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Distribution, population size and IUCN Red Listing of an isolated population of the threatened franciscana

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ABSTRACT: The franciscana *Pontoporia blainvillei* is the only extant member of the family Pontoporiidae, and its occurrence is restricted to coastal waters from Brazil to Argentina. The species is one of the most threatened cetaceans in the southwestern Atlantic Ocean, due to unsustainable bycatch levels. A total of 11 Franciscana Management Areas (FMAs) have been defined throughout the species' range. FMA Ia represents the northernmost franciscana population, demographically isolated on the north coast of Espírito Santo State, Brazil. In March 2018, aerial surveys were conducted to assess the distribution and estimate the abundance of franciscanas in FMA Ia. A total of 2986 km of survey effort was conducted, and 27 groups were seen (average group size: 2.52 ind., coefficient of variation [CV] = 0.50) in coastal habitats (average distance from the shore: 3.3 km, CV = 0.70). Abundance, corrected for visibility bias and group size bias, was estimated at 1183 (CV = 0.76) individuals, and the potential biological removal was computed at 1. Results suggest that at least during the summer, franciscanas in ES are distributed in coastal habitats between Conceição da Barra and Santa Cruz, with a high-density area observed near the estuary mouth of the Doce River. This is one of the smallest of all franciscana populations and one with a restricted range. The estimated abundance indicates that the ES population qualifies for listing as Endangered under IUCN Red List criterion C2a(ii). In order to reduce threats to this population, management actions are urgently needed.

KEY WORDS: Distribution · Abundance · Aerial surveys · Franciscana · Threatened species · Potential biological removal

1. INTRODUCTION

The franciscana *Pontoporia blainvillei*, also known as 'toninha' in Brazil, and formerly referred to as the La Plata dolphin, is the only extant member of the family Pontoporiidae (Ribeiro et al. 1998, Lambert et al. 2018). The species is endemic to the southwestern Atlantic Ocean waters of Brazil, Uruguay and Argentina (Crespo 2009). Franciscanas occur in coastal and estuarine habitats typically shallower than 50 m,

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between Itaúnas, Brazil (18° 25′ S), and Golfo San Matías, Argentina (42° 10′ S) (Crespo et al. 1998, Siciliano et al. 2002, Danilewicz et al. 2009).

The franciscana is considered one of the most threatened cetacean species in South America (Secchi et al. 2021). Bycatch has been a worldwide recognized threat to marine mammal populations since at least the 1970s (see Perrin et al. 1994, Read et al. 2006, Read 2008, Reeves et al. 2013). Franciscana mortality in fishing operations, especially in gillnets and trammel nets, is believed to be unsustainable and has been reported along most of the species' range for the last 70 yr (Van Erp 1969, Ott et al. 2002, Secchi et al. 2003a, 2021). Habitat degradation in multiple forms has recently been better documented and is now considered another important threat to the survival of franciscana populations (Yogui et al. 2010, Lailson-Brito et al. 2011, Alonso et al. 2012, de la Torre et al. 2012, Lavandier et al. 2016, de Oliveira-Ferreira et al. 2022, Domit et al. 2022). The species is currently listed as Vulnerable on the IUCN Red List of Threatened Species (Zerbini et al. 2017) and critically endangered by the Brazilian Government (MMA 2022).

In order to guide conservation and management actions, the franciscana range was initially divided into 4 zones, known as Franciscana Management Areas (FMAs): 2 in Brazil (FMA I and FMA II), one shared between Brazil and Uruguay (FMA III) and one in Argentina (FMA IV) (Secchi et al. 2003b). Studies on genetics, morphology, distribution, and population parameters provide evidence for population substructure within each FMA (Crespo et al. 2010, Mendez et al. 2010, Barbato et al. 2012, Cunha et al. 2014, Nara et al. 2022) and call for a reassessment of the FMA boundaries in order to enhance franciscana conservation and management actions.

