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Threats to franciscana dolphins (Pontoporia blainvillei) in FMA II: a review and future recommendations

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INTERNATIONAL WHALING COMMISSION

THREATS TO FRANCISCANA DOLPHINS (*PONTOPORIA BLAINVILLEI*) IN FMA II: A REVIEW AND FUTURE RECOMMENDATIONS

Camila Domit[1], André S. Barreto[2], Carolina P. Bertozzi[3], Lara G. Vidal[1], Marta J. Cremer[4], Alexandre N. Zerbini[5,6,7]

[1] Laboratório de Ecologia e Conservação, Centro de Estudos do Mar, Universidade Federal do Paraná, Pontal do Paraná, Brazil

[2] Laboratório de Informática da Biodiversidade e Geomática, Universidade do Vale do Itajaí, Itajaí, SC, Brazil

[3] Laboratório de Biologia e Conservação de Organismos Pelágicos, Instituto de Biociências, câmpus do Litoral Paulista, Universidade Estadual Paulista, CLP/UNESP, Brazil.

[4] Laboratório de Ecologia e Conservação de Tetrápodes Marinhos e Costeiros, Universidade da Região de Joinville, São Francisco do Sul, Brazil

[5] Joint Institute for Studies of the Atmosphere and Ocean/University of Washington & Marine Mammal Laboratory, Alaska Fisheries Science Center, Seattle, WA, 98125, USA

[6] Marine Ecology and Telemetry Research (MarEcoTel), Seabeck, WA, USA

[7] Instituto Aqualie, Juiz de Fora, MG, Brazil.

1. OPENING REMARKS

The franciscana dolphin (*Pontoporia blainvillei*) is one of the most impacted cetaceans in the Southwest Atlantic Ocean (Secchi & Wang, 2002). To facilitate management and conservation, geographic range of the species was divided into four 'Franciscana management areas' (FMAs: I to IV; Secchi et al., 2003, Cunha et al., 2014). FMA II encompasses the Brazilian states of São Paulo (SP), Paraná (PR), and Santa Catarina (SC) and ranges between 23 and ~28ºS (Secchi 2003; Cunha et al. 2014; Ott et al. 2015; Amaral et al. 2018). Recently, genetic analyses supported subdivision of FMA II into two distinct sub-populations: FMA IIa (north area of SP) and IIb (SP, PR and north-central SC) (Cunha et al., 2014). Abundance estimates computed in 2008/9 indicate the population in the whole of FMA II corresponds to 6,827 (CV = 0.26) franciscanas, with 1,915 individuals (CV = 0.32) in FMA IIa and 4,353 dolphins (CV = 0.24) in FMA IIb (Sucunza et al., 2019). Franciscanas in FMA II are typically found in nearshore oceanic waters up to the 30 m isobath, but the occurrence of the species is also regularly documented in both Paranaguá Estuarine Complex (Paraná state) and Cananéia Estuarine Complex (São Paulo state), and a resident population is monitored at Babitonga Bay, Santa Catarina state (Cremer & Simões-Lopes, 2005; Sartori et al., 2017, Santos et al., 2009; Weyn, 2018).

The franciscana is classified as "Vulnerable" under the IUCN Red List (Zerbini et al., 2017), mostly due to the population decline in 30% along three generations. The vulnerability is increased by the overlap between the species distribution and human activities, exposing populations to multiple threats. Despite long-term studies to assess the effects of anthropogenic threats within FMA II, but sources of franciscana non-natural mortality are still poorly known and likely underestimated. Nevertheless, fishing mortality, mostly by gillnets, seems to be by far the greatest threat to the species. In 2016, a Conservation Management Plan (CMP) for the species was implemented by the International Whaling Commission (IWC) and 27 actions were proposed (SC/67b/CMP16) to prioritize scientific and conservation efforts.

The IWC Scientific Committee (IWC-SC) is expected to conduct a review of the status of the franciscana to improve conservation actions by the franciscana CMP. The purpose of this document is to summarize the anthropogenic threats and potential impacts for franciscana conservation in FMA II to facilitate with the species review by the IWC-SC.

2. ANTHROPOGENIC THREATS

The expansion and intensity of anthropogenic activities generate a wide array of environmental stressors and changes, which might impact biodiversity both directly and indirectly (Maxwell et al., 2013). The franciscana dolphin distribution overlaps an area with intense human use, and because of that, the species is exposed to multiple anthropogenic activities. These activities encompass fishing, aquaculture, ports, mining, hydropower, industrial and agricultural activities, development of urban areas, as well as heavy marine traffic. Based on the distribution patterns and the endemism, a recent review of the current global risk to marine mammals considered the franciscana one of the most affected threatened species, mainly due to its smaller distributional range (Avila et al., 2018).

