



History of monitoring and statistics of fishing landings on the coast of Paraná: advances, challenges and lessons for local fisheries management

Histórico do monitoramento e estatística do desembarque pesqueiro no litoral do Paraná: avanços, desafios e aprendizados para a gestão pesqueira local

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ABSTRACT: Despite its social economic importance at the global level, there are major gaps in the monitoring of fishing activities. In Brazil, this situation is quite evident, due to the lack of an integrated monitoring system, fishing statistics and a governmental management system. On the coast of Paraná state, this reality remains, with past monitoring experiences being carried out in a fragmented and punctual manner, generating underestimated and unreliable data. Thus, this article aimed to analyze fishing monitoring experiences carried out on the coast of Paraná, reflecting on the integration of different databases and a discussion on fishing monitoring, with a proposal for improvements in the management process of this activity. We evaluated experiences from 1946 to 2023, classified into four phases, encompassing the historical evaluation of the available data. In the first phase, governmental agencies carried out surveys, and there was little information about methodologies and no data on fishing efforts. In the second period, Ibama carried out monitoring activities, the methodology was improved and the fishing statistics system received financial support, generating more reliable data. The third phase of fishing monitoring, which included NGO involvement, presented an evolution in methodologies, with projects being developed on the coast focusing on artisanal fishing monitoring. In the fourth phase, with monitoring actions carried out by large enterprises as environmental programs, clear advances were

observed in the methodologies, sampling efforts and information availability. In general, to improve fishing monitoring at the national level, the involvement of fishermen in data collection is a possibility, by self-monitoring. However, coordination between the various actors involved with fishing activity is necessary, so that better political and management strategies are applied to improve the activity of artisanal fishermen.

Keywords: artisanal fishing; fishing activity monitoring; participative monitoring; public management.

RESUMO: O monitoramento da atividade pesqueira, principalmente da pesca artesanal, possui grandes lacunas a nível global, apesar da importância social e econômica dessa atividade. Essa situação é bastante evidente no Brasil, devido à ausência de um sistema integrado de monitoramento, de estatística pesqueira e de um sistema de gestão contínuo e eficiente. No litoral do Paraná essa realidade se mantém, sendo que experiências passadas de monitoramento foram realizadas de forma pulverizadas e pontuais, gerando dados subestimados e pouco confiáveis. Assim, este artigo teve como objetivo analisar experiências de monitoramento pesqueiro realizadas no litoral do Paraná, trazendo uma reflexão sobre a integração das diferentes bases de dados e uma discussão sobre essa ferramenta, com proposição de melhorias no processo de gestão dessa atividade. Foram avaliadas experiências de 1946 a 2023, englobando a avaliação histórica dos dados, as quais foram classificadas em quatro fases. Na primeira fase, com levantamentos realizados por órgãos governamentais, há pouca informação sobre as metodologias usadas e não há dados de esforço pesqueiro. No segundo período identificado, com o monitoramento realizado pelo Ibama, a metodologia foi aprimorada e o sistema de estatística pesqueira recebeu suporte financeiro, gerando dados mais confiáveis. A terceira fase de monitoramento descrita, que compreende o envolvimento de ONGs, apresentou uma evolução nas metodologias, com projetos sendo desenvolvidos no litoral com vistas à pesca artesanal. Na quarta fase, com ações de monitoramento realizadas pelos grandes empreendimentos como condicionantes ambientais, observaram-se nítidos avanços nas metodologias aplicadas, na amostragem e na disponibilização das informações. De forma geral, para aprimorar o monitoramento pesqueiro a nível nacional, o envolvimento de pescadores na coleta de dados é uma possibilidade, utilizando o automonitoramento. Entretanto, ressalta-se a necessidade de articulação de vários atores ligados à pesca, para que melhores estratégias políticas e de gestão sejam aplicadas em benefício da atividade dos pescadores artesanais.

Palavras-chave: pesca artesanal; monitoramento pesqueiro; monitoramento participativo; gestão pública.

1. Introduction

In 2018, world marine fishing activity had an estimated global production of 79.3 million tons of fishing resources, directly involving approximately 39 million people (FAO, 2020). However, more than 90% of the world's fisheries are still not directly assessed, mainly because of deficiencies in data collection (Gutierrez, 2017; FAO, 2020). In Brazil, there is some monitoring of landings in around 23% of the main fisheries nationally (Zamboni *et al.*, 2020).

According to the literature, the lack of more detailed information on fishing activity compromises more efficient and durable arrangements for the sector (Berkes *et al.*, 2006; Salas *et al.*, 2007; Gutierrez, 2017; FAO, 2020) and also makes it difficult to achieve Sustainable Development Goal (SDG) 14, which deals with life below water, the conservation and sustainable use of the oceans and marine resources, and has, among other purposes, "to provide artisanal fishers with access to marine resources and markets" (UN, 2015, p. 36). In order to achieve this objective, it is necessary to under-

stand the fishing production systems, especially in terms of production, in order to give them visibility and provide political and management alternatives.

The fragility of available information is believed to be more detrimental to artisanal fishing (FAO, 2020). Compared to industrial fishing, artisanal fishing is in an extremely unequal context: it has a lower degree of capitalization, political influence, individual production capacity, and commercialization of resources (Berkes *et al.*, 2006). Furthermore, the lack of information exacerbates these differences. It is estimated that 90% of people involved in fishing activities worldwide are engaged in artisanal fishing (World Bank, 2012), which is responsible for more than half of global catches (Berkes *et al.*, 2006). These data demonstrate the social, economic and productive importance of artisanal fishing on a global scale. However, to understand the activity's real productive, biological and socioeconomic effects, it is necessary to be informed about its production through continuous records of landings, which historically has not been done efficiently (Salas *et al.*, 2007).

The situation is no different in Brazil. The country does not have an integrated system for monitoring and statistics on fishing – especially artisanal fishing – that is efficient and continuous. Several experiences of monitoring fishing landings, through specific actions, different methodologies, limitations due to spatial distribution, political and management difficulties, and the absence of an effective program are described in the literature (Catella *et al.*, 2008; Alves *et al.*, 2012; Ribeiro, 2018; Mendonça *et al.*, 2018). According to Dias & Seixas (2019), there is no strategic approach that allows the data collected to lead to effective

management of fishing activity in Brazil. Several fishing monitoring experiences are currently being developed on the Brazilian coast. However, the absence of a centralizing and organizing body for these programs and the information generated has caused numerous problems such as “lack of standardization of collections; difficulty summarizing the production; periodicity of data, and time differences in the collection and/or availability of this data” (Mendonça *et al.*, 2018, p. 61).

On the coast of Paraná, artisanal fishing is a socioeconomically representative activity for part of the population. In 2015, an estimated 5,752 people worked directly in the sector (Mendonça *et al.*, 2017). The activity can be grouped into two different universes: a more technified universe, which operates on the continental shelf, with trawl fishing for catching shrimp, and the use of longer gillnets for larger, more powerful fish and vessels, such as wide-sided canoes with inboard engines; and a second estuarine universe, with less technified, more diversified fishing practices, with the exploitation of mangrove resources, and which uses smaller and less powerful vessels (Andriguetto Filho *et al.*, 2006).

Local monitoring experiences are criticized because of the underestimated generation of production data, insufficient coverage, and fluctuating greatly over the years, which can only show general trends and relative comparisons (Andriguetto Filho *et al.*, 2006; Natividade *et al.*, 2006; Caldeira *et al.*, 2016). Reports on local fishing activity, especially artisanal fishing, reveal misleading statistical data, due to the lack of systematization of data collection and processing, in addition to the small scope of the communities monitored (Prozee, *et al.*, 2005).

During the 21st century, until 2023, initiatives to monitor fishing landings had different causes and origins on the coast of Paraná, including government initiatives, non-governmental organizations (NGO) actions and, recently, the contractual clauses on environmental licensing for large projects. However, there is no more detailed historical analysis of the evolution of these various programs, which would allow a discussion on advances and lessons learned from all the actions carried out, especially about the benefits of this tool for the management of artisanal fishing, as well as a more integrated evaluation of the data from these various experiences of fishing monitoring and statistics. The comparison of experiences aims mainly to design better future alternatives for the implementation of this tool and to generate contributions for the local management of the sector.

Therefore, this article aims to analyze the experiences of fishing monitoring and statistics carried out on the coast of Paraná, from the first production records found in 1946, until 2023, pointing out advances, lessons learned and challenges for the implementation of an effective system for the region, also seeking to verify the degree of visibility of artisanal fishing during the investigated experiences. This study also reflects on possibilities of integration between the different historical databases, seeking to generate a discussion about the topic, disclosing what has already been done, what has been put into practice and the prospects for the future. The paper is based on an interdisciplinary approach to the object of study, in which fishing management, management of

common use resources and ecosystem approach constitute the theoretical basis.

