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INTERNATIONAL
WHALING COMMISSION

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Introduction

Franciscana (*Pontoporia blainvillei*) is the most threatened small cetacean in Brazil. In Franciscana Management Area IA (FMA IA -Espírito Santo State, Brazil) it´s estimated less than 1,000 individuals which are isolated from the rest of the species. Genetic analysis indicates a deep evolutionary break between franciscana in FMA I and in the others FMAs indicating they must be managed as two Evolutionary Significant Units (ESU) (Cunha *et al.*, 2014). Despite its current threat level, this is the least known population of the species. Most of the available information is fragmented and there are few systematized studies in the region. The little information available in the literature comes from carcasses found on the beaches. We recorded 88 franciscana strandings in FMA IA from 2003 to 2019 (figure 1). Since 2011there is a daily effort to monitoring and recovery of carcass along all the coast of Espírito Santo (Beach Monitoring Program) before that carcass registration was carried out only through information received from the community. The proportion of carcasses recovery since 2011 is three times bigger than from 2003-2010, period in which carcass registration was carried out only through information received by the community, suggesting that the number of dead franciscana was probably higher. There is a remarkable seasonality of strandings, with 52.8% of them occurring from December to February. Human activities and disasters in the region raise great concern about the future of franciscana at FMA IA and urgent action is required to address these threats.

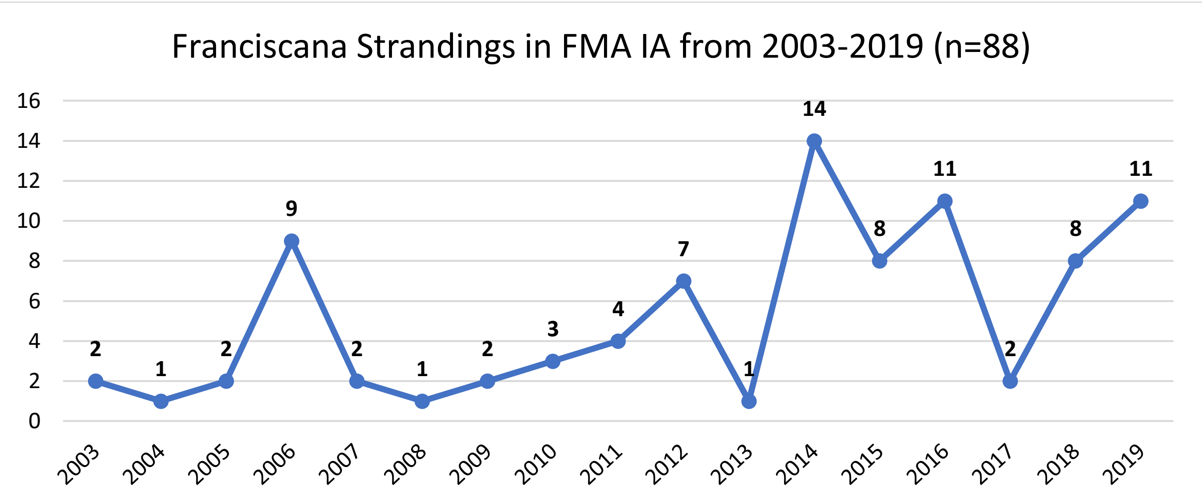

Figure 1. Franciscana strandings in FMA IA from 2003 to 2019.

1. Human induced mortality (bycatch)

The main threat to franciscana in FMA IA is accidental capture in gillnets. From 88 carcasses found ashore from 2003 to 2019, 60.2% (n=53) had signals of entanglement (Figure 2). Considering that in many cases the decomposition of the carcass made it more difficult to establish the cause of death, the number of animals that end ashore because of entanglements could be bigger.