FMA I is isolated from all other FMAs and encompasses the latitudinal range of the species' northern 'Evolutionarily Significant Unit' (Cunha et al. 2014), including Espírito Santo State (ES) and northern Rio de Janeiro State (RJ) in southeastern Brazil (Secchi et al. 2003b). An assessment of the franciscana population structure based on molecular analyses proposed that individuals from FMA I comprise 2 distinct populations: one in the northern coast of ES (referred to as FMA Ia) and the other along the northern coast of RJ (referred to as FMA Ib) (Cunha et al. 2014, Nara et al. 2022). New evidence of population structure within FMAs indicates the existence of 11 management units (Cunha et al. 2020, IWC 2023). Demographic isolation may represent an additional challenge for the conservation of the franciscana, especially if anthropogenic threats are greater for smaller units within more restricted habitats.

Franciscanas in FMA Ia are genetically and geographically isolated from individuals in other portions of the species' range (Cunha et al. 2014, 2020). This population is under intense and increasing anthropogenic pressure (Pinheiro et al. 2019). Low genetic diversity and increasing concentrations of contaminants challenge the long-term viability of this franciscana population (de Oliveira et al. 2020, de Oliveira-Ferreira et al. 2022). Mortality due to bycatch in gillnet fishing has been reported since the 1990s (Siciliano 1994, Netto & Di Beneditto 2008, Marcondes et al. 2020). Recent fisheries monitoring reported small- and medium-scale fishing boats operating throughout the FMA Ia, using multi-gillnet types including surface, midwater, and bottom nets, either fixed or drifting (Marcondes et al. 2018, 2020).

Aerial surveys conducted off FMA Ia indicated that franciscanas occur in relatively low numbers throughout the range of the population (Moreno et al. 2003, Danilewicz et al. 2012). During a dedicated franciscana abundance aerial survey conducted in 2011–2012, more than 1000 km were surveyed, but only 3 franciscana groups were recorded (Danilewicz et al. 2012). Neither of these groups were recorded during on-effort transect lines (Danilewicz et al. 2012), precluding estimates of abundance from that survey. Although monitoring population abundance and trends provides key information to plan effective management actions, it is remarkably difficult to detect declines in population abundance before the population has been severely depleted, especially for small populations (Gerrodette 1987, Wade & Gerrodette 1992, Taylor & Gerrodette 1993, Fujiwara & Caswell 2001, Taylor et al. 2017). In this sense, to predict the long-term viability of a population based on bycatch, mortality estimates are key to planning effective management actions. An internationally recognized assessment method, the potential biological removal (PBR) (Wade 1998), can be calculated as a reference for sustainable bycatch. Although known limitations of the PBR include accounting for demographic or environmental stochasticity, this is a robust and conservative method to support management efforts (Punt et al. 2021, Manlik et al. 2022).

In this study, aerial surveys were conducted across the extent of FMA Ia to estimate abundance and assess distribution, in particular with respect to the distributional gap between FMA Ia and FMA Ib, and to compute the PBR for this population. It is expected that results from this study will address many recommendations of local and international organizations, including the governments of Brazil, Uruguay, and Argentina, the IUCN, and the International Whaling Commission (Reeves et al. 2003, ICMBio 2019, IWC 2023).

2. MATERIALS AND METHODS

2.1. Study area and field methods

Line-transect aerial surveys (Buckland et al. 2001) were conducted on 17–31 March 2018 between the northern (18° 25′ S) and southern (21° 17′ S) boundaries of ES (Fig. 1). This area includes the entire latitudinal range of FMA Ia as well as the gap in the distribution of the franciscana between FMA Ia and FMA Ib, termed the 'Hiatus' (Fig. 1). Transect lines were placed perpendicular to the coastline, following line transect distance sampling methods (Buckland et al. 2001). This design makes no assumption about the spatial distribution of the animals, maximizes equal sampling probability and, if needed, allows for post-stratification of the study area.

Post-stratification of the study area was carried out by geographic region with management purposes of estimating density in sub-sections of the study area under different anthropogenic pressure (Thomas et al. 2010). Three survey strata were proposed: (1) FMA Ia north stratum (18° 36′ S–19° 29′ S); (2) FMA Ia south stratum (19° 29′ S–19° 57′ S); and (3) the distributional gap in southern ES ('Hiatus stratum'; 19° 57′ S–21° 18′ S) (Fig. 1). Total planned effort within the 3 survey strata corresponded to 1512 km. Total effort by unit of area was equal to 0.38 within FMA Ia north stratum and 0.37 within FMA Ia south stratum.