2. Methodology

The present study investigates the experiences of fishing monitoring and statistics on the coast of the state of Paraná (municipalities of Guaratuba, Matinhos, Pontal do Paraná, Paranaguá, Antonina and Guaraqueçaba) (Figure 1). To achieve this, fishing production records from 1946 to 2023 were collected from official reports from the different state bodies responsible for reporting fishing data in each phase. These reports were accessed through the website¹ of the National Center for Fishing Research and Extension for the Southeast and South Regions (Centro Nacional de Pesquisa e Extensão Pesqueira das Regiões Sudeste e Sul – Cepsul), an organization linked to the Chico Mendes Institute for Biodiversity Conservation (Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio). The reports identified the management relationships between the bodies, the possible methodologies used in the execution of each experiment and the catch records for each year analyzed.

Semi-structured interviews were also conducted with technicians responsible for projects involving fishing monitoring experiences, mainly those carried out after the year 2000. Seven professionals who were or are responsible for or executors of local fishing activity monitoring programs were interviewed. In the interviews, the professionals were asked about resources for

¹ The page to download the reports is <https://www.icmbio.gov.br/cepsul/acervo-digital/37-download/estatistica/111-estatistica.html>.

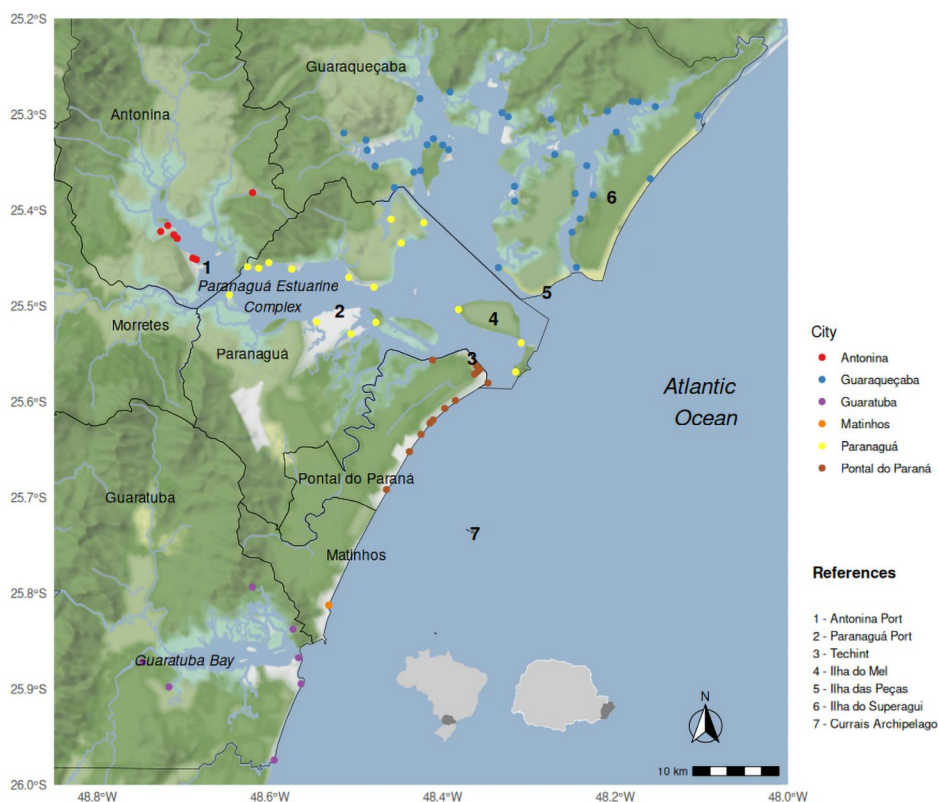


FIGURE 1 – Coast of Paraná: municipalities, reference points for identifying the scenario investigated and fishing communities at the colored dots. SOURCE: the authors.

implementing the project; technical information on the methodology applied; ways of validating and returning data to the community; difficulties and challenges in implementing the methodology and reporting statistical data; program results; and the conditions for accessing the data collected. In addition to the interviews, conversations were held with eight professionals involved in collecting fishing data, with managers and extension workers involved with local artisanal fishing in 2021 and

2023. The data collected by these tools helped to categorize the monitoring phases and fishing statistics described and to interpret the actions carried out in each period.

Data from programs carried out since 2008 were collected from the executing institutions. Some institutions that made data available from monitoring programs include the NGO IPÊ – Instituto de Pesquisas Ecológicas (Ecological Research Institute) (data from 2009), the NGO

Mater Natura (data from 2010), public company Administration of the Ports of Paranaguá and Antonina (Administração dos Portos de Paranaguá e Antonina – APPA; data from 2013 to 2023) and the Santos Basin Fishing Activity Monitoring Program (Programa de Monitoramento da Atividade Pesqueira – PMAP) of Petrobrás².

Data analysis was carried out in two stages. First, a historical analysis of the management relationships of fishing activity over the years and the methodological process applied to monitoring and fishing statistics was carried out, with an assessment of the evolution of this stage of fishing management. Based on the historical analysis, a categorization was made into four different phases, grouped by the profile of the groups involved, the systematization of data collection and the information reporting system. Secondly, the fishing production data collected were unified into a single database, enabling a historical comparative assessment of the magnitude variability – expressed in tons – of fishing production in the region.

3. Results

3.1. 1st phase – The first surveys carried out by government agencies (1946 – 1989)

The first records of fishing landings in the state of Paraná date back to the 1946-1953 period, in the document entitled Statistical Yearbook of Brazil – 1955, carried out by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro

de Geografia e Estatística – IBGE). From 1956 onwards, landing data began to be presented by resource groups (fish, crustaceans, and molluscs). In 1962, the year the Superintendence for Fisheries Development (Superintendência do Desenvolvimento da Pesca – Sudepe) was created, the disclosure report with fishing data was expanded. Although there is no emphasis on the separation between marine and continental fishing, this report discloses the first records identified by species (common names), some of which are exclusively marine, such as catfish (*Ariidae*), mullet (*Mugil* sp.) and sharks (*Carcharhinidae*). From that year onwards, records of the number of vessels and equipment used at the time were also presented.

In 1971, responsibility for producing the information, and fishing statistics as a whole, was transferred from the Agricultural Statistics Office of the Ministry of Agriculture to Sudepe, which had the support of IBGE in data collection. During this period, there was an improvement in data collection thanks to the Brazil Fisheries Research and Development Program (Programa de Pesquisa e Desenvolvimento Pesqueiro do Brasil – PDP), the result of an agreement signed between Sudepe and Food and Agriculture Organization (FAO) (Prozee *et al.*, 2006). From then on, the data was obtained through three types of questionnaires that were answered by the following actors: corporate fishing, fishermen associated with the colonies and fishermen not linked to the colonies (Sudepe & IBGE, 1975).

In 1980, the PDP program was extinguished, which compromised the financial resources allo-

² This last program accessed through the website of the Agribusiness Research Development Foundation – Fundepag, which runs the program (<http://pescapir.fundepag.br>).

cated to fishing monitoring in subsequent years, to the detriment of the quality of the information (Prozee *et al.*, 2006). At that time, IBGE began to produce fishing statistics reports on its own, without mentioning Sudepe, until 1989 when the latter was extinguished.

In short, throughout this period little was revealed about the methodology used in the collection and analysis of data, as well as in the recorded universe. The reports generally lack data on fishing efforts, which are essential for calculating yield and catch per unit of effort (CPUE). This first phase of fishing monitoring on the coast of Paraná overlaps with what Azevedo & Pierri (2014) call the first period of the back-and-forth of previous fishing policies, controlled by Sudepe, which lasted from 1962 to 1989. In practice, this phase is characterized by development actions focused on industrial fishing, little investment in artisanal fishing, and harmful effects on a series of target stocks (Dias Neto, 2010).

3.2. 2nd phase – Monitoring carried out by Ibama (1990 – 2007)

From 1990 onwards, the process of disclosing fishing production data by IBGE was interrupted. In the same year, on the coast of Paraná, the office of the Brazilian Institute of Environment and Renewable Natural Resources (Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis – Ibama³) in Paranaguá began collecting and processing fishing production data, through visits to the main production units in the munici-

palities of Paranaguá, Pontal do Paraná, Guaratuba and Matinhos (Prozee *et al.*, 2006).