Interactions between cetaceans and fisheries have been recorded in Espírito Santo State (e.g. Freitas Netto & Barbosa 2003) but the identification of franciscana by fishermen is difficult since them use different names for this species and sometimes use the same name for different cetaceans species (Freitas Netto & Di Beneddito, 2008). In January 2006, during 15 days of effort on board of fishing boats at the Doce River mouth, researchers recorded the capture of four *Pontoporia blainvillei* and four Guiana dolphins *Sotalia guianensis* (Frizzera *et al*., 2012). During interviews with 76 fishermen from 2016 to 2017 in FMA IA, 54 fishermen were able to identify *Pontoporia blainvillei*, and 36.8% (N=2) reported bycatch of franciscana during their activities (Marcondes *et al*., 2017).

The fishing fleet in the main communities along FMA IA (see Annex 1) is composed of 231 small boats with sizes varying from 2 to 15 meters long (9 meters on average) and cargo capacity from 20 to 18,000 Kg. The length of the nets varied from 90 to 16,670 m, and mesh size from seven to twelve cm. The persons responsible for the boats were interviewed about bycatch of small cetaceans and 16.6% reported incidental captures in gillnets in the last 12 months, with a single animal in 54%, two animals in 27% and 3 to 5 animals in 19% (Dapper & Campos 2017).

Figure 2. Franciscana with marks of entanglement in the rostrum.

From July 2017 to September 2019 fisheries landings in the six main communities using gillnet in FMA IA were monitored (see Annex 1 for more details) with resources from the Brazilian Fund for Biodiversity (FUNBIO). From 4,487 fisheries landings of all types of fishing gear only 0.27% (N=12) reported bycatch of small cetaceans. Of the 12 cases, seven were reported as Guiana dolphin, three as franciscana and two were unknown. 15 animals were captured, including three franciscana, all of them in Regência in waters from 2.5 to 10 meters deep (Dapper & Campos 2020). Data from this monitoring was used to estimate the franciscana bycatch in FMA 1 (see Annex 1). Using data only from gillnets in a Poisson model it was estimated that eleven (IC95% 3-36) franciscana were captured per year in Regência community. When all the area is considered the estimated captures were six (IC95% 2-22) per year. The small number when considering all the area is because all the observed captures occurred in Regência. It needs to be considered that this estimate was made based only in the spontaneous report by the fishermen during catch landing. Given that in previous interviews the percentage of captures reported was larger than during the monitoring, these results must be interpreted with caution. It is very likely that fishermen omitted information about the accidental capture of franciscanas during the interviews due to fear of reprisals, as they understand that the capture of this species is prohibited. During the same time of this monitoring, 17 franciscana strandings in FMA IA were recorded with at least five with entanglement markings. Although it is clear that the catches are not intentional, Brazilian law is not clear regarding these incidents. This situation is even more aggravated in the region of Regência, where fishing was prohibited along the coast, up to the 20 meters isobath, due to water contamination resulting from Mariana's disaster (see below). Even with the ban, and with the payment of indemnities to fishermen, they continue to operate in the area, mainly with gillnets.

2. Environmental concerns

Different stressor agents occur at FMA IA: chemical pollution; noise pollution; marine debris, diseases, overfishing, climate change, coastal development and environmental disasters. While entanglement continues to be the main source of impact, these factors can contribute to cumulative and synergic negative effects for franciscana.

Chemical contamination

Mariana disaster

In November 2015, one of the biggest environmental disasters occurred in Brazil, the Fundão Dam collapse, also known as Mariana disaster. This event released around 60 million tons of iron mining waste from the Samarco mining company into the Doce River (GFT, 2016). The waste mud traveled more than 600 km from Minas Gerais state along the Doce River and reached the South Atlantic Ocean. The area that received and accumulated most of the mining waste contamination, close to the River Doce mouth, is the main franciscana area in FMA IA but the plume covered all the area of FMA IA (Pinheiro *et al*., 2019).