Bycatch is the greatest known threat to franciscanas populations and encompasses several different scales, from regional to national governments and inter-governmental fishery bodies (BMI/IWC, https://iwc.int/bycatch). This species is predominately caught by gillnets used by both large-scale, industrial, and smaller-scale, artisanal fisheries (e.g., Ott et al., 2002; Franco-Trecu et al., 2009; Negri et al., 2012). Fishing operations affecting the franciscana are complex, making assessments of the effects of bycatch challenging, particularly for the small-scale fisheries. Even though the CMP has been developed for franciscana as part of IWC scientific committee, and fishing interactions are being treated as the most important action to be addressed over both short and long terms, bycatch estimates in the industrial and artisanal fisheries from FMA II (CMP action MON 1.2; 1.3) are diverse and poorly monitored. The estimates of bycatch for FMAII are fragmented in space and time and, where available, likely is underestimated. However, since August 2015, beach monitoring (CMP action MON 1.4) in FMA II significantly increased. This approach is bringing some critical data describing threats and mortality rates.

2.1. Human-induced mortality

Few data are available concerning fishing effort and bycatch rates in FMA II, and these are limited to specific fishing communities or short-term assessments (Table 1; Annex 1). Specifically, Rosas et al. (2002), documented the mortality of 11 franciscanas between 1998 and 1999 by monitoring just one industrial gillnet fishing boat in southern São Paulo and an average mortality of 10 franciscanas per year by ~5 artisanal fishing communities in Paraná state from 1997 to 1999. Bottom-set gillnets, with a stretched mesh size of 7.0 and 13.0 cm, and driftnets with a stretched mesh size of 10.0 cm, recorded the greatest number of captures. Bycatch monitoring indicated a predominance of males caught in offshore fisheries, and a bias towards sexually immature franciscanas of both sexes caught closer to the coast. The lack of information on fishing effort in the study by Rosas et al. (2002) precludes a comparison of these figures with other studies, areas and prevents any long-term assessment of mortality associated with these fisheries.

In early 2000, Bertozzi and Zerbini (2009) evaluated franciscana incidental mortality in Praia Grande, São Paulo state and reported the capture of 34 franciscanas between August 1998 and June 2001. The estimated annual catch per unit of effort (CPUE) was 5.0 franciscanas x 1000 x (km of net x day)$^{-1}$. Assuming the CPUE observed in Praia Grande (São Paulo state) applied to other regions, Bertozzi (2009) estimated that 372 franciscanas were incidentally killed along the coast of São Paulo in 2004. This estimate does not apply to other areas in FMA II (Paraná and Santa Catarina states) and therefore is an underestimate for the whole range of the population stock. Monitoring of a fishing community in northern Santa Catarina state during 20 months between 2001 and 2002 documented the bycatch of 12 franciscanas in gillnets (Barreto 2004). The estimated CPUE in this region was lower than that for São Paulo across a similar temporal scale.

Another study conducted along the central coast of São Paulo reported a subtle decline in the relative abundance (based on standardized CPUE) of franciscanas during the period 1999–2015, particularly after 2003 (Rosas, 2019). During this period, 28,690 fishing trips were monitored and 277 franciscanas were caught. A mortality estimates of 1,404 individuals (CV = 1,35) was computed for this period, which implies an average annual mortality of ~90 franciscanas. This estimate is likely biased low because the average CPUE was calculated for the small-scale fisheries and extrapolated to industrial fisheries, which, according to Rosas et al. (2002), the unique published data, have a greater average CPUE value. Reliable estimates of franciscana bycatch are not available for FMA II because no systematic effort to monitor bycatch over broad spatio-temporal scale has occurred.

Fishery interactions were also monitored in Parana and Santa Catarina states using ethnoecological methods, such as fishing landing and interviews with fishermen (Pinheiro & Cremer; 2005; Zappes et al., 2016). These studies reported a high level of local ecological knowledge about franciscanas and their bycatch near Babitonga Bay (Santa Catarina state) and two villages at the Superagui National Park (Paraná state). During interviews in two areas along the Paraná coast (Gama, 2013), most fishers described franciscana captures as rare, but meat consumption and fishing bait were both reported as a possible destination for carcasses (Gama, 2013).

Reliable estimates of franciscana bycatch are not available for FMA II because no systematic effort to monitor bycatch over broad spatio-temporal scale has occurred. However, estimates in the early 2000s reached a maximum of nearly 500 individuals per year in FMA II (e.g., Secchi et al. 2003). Despite no bycatch systematic effort have been conducted, a daily beach monitoring conducted since August 2015 may provide minimum estimates of fishery-related mortality along the range of the stock (Cremer et al., 2018; Barreto et al., this meeting).