Between 1990 and 1994, Ibama reports presented an estimate of production in the state of Paraná, based on data released by IBGE in the late 1980s. However, from 1995 onwards, Ibama improved the system for consolidating national fishing statistics through the National Fishing and Aquaculture Information System (Sistema Nacional de Informações de Pesca e Aquicultura – Sinpesq), integrating results from various monitoring projects carried out in Brazil. Data was collected through landing control systems, on-board maps, production reports provided by fishing companies and statistical sampling.

Dias Neto (2010) characterizes the 1989-1998 period of national fishing management as the phase of Ibama's environmental management, characterized by the crisis in several sectors of the activity and environmental control measures. This factor led to the adoption of solely conservationist strategies for the sector in the period described (Azevedo & Pierri, 2014).

In its reports, Ibama considers the monitoring system inefficient in many states during this period, indicating the need for a national fishing statistics project, with the participation of multiple involved with the topic (MMA *et al.*, 2002). In 2003, with the creation of the Special Department for Aquaculture and Fishing of the Presidency of the Republic (Secretaria Especial de Aquicultura e Pesca da Presidência da República – Seap/PR), national fishing statistics received financial support for their execution. At first, an agreement was signed between Seap/PR, Ibama and the Foundation for

³ Body created in 1989 and which replaced Sudepe in its fishing-related responsibilities.

Support of Research on Living Resources in the Exclusive Economic Zone (Fundação de Amparo à Pesquisa de Recursos Vivos na Zona Econômica Exclusiva – PROZEE), which allowed the implementation of the Estatpesca methodology – already adopted in the state of Ceará – in all Brazilian coastal states, an activity carried out by Ibama’s regional fishing research and management centers (MMA *et al.*, 2007). However, after this period, a transition phase of fisheries monitoring and statistics was consolidated from Ibama to Seap/PR, which in 2009 would become the Ministry of Fishing and Aquaculture (Ministério da Pesca e Aquicultura – MPA). In 2008, Ibama was no longer responsible for this function.

During this period, more precisely from 1998 onwards, Dias Neto (2010) characterizes national fishing management as a phase of “official anarchy”, in which management is shared between different bodies, of a conservationist and developmental nature, generating what the author calls “division of the indivisible”. This stage is characterized by numerous conflicts of interest between the bodies involved (Azevedo & Pierri, 2014).

3.3. 3rd phase – Monitoring carried out by NGOs with state funding (2002 – 2016)

In this third phase, characterized in the present study, monitoring was carried out through project financing. During this period, Seap/PR and, later, MPA, decided to establish partnerships with state agencies, universities, foundations, NGOs, and the productive sector itself, a strategy that aimed to

expand data collection (MPA, 2010). Thus, from 2002 onwards, a series of projects developed by NGOs, funded by the federal government, and which included fishing monitoring, began on the coast of Paraná. This phase, especially in the beginning, overlapped with the publication of fishing data carried out by Ibama.

The first monitoring actions developed were carried out by NGO IPÊ. Initially, between 2002 and 2005, monitoring was carried out in the villages of Barra do Superagüi and Vila das Peças, communities on the northern coast of the state, and, in 2009, in 15 communities on the northern coast of the state of Paraná, the latter funded directly by Seap/PR. In these experiments, the data collectors were residents of the monitored communities themselves, and data were collected as suggested by Sparre & Venema (1998), who recommend recording the total catch and effort of all species and fleets.

From August 2010 to 2011, fishing monitoring was expanded to the entire coast of Paraná, through a project implemented by the NGO Mater Natura and funded by the MPA. The project involved the work of 11 data collectors, members of the communities, who monitored 14 fishing posts/stations on the coast. Both NGOs (IPÊ and Mater Natura) received initial support in monitoring from the São Paulo Fishing Institute, which has extensive experience in the sector, monitoring fishing in the coastal regions of the state of São Paulo since 1969⁴.

During this phase, another experiment was carried out between June 2010 and March 2016, developed by NGO Mar Brasil, in the municipali-

⁴ For more information about the fishing monitoring program carried out by the Fisheries Institute, visit the portal <https://www.pesca.sp.gov.br/>.

ties of Pontal do Paraná and Matinhos. In this case, data collection system based on estimates made periodically by the project technicians themselves.

In general, the phase described is characterized locally by a technical and methodological improvement in data collection processes. Throughout the country, the period comprising the local monitoring phase described had a stronger presence of regulatory and management agencies in the sector and an increase in participatory fishing bodies (Azevedo & Pierri, 2014). The experiences reported in this phase, mainly those carried out by IPÊ and Mater Natura, are the closest thing we have to participatory monitoring methodologies (Medeiros *et al.*, 2007; Malafaia *et al.*, 2014; Dias & Seixas, 2019), as they directly involved residents of the sampled communities in data collection. However, an obvious problem of the referred period is the lack of availability of data in official databases for public access, with much of this data accessible only to the technicians who developed the projects. This reveals a waste of public investment, which could be allocated to management and research in the sector, but ultimately it is not used due to lack of availability of information. Another problem to be pointed out is the fragmentation of the programs implemented, since in some experiments carried out data collection took place in few locations or only in one municipality.

3.4. 4th phase – Monitoring carried out by large enterprises within the scope of federal environmental licensing (2014 – 2023)

From 2014 to 2023, fishing monitoring began to be carried out on the coast of Paraná within the scope of federal environmental licensing, mainly as a condition for the operating licenses of three large enterprises licensed by Ibama, namely: the ports of Paranaguá and Antonina, managed by the public company APPA; the private company TCP – Terminal de Contêineres de Paranaguá; and Petrobrás, within the scope of oil and natural gas exploration and production activities developed in the Santos Basin area.

The methodologies used in each monitoring are of the census type, differing only in the collection locations. According to this strategy, data is collected at coastal fishing depots, from middlemen, from fishermen at the time of unloading or through self-registration carried out by the fisherman and later provided to field agents⁵.

APPA and TCP have been monitoring landings at fishing depots in Paranaguá Bay since 2014. Some collection points are overlapped by the two companies, such as Vila Guarani (Paranaguá) and Paranaguá Fish Market. APPA also records data in Antonina and Vila dos Pescadores (Pontal do Sul/ Pontal do Paraná). In general, monitors are local residents of the collection points.

In turn, the monitoring carried out within the scope of the Petrobrás license has been taking place along the entire coast of the state of Paraná

⁵For the Fishing Activity Monitoring Program (Programa de Monitoramento da Atividade Pesqueira – PMAP), within the scope of oil and natural gas exploration and production activities developed in the Santos Basin area, Jankowsky *et al.*, (2019) describe the methodology better, making clearer the details used in data collection and processing.

since August 2016. The activity is carried out by the Agribusiness Research Development Foundation (Fundação de Desenvolvimento da Pesquisa do Agronegócio – Fundepag) and the São Paulo State Fisheries Institute. The team is made up of 12 field agents throughout the state's coastline⁶.

This fourth phase is characterized by a broad methodological improvement in the monitoring of fishing landings in the region. With monitoring carried out by local companies, especially of the licensing of APPA and Petrobrás, there is evidence of the use of well-known methodologies, involvement of qualified professionals, more reliable records and diversity of information, corrections of process failures and data availability.

Ibama's involvement is essential in this phase of monitoring. It now acts as a regulatory body for federal environmental licensing and monitors the effectiveness of companies' environmental programs, and no longer as an executor of the fishing monitoring process. Such control over the licensing process ensures greater sustainability in the collection system, maintaining the standardization of the methodology over the years, and with data analysis associated with the strengthening of the licensing body of the projects.

However, in this same phase there was a setback in comparison with the national fishing regulation system, with practically the non-existence of an efficient fishing management system, and almost no action by the regulatory body. Mendonça *et al.* (2018) stated that national fishing statistics faced a "headless" period at this stage, as there was no institution responsible for developing monitoring programs in an orderly manner.

Nationally, the fishing management scenario in the period described was not at all positive, with an estimated record of only 23% of national fisheries and a general picture of institutional instability (Zamboni *et al.*, 2020).

3.5. The main historical milestones and the productive variability of landings over the years analyzed

Figure 2 shows the evolution of marine fishing production from 1946 to 2023, based on available data, as well as the institutions involved in fishing monitoring and the dissemination of production reports in each period. Figure 2 also shows the complexity of the scenario analyzed due to the large number of institutions responsible for executing the programs: 12 in total, 3 from the private sector, 3 NGOs, and the others are government agencies. This situation is like a "passing of the baton" in the mission of monitoring and managing such a locally representative activity.

Based on the compilation of records of fishing landings from the coast of Paraná, it can be seen that the annual average of marine fishing production in the state of Paraná is 2,141 tons, with 1996 being the year of lowest production (1,232 tons), with fishing monitoring by Ibama, and 1977 (with monitoring by Sudepe) and 2009 (monitoring by the MPA) being the years with the highest production (6,521 and 6,093 tons respectively).