Aerial surveys were conducted from a high-wing, twin-engine aircraft, an Aerocommander 500B, at an approximately constant altitude of 150 m (500 ft) and a speed of 170–200 km h^{-1} (~90–110 knots). A total of 4 observers (2 on each side of the plane) searched for franciscana groups, with bubble and flat windows available for front and rear observers, respectively.

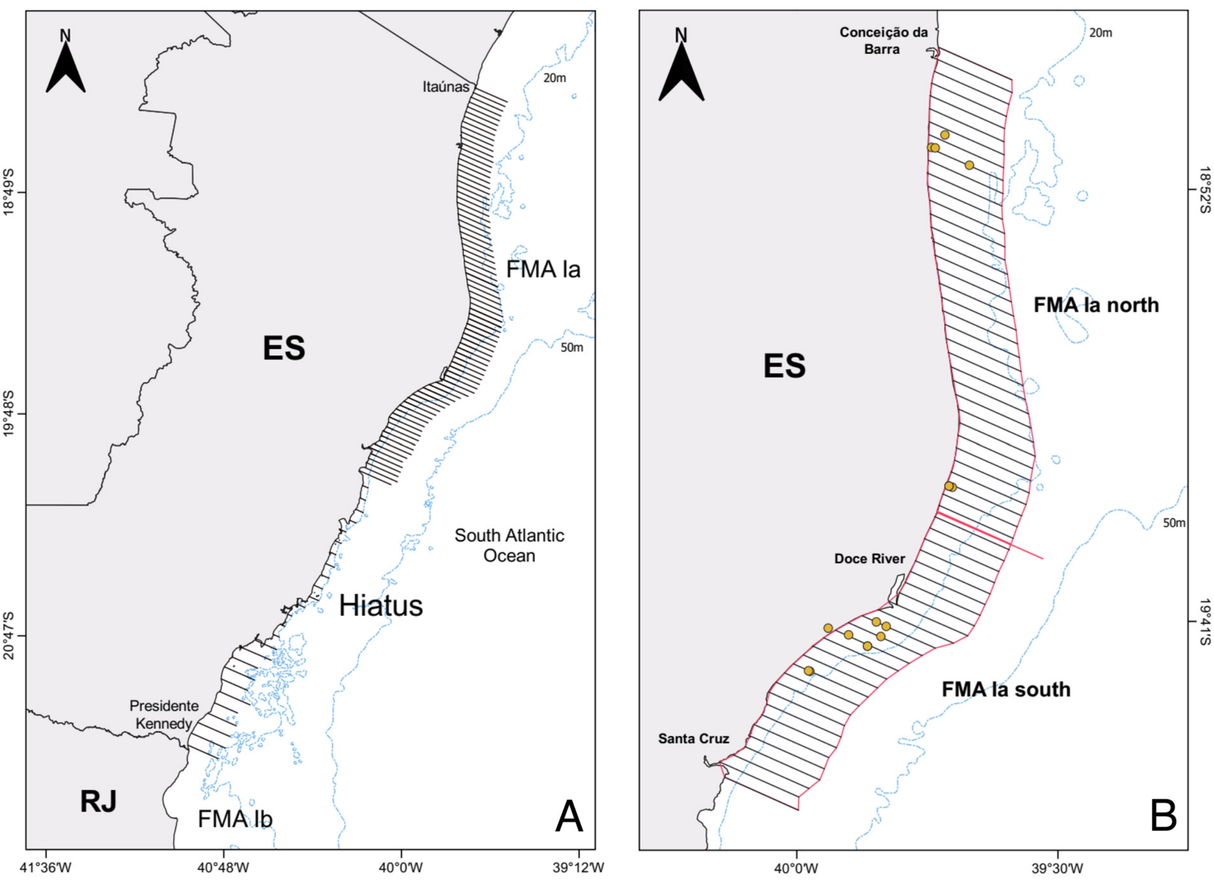

Fig. 1. (A) Study area and total realized effort during aerial surveys conducted off Espírito Santo State (ES) in March 2018. This area encompasses the latitudinal range of the Franciscana Management Area (FMA) Ia, and the hiatus in the distribution of the franciscana between FMA Ia and FMA Ib. RJ: Rio de Janeiro State. (B) Franciscana groups sighted during the aerial surveys conducted in 2018 (yellow dots) off ES and the survey effort used for estimation of abundance