From August 2015 to February 2020, 2,163 franciscana strandings were recorded along the coast of FMA II. Evidence of interactions with fisheries (e.g., linear cuts; fishing gear entanglement) were observed in 355 individuals (16.5%; Figure 1 and 2). However, for 112 carcasses recorded "fresh" (decomposition state 2; e.g. Geraci & Lounsbury, 2005) the necropsies analyses suggested that 67.9% had *causa mortis* identified as 'drowning'; and 58.0% had clear signs of fisheries interactions. Therefore, in the absence of other information and applying the percentage of 67% for all the 2163 carcasses recorded, a minimum estimate for fishing interaction mortality might be1449 individuals (~290 individuals/year). Since a portion of the carcasses do not reach the beaches, this mortality rate is underestimated

2.2. Environmental concerns

Notwithstanding the greatest threat to the conservation of franciscanas is bycatch, the species is also subject to other potentially severe threats that consequently increase their risk of mortality and morbidity. These threats, described in more detail below, include pollutants, pathogens and habitat degradation, which can independently and, more likely, cumulatively, affect the immune system and ultimately, population health.

Chemical pollution

Several studies assessing chemical contamination have been carried out for franciscanas in FMA II with a focus on two classes of chemical pollutants: (1) trace elements (metals and metalloids), and (2) organic compounds (including organochlorines, dechlorane-related compounds, octocrylene, brominated compounds, and pyrethroids). Most studies indicate multiple intra-specific contaminations and chronic contamination by both classes of pollutants, with high levels in all ages when compared with the global literature, including neonates. Maternal transfer for some compounds was also reported. The main results are presented in Tables 2–4.

Trace elements

Only a few studies have been conducted focusing on trace elements in franciscanas in the FMAII. Kunito et al. (2004) evaluated the concentration and subcellular distribution of trace elements in the liver of 24 individuals incidentally caught off São Paulo and Paraná. Franciscanas showed greater concentrations of manganese (Mn), cobalt (Co), arsenic (As) and rubidium (Rb) than other local dolphin species. The ratio of organic-mercury (Org-Hg) to total-mercury (T-Hg) in livers was significantly higher than in the predominantly estuarine Guiana dolphin (*Sotalia guianensis*), suggesting the demethylation ability of methyl Hg might be lower in the liver of franciscanas. High hepatic concentrations of silver (Ag) were found in some franciscanas (maximum, 20 µg/g dry wt.) and 17% showed greater concentrations of Ag than Hg. Dolphins with high Ag concentrations also exhibited elevated hepatic selenium (Se) concentrations, implying Se might detoxify Ag in the liver. The higher correlation coefficient between (Hg + 0.5 Ag) and Se than between Hg and Se and the large distribution of Ag in a non-soluble fraction in the nuclear and mitochondrial fraction of livers also suggest Se might detoxify Ag via formation of Ag_2Se in franciscanas.

A thesis comparing three estuaries in southeastern and southern Brazil (Paranaguá in Paraná, and Cananéia & Santos in São Paulo) assessed franciscanas dolphins. Several metals and metalloids (As, Cu, Cr, Se, Zn and Hg) were detected in franciscanas tissues, with greater values in the liver than in muscle (Trevizani 2018).

Persistent organic pollutants

Kajiwara et al. (2004) determined organochlorine compounds in the blubber of 20 franciscanas in São Paulo and Paraná. Concentrations of Dichlorodiphenyltrichloroethane (DDTs) and Polychlorinated biphenyl (PCBs) were the highest, followed by chlordane-related compounds (CHLs), tris(4-chlorophenyl)methanol (TCPMOH), dieldrin, Tris(4-chlorophenyl)methane (TCPMe), heptachlor epoxide, hexachlorobenzene (HCB), and hexachlorocyclohexane isomers (HCHs). The concentrations of DDTs were higher than PCBs, probably reflecting extensive regional agriculture. The authors highlighted a significant pollution of PCBs, DDTs, TCPMe, and TCPMOH in cetaceans from Brazil, implying the occurrence of local sources in the Southern Hemisphere comparable to those in the Northern Hemisphere, probably by the recent high industrialization in Brazil.

Yogui et al. (2010) investigated organochlorines in eight franciscanas from São Paulo found dead between 1999 and 2001. Of note, DDTs and PCBs exhibited the greatest concentrations in the animals, reflecting the large amounts that were formerly used in Brazil. Lower concentrations of mirex, HCB, CHLs and HCHs were detected. The levels of PCB highest of DDT, first to indicate the most urban character of the region. Regarding DDTs, the distribution of the mean percentages decreased in the following order: p,p′-DDE > p,p′-DDT > p,p′-DDD.

Lailson-Brito et al. (2011) investigated organochlorines in 10 franciscanas found dead along the coast of São Paulo and Paraná (PR). The ΣDDT/ΣPCB ratio varied between 0.27 and 0.42 for the northern and central coasts of São Paulo, while to the south, including Parana the values were 1.6 and 1.9, respectively. In terms of

DDTs, the distribution of the mean percentages decreased in the following order: p,p′-DDE > p,p′-DDD > p,p′-DDT.