In summary, the compiled data shows that the average fluctuation in production from one year to the next varied, on average, by 23% (up or down).

⁶ The production data is open to the public and can be consulted on the pescapr.fundepag.br portal.

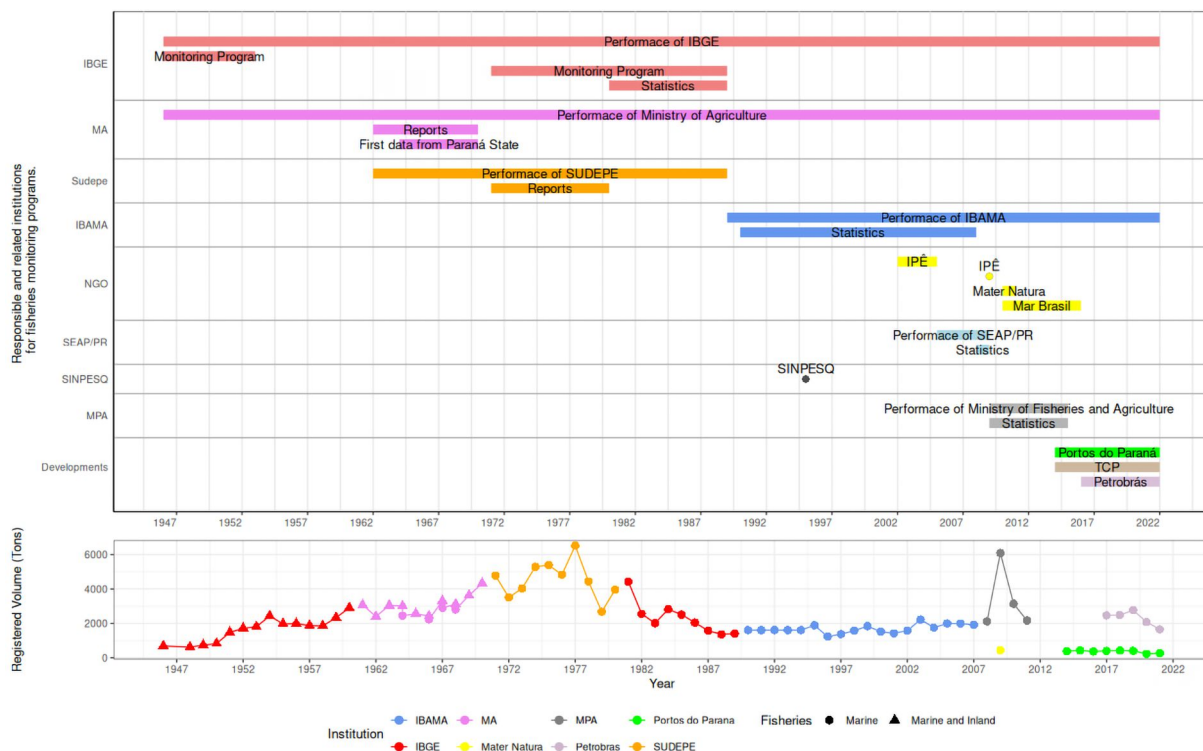


FIGURE 2 – History of fishing landings on the coast of Paraná based on past data, with the upper graph showing the period of activity of the agencies and their programs carried out, and the lower graph showing the production recorded over the years, with the colors of each line referring to the institution executing the programs (the color of the executing and/or responsible institutions is based on the upper figure).

SOURCE: the authors.

The biggest difference between the years was between 2007 and 2008 when there was a 188% increase in production records. It should be noted that despite the difference in the methodologies adopted and the level of precision of the actual capture data, the average production since the mid-1970s has been approximately 2,000 t. Some

peaks in the production report, such as those in 1977 and 2009, are *outliers*⁷ of the standard curve, and no clear explanation has been found for these production peaks. Regarding the value for 2009, there are even doubts about the legitimacy of this data, since in that year the only program existing on the coast of Paraná was carried out in the north-

⁷ An *outlier* is considered to be an atypical value, outside the standard, which deviates greatly from the series data and may be inconsistent with monitoring or sampling.

ern part of the coast by the NGO IPÊ, and this is not even mentioned in the MPA report, which also does not provide the source of the data.

From the 1970s onwards there was an increase in the recorded values, with a clear increase in production from 1971 (4,774 t) to 1977 (6,521 t), and it was in this second year that reports began to highlight the production of artisanal coastal fishing for the first time. In addition to improvements in the monitoring system, resulting from the PDP program, the result of an agreement signed between Sudepe and FAO (Prozee *et al.*, 2006), it is also believed that the process of intense technological development, capitalization, and growth of the fishing sector on the coast of Paraná, which began during this period, mainly with the implementation of the small-scale motorized fleet in the region, resulted in the increase in production recorded (Andriguetto Filho *et al.*, 2014).

On the other hand, there was a decline in recorded fishing production from 1977 onwards. During this period, an antagonistic relationship to that of the early 1970s was observed, which was intensified at the beginning of the 1980s. During this period, the fishing data collection system was significantly affected by the closure of the PDP (Prozee *et al.*, 2006) and, in the same way, from 1982 onwards, a reduction in production and income in the sector began to be noticed on the coast, mainly in shrimp fishing. These are reflections of the previous fishing expansion, which already showed signs of an ecological crisis related to the limits of available stocks (Andriguetto Filho *et al.*, 2014). This decline in fishing production in the state of Paraná occurred shortly before the period of decrease in national fishing production, which showed abrupt drops from 1985 onwards

(Abdallah & Bacha, 1999; Freire, 2003). From 1982 onwards, there is a trend towards balance in production data, with an average of approximately 2,300 t/year in this period, except in 2009.

4. Discussion

4.1. Evolution and findings on monitoring systems, methodologies employed and fishing production on the coast of Paraná

Based on more than half a century of fishing statistics records on the coast of the state of Paraná, it is clear that, as pointed out in the previous bibliography, the data collection process is very poor (Andriguetto Filho *et al.*, 2006; Natividade *et al.*, 2006; Caldeira *et al.*, 2016). Since the first records, there have been numerous interruptions in monitoring, which has always been carried out in a fragmented manner, disregarding many important landing sites, and using different methodologies that are often poorly described or not even presented. The large number of institutions involved over the years is another factor highlighted in the literature that makes it difficult to implement an efficient and permanent system (Freire, 2003). Furthermore, the lack of some records, especially of efforts, compromises the use of historical data to assess fisheries stocks and yields (Sparre & Venema, 1997). These facts do not concern exclusively the study area, being recurrent for a large part of artisanal fishing in Latin America (Salas *et al.*, 2007).

Nevertheless, the proposed analysis may offer some lessons. The first records of fishing landings

in Paraná date back to the end of the 1940s. However, since 1956 onwards, landing data began to be presented by marine resource groups, and in the 1970s and 1980s, reports presented the relationship between marine and continental production. It is believed that the first records from the 1950s came largely from the coastal region and, consequently, from artisanal fishing, the predominant group in fishing activity on the state's coast (Andriguetto Filho *et al.*, 2006; Mendonça *et al.*, 2017), although this fact was not explicitly stated in the reports. This demonstrates the historical obscurity of artisanal fishing activity in most of the fishing monitoring phases described in the article.

The availability of data from the 1950s onwards for the coast of Paraná is consistent with a national and international trend, as observed in studies that reconstruct past fishing data in Brazil and worldwide (Zeller & Pauly, 2018; Pauly & Palomares, 2019; Freire *et al.* 2021). Although the present study does not develop such a compilation for marine fishing in the region, and despite the data having the limitations highlighted, they demonstrate potential for a reconstruction analysis, whether for a productive discussion on the total biomass captured or for certain specific groups or resources, the latter option being more reliable for data from the year 2000 onwards. Freire *et al.* (2021) recommend refining reconstructions of historical fishing data at regional scales, identifying more localized failures in the processes of recording these data. This proposal would be of great relevance for artisanal fishing on the coast of Paraná, historically recovering the evolution of certain fisheries carried out by this group, giving the deserved visibility to this important practice in the scenario investigated.

Regarding the first two phases described, Natividade *et al.* (2006) already mentioned that the fishing statistics reports carried out by Sudepe, IBGE and Ibama contain useful data only for projecting general trends and comparisons of the monitored production systems. Technicians involved in the monitoring process from the 1980s to 2000s reported the inconsistency of the methodologies used, the scarcity of resources allocated to the process, and the lack of personnel for broad coverage of landings (Natividade *et al.*, 2006). These problems have not been resolved over the years and are part of the national challenge of implementing this instrument (Zamboni *et al.*, 2020).