Different window configurations resulted in a partial overlap in the front and rear observer's field of view (beyond 80 m from the trackline). Flights were conducted under good visibility conditions (i.e. Beaufort sea state ≤3), and each observer recorded environmental data (e.g. Beaufort sea state, presence of glare) at the beginning of each transect and whenever the conditions changed. The beginning and the end of the transect lines were informed to the observers by the pilot. The 4 observers were independent, as they were visually isolated and did not communicate with each other during the flights. When a group of franciscanas was detected, the declination angle between the horizontal and the group was obtained using an inclinometer when the group passed abeam of the plane. In addition, the size of the group was estimated and additional information such as presence of calves were recorded. Data were entered on audio digital recorders synchronized to the GPS. This allowed every record to be geo-referenced.

Additional transit lines were randomly allocated in areas of high density of franciscanas to increase sample size for the estimation of detection probability. All sightings recorded in these lines were used, along with all other transect line 'on-effort' sightings, for the estimation of detection probability, average group size and group size range. However, sightings detected while flying these transit lines were not used to estimate density or abundance. Estimates of density and abundance were calculated only with observations recorded in the actual transect lines (i.e. in the original parallel transect design; Fig. 1). In addition, because the field of view between front and rear observers only partially overlapped, only data recorded by the front observers in the airplane (bubble windows) were considered to estimate detection probability, density and abundance.

2.2. Analytical methods

All sightings recorded in either FMA Ia north or south strata (Fig. 1) were used to assess distribution patterns of franciscanas in FMA Ia. For each franciscana group, distance from the shore was calculated using GPS TrackMaker Pro software. A buffer zone was created from the northern limit of the FMA Ia north stratum to the southern limit of the FMA Ia south stratum with a width equal to the maximum distance from the shore that a franciscana group was recorded. This area was assumed to represent the area of occupancy (IUCN 2012) of franciscanas in FMA Ia. To visualize areas of higher concentration of franciscana groups within the buffer zone, a kernel density map was produced using the 'adehabitatHR' package (Calenge 2006) in R v.4.1.1 (R Core Team 2021).

Detection probability was estimated using conventional and multiple covariate distance sampling methods (Buckland et al. 2001, Marques & Buckland 2003, Thomas et al. 2010). Exploratory analyses indicated that binning perpendicular distance data at 0, 4.5, 18.5, 33, 80, 135 and 200 m intervals resulted in better model fits. A set of detection function models were fitted to the binned data, including the uniform, half-normal, and hazard-rate key functions with cosine, Hermite polynomial and simple polynomial adjustment terms and the covariate group size, following standard combinations proposed in Thomas et al. (2010). Models with acceptable fit based on visual assessment and goodness-of-fit statistics where ordered based on Akaike information criterion (AIC) values.

Bootstrap analysis was performed using a set of customized functions in the 'Distance' v.1.0.5 (Miller et al. 2019) and 'mrds' v.2.2.8 (Laake et al. 2022) packages in R v.4.1.1 (R Core Team 2021). Bootstrap resample data sets (n = 10 000) were generated by sampling with replacement from the replicate lines within each stratum, ensuring that the number of lines in the resample equaled the number in the original data set and that at least one detection was included in the resample data set. For each resample data set, the best model was selected based on AIC value; the mean detection probability was estimated globally, while encounter rate, group size and density were estimated by stratum, and for the whole survey area (FMA Ia) as the weighted average of the strata for each bootstrap replicate (Williams & Thomas 2009).