De la Torre et al. (2012), was the first article reporting the presence of Dechlorane 603 (Dec 603), Dechlorane 602 (Dec 602), and chlordane plus (CP) in mammals. The study investigated dechlorane in 13 franciscanas found dead along the coast of São Paulo and Santa Catarina. Concentrations of Dec 603 (0.75 ng/g lipid weight (lw); mean) and Dec 602 (0.38 ng/g lw; mean) were quantified in more than 95% of the franciscanas, whereas the frequency of detection decreased to 75% for Dechlorane Plus (DP) (1.53 ng/g lw, mean). The presence of CP was also observed (0.13 ng/g lw, mean) in half of the samples. In contrast, Dec 604, decachloropentacyclooctadecadiene (aCl10DP), and undecachloropentacyclooctadecadiene (aCl11DP) concentrations were below limits detection in all cases.

Dorneles et al. (2013) investigated dioxins, and related compounds (DRCs) in liver samples from 20 franciscanas found dead along the coast of São Paulo, Santa Catarina, Rio Grande do Sul e Espírito Santo. Significant negative correlations were found between dolphin total length (TL) and three variables, ΣTEQ-DRCs, ΣTEQ-PCDF and ΣTEQ non-ortho PCB. Increasing efficiency of the detoxifying activity with the growth of the animal may be a plausible explanation for these findings.

Leonel et al. (2014) investigated polybrominated diphenyl ethers (PBDE) in blubber samples from 41 Franciscana dolphins found dead along the coast of São Paulo between 2002 and 2005. Total PBDE in these animals was greater (67.8 to 763.7 ng g^{-1} lw) than those from FMA III. This result is possibly due to proximity to important industrial development sites in São Paulo.

Alonso et al. (2012) investigated organobrominated compounds (anthropogenic pollutants as well as those naturally generated) in liver samples from 51 Franciscana dolphins found dead along the coast of São Paulo, Paraná, Santa Catarina, Espírito Santo e Rio Grande do Sul. PBDE levels were similar to those observed in other cetaceans from Northern Hemisphere. Nevertheless, franciscanas from Brazil presented the highest methoxylated polybrominated diphenyl ethers (MeO-PBDE) concentrations ever reported for coastal cetaceans.

Yogui et al. (2011) investigated PBDE in liver samples from eight franciscana dolphins found dead along the coast of São Paulo. Compared to other cetaceans in the state, franciscanas had the lowest concentrations to. Feeding habits might be a possible explanation for such differences. The pattern of contamination indicates that Penta-BDE commercial mixtures are a major source of PBDEs among top predators in the southwestern Atlantic Ocean.

Alonso et al. (2012) investigated pyrethroid in liver samples from 23 Franciscana dolphins stranded along the coasts of São Paulo and Rio Grande do Sul. This study was the first investigation to demonstrate pyrethroid bioaccumulation in marine mammals, despite a previous assumption that these insecticides are converted to non-toxic metabolites by hydrolysis in mammals. Permethrin was the predominant compound, accounting for 55% of the total pyrethroids recorded. The results showed a distinct metabolic balance of pyrethroids throughout the entire life cycle. High loads were present among juveniles but, when they reach sexual maturity, individuals seem to degrade/metabolize pyrethroids. Maternal transfer of compounds was also evaluated through the analysis of breast milk and placenta samples. Pyrethroids were detected in both matrices, with values between 2.53–4.77 ng/g lw and 331–1812 ng/g lw, respectively. Therefore, for the first time, the study showed mother-to-calf transfer of pyrethroids by both gestational and lactation pathways in dolphins.

Gago-Ferrero et al. (2013) was the first study to investigate the presence of sunscreen agents in marine mammals worldwide. Fifty-six liver tissue samples were taken from dead franciscanas accidentally caught or found stranded in São Paulo, Paraná, Santa Catarina, Espírito Santo, Rio de Janeiro and Rio Grande do Sul, encompassing FMAs I, II and III). The extensively used octocrylene (2-ethylhexyl-2-cyano-3,3diphenyl-2-propenoate, OCT) was frequently found in the samples investigated (21 out of 56) at concentrations in the range 89−782 $ng \cdot g^{-1}$ lipid weight. São Paulo was the most polluted area (70% frequency of detection).

Alonso et al. (2015) investigated pyrethroids (PYR) and UV filters (UVF) in the tissues of paired mother-fetus dolphins off Brazilian (including from São Paulo, Paraná and Santa Catarina) to investigate the possibility of maternal transfer of these emerging contaminants. Comparison of PYR and UVF concentrations in maternal and fetal blubber revealed Franciscana transferred both contaminants efficiently to their fetuses through the placenta (F/M > 1). This study was the first to report a maternal transfer of pyrethroids and UV filters in marine mammals.

The source of all the above analysed compounds are anthropogenic, and the animals' exposure depends on their release into the environment by human action. These contaminants cause endocrine, cancerous, neurotoxic disorders, allergies, influence immunosuppression and affect reproductive parameters (O´shea and Odell 2008; Bossart 2006). Such compounds, if unique in the animals' tissues, could rarely cause death; but the synergy of these compounds and their cumulative effects could represent significant contributors to lethality among Franciscana dolphins. Further, any sublethal impacts to endocrine and reproductive parameters might not only affect the individual but the entire population. These compounds potentially contribute significantly to the weakening of the health condition of Franciscans and their ability to respond to other direct impacts, such as interactions with fisheries.