During the 1970s and 1980s, records of improvements and declines in fishing data collection systems were described, mainly associated with the implementation of public policies to promote the fishing sector (Prozee *et al.*, 2006). An example of this dynamics of public investment in fishing monitoring is reflected in the variation in catches between the 1970s (increase in overall fishing production in the state) and 1980 (decrease in overall fishing production). This dynamic can be assessed based on the definition by Zeller and Pauly (2018), as a “presentist bias”, when improvements in the data collection system obscure larger productions in older periods, masking a sign of stability or the increase in fishing production. However, such a finding would require a more advanced reconstruction of local data.

Despite the apparent limitation in national monitoring systems during the period analyzed in this article, which is also believed to have been the reality on the coast of Paraná, small improvements in methodologies result in increases in recorded production, as occurred in 2003. At the time, fish-

ing production in the region increased by 40.7% compared to 2002, with this effect attributed to improvements in the fishing statistics generation system (MMA *et al.*, 2004).

The third phase of monitoring described in the article, which includes the involvement of NGOs in the execution of the programs, already shows an evolution in the methodologies used, with good records of the efforts that allow more robust analyses of the recorded fisheries. From this stage onwards, socioeconomic data on the outputs also begins to be collected, which at the very least allows for an estimate of their revenue. The collection of social data is described in the literature as essential for evaluating fishing activity and implementing good fishing monitoring programs (Mendonça *et al.*, 2018; Dias & Seixas, 2019).

The third phase also highlights the importance of involving expertise in the execution of actions, in this case, mainly the participation of professionals from the São Paulo Fishing Institute in structuring the methodologies applied by the NGOs IPÊ and Mater Natura. The performance of the aforementioned Institute highlights the importance of investments in research groups focused on the topic, which can deal with the complex issue of multispecies fishing activity. Regarding the Paraná coast, scientific knowledge still contributes very little to improving the monitoring of activity, as well as to understanding the effects of fishing on natural systems (Caldeira *et al.*, 2016), and this is due to the absence of a research center focused on fishing activity in the region. This situation is also common throughout Latin America (Salas *et al.*, 2007).

A major problem faced in the first three phases identified is the availability of the infor-

mation collected. In the first two phases, there is little information about the methodologies used in data collection, and in the first three phases, there is no official database for the archival of easily accessible raw data that can be used for research and management of resources and fisheries. The lack of a strategic vision for ecosystem-based management of fisheries in Brazil, characterized in this case by the absence of a clear method for storing, analyzing, and disseminating data, is another factor that compromises more effective long-term actions for the sector (Dias & Seixas, 2019). As part of this analysis, the need for an integrated digital platform that compiles several databases of fishing activity, similar to the models of IMarine, Global Fishing Watch, and the Fisheries and Resources Monitoring System (FIRMS) (FAO, 2020), becomes clear.

The non-availability of public information, such as fishing production data obtained from fishermen, may characterize a strategy of information control, since the data may somehow impact local actors (Dias & Seixas, 2019). In the context investigated, this strategy was adopted by the Brazilian State, which was not willing to organize a system for making historical production data available, and this is just a small part of the process of denying a larger structure of fishing management, especially concerning artisanal fishing on the coast of Paraná.

In the fourth phase, with monitoring actions carried out by large enterprises as compensatory measures, there were clear advances, for example, in the dynamics of data collection, with daily records of disembarkation at priority points; in the improvement of the diversity of data collected, with productive, effort and economic information; and in the availability of basic information, in at

least two programs examined. Therefore, current monitoring adopts general production models – with surveys at landing points – a measure classified as the simplest and most effective for monitoring the multispecies system and various fleets (Sparre & Venema, 1998).

Zamboni *et al.* (2020) point out that in such programs, carried out within environmental constraints, it is generally difficult to access the data collected, except for large-scale projects, such as the PMAP in the area of influence of the Santos Basin pre-salt, linked to Petrobras. Despite the lack of a public place where data is made available for the coast of Paraná there is also greater dissemination of data by the public company APPA, which has been providing its databases for various research projects carried out in Paranaguá Bay.

The dissemination of fishing production data is an important stage in the fishing monitoring and statistics process, reporting and returning information to resource users and making data available for research and management. In Brazil, the last general production report refers to the year 2011, which was published in 2013 (MPA, 2013). Since then, there have been no publications on the overall production of national fishing, and national-scale monitoring programs have been suspended (Zamboni *et al.*, 2020). The absence of national production reports is a recent setback in the national fishing policy, with direct repercussions on the coast of Paraná. Nevertheless, Paraná is one of the only Brazilian coastal states that maintains online fishing landing records online databases, through Fundepag/ Fishing Institute (Freire *et al.*, 2021).

4.2. Historical weaknesses of fishing monitoring actions on the coast of Paraná and challenges to ensure continuity of programs

Regarding the management of fishing activity, it is clear that the recording of production data over the years has done little to improve the local fishing scenario. This was partly due to the poor quality of data over many years (Natividade *et al.*, 2006), the result of historical systemic failures caused by the absence of a state policy for the sector, but also by the lack of historical linearity in the management structure (Dias Neto, 2010; Azevedo & Pierri, 2014), and, more recently, after 2015, due to the dismantling of the fragile structure of fishing management structure in Brazil (Zamboni *et al.*, 2020). At the national level, this process has been reconstructed since 2023, with the recreation of the Ministry of Fishing and Aquaculture.

The interruption and resumption of monitoring is another chronic problem that makes it difficult to implement an effective program on the coast of Paraná. Catela *et al.* (2008) report a similar situation in the fishing activity in the Pantanal, describing that such interruptions are the result of sudden and drastic changes in the state fishing policies: and that these changes require a great effort to resume the collection of records. Currently, the scenario on the coast of Paraná points in another direction, that is, the continuity of long-term monitoring, as this is associated with the operating licenses of mega-enterprises, which must be maintained for a rather long period.

Another contradiction in the scenario is the ambiguous relationship imposed by a highly

complex and diverse legal framework for artisanal fishing, guided by several institutions, some of which are now extinct or no longer responsible for local fishing management (Caldeira *et al.*, 2016), and on the other hand, the absence of a robust monitoring system to validate the effectiveness of the regulations imposed (Jankowsky *et al.*, 2019). This scenario further compromises the almost six thousand fishermen and their families who work in the region.

The implementation of a consolidated monitoring system for a complex and dynamic activity, such as artisanal fishing, requires the coordination of several actors involved, including users of the resources (Catela *et al.*, 2008). An important aspect of effective resource management is the dialogue with fishermen and fisherwomen, not only during the consultation processes, but throughout the planning process until the implementation of the programs (Seixas & Kalikoski, 2009).

However, given the poor fishing management at different scales, fishermen still have many doubts and uncertainties about the generation of information about their production and the involvement of participatory processes led by the State (Dias & Seixas, 2019). This is a barrier that must be overcome, and when the State fails as a regulator, this process is carried out by fishing leaders, who must adopt an efficient monitoring and statistics system that is representative of their reality. However, as is the case in some scenarios described in the literature (Malafaia *et al.*, 2014), changing the perception of local fishermen about the relevance of fishing monitoring, so that fishing representatives take hold of this tool and view it favorably, is very challenging. According to reports from collectors who have worked or are working

in the most recent monitoring programs, this perception is still very present in the discourse of local fishermen. The fear of more intense monitoring and increased tax burdens are factors that limit the free and real provision of data for monitoring actions by fishermen (Caldeira *et al.*, 2016).

On the coast of Paraná, large enterprises that are implementing fishing monitoring programs can be important partners in the development of the tools mentioned. However, a negative point of the current programs is the overlapping of collection points and methodologies, in this case, carried out by the companies APPA and TCP in the Paranaguá Bay region, and the lack of dialogue between those involved in the programs. According to Mendonça *et al.* (2018, p. 66), this occurrence is common in places close to large enterprises, such as the Port of Paranaguá and associated terminals. This is an fruitless scenario and disruptive to the search for better information, as it triggers great discredit in the fishing sector. Both projects are licensed by Ibama, which is focused on the efforts of the agency's licensing sector in executing basic environmental monitoring programs. However, it fails to achieve internal coordination to propose new arrangements for fishing monitoring carried out in the territory, to contribute to more effective management of local fishing activity, which would truly result in improvements for artisanal fishing. The need for coordination between these actors (enterprises and licensing bodies) is essential to improve the methodology for monitoring fishing landings in Paranaguá Bay and along the coast as a whole, an area of direct influence of both of the aforementioned enterprises.