To monitor the effects of the mining waste on the environment, the Aquatic Biodiversity Monitoring Program (PMBA) was established in 2018, with financial support from the FEST-RENOVA consortium. Many research institutions compose the Rio Doce Mar Network (RRDM) which executes the PMBA. Several biotic and abiotic analyses involving the affected coast are been developed. Franciscana data collected include: biological parameters, abundance, use of the habitat, acoustics, stranding, contaminants, genetics, pathologies, reproduction, diet and fishing interactions (RT-23 Megafauna, 2019). The first results are being analyzed and it is hoped that in the coming years we will be able to assess the impacts of the Mariana Disaster on the franciscana.

Oil spill

In August 2019 the biggest oil spill ever registered in Brazil affected the Northeast and part of the Southeast Brazilian coast. The main hypothesis is that the oil had spilled from an unknown ship close to 700 km from the Brazilian coast. The Brazilian Government estimated 2.5 million tons of crude oil spilled, either accidently or intentionally, but the accuracy of this estimate is unknown. The oil has reached more than 3,000 km of coastline including more than 55 Marine Protected Areas. Given its high density, the crude oil moved beneath the ocean surface and affected marine organisms including benthic, planktonic, and nektonic biological communities (Soares *et al*.,2020).

The latest information by the Brazilian Environmental Agency (IBAMA) in February 12, 2020 indicated at least 159 large animals directed affected by the oil, mostly sea turtles (105) and two marine mammals. The Espírito Santo coast (FMA IA) was affected by the oil spill in November 2019. Even with smaller oil effects in this area, the risk of contamination of the franciscana food web might not be discarded.

Crude oil tends to undergo fragmentation, leading to the accumulation of microparticles at different trophic levels, such as in eggs and larval stages, suspension benthic filter feeders, and animals of commercial interest. These microparticles will probably induce significant long-term damage to wildlife and human health along the Brazilian coastline (Soares *et al*.,2020).

At the top of the food web, franciscana can suffer from the bio-magnification of pollutants, whether oil spills, from Mariana's disaster or other contamination sources. Some of them can affect the fertility of animals while others can cause immunodeficiency, making animals more susceptible to infections.

Marine debris

The accidental ingestion of plastic waste by cetaceans is one cause of concern for both coastal and pelagic species. Records on marine mammals showing ingestion of debris or plastic indicated that 4% examined animals were affected (Kuhn & Franeker, 2020). The effect of ingesting these residues on the health of cetaceans has not been determined and the implications at the population level are unknown. Studies suggest that the relevance for assessing potential damage to species or populations is the frequency of occurrence of plastic waste found in individuals (Kuhn & Franeker, 2020).

In FMA IA 47 carcasses of franciscana had their stomach contents analyzed for marine debris. In 6% of the animals plastic fragments were found (Figure 3). Even with low numbers of affected animals, it is important to investigate the impacts of marine debris for franciscana considering the small population in FMA IA.

Figure 3. Plastic fragments found in the main stomach of franciscana in FMA IA.

Diseases of concern

The relationship between the presence of potentially pathogenic agents and the causes of natural mortality in Franciscana is still poorly studied. From 2015 and 2019, 30 franciscana carcasses from FMA IA where examined for *Brucella*, *Toxoplasma* and morbilivirus using Reverse Transcription Polymerase Chain Reaction (RT-PCR). All samples were negative for these three etiologic agents.

Climate change

There are no studies about the impacts of climate changes on Franciscana in FMA IA. Gomez & Cassini (2015) evaluate factors that could affect the distribution of franciscana. These factors include sea temperature, salinity and prey availability. Climate change could affect environmental conditions and consequently the factors that made a habitat suitable to franciscana.

Others

Ports

Ports can affect franciscana causing a decrease in food supply, noise pollution, water contamination, risk of oil and other products leaking and ship strikes (Pinheiro *et al*., 2019). Two harbor structures are installed at FMA IA area: Jurong shipyard and Portocel port, both in Aracruz municipality, ES. Other 14 new ports and shipyards are planned for the coast of Espírito Santo State, which would represent close to one port for every 20 km of coastline, all of them overlapping with FMA IA (Pinheiro *et al*., 2019). Considering the franciscana conservation status in FMA IA any installation may be considered an enormous risk for this small population.