Noise pollution

There is no information available on the potential effects of noise pollution on franciscanas in FMA II. However, the region is one of the most important areas for port activities. Specifically, the four largest ports in Brazil occur within the range of this stock (São Paulo, Paraná and the Santa Catarina states).

A ten-year study of the distribution patterns in Babitonga Bay (a port area in Santa Catarina), show that the franciscana does not typically approach the port areas (Cremer and Simões-Lopes, 2008), and that is believed to be related to the high ambient noise in these areas (Cremer et al., 2017) where underwater noise recorded at 0 to 12 kHz reached 116.9 dB (Holz, 2014). Predictive maps of acoustic energy show the innermost region of Babitonga Bay has lower noise intensity and that this increases towards the mouth of the bay with increasing proximity to the ports (Holz 2014). Notably, franciscanas occurrence is concentrated in the inner area of that bay (Cremer and Simões-Lopes 2008), where noise intensity is lower than in other areas around.

This pattern is similar near another large port in the Paranaguá Estuarine Complex (PEC) includes the Paranaguá port (3rd largest in Brazil). In this region, franciscanas have been documented using areas around designated protected areas and also away from the ports (Santos et al., 2009; Zappes et al., 2016; Weyn, 2018). In the PEC, underwater noise recorded at 0 to 8 kHz reached 206 dB (Domit et al., 2018 – APPA report), an intensity even higher than those observed near Babitonga Bay.

Marine debris

There is no specific study being conducted focusing on interactions with franciscanas and marine debris in FMA II. Nevertheless, the systematic beach monitoring program (PMP-BS) recorded 2163 individuals stranded on the beaches and debris were observed in 5% of all franciscanas evaluated by necropsy. The interaction includes ingestion and entanglement (Figure 3).

Diseases of concerns

Approximately 1500 individuals have been necropsied and investigated for pathological findings and mortality, particularly between 2015–2020, within the range of FMA II. In general, drowning is the most common cause of death (~70%); however, 17% of the cases were related to infections (bacterial or viral infection agents) (PMP-BS). Emaciation was determined for ~5% of individuals examined (Domiciano et al. 2016; PMP-BS).

Histopathological analysis was performed on different tissues of 288 franciscanas found dead along the entire coastline of FMA II (data available at http://simba.petrobras.com.br). These analyses were conducted only for animals in decomposition stages 2 and 3 (Geraci & Lounsboury, 2005). Of these, 96.9% had histopathological findings in the lungs (n = 217), 67.3% in the kidneys (n = 159), 54.4% in the liver (n = 104), 28.6% in the heart (n = 65) and 26.7% in the lymph nodes (n = 58).

Further, a total of 102 individuals from FMAs II and III were analysed for *Toxoplasma gondii* by immunohistochemistry. Nevertheless, no franciscana dolphin was IHC-positive (Costa-Silva et al., 2019). Brucella has been detected in 2.5% of the franciscanas analysed in southern Brazil (Sanchez-Sarmiento et al., 2019).

Overfishing of prey

No studies have been conducted to assess the potential effect of overfishing franciscana prey along the FMAII. However, available information on the diet of this species suggests that many important prey for franciscanas throughout FMA II (e.g. *Pellona harroweri*, *Isopisthus parvipinnis*, *Cetengraulis edentulus*, *Ophistonema oglinum*, *Lycengraulis grossidens*, *Anchoa filifera*, and *Micropogonias furnieri*) are of commercial interest and are heavily exploited (Henning et al., 2018; Campos et al., 2020). The overlap of fisheries target species subject to overfishing and franciscana prey could increase the vulnerability of this dolphin species by reducing food availability, while also increasing their exposure to fisheries interactions.

Climate change

There is no specific study being conducted focusing on climate change effects in Franciscana dolphins in FMA II.

3. CONCLUSION AND RECOMMENDATIONS

While bycatch is the most critical conservation problem faced by Franciscana in FMA II, other potential threats are reported. However, several knowledge gaps must still be filled to better assess their effects to the species. Limited studies on habitat degradation and exposure to threats have been carried out within FMAII. In addition, some pathogens and chemicals can negatively affect reproduction, population resilience and cause mortality among cetaceans (Bossart, 2011). In general evidence for cause-effect relationships of these threats and franciscanas has not been determined. The potential for long-term synergistic and cumulative effects to the franciscana fitness, health and population viability should not be overlooked.

A coordinated and systematic monitoring program is crucial to continue to assess the effects of anthropogenic threats, particularly fisheries interactions to franciscanas in FMA II. Such studies would also further support actions and decision-making concerning the conservation of this species within the context of the IWC CMP for the franciscana.