4.3. Conditions for improving monitoring/statistical actions and management of local artisanal fishing

Considering alternatives for improving the monitoring tool in the current phase, it is believed that an evolution of this system locally could be the expansion of the census methodology within the communities, mainly in Paranaguá Bay, places well-known by those responsible for executing the programs linked to port projects, thus avoiding the overlapping of sampling points. Well-designed sampling models can reduce costs, and this requires good knowledge of the local fishing scenario (Miranda *et al.*, 2016).

In the local context, another solution for improving ongoing programs is related to the need to further increase the involvement of the fishing community. Currently, this can be done by the executing companies in partnership with the licensing agency (Ibama), which is in charge of implementing the monitoring. This process involves the acceptance by fishermen and the implementation of participatory program management arrangements, demonstrating the relevance of monitoring and strengthening the appropriation of the process by communities (Alves *et al.*, 2012). The involvement of fishermen in data collection and fisheries analysis is essential for good management (Salas *et al.*, 2007). Positive aspects of experiences with participatory fishing monitoring methodologies or self-monitoring, when resource users actively participate in data recording, have been presented in the literature (Medeiros *et al.*, 2007; Seixas *et al.*, 2011; Malafaia *et al.*, 2014; Kalinke *et al.*, 2017; Ribeiro, 2018; Dias & Seixas, 2019). The

positive points highlighted concern better record keeping, positive effects on decision-making, and the implementation of good experiences in fishing co-management. Participatory actions also tend to reduce spending on these programs, tools that are often costly (Pinto da Silva, 2007; Santos *et al.*, 2023).

Given the scenario of institutional instability in recent decades in fishing management in Brazil (Zamboni *et al.*, 2020), it is also believed that fishing communities should internalize the action of recording landings or take possession of the results of the existing programs, as a tool favorable to them. For effective monitoring, it is essential to implement cooperative networks (Gutierrez, 2017) that mainly involve partnerships between universities, social movements, NGOs, communities and other actors, which can broaden this perspective. Otherwise, this leads to what is known in the literature as the “cascade of blame”, common in failed fisheries, which occurs when managers and fishermen blame scientists for the poor quality of information and bad advice in decision-making; and fishermen and scientists blame managers for the lack of effective regulations (Kritzer, 2020). Something similar was detected in the scenario of this study.

Examples show that involving local stakeholders in monitoring tends to improve management responses and increase the speed of decision-making to address negative environmental issues linked to the monitored resources (Danielsen *et al.*, 2010), for example, in cases of environmental accidents and recognition of fishermen working in the region and their quantities caught, demonstrating more accurately the real environmental and economic damage to the

affected groups. In the case of fishing, monitoring can also be used to individually view the fisheries of each fisherman, allowing interested parties to know their catches throughout the sampling period, which can help in planning their future fisheries (Malafaia *et al.*, 2014).

However, although there is an awareness of the need to generate catch records, mainly by collective organizations in the fishing sector, there has not yet been a dissemination of this discourse to the entire coastal fishing class in Brazil (Mendonça *et al.*, 2018), a situation also observed on the coast of Paraná.

Another issue associated with the most recent phase of fishing monitoring is that, despite the execution of this monitoring in the form of environmental compensation by large enterprises, the current scenario of institutional instability in national fishing management persists (Zamboni *et al.*, 2020), which resulted in the absence of a federal fishing monitoring program until 2022 and the almost absence of an active and responsible institutional management structure for the sector. Given this situation, until the period referred to, fishing activity was not concerned with the generation of such data. Thus, there was minimal use of these data for resource management, public sector policies and social programs for the most vulnerable fishermen. There are a few examples of this, and one is the use of data to support a commitment term for fishing at certain times of the year in the area of Currais Islands Marine National Park (Parque Nacional Marinho das Ilhas de Currais) (Madeira *et al.*, 2018). The new national fishing management structures, implemented from 2023 onwards, are expected to change this scenario.

As can be seen, the challenges for implementing efficient methodologies for collecting fishing data are diverse, especially in this scenario of minimal or inaccurate data. Given this, FAO (2018) presents four points that serve as a basis for improving the monitoring of fishing activity in regions with little conclusive information about the production base. The first point is overcoming technical limitations, moving towards achieving efficient methods of fisheries assessment. The second base point is the compilation of minimum data, where available, in arrangements similar to those proposed in this study, but with a direct focus on resource management and attention to the social conditions of the most vulnerable fishermen and fisherwomen. The third point concerns the need for advances in coordination in the management of shared resources. Finally, the fourth point listed is the need to invest in strengthening institutional and human capacity, which for the local context, is the need to give stability to institutional responsibility. These actions are more than necessary for the coast of Paraná and must follow a different management path, because as Andriguetto Filho *et al.* (2014, p. 98) state, “conventional management will hardly be able to transform reality in a socially and ecologically desirable way.”

5. Final considerations

This historical review makes the lack of continuity in data collection, analysis systems, and sample series clear. It is then very difficult to carry out an analysis that allows for detailed reflections on the exploitation of species, between specific sectors and certain fishing practices be-

tween the recorded periods. However, there is a relationship of learning over time. Monitoring and statistics systems have gone from being mere general production reports, which did not describe the collection methodology and did not have a detailed database of attributes, to systems with well-described methodologies and full availability of all recorded data.

Throughout the historical series analyzed, it can be seen that minimal investments, in projects or installed management structures, generate increases in the recorded values. This finding also leads to possible interpretations about the variability of production data over the years, which may in some cases be related to failures in the monitoring system and alternations in other support programs for the sector, and which would require further studies for precise identification. However, without continuous monitoring using a standardized methodology, it is difficult to infer the variation in fishing production over the years.

Environmental licensing monitoring, if well organized and managed by responsible bodies, can encourage the generation of productive information on local artisanal fishing. In 2023, with the re-creation of the MPA, especially the National Departments for Artisanal Fishing and Registration, Monitoring and Research, there seems to be hope for the sector, which is once again dreaming of a registration and control system that will support the formulation of policies for the sector. However, as long as this issue does not become a matter of State policy, with a long-term goal, we will be at the mercy of management changes, and a fishing monitoring and statistics system will not be implemented.

Given these conditions, it is up to social movements, other organized groups and entities that support artisanal fishing to incorporate monitoring actions and/or strengthen partnerships with institutions that are able to carry out this activity in its various stages. On the coast of Paraná, by 2023, these partnerships will involve the groups executing the programs associated with the projects, which are required to perform this function due to the environmental licensing process.

The national fishing management structure, established in 2023, must be directly linked to the movements and institutions implementing current programs, to strengthen the systems and use the information collected to support local fishing management. Although they do not have a history of actions related to the topic, local research institutions on the coast of Paraná should be included in relevant discussions, so that they may be able to internalize contributions to future debate.

Regarding the appropriation of monitoring by the artisanal fishing class, the entities involved must make an effort to demystify this tool among different fishing groups and communities, who still perceive it with apprehension, mainly because they believe that it has a more supervisory character than one supporting the management of the activity.

A necessary step for effective monitoring is to carry out an advanced investigation into the perception of fishermen regarding this action, aiming to identify their demands, how to adapt the methodology to their needs, consider their interpretations in the analysis, and in general integrate more the methodological process to the communities and other fishing groups. This makes the

process more participatory and can increase trust in it. Participatory monitoring can be an alternative to the difficulties of the census, which is generally expensive and has logistical problems. Creating a useful and informative feedback system for fishers can support this participatory process.

On the other hand, a critical point is related to illegal fishing practices not reported even by fishermen involved in monitoring. However, overcoming this barrier depends on correcting another flaw in the local artisanal management system, i.e. the lack of effective participatory management in the sector. Most fishing regulations are not based on discussion and data collection to create the necessary rules for the local sector. Thus, fishermen continue carrying out illegal fishing and not reporting their catches.

FAO declared 2022 as the International Year of Small-Scale Fisheries (FAO, 2021). Therefore, monitoring actions in the sector must be seen as crucial to understanding the production of this group, giving visibility to these subjects, and ensuring that better political and management strategies are applied. Without landing information, actions aimed at artisanal fishing are less efficient and the rules are more restrictive and inadequate. Consequently, artisanal fishermen and fisherwomen remain anonymous. If this scenario persists, this group will remain invisible to the government, with difficulties in accessing credit, unable to fight for their rights and show their value and the importance of their activity to society.