A correction factor (CF) for visibility bias (Marsh & Sinclair 1989) and group size bias, computed to correct abundance estimates of franciscanas from aerial survey data (CF = 4.76, coefficient of variation [CV] = 0.25; Sucunza et al. 2022), was applied to correct the uncorrected estimate (D_u). Assuming a normal distribution with a mean equal to 4.76 and standard deviation of 1.19, a vector with 10 000 values was created, and for each bootstrap resample, the corrected density estimate (D_c) was computed by multiplying D_u by one value of the vector. Abundance was then estimated as the product of D_c and the total area. Bootstrap resample data sets by stratum were filtered, using the interquartile range standard formula, to remove D_u outliers. Estimates of encounter rate, group size and density (D_u and D_c) were then taken by stratum as the mean of the bootstrap resample estimates, and for whole survey area (FMA Ia) as the weighted average of the strata for each bootstrap replicate (Buckland et al. 1997, Williams & Thomas 2009). CVs were calculated as the standard deviation of the bootstrap estimates divided by the mean, and variance was approximated by the delta method (Seber 1982) for whole survey area (FMA Ia). Confidence intervals were obtained by stratum using the percentile method (Buckland et al. 2001). Log-normal 95% confidence intervals (Buckland et al. 2001) were computed for FMA Ia.

PBR was calculated as (Wade 1998):

$$PBR = N_{min} \times F_R \times 0.5 \times R_{max} \quad (1)$$

where N_{min} is the 20th percentile of the estimated abundance and F_R is a recovery factor that accounts for uncertainty in population status. F_R was defined as being equal to 0.1 because of the assumed 'Endangered' conservation status of the FMA Ia population. R_{max} = 0.04 (default used for cetaceans when no information on the maximum intrinsic rate of increase is available for a population).

3. RESULTS

A total of 2986 km of sighting effort was conducted between Itaúnas (18° 25′ S) and Presidente Kennedy (21° 17′ S) (Fig. 1). Realized effort was greater than planned effort because additional lines were placed to obtain sighting data in order to improve estimates of detection probability. Franciscana groups were seen off the FMA Ia north and south strata, but no sightings were recorded in the Hiatus stratum (Fig. 1). Groups were sighted within a maximum distance of 8 km from shore (average ± SE: 3.3 ± 2.3 km, range: 0.4–8 km), with a large aggregation near the estuary mouth of the Doce River (Fig. 2). Assuming 8 km as the maximum distance from the shore that franciscanas occur off FMA Ia, at least during the summer, the area of occupancy was estimated at 1400 km^2 (Fig. 2).

The realized effort between Conceição da Barra (18° 35′ S) and Santa Cruz (19° 56′ S) (Fig. 1B) used for abundance estimation is reported in Table 1. A total of 27 on-effort recorded franciscana groups (n = 8 transect lines, n = 19 transit lines) were used to fit detection function models (Fig. 3). Group size ranged from 1 to 6 individuals, with a median of 3 and a mean of 2.52 (CV = 0.50). All proposed detection function models (Table 2) provided a good fit to the data, with estimates of average detection probability varying between 0.61 and 0.65 (Table 2); the mean detection probability averaged over bootstrap resamples was 0.62 (CV = 0.24). Mean uncorrected density averaged over bootstrap resamples was 0.097 ind. km^{-2} (CV = 0.676, 95% CI = 0.029–0.324). Density, corrected for visibility bias and group size bias ($\widehat{D_c} = \widehat{D_u} \times CF$), was estimated at 0.462 ind. km^{-2} (CV = 0.756). This estimate corresponds to a total abundance of 1183 individuals (CV = 0.756, 95% CI = 163–3150) in FMA Ia (Table 3). Based on these results, PBR was computed at 1. Values of PBR for