Multiple research and conservation actions are recommended for FMAII. Perhaps most important are those related to mitigating franciscanas bycatch, including specific actions considered a priority by the IWC Bycatch Mitigation Initiative Workplan 2018-2020 (e.g., Objectives 2, 3 and 4 in the work-plan):

- Conduct a bycatch assessment (e.g. rapid assessment as suggested by FAO, 2020), particularly for small-scale fisheries, estimating fishing effort, existing bycatch data, and also the challenges and opportunities for co-management initiatives to mitigate fishing interaction.
- Identify specific fisheries where achievable bycatch mitigation strategies could be tested and introduced.
- Build capacity and methods to design alternative approaches to achieve effective bycatch mitigation and monitoring solutions, if possible in partnership with fishing communities.
- Perform experiments to evaluate the effectiveness of methods already known for reducing bycatch, such as pingers.
- Engage communities participating in pilot and affiliated projects to mitigate fishing mortality.
- Develop a ‘toolbox’ of socio-economic incentive-based approaches for small-scale fisheries.
- Strengthen the maintenance of the beach monitoring project as a strategy to assess species mortality, including assessing the effectiveness of mitigation methods.

Other recommendations include:

- Implementing a health assessment for Franciscana in FMA II, including (1) metal, organic and emerging composts (nanoparticles, hormones, pharmaceuticals) (2) exposure biomarkers, and (3) the presence of diseases through extensive pathological assessments (histological, bacteriological, fungal and/or virologic).
- Strengthen recommendations for mitigating impacts related to the establishment of new port areas along the coast.
- Monitoring to evaluate the effects of ports and coastal development in the health and habitat quality of Franciscana along the FMA II
- Assess and mitigate underwater noise in FMA II.

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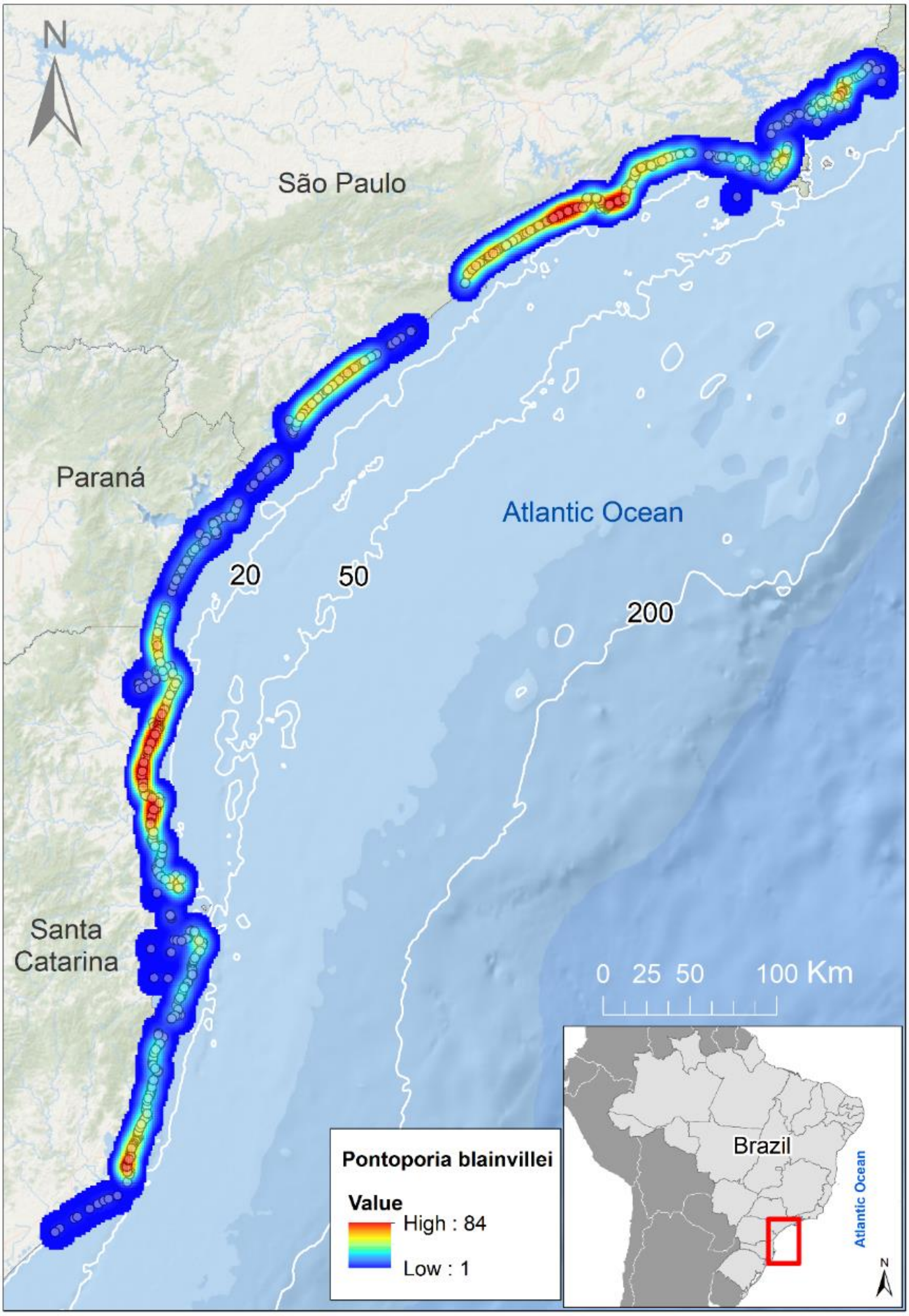