References

- Abdallah, P. R.; Bacha, C. J. C. Evolução da atividade pesqueira no Brasil: 1960-1994. *Teoria e Evidência Econômica*. 7, 9-24, 1999. Disponível em: <https://seer.upf.br/index.php/rtee/article/view/4803>.
- Alves, D. C.; Moura, R. L. de; Minte-Vera, C. V. Estimativa da captura total: desenhos amostrais para pesca artesanal. *Interciência*, 37(12), 899-905, 2012. Disponível em: <https://www.interciencia.net/wp-content/uploads/2018/01/899-c-1%C2%BA-MINTE-7.pdf>.
- Andriguetto Filho, J. M.; Chaves, P. de T.; Santos, C.; Liberati, S. A. Diagnóstico da pesca no litoral do estado do Paraná. In: Isaac, V. J.; Martins, A. S.; Haimovici, M.; Andriguetto Filho, J. M. (Org.). *A pesca marinha e estuarina do Brasil no início do século XXI: recursos, tecnologias, aspectos socioeconômicos e institucionais*. 1ed. Belém: Editoria Universitária da UFPA, v. 1, p. 117-140, 2006.
- Andriguetto Filho, J. M.; Krul, R.; Feitosa, S. Contradições históricas entre gestão e fomento e a evolução da pesca de arrasto de camarão na plataforma interna do Paraná. In: Haimovici, M.; Andriguetto Filho, J. M.; Sunye, P. S. (Org.). *A pesca marinha e estuarina no Brasil: estudos de caso multidisciplinares*. 1ed. Rio Grande: Editora da FURG, p. 87-99, 2014.
- Azevedo, N. T. de; Pierri, N. A política pesqueira no Brasil (2003-2011): a escolha pelo crescimento produtivo e o lugar da pesca artesanal. *Desenvolvimento e Meio Ambiente*, 32, 61-80, 2014. <http://dx.doi.org/10.5380/dma.v32i0.35547>.
- Banco Mundial. *Hidden Harvest: the global contribution of capture fisheries*. Washington. 2012. Disponível em: <http://documents.worldbank.org/curated/en/515701468152718292/pdf/664690ESW0P1210120HiddenHarvest0web.pdf>. Acesso em: mar. 2021.

Berkes, F.; Mahon, R.; Mcconney, P.; Pollnac, R.; Pomerooy, R. *Gestão da pesca de pequena escala: diretrizes e métodos alternativos*. Kalinoski, D. C. (Org.). Rio Grande: Editora da FURG, 2006.

Caldeira, G. A.; Mafra, T. V.; Malheiros, H. Z. Limites e possibilidades para a gestão participativa da pesca no litoral do Paraná, sul do Brasil: experiências do Projeto “Nas Malhas da Inclusão”. *Desenvolvimento e Meio Ambiente*, 36, 331-353, 2016. <http://dx.doi.org/10.5380/dma.v36i0.42877>.

Catella, A. C.; Mascarenhas, R. de O.; Albuquerque, S. P.; Albuquerque, F. F. de; Theodoro, E. R. de M. Sistemas de estatísticas pesqueiras no Pantanal, Brasil: aspectos técnicos e políticos. *Pan-American Journal of Aquatic Sciences*, 3(3), 174-192, 2008. [https://panamjas.org/pdf_conteudos/PANAMJAS_3\(3\)_174-192.pdf](https://panamjas.org/pdf_conteudos/PANAMJAS_3(3)_174-192.pdf).

Danielsen, F.; Burgess, N. D.; Jensen, P. M.; Pirhofer-Walz, K. Environmental monitoring: the scale and speed of implementation varies according to the degree of people’s involvement. *Journal of Applied Ecology*, 47, 1166–1168, 2010. <https://doi.org/10.1111/j.1365-2664.2010.01874.x>.

Dias, A. C. E.; Seixas, C. S. Delineamento Participativo do Protocolo de Monitoramento da Pesca Artesanal da comunidade de Tarituba, Paraty, RJ. *Ambiente & Sociedade*, 22, 2-24, 2019. <http://dx.doi.org/10.1590/1809-4422asoc0070r2vu19L1AO>.

Dias Neto, J. Pesca no Brasil e seus aspectos institucionais – um registro para o futuro. *Revista CEPSUL – Biodiversidade e Conservação Marinha*, 1(1), 66-80, 2010. <https://doi.org/10.37002/revistacepsul.vol1.30066-80>.

FAO – Food and Agriculture Organization. *El estado mundial de la pesca y la acuicultura 2018*. Cumplir los objetivos de desarrollo sostenible. Roma: FAO, 2018. Disponível em: <http://www.fao.org/3/I9540ES/i9540es.pdf>. Acesso em: mar. 2021.

FAO – Food and Agriculture Organization. *El estado mundial de la pesca y la acuicultura 2020*. La sostenibilidad en acción. Roma: FAO, 2020. Disponível em: <https://www.fao.org/3/ca9229es/ca9229es.pdf>. Acesso em: mar. 2021.

FAO – Food and Agriculture Organization. *Año Internacional de la Pesca y la Acuicultura Artesanales 2022*. 2021. Disponível em: <https://openknowledge.fao.org/server/api/core/bitstreams/ae439370-d5a7-4552-9968-46ab8dd13b58/content/sofia/2022/international-year-artisanal-fisheries-aquaculture.html>. Acessado em: jan. 2022.

Freire, K. M. F. A database of landing data on Brazilian marine fisheries from 1980 to 2000. *Fisheries Centre Research Reports*, 11(16), 181-189, 2003.

Freire, K. M. F.; Almeida, Z. S.; Amador, J. R. E. T.; Aragão, J. A.; Araújo, A. R. R.; Ávila-da-Silva, A. O.; Bentes, B.; Carneiro, M. H.; Chiquieri, J.; Fernandes, C. A. F.; Figueiredo, M. B.; Hostim-Silva, M.; Jimenez, É. A.; Keunecke, K. A.; Lopes, P. F. M.; Mendonça, J. T.; Musiello-Fernandes, J.; Olavo, G.; Primitivo, C.; Rotundo, M. M.; Santana, R. F.; Sant’Ana, R.; Scheidt, G.; Silva, L. M. A.; Trindade-Santos, I.; Velasco, G.; Vianna, M. Reconstruction of marine commercial landings for the Brazilian industrial and artisanal fisheries from 1950 to 2015. *Frontiers in Marine Science*, 8, 1-16, 2021. <https://doi.org/10.3389/fmars.2021.659110>.

Gutierrez, N. L. Harnessing citizenry awareness and technology to improve fisheries information: the power of data. *Fisheries*, 42, 613-618. 2017. <https://doi.org/10.1080/03632415.2017.1383904>.

Jankowsky, M.; Mendonça, J. T.; Morroni, D. Monitoramento pesqueiro no litoral do Paraná. In: Tullio, L. (Org) *Fronteiras Para a Sustentabilidade*. 2. ed. Ponta Grossa: Atena Editora, 41.55. 2019.

Kalinke, A. M.; Lamberts, A. V. D. H.; Rios, C. M. A.; Barreto, G. C.; Macedo, H. S.; Faraco, L. F. D.; Silva, M. C.; Galvão, M. C.; Medeiros, R. P.; Steenbock, W.

SocMon Brasil – Síntese das Lições Aprendidas. Unidades de Conservação Piloto Estação Ecológica de Guaraqueçaba e Área de Proteção Ambiental de Anhatomirim. ICMBio. 2017. Disponível em: https://www.icmbio.gov.br/portal/images/stories/comunicacao/publicacoes/publicacoes-diversas/socmon_brasil_sintese_das_licoes_aprendidas.pdf. Acesso: abr. 2021.

Kritzer, J. P. Influences of at-sea fishery monitoring on science, management, and fleet dynamics. *Aquaculture and Fisheries*, 5(3), 107-112, 2020. <http://doi.org/10.1016/j.aaf.2019.11.005>.

Madeira, J. A.; Muller, B. R.; Medeiros, R.; Giralddi, A. C.; Mendonça, J. T.; Alvite, C.; Steenbock, W.; Corre, F. M. Termo de Compromisso: conciliação permite a pesca em unidade de proteção integral recém-criada pelo poder legislativo. In: ICMBio (Ed), *Boas Práticas Na Gestão de Unidades de Conservação*. ICMBio: Brasília, p. 149-152. 2018. Disponível em: https://www.icmbio.gov.br/parnaabrolhos/images/stories/destaques/boas_praticas_na_gestao_de_ucs_edicao_3_2018.pdf.

Malafaia, P. N.; Olavo, G.; França, A. R.; Seara, F. S.; Freitas, M. B. O.; Almeida, J. C. Experiência de monitoramento participativo a bordo de embarcações da pesca artesanal no Território da Cidadania do Baixo Sul da Bahia, Brasil. *Desenvolvimento e Meio Ambiente*, 32, 165-180, 2014. <http://dx.doi.org/10.5380/dma.v32i0.35742>.