Marine Noise

Anthropogenic noise contribution to overall underwater sound has been increasing significantly in coastal waters (Hildebrand, 2009). Different sound sources play a different role and can be accountable for animal disturbance, particularly in marine mammals, including hearing impairment, physiological responses changes in behavior, and acoustic masking (e.g., Clark *et al*., 2009; Erbe, 2012; Richardson *et al*., 1995). The franciscana dolphin produces high-frequency echolocation clicks at 139kHz (Melcón *et al*. 2012), but the range of frequency used by the species can be much broader (clicks - Busnel *et al*., 1974, Von Fersen *et al*.,1997, Melcón *et al*., 2016, whistles – Cremer *et al*., 2017). Sailboat surveys were performed at the FMA IA (RT-23 Megafauna, 2019) and FMA IB (Andriolo *et al*., 2018) and have confirmed the high-frequency click trains of franciscana at around 130-140kHz in both areas. Taking into consideration the wide range of acoustic environments that franciscana may use, strategies to evaluate and mitigate the underwater noise pollution are strongly recommended.

3. Conclusion

The population of franciscana in FMA IA it´s probably the most threat along the distribution of the species. It´s not only a small number of animals but they are suffering a continues impact through the bycatch and the degradation of the habit by large disasters. The impact of Mariana disaster and 2019 oil spill on the franciscana are still unknown but it´s important to note that multiple stressors could have a cumulative effect on marine mammals.

4. Recommendations

- It is imperative to take immediate actions to significantly reduce franciscana bycatch in FMA IA. This must include a ban on gillnets from the coastline to the 20 meter isobath in FMA IA, and the establishment of a participatory process to identify alternatives to artisanal fishermen such as fishing gear replacement and/or capacity-building for other economic activities.
- Incorporate franciscana monitoring and conservation measures in the permitting and operational processes for all existing and planned ports in FMA IA.
- Monitor short and long time the impacts of the Mariana disaster and the oil spill on the franciscanas in FMA IA.
- Evaluate and mitigate underwater noise in FMA IA.

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ANEXX 1. Franciscana *Pontoporia blainvillei* **Bycatch Estimate in Espírito Santo State (FMA IA) and Rio de Janeiro State (FMA IB), Southeastern Brazil.**

Methodology

This study was conducted along the Northern coast of Espírito Santo State in six fishing communities (Conceição da Barra, Barra Nova, Regência, Barra do Riacho, Santa Cruz and Guriri) and Northern coast of Rio de Janeiro State in four fishing communities (Barra de Itabapoana, Atafona, Macaé and Rio das Ostras), figure 1.

Franciscana bycatch data were recorded through a fishery monitoring program from July 2017 to September 2019. In each landing sample, fishing effort (days at the sea), fishing gears, fishing grounds, total catch and cetacean bycatch were recorded. The fishing grounds were defined in 5 NM squares, on each side, overlaid on nautical charts of the each region. Total daily landings was recorded as total effort for samples extrapolation.