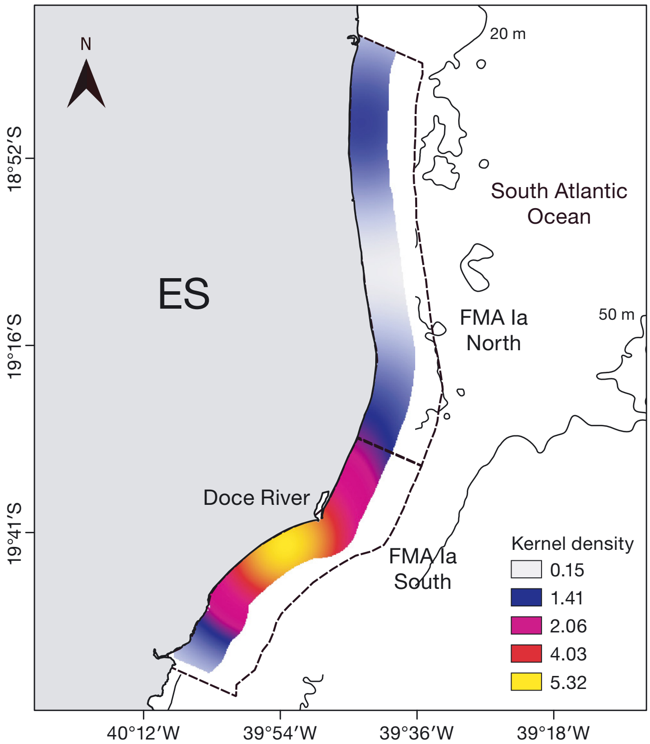

Fig. 2. Latitudinal variation in the distribution of franciscana groups recorded during aerial surveys conducted off ES in March 2018, represented by kernel density estimates within a buffer zone assumed to represent the area of occupancy of franciscanas in FMA Ia. Dotted polygon: survey area of FMA Ia north and south strata

Table 1. Survey strata, area covered, number of transects, and aerial survey effort used for estimating the abundance of franciscanas off Espírito Santo State, Brazil

Stratum	Area (km^2)	No. of transects	Effort (km)
FMA Ia north	1444	33	544
FMA Ia south	1115	35	412
Hiatus	–	30	274
Total	2559	88	1230

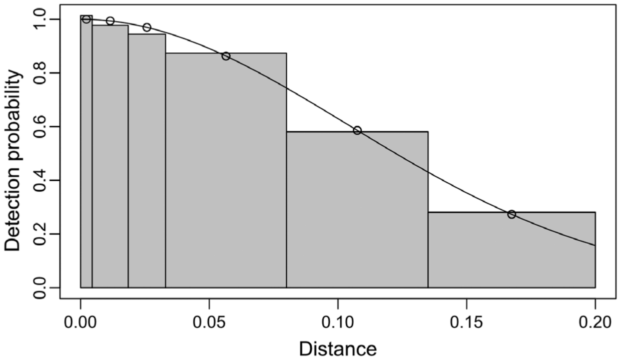

Fig. 3. Half-normal detection function plot from perpendicular distance (km) data estimated during franciscana aerial surveys in FMA Ia

Table 2. Proposed detection function models, estimated average detection probability ($\hat{P}$), coefficient of variation (CV) of $\hat{P}$, Akaike's information criterion differences between the model in question and the most parsimonious model (ΔAIC) and proportion of the bootstrap resamples for which the model in question was selected (w_{boot}). Model terms include uniform (Unif), half-normal (Hn) and hazard-rate (Hr) key functions, cosine (cos), Hermite polynomial (Herm) and polynomial (poly) adjustment terms of order(x), and group size covariate (size)

Model	$\hat{P}$	CV ($\hat{P}$)	ΔAIC	w_{boot} (%)
Hn	0.616	0.176	0.000	38
Unif+cos(1)	0.607	0.145	0.005	38
Hn + size	0.616	0.177	1.998	10
Hn + cos(2)	0.618	0.327	1.999	2
Hn + Herm(4)	0.616	0.274	1.999	<1
Hr	0.652	0.240	2.010	6
Hr + poly(4)	0.636	0.337	3.997	<1
Hr + size	0.651	0.242	4.009	6

each proposed detection function model are reported in Table S1 in the Supplement at www.int-res.com/articles/suppl/n052p017_supp.pdf.

4. DISCUSSION

The present study indicates that approximately 1000 franciscanas comprise the FMA Ia population inhabiting a restricted coastal area of about 1400 km^2, at least during the summer, mainly between Conceição da Barra and Santa Cruz. This population is completely isolated from all other populations by a distributional gap of ~200 km of coast, reinforcing the evidence for its demographic isolation (Siciliano et al. 2002, Danilewicz et al. 2012, Cunha et al. 2014, do Amaral et al. 2018, Nara et al. 2022). Groups of franciscanas were distributed close to the shore, with a high-density area observed south and near the estuary mouth of the Doce River. Data derived from the analysis of stranding franciscana carcasses (Rupil et al. 2019, Mayorga et al. 2020, de Oliveira-Ferreira et al. 2022) as well as from drone and acoustic monitoring (Giacomo et al. 2021, Amorim et al. 2022) also indicate a high concentration of franciscanas in the vicinity of the Doce River estuary mouth. These findings reinforce the critical significance of this area for the conservation of the FMA Ia population and corroborate the recognized importance of the establishment of a marine protected area in this region (ICMBio 2019, Ott et al. 2022, IUCN-MMPATF 2023, IWC 2023).

