-3), 91-102. https://doi.org/10.3354/esr00175

Sultan, F. A., Routroy, S., & Thakur, M. (2023). Understanding fish waste management using bibliometric analysis: A supply chain perspective. *Waste Management & Research*, 41(3), 531-553. https://doi.org/10.1177/0734242X221122556

Taşkın, Z., Taşkın, A., Doğan, G., & Kulczycki, E. (2022). Factors affecting time to publication in information science. *Scientometrics*, 127, 7499-7515. https://doi.org/10.1007/s11192-022-04296-8

Thomaz, S. M., & Mormul, R. P. (2014). Misinterpretation of 'slow science' and 'academic productivism' may obstruct science in developing countries. *Brazilian Journal of Biology*, 74(3 Suppl. 1), S001-S002. https://doi.org/10.1590/1519-6984.03013

Vella, A., Vella, N., & Schembri, S. (2017). A molecular approach towards taxonomic identification of elasmobranch species from Maltese fisheries landings. *Marine Genomics*, 36, 17-23. https://doi.org/10.1016/j.margen.2017.08.008

Vooren, C. M., & Klippel, S. (2005). Diretrizes para a conservação de espécies ameaçadas de elasmobrânquios. In C. M. Vooren & S. Klippel, editores. *Ações para a conservação de tubarões e raias no sul do Brasil* (Vol. 1, pp. 213-228).

Waltman, L., Van Eck, N. J., & Wouters, P. (2013). Counting publications and citations: Is more always better? *Journal of Informetrics*, 7(3), 635-641. https://doi.org/10.1016/j.joi.2013.04.001

Willems, T., Depestele, J., Backer, A., & Hostens, K. (2016). Ray bycatch in a tropical shrimp fishery: do bycatch reduction devices and turtle excluder devices effectively exclude rays? *Fisheries Research*, 175, 35-42. https://doi.org/10.1016/j.fishres.2015.11.009

Wilson, S. M., Raby, G. D., Burnett, N. J., Hinch, S. G., & Cooke, S. J. (2014). Looking beyond the mortality of bycatch: sublethal effects of incidental capture on marine animals. *Biological Conservation*, 171, 61-72. https://doi.org/10.1016/j.biocon.2014.01.020

World Register of Marine Species (WoRMS) (2023). *Portal*. WoRMS. Retrieved from https://www.marinespecies.org/index.php

Wosnick, N., Adams, K. R., & Freire, C. A. (2018). Ultrasonography as a promising methodology to indicate captured-induced abortion in viviparous elasmobranchs. *Journal of Fish Biology*, 93(6), 1033-1037. https://doi.org/10.1111/jfb.13746

Wosnick, N., Giareta, E. P., Leite, R. D., Hyrycena, I., & Charvet, P. (2023). An overview on elasmobranch release as a bycatch mitigation strategy. *ICES Journal of Marine Science*, 80(3), 591-604. https://doi.org/10.1093/icesjms/fsac164

Wosnick, N., Niella, Y. V., Navas, C. A., Monteiro-Filho, E. L., Freire, C. A., & Hammerschlag, N. (2019a). Multispecies thermal dynamics of air-exposed ectothermic sharks and its implications for fisheries conservation. *Journal of Experimental Marine Biology and Ecology*, 513, 1-9. https://doi.org/10.1016/j.jembe.2019.01.002

Wosnick, N., Nunes, A. R. O. P., Feitosa, L. M., Coelho, K. K. F., Brito, R. M. S., Martins, A. P. B., Rincon, G., & Nunes, J. L. S. (2019b). Revisão sobre a diversidade, ameaças e conservação dos elasmobrânquios do Maranhão. In J. M. B. Oliveira Júnior & L. B. Calvão, editores. *Tópicos Integrados de Zoologia* (pp. 44-54). Atena. https://doi.org/10.22533/at.ed.1471915105