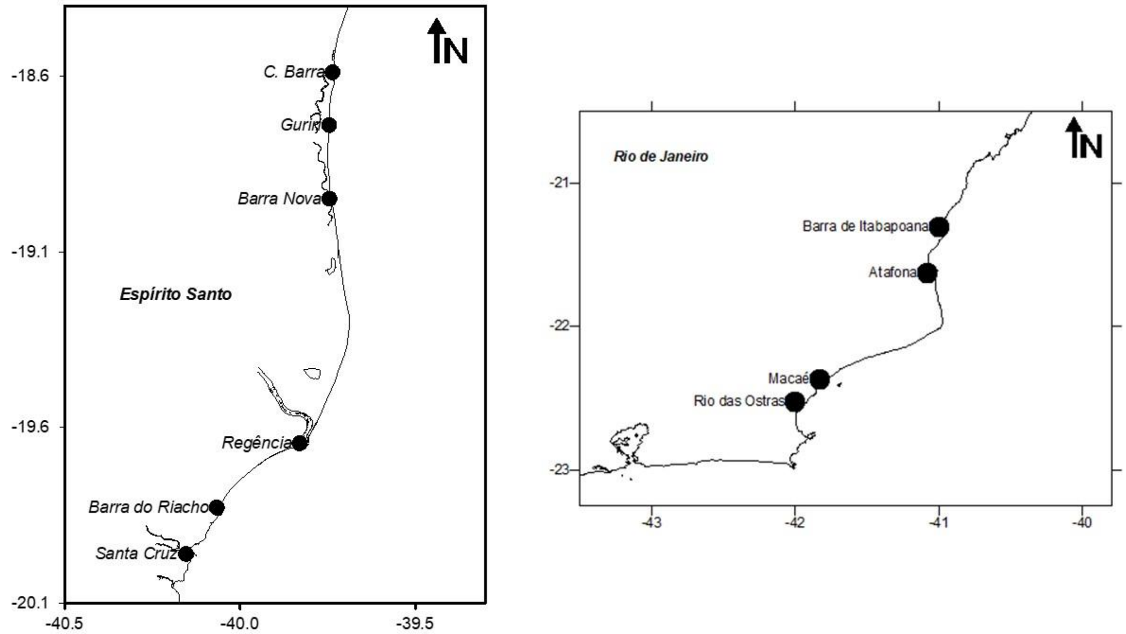

Figure 1: Research area in FMA IA (left) and FMA IB(right). Each dot is a monitored fishing community.

Distribution of franciscana bycatch

The distribution of franciscana incidental catch values by time periods, fishing gear and fishing grounds obtained from landing survey were analyzed through Generalized Linear Models (GLM), with the number of franciscana caught by landing as response variable.

A GLM has three relevant properties: (i) error structure; (ii) a linear predictor; and (iii) the link function. In this regard, count data encompass some relevant characteristics regarding these properties. As regards error structure, the counting of whole numbers presents an error according to the Poisson distribution. About the linear predictor, the model structure relates each observed value in the response variable to a predicted value. This predicted value is obtained by transforming the emerging value of the linear predictor. The linear predictor, ŋ (eta) is a linear sum of the effects of one or more explanatory variables of interest, $x_{j:}$

$$ŋ = \sum_{j=1}^{p} x_{ib}\beta_j$$

where the *x*'s are the values of the *p* different explanatory variables, and the β's are the unknown parameters to be estimated from the data. The right-hand side of the above equation is, then, called the *linear structure* (Crawley, 2005). To determine the fit of a given model, a GLM evaluates the linear predictor for each value of the response variable and compares the predicted value with the transformed value of *y* (i. e. response variable). The transformation to be used is specified in the link function. An important criterion in the choice of link function is to ensure that the fitted values remain inside reasonable bounds. Count values, for instance, should be all higher or equal to zero; otherwise, they would not make sense. Using different link functions, the performance of different models can be directly compared. It is to be noted that under this approach, total deviation is always the same, and the consequences of altering assumptions can be investigated concerning how a given change in the linear predictor can generate a response in the fitted value of *y*. In this way, the most appropriate link function is the one that results in the minimum residual deviance (Crawley, 2005).

For bycatch estimates, a subset of landing data from gillnet fisheries which fishing effort has been undertaken in the spatial stratum pertaining to the assumed franciscana bioecological distribution area was selected, considering to this end the same approximate area used in flights survey to estimate franciscana population (Danilewicz et al., 2018).

Therefore, the data subset used for Espírito Santo was limited approximately by the spatial squares located 17 Km far from the coastline, from 10 miles south of Santa Cruz to the State limit between Espírito Santo and Bahia in the north. In Rio de Janeiro the data subset was selected by the 30m isobath, from the State limit between Espírito Santo and Rio de Janeiro in the north to 23° South latitude, south toward.