The cumulative effect of anthropogenic activities in coastal waters is considered a major threat to the conservation of many coastal cetacean species, especially those with small populations and high site fidelity (Nelms et al. 2021). Intensive small-scale fisheries, port facilities and contamination from pulp–paper and mining industries are indicated as the main environmental stressors faced by franciscanas and their habitats off the ES coast (Domit et al. 2022). In 2015, one of the most catastrophic environmental disasters in Brazilian history was caused by the collapse of the Fundão tailing dam in the Doce River, discharging millions of cubic meters of metal-

Table 3. Density and abundance estimates of franciscans in Espírito Santo State, southeastern Brazil, through the study period in Franciscana Management Area Ia (FMA Ia). FMA Ia north and FMA Ia south correspond to geographic regions (i.e. strata) used for density estimation. CV: coefficient of variation; n: number of sightings used for density estimation (averaged over all bootstrap resamples); ER: number of franciscana groups detected per km on-effort of planned effort (averaged over all bootstrap resamples); $\widehat{E_s}$: estimated average group size (averaged over all bootstrap resamples); $\widehat{D_u}$: estimated uncorrected density of individuals per km^2 (averaged over all bootstrap resamples); $\widehat{D_c}$: estimated density of individuals per km^2 corrected for visibility bias and group size bias (averaged over all bootstrap resamples); $\widehat{N_c}$: abundance corrected for visibility bias and group size bias (averaged across all bootstrap replicates); CI: confidence interval

Strata	n	ER (CV)	$\widehat{E_s}$ (CV)	$\widehat{D_u}$ (CV)	$\widehat{D_c}$ (CV)	$\widehat{N_c}$ (CV)	95% CI
North	4	0.007 (0.572)	1.388 (0.191)	0.049 (0.708)	0.232 (0.764)	336 (0.764)	31–960
South	4	0.010 (0.507)	4.083 (0.201)	0.160 (0.572)	0.760 (0.640)	847 (0.640)	132–2190
FMA Ia (Total)	8	0.008 (0.540)	2.562 (0.226)	0.097 (0.676)	0.462 (0.756)	1183 (0.756)	163–3150

contaminated slurry into ES coastal waters (Hatje et al. 2017, Magris et al. 2019). The plume of pollutant sediments from the Fundão dam collapse spread towards the area containing the greatest density of franciscanas in FMA Ia (Magris et al. 2019). The effect of the collapse of the Fundão dam has been reported in fluvial and costal ecosystems (Andrades et al. 2021, Longhini et al. 2022, Nunes et al. 2022), and the observed increase in the bioaccumulation of trace elements and organochlorine pesticides in stranded franciscana carcasses collected before and after the dam failure reflects not only temporal trends in the bioaccumulation of these elements, but also expressive changes in their associations with biological parameters of franciscans (Manhães et al. 2022, de Oliveira-Ferreira et al. 2022).

Habitat degradation likely causes habitat loss and contributes to reducing the habitat of the franciscana in ES. The north coast of ES is experiencing an escalation in mining and port-related activities, which have the potential to diminish the quality of habitat for franciscans (Pinheiro et al. 2019). Despite the need for further efforts to refine the area of occupancy of the FMA Ia population, during the present study, groups of franciscanas were not detected as far south as during aerial surveys conducted in 2011–2012 (Danilewicz et al. 2012) (Fig. S1). The low detection probability of franciscana groups during aerial surveys (Sucunza et al. 2018, 2022) could explain these findings. However, considering the construction of the large shipyard 'Jurong Aracruz' near Santa Cruz in 2015 (Fig. S1) as well as the numerous proposed ports in the area (Pinheiro et al. 2019), it is crucial to continue monitoring this population to refine the distribution and habitat use of franciscanas off ES and effectively evaluate and mitigate the effects of human activities.