Figure 1. Spatial distribution of Franciscana (*Pontoporia blainvillei*) stranding events along beaches of FMA II from 25th August 2015 to 28th February 2020 (*Database from PMP-BS).*

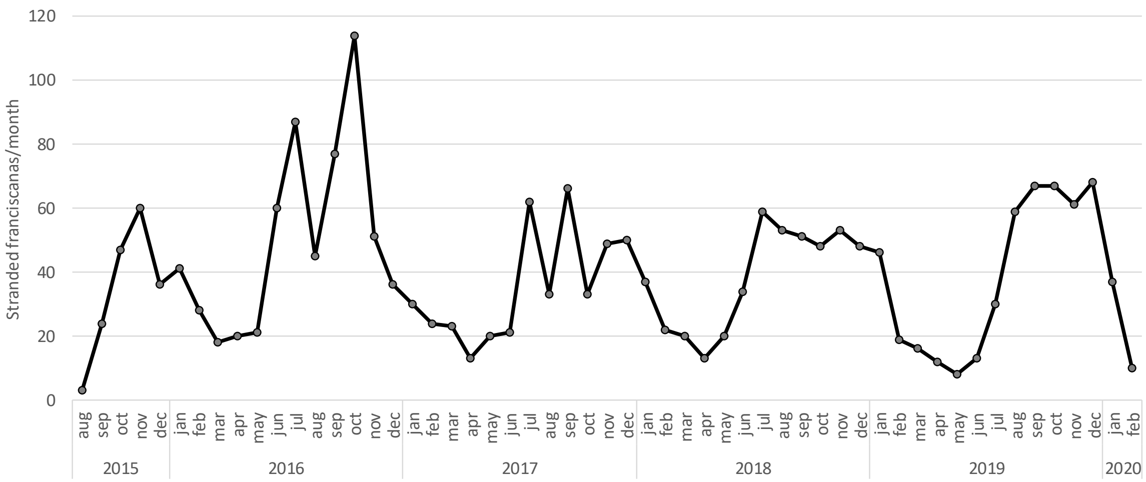


Figure 2. Number of Franciscana dolphins**,** *Pontoporia blainvillei,* collected along beaches of FMA II from 25th August 2015 to 28th February 2020 (*Database from PMP-BS).*

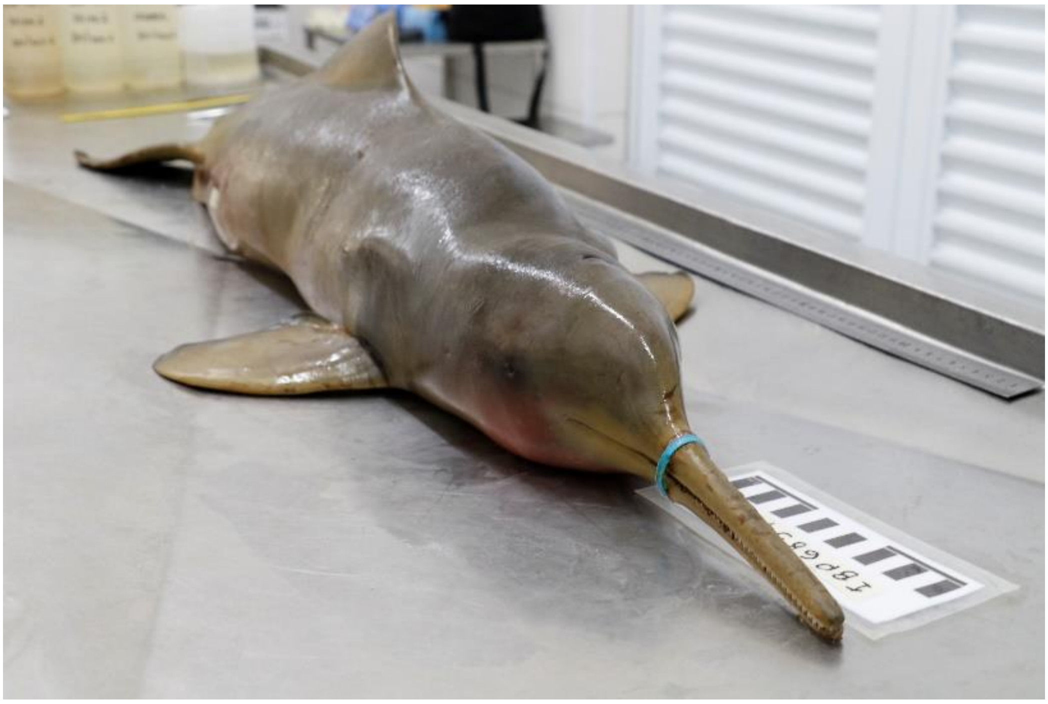


Figure 3. A juvenile franciscana dolphin found stranded in Praia Grande beach, São Paulo state, with a plastic circle seal around the rostrum. ©Intituto Biopesca/Kaio Nunes.