Initially, data of bycatch events were fitted to the Poisson and Negative Binomial models and their respective versions inflated with zeros, with only the best adjustments being used for estimates. The total number of landings from gillnet fishing (total effort) obtained through monitoring was used for the extrapolation based on the estimates generated by the models. Therefore, a raising factor was applied over the total gillnet fishing effort, corresponding to the gillnet sample fraction contained in the known franciscana distribution area. In order to take into account the uncertainty associated with the estimated values, a nonparametric *bootstrap* procedure was carried out (EFRON: Tibshirani, 1994). According to the sample fraction and total effort values, random resampling with replenishment were undertaken. This procedure was replicated 1000 times and the interval calculated from the resulting distribution of predicted values.

Results

For Espírito Santo, among the 1400 gillnet fishery landings samples, obtained for the franciscana distribution area stratum, three individual bycatch records were observed, in distincts events. Total bycatch estimates for the Espírito Santo area, considering the entire period between July 2017 and September 2019, are presented in Table 1, for the whole area and only for Regência, the only site where bycatch was observed in the State. Franciscana bycatch estimate was determined to be 6 individuals for the whole area, according to the Poisson model, with a confidence interval of 95% of 2 to 22 individuals. Considering only the Regência site, the model predicted estimate was 11 individuals, with a 95% confidence interval of 3 to 36 individuals. It is to be noted that the Poisson and Negative Binomial models recorded similar adjustments, with the results being the same for these models.

Table 1: Franciscana bycatch estimates for the period July 2017 to September 2019 in the Espírito Santo area.

Year	Model	Estimation stratum	No. of observed landings	Total landings	Franciscana bycatch estimate	CI 95%
Whole period	Poisson	N_DES	1400	3671	6	2 -22
Whole period	Poisson	Regência	274	1804	11	3–36

For the Rio de Janeiro area, the bycatch of 5 individuals in 3 different events was recorded among the 6298 gillnet fishery landings samples obtained for the stratum of the franciscana distribution area.

Estimates of total franciscana bycatch for the Rio de Janeiro, considering the period between July 2017 and August 2019, area are presented in Table 2, considering the Poisson model adjusted to the data. As in Espírito Santo, a median estimate and respective 95% confidence intervals were obtained by resampling (N=1000). The estimate was undertaken for the whole area, since no satisfactory fits were identified for the tested models, in explaining the bycatch for the State by the assessed explanatory variables. The average estimate was eight franciscanas, with a confidence interval of 5 to 15 individuals.

Table 2: Franciscana total bycatch estimate for the period between July 2017 and August 2019 in the Rio de Janeiro area.

Year	Model	Estimation stratum	No. of observed landings	Total landings	Franciscana bycatch estimate	Confidence Interval 95%
Whole period	Poisson	Entire area	6298	9700	8	5 -15

Samples obtained in these areas contained in FMA I represented 38% and 65% of the gillnet landings population which happened in the monitoring period, respectively for Espírito Santo and Rio de Janeiro. Although in both cases sampling proportion was relatively high, the intrinsic character of "rare event" for bycatch occurrence implies the need for relatively larger sample sizes if compared to normally distributed events. In this regard the accumulation of bycatch data originated in long-term fisheries monitoring favor a better understanding of the distribution of events of interest, especially when dealing with rare events.

In the specific case of Espírito Santo the smaller proportion observed in comparison to Rio de Janeiro can be related to a restriction in fishing are imposed by the Federal Attorneys Office after a mine tailings spill disaster in *Rio Doce*. Further, given that bycatch information is voluntarily given, there is a need to consider that some fishermen might not have reported bycatch events ("false zeros") by fear of legal restrictions to their fishing effort which could impact their income. In any case an exhaustive list of management measures built under a formal decision analysis framework, mainly regarding fishing gears technology improvements, could contribute to select more effective measures for the conservation of franciscanas, minimizing conflicts with fishermen at the same time.

To this effect, information on specific characteristics of fisheries operations and fishing gears should subsidize the search for creative solutions that can be effectively managed, be it based in lesser impact fishing techniques and/or in the knowledge of franciscana behavior which makes the species vulnerable to bycatch in certain types of gillnet.