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Baseline

The first baseline of ALDFG generated by the artisanal fishery during the SARS-CoV-2 pandemic on the north coast of Pernambuco, Brazil

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**ABSTRACT**

To prevent the spread of the COVID-19 contagion, some regions of Brazil implemented a prohibition of beach use, which contributed to a reduction of artisanal fishing activity. This study aimed to evaluate the influence of these beach closures on the incidence of abandoned, lost, or discarded fishing gear (ALDFG) along four beaches located on the northern coast of Pernambuco, Brazil. The absolute and relative frequency of occurrence and the number of observations per unit of effort (OPUE) between the periods before and after the prohibition period were analyzed. A total of 1935 fishing gear residues were found (63% before and 37% after prohibition). There was also a significant reduction in OPUE and in absolute frequency (p < 0.05) between these two periods. Although beach closures appear to have contributed to a reduction in the amount of ALDFG in the region, it does not indicate a complete pause in fishing activities.

Ghost fishing is described as the ability of abandoned, lost, or discarded fishing gears (ALDFG) to continue catching marine animals, generating ecological, economic, or social impacts (Laist, 1997; Macfadyen et al., 2009). ALDFG also contributes to approximately 10% of the marine debris volume globally, commonly found as residues from fisheries (Macfadyen et al., 2009). It can be responsible for wasting fishing resources, dispersal of invasive species, interaction with endangered species, physical changes in habitats, injuries, and animal death by entanglement or ingestion. Due to its contribution to ocean pollution, ALDFG is equally harmful to humans (Macfadyen et al., 2009; Gilman, 2015; Link et al., 2019; FAO, 2020), also causing the death of divers, surfers, and bathers who sporadically can also get entangled.

On the northeast coast of Brazil, more specifically the Pernambuco state, shrimps, lobsters, crabs, mollusks, and a high diversity of fish species are captured using trawl nets, gillnets, corral setnets, line and hook, longlines, traps, pots, diving and other, totaling about 18 different types of fishing gears (Lessa et al., 2004; MMA, 2009; Lucena-Frêdou et al., 2021; Viana et al., 2021). This high diversity of fishing gears and practices contributes to ALDFG in the region, creating a range of impacts associated with ghost gear, making it difficult to use adequate management measures to prevent ghost fishing (Macfadyen et al., 2009; Gilman et al., 2016).

To mitigate ghost fishing and to avoid generating new ALDFG, Gilman et al. (2016) proposed remedial and preventive measures, such as input controls, including a limit on soak time and spatial and temporal restrictions on fishing. However, no such management measure has ever been implemented in Brazil to reduce the impact of ALDFG, an issue that has been entirely off the radar. As a result, the SARS-CoV-2 pandemic had an immediate socio-economic negative effect on fishing communities. The ensuing reduction in demand for fishery resources lead to a collapse of prices, financial and commercial difficulties, and low fish production (Bennett et al., 2020; Reis-Filho and Quinto, 2020; Sunny et al., 2021). According to a survey by Salas et al. (2011), coastal and small-scale fishers are the most vulnerable to any ecosystem change or extreme situations that may result in the suspension of their activities, given their direct dependence on fisheries resources for their subsistence.

Due to the new coronavirus pandemic (SARS-CoV-2) (Phan, 2020),...
the government of Pernambuco implemented drastic health measures, including social isolation, to control the spread of the disease (enforced by the State decree n° 48.832, of March 19, 2020). This included prohibiting activities of any nature on the beaches of Pernambuco, northeast coast of Brazil, including fishing. The objective of this study was to evaluate the influence of the social isolation period, or lockdown, on the incidence of ALDFG and, indirectly, on the artisanal fishing activities in two areas on the northern coast of Pernambuco, Brazil.

We conducted beach surveys in August and October 2019 and 2020, coinciding with periods before and after the prohibition of beach use. The northern coast of Pernambuco was selected, a region known for its significant contribution to the state’s fishery production, discharge of various rivers, and the presence of Conservation Units (CU’s) (Terrestrial and Marine Protected Areas). Three fisher’s associations (Colônia de Pesca) are also present in this region, including the Z-11, in Itamaracá Island (7° 44’ S 34° 49’ W), where the Jaguaribe river is located, as well as the Z-3 and Z-14, in Goiana (7° 33’ S 35° 00’ W), where the Goiana river is located.

The survey effort utilized was standardized as two researchers per scrolled hour on each beach. This measure was used for calculating the number of ALDFG observations per unit of effort (OPUE) using the formula: OPUE = (faf/Nr)/t(h), where faf = absolute frequency of fragments (N); Nr = number of researchers; t(h) = walking time, in hours. Each walk was done at the supratidal limit as the highest frequency of ALDFG has been shown to occur in this region (Chaves and Robert, 2009).

The OPUE was estimated for two distinct periods: before and after the prohibition of beach use, to compare the incidence of ALDFG between them. The statistical significance of the differences in absolute frequency of fishing gear residues per beach was assessed by the Chi-square test (χ²), with a significance level α = 0.05, assuming: 1 - the data are independent due to types of ALDFG and the place of survey, and 2 - the frequencies are related to categorical variables. Also, these values are numerical discrete, suggesting a proportion test such as Pearson Chi-square (Bussab and Morettin, 1986).