While the threats from habitat degradation are extensive and complex, it is widely recognized that mortality caused by bycatch in gillnets poses the major pressure on the long-term viability of franciscana populations (Kinas 2002, Ott et al. 2002, Secchi et al. 2021). This mortality is considered unsustainable and will likely drive the species to extinction if no management actions are effectively enforced (Kinas 2002, Kinas et al. 2002, Secchi 2006, Danilewicz et al. 2010, Secchi et al. 2021). Data from the 1990s reported fishing communities along the ES coast that captured franciscanas in various stages of maturity, including adult females and calves, that operated well within the preferred habitat of the species (Siciliano 1994). New fisheries monitoring data have become available since the late 2000s. These data show an apparent increase in fishing effort through most fishing communities of ES, and have also shown that mortality in gillnets continues to occur (Netto & Di Beneditto 2008, Frizzera et al. 2012, Marcondes et al. 2018). Estimates of franciscana bycatch between 2017 and 2019 in FMA Ia indicates an average mortality of 6 ind. yr^{-1}, mostly occurring in the greatest density area reported in this study (i.e. near the Doce River estuary mouth; see Marcondes et al. 2020). This value is nearly 6 times greater than the computed PBR for the FMA Ia population, indicating that the long-term viability of the FMA Ia population is threatened, and that a marked reduction in the franciscana bycatch rate is urgently required.

Brazilian fishing regulation INI 12/2012 (MPA/MMA 2012) was established to manage gillnet fisheries in south and southeastern Brazil, mainly by controlling fishing effort and establishing no-fishing zones. Notably, this regulation has the potential to reduce franciscana bycatch in the region by banning gillnet fishing in motorized boats and industrial boats (i.e. >20 gross tonnage) within 1 and 3 nautical miles from the coast, respectively. These protected zones account for, respectively, 35 and 79% of the total sightings recorded in this study off FMA Ia. These numbers suggest that full compliance with INI 12/2012 along the ES coast would likely lead to a substantial reduction in bycatch and increased protection for the species, at least during austral summer months. Therefore, management actions should be directed to guarantee full compliance by fishing communities.

Based on the estimated abundance of 1183 (CV = 0.756) individuals and assuming an even sex ratio (Brownell 1984) and an even proportion of mature and immature animals in the population, it is expected that about 591 individuals are mature individuals, of which 295 are females. Under these circumstances, the FMA Ia population qualifies for listing as Endangered under IUCN Red List criterion C2a(ii) because of the small size (less than 2500 mature individuals) and because of an inferred decline in mature individuals, with at least 95% of the mature individuals contained in one subpopulation (IUCN 2012). The low abundance associated with multiple threats to this population, which continue at higher levels than in the past (Marcondes et al. 2020, de Oliveira et al. 2020, de Oliveira-Ferreira et al. 2022), highlights the higher risk of extinction for this isolated population, and suggests that it qualifies for a higher threat category than the species as a whole, which is currently listed as Vulnerable (Zerbini et al. 2017).

5. CONCLUSIONS

The information presented here suggests that the demographically isolated franciscana population of FMA Ia should be listened as Endangered under the IUCN Red List Categories and Criteria (IUCN 2012). In addition, we have highlighted the critical significance of the establishment of a marine protected area near the estuary mouth of the Doce River for the conservation of the franciscana in ES. In order to reduce threats to this population, management actions are needed. An important measure would be to eliminate bycatch mortality, at least in areas adjacent to the Doce River estuary mouth. Although fishing has been temporarily banned in these areas since 2016 due to contamination resulting from the Fundão dam collapse, effective enforcement has never been achieved. Habitat degradation is potentially shrinking available habitats for franciscanas in ES, increasing the exposure of individuals to threats and adding to the risk of mortality in fishing nets, which is already unsustainable. Clearly, additional conservation efforts are needed to minimize the risk of extinction to the small, northernmost franciscana population. New data on abundance, distribution and bycatch will allow monitoring of the population status of franciscanas in ES as well as refining existing and future management actions. In addition, population-level impacts of chemical pollution, ship disturbance, noise, and other human activities must be quantitatively evaluated.

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