Medeiros, R. P.; Matarezi, J.; Bonilha, L. E. C.; Warhrlich, R. “Se der rebojo de vento sul vai dar tainha”: elementos para o monitoramento participativo da pesca artesanal – lições do litoral sul do Brasil. In: Costa, A. L. (Org.). *Nas redes da pesca artesanal*. Brasília: IBAMA, p. 206-224. 2007.

Mendonça, J. T.; Lucena, A. C. M.; Muehlmann, L. D.; Medeiros, R. P. Socioeconomia da pesca no litoral do estado do Paraná (Brasil) no período de 2005 a 2015. *Desenvolvimento e Meio Ambiente*, 41, 140-157, 2017. <http://dx.doi.org/10.5380/dma.v41i0.49194>.

Mendonça, J. T.; Campanha, P. M. G. C.; Machado, I. C.; Silva, M. H. C. Emprego de métodos participativos, qualitativos e mistos na pesquisa voltada para a gestão pesqueira no Brasil. In: Brandão, C.; Carvalho, J. L.; Ribeiro, J.; Costa, A. P. (Org.) *A prática na investigação qualitativa: exemplos de estudos*. Aveiro: Ludomedia. Vol. 2, 53-88. 2018. Disponível em: <https://ludomedia.org/publicacoes/a-pratica-na-investigacao-qualitativa-exemplos-de-estudos-vol-2-2/>.

Miranda, L. V. de; Kinas, P. G.; Moreira, G. G.; Namora, R. C.; Carneiro, M. H. Survey sampling for fisheries monitoring in Brazil: implementation and analysis. *Brazilian Journal of Oceanography*, 64(4), 401-414, 2016. <https://doi.org/10.1590/S1679-87592016132706404>.

MMA – Ministério do Meio Ambiente; IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis; DIFAP – Diretoria de Fauna e Recursos Pesqueiros; CGREP – Coordenação Geral de Gestão de Recursos Pesqueiros. *Estatística da pesca 2003 – Brasil – Grandes Regiões e Unidades da Federação*. Brasília/DF, 2004. Disponível em: https://www.icmbio.gov.br/cepsul/images/stories/biblioteca/download/estatistica/est_2004_boletim_03_brasil.pdf. Acesso em: mai. 2021.

MPA – Ministério da Aquicultura e Pesca. *Boletim estatístico da pesca e aquicultura – Brasil 2008-2009*. Brasília/DF, MPA. 2010. Disponível em: https://www.icmbio.gov.br/cepsul/images/stories/biblioteca/download/estatistica/est_2008_2009_nac_pesca.pdf. Acesso em: mai. 2021.

Natividade, C. N. da; Pereira, M. J. C. da F.; Andriguetto Filho, J. M. Small-Scale Fishing Landings on the Coast of the State of Paraná, Brazil, from 1975 to 2000, with Emphasis on Shrimp Data. *Journal of Coastal Research*, 39, 1272-1275, 2006. Disponível em: <https://www.researchgate.net/publication/295772437>.

ONU – Organização das Nações Unidas. *Transformando Nosso Mundo: A Agenda 2030 para o Desenvolvimento Sustentável*. 2015. Disponível em: <https://brasil.un.org/>

sites/default/files/2020-09/agenda2030-pt-br.pdf. Acesso em: jan. 2022.

Pauly, D.; Palomares, M. L. D. Editorial: Historical reconstructions of marine fisheries Catches: Challenges and Opportunities. *Frontiers in Marine Science*, 6, 128. 2019. <https://doi.org/10.3389/fmars.2019.00128>.

Pinto da Silva, P. Da Propriedade Coletiva ao Co-Geenciamento: lições da primeira reserva extrativista marinha brasileira. In: Prates, A. P.; Blanc, D. (Org.). Áreas Aquáticas Protegidas como Instrumento de Gestão Pesqueira. Série Áreas Protegidas do Brasil, 4. Brasília: MMA/SBF. 272p. 2007. Disponível em: https://ava.icmbio.gov.br/pluginfile.php/4592/mod_data/content.

Prozee – Fundação de Amparo à Pesquisa de Recursos Vivos na Zona Econômica Exclusiva; SEAP/PR – Secretaria Especial de Pesca e Aquicultura da Presidência da República; IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. *Relatório técnico sobre o censo estrutural da pesca artesanal marítima e estuarina nos estados do Espírito Santo, Rio de Janeiro, Paraná, Santa Catarina e Rio Grande do Sul* – Convênio SEAP/IBAMA/PROZEE N° 110/2004 (Processo n°00350.000748/2004-74). Itajaí/SC, novembro de 2005. Disponível em: <http://ibama.gov.br/phocadownload/biodiversidade/biodiversidade-aquatica/gestao-pesqueira/publicacoes/2005-relatorio-tecnico-censo-estrutural-pesca-artesanal-maritima.pdf>. Acesso em: abr. 2021.

Prozee – Fundação de Amparo à Pesquisa de Recursos Vivos na Zona Econômica Exclusiva; SEAP/PR – Secretaria Especial de Pesca e Aquicultura da Presidência da República; IBAMA – Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. *Monitoramento da atividade pesqueira no litoral do Brasil – Relatório técnico final* – Convênio SEAP/PROZEE/IBAMA: 109/2004 Processo N 00.350.000.749/2004-19. Brasília/DF, agosto de 2006. Disponível em: http://ava.icmbio.gov.br/mod_data. Acesso em: mai. 2021.

Ribeiro, K. T. (Org.). *Estratégia do Programa Nacional de Monitoramento da Biodiversidade – Programa Monitora: estrutura, articulações, perspectivas*. Brasília: ICMBio, 2018. Disponível em: https://www.icmbio.gov.br/portal/images/stories/o-que-fazemos/monitoramento/estrategia_geral.pdf. Acesso em: mai. 2021.

Salas, S.; Chuenpagdee, R.; Seijo, J. C.; Charles, A. Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. *Fisheries Research*, 87, 5-16, 2007. <https://doi.org/10.1016/j.fishres.2007.06.015>.

Santos, J. P.; Guimarães, E. C.; Garciov-Filho, E. B.; Brito, P. S.; Lopes, D. F. C.; Andrade, M. C.; Ottoni, F. P.; Dias, L. J. B. S.; Anjos, M. R. Carvalho-Neta, R. N. F.; Rodrigues, L. R. R.; Nogueira, M. A. M. P.; Pelicice, F. M.; Agostinho, A. A.; Fearnside, P. M. Fisheries monitoring in Brazil: how can the 2030 agenda be met without fisheries statistics? *Biota Neotropica*, 23(2), 1-6, 2023. <https://doi.org/10.1590/1676-0611-BN-2022-1439>.

Seixas, C. S.; Kalikoski, D. C.; Almudi, T.; Batista, V. S.; Costa, A. L.; Diogo, H. L.; Ferreira, B. P.; Futemma, C. T.; Moura, R. L.; Ruffino, M. L.; Salles, R. de; Thé, A. P. G. Gestão compartilhada do uso de recursos pesqueiros no Brasil: elementos para um programa nacional. *Ambiente e Sociedade*, 14, 23-44, 2011. <https://doi.org/10.1590/S1414-753X2011000100003>.

Seixas, C. S.; Kalikoski, D. C. Gestão participativa da pesca no Brasil: levantamento das iniciativas e documentação dos processos. *Desenvolvimento e Meio Ambiente*, 20, 119-139, 2009. <http://dx.doi.org/10.5380/dma.v20i0.12729>.

Sparre, P.; Venema, S. C. *Introdução à avaliação de estoques de peixes tropicais*. Parte 1. Manual. Artigos técnicos da FAO n° 306. Roma: FAO, 1998. In: <http://www.fao.org/3/w5449p/w5449p00.htm>. Acesso em: mai. 2021.

Sudepe – Superintendência do Desenvolvimento da Pesca; IBGE – Instituto Brasileiro de Geografia e Estatística.

Estatística da Pesca Produção 1972. Rio de Janeiro: Sudepe/IBGE, 1975. Disponível em: https://www.icmbio.gov.br/cepsul/images/stories/biblioteca/download/estatistica/est_1972_bol_bra.pdf. Acesso em: jul. 2020.

Zamboni, A.; Dias, M. C.; Iwanicki, L. S. *Auditoria da pesca – Brasil 2020: uma avaliação integrada da governança, da situação dos estoques e das pescarias*. 1. ed. Brasília, DF: Oceana Brasil, 2020. Disponível em: <https://brasil.oceana.org/pt-br/relatorios/auditoria-da-pesca-brasil-2020>. Acesso: abr. 2021.

Zeller, D.; Pauly, D. The ‘presentist bias’ in time-series data: implications for fisheries science and policy. *Marine Policy*, 90, 14-19, 2018. <https://doi.org/10.1016/j.marpol.2018.01.015>.