In total, 1935 fishing gear residues were found during the four months of the survey, with a total weight of 58.64 kg. Ropes were the most abundant ALDFGs, with 1699 items and 37.72 kg. Several other kinds of fragments, as well as full ALDFGs, were also found, including (absolute frequency, in numbers; total weight, in kg): plastic flat netting (99; 4.24), gillnets (89; 12.57), floats (35; 0.31), corral setnets (6; 4.30), line and hook (3; 0.05), bait bags (2; 0.18), trap entrance (1; 0.02), and ring net (1; 0.24). Of all the collected materials, 63% were found in 2019, before prohibition of beach use due to the pandemic, and 37% in 2020, after the prohibition was lifted. Of the 5 types of fragments that were collected before and after social isolation, four of them, (floats, ropes, nets, and plastic flat netting) were more common before the prohibition of beach use, while only one of them, corral setnet fragments, was found in higher numbers after the prohibition (Fig. 1). There was a significant reduction (p < 0.0001) in the OPUE between the
periods before (609.0 items/col. h⁻¹) and after prohibition (358.5 items/col. h⁻¹), although a similar monthly variation was observed in both years, with the OPUE increasing in October (Fig. 2). There was also a significant reduction ($\chi^2 > 3.8; p < 0.05$) in the frequency of occurrence of ALDFG, indicating a decrease in the formation of ALDFG and fishing gear fragments during the social isolation in all beaches (Table 1).

The decrease in the number and types of ALDFG found in this study indicates that the artisanal fishing fleet significantly reduced its activities on the north coast of Pernambuco, during the period of prohibition of beach use due COVID pandemic. The negative social-economic impact associated with curtailing fishing activity would have compounded the already existent social-economic challenges generated by the oil spilled on the coast of Pernambuco between 2019 and 2020 (Araújo et al., 2020; Disner and Torres, 2020; Magalhães et al., 2021). The main fishing gears used in artisanal fishery of this region are trap, gillnet, and hand line and hook (Lessa et al., 2006; Lucena-Fredu et al., 2021; Viana et al., 2021), accounting together for 72.2% of the landings. These fishing gears are primarily made of buoys, cables, nets, and monofilament lines, coinciding to the types of residuals found in the present study.

Goiana and Itamaracá have many corral setnets, a structure formed by a wooden structure covered with a net panel (Lucena et al., 2013). All the corral setnet pieces found in the present study were cut and discarded on the beaches, indicating that other cable fragments found in this work may also come from this same activity, since it generates smaller multifilament cable fragments that can be spread out along the coast.

According to the Instituto Oceânário de Pernambuco (2010), about 92.5% of the fishers on the northern coast of Pernambuco depend on fishing for their livelihoods. Moreover, 84.5% of fishers have a family income of less than two minimum wages and are heavily dependent on fishing to ensure their subsistence. Despite reducing ALDFG after social isolation, the same pattern of OPUE growth from August to October in all beaches indicates that fishing activity was not completely interrupted with the decree restricting the use of beaches but not the sea. Differences observed between years may also be attributed to environmental conditions. The Pernambucana Agency of Water and Climate (APAC) database shows that the months studied in 2020 were dryer than in 2019. This environmental parameter could correlate with reduced ALDFG in 2020 because it reduces the level of the rivers in the region.

Despite the prohibition on using the beaches, the results suggest that local fishermen continued to work, probably in an attempt to obtain money and be able to pay the family's expenses, in addition to complementing the Federal Government's emergency financial assistance, possibly insufficient to cover the costs of the family. Similar behavior was described by Reis-Filho and Quinto (2020) in the state of Bahia, in which fishers maintained their regular work during the restrictions caused by the pandemic. Sunny et al. (2021), in turn, reported that social isolation negatively impacted all aspects of fishing activity in Bangladesh. For Bennett et al. (2020), the adverse effects also affected other commercial activities linked to the seafood trade, such as restaurants, markets, and hotels.

In conclusion, the change in abundance of fishing gear residues from ALDFG in the beaches on the northern coast of Pernambuco points to a reduction in fishing activity during the period when beach use was prohibited, probably accompanied by a similar reduction in the overall income of artisanal fishers in the region. The emergency financial support made available by the Federal Government was probably not enough to cover family expenses, besides not being accessible to all fishers, forcing them to maintain their activities during lockdown, consequently exposing themselves and their families to infection. Despite the similar monthly variation observed in both years, the continuous presence of ALDFG fragments indicate that fishing activities did not pause during the lockdown period.

CRediT authorship contribution statement

Sidney Andrade: Data collection, data analysis, and paper writing;
Gabriella Gomes: Data collection and methodological development;
Sindy Freitas: Data collection and methodological development;
Victor Dias: Data analysis and paper writing;
Bruno Silva: Logistics and support;
Danielle Viana: Paper writing and correction;
Paul D. Winger: Paper writing and correction;
Paulo Oliveira: Paper correction, and financial support;
Fábio Hazin: Supervision, paper correction, and financial support.

Declaration of competing interest

None.

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