Table 1. Summary of fisheries interactions and incidental mortality of franciscana dolphins, *Pontoporia blainvillei*, along the FMAII, Brazil. (LEK = Local ecological knowledge)

Location	Annual mortality	General characteristic of the fisheries	Data sources	Reference
Praia Grande, SP/Brazil 24º00'S 46º24'W	Min.: 10 Ave.: – Max.: –	Fleet: 6 small boats (6–8m long) Power engines: 18–40 Hp Gear: surface and bottom gillnets Main target species: Sciaenid, Carangidae, sharks Mesh size: 7–16cm Net height: 1.6–3.3m (bottom gillnets); 7.4–10m (surface gillnets) Net length: 120–1,800m Depth: up to 25 m Distance from the coast: – Fishing season: year-round CPUE: 0.005 Franciscana × (km of net × day)$^{-1}$ Dolphin use: no records	2 years (1998–2000) fleet monitoring program (100% of the fleet). Interview and onboard surveys.	Bertozzi and Zerbini, 2002.
Ubatuba to Iguape, SP/Brazil 23°26'02''S 45°04'15''W 24°42'28''S 47°33'18''W	Estimate: 372	Fleet: 1.192 (3.8–16m long) Power engines: 9–260Hp Gear: surface and bottom gillnets Main target species: Sciaenid, Carangidae, sharks Mesh size: 6–30cm Net height: 1.5–3.5m (bottom gillnets); 7.4–10m (surface gillnets) Net length: 60 –3,900m Depth: 10 to 2,000 m Distance from the coast: – Fishing season: year-round CPUE: 0.00008 Franciscana × (km of net × day)$^{-1}$ Dolphin use: no records	1 year (2004 – 2005) fleet monitoring program 3 boats Ubatuba; 4–11 Praia Grande; 1–4 Mongaguá, 1–4 Itanhaém. Interview and onboard surveys.	Bertozzi, 2009
Ubatuba to Iguape, SP/Brazil 23°26'02''S 45°04'15''W 24°42'28''S 47°33'18''W	Est.: ~88/year (a total of 1.404)		(1999–2015) Interview and onboard surveys – ~7% of the fleet	Rosas, 2019

Cananéia, SP/Brazil Latitude: 25º00'S	Est. a: Min.: 9 Ave.: – Max.: – Est. b: Min.: 11 Ave.: – Max.: 330	Fleet: 30 boats (18 m long) Power engine: – Gear: surface and bottom gillnets Main target species: sciaenid and shark Mesh size: 7–13 cm Net height: 5–10 m Net length: up to 6,000 m (bottom gillnets); up to 2,000 m (surface gillnets) Depth: – Distance from the coast: 10–40 nautical miles offshore Fishing season: year-round (bottom gillnets), May-July (surface gillnets) CPUE: – Dolphin use: no records	a) 2 years (1986–1988) survey of stranded cetaceans. b) 2 years (1998–2000) fleet monitoring program (small-scale fisheries n = 30; industrial fisheries n=01). Interview.	**a)** Schmiegelow, 1990 b) Rosas et al., 2002
Ilha das Peças (VP; (25º827′S–48º820′W) e Ilha do Superagui (VS; 25º828′S–48º813′W), PR/Brazil		Dolphin use: eventually human consume or for fishing bait	2012–2013 – Interview (LEK) March to September 2012, 90 fishermen were interviewed	a) Gama 2013 b) Zappes et al., 2016 and 2017
Pontal do Sul and Matinhos, PR/Brasil Latitude: 25º18'S–25º58'S	Est. a: Min.: 5 Ave.: – Max.: – Est. b: Min.: 10 Ave.: – Max.: 25	Fleet: small boats (7–10 m long) Power engine: 11–36 Hp Gear: surface and bottom gillnets Main target species: sciaenids, sharks, mullets, flounders Mesh size: 6–22 cm Net height: 2–5m (bottom gillnets); 8–12 m (surface gillnets) Net length: 500–1,200 m Depth: up to 30m Distance from the coast: up to 5 nautical miles offshore Fishing season: year around CPUE: – Dolphin use: eventually human consume	a) 7 years (1991–1997) survey of stranded cetaceans. b) 2 years (1998–2000) fleet monitoring program. Interview.	c) Zanellato, 1997; Rosas et al., 2000b. a) Rosas et al., 2000a.
Ubatuba/SP to Laguna/SC, Brazil		From August 2015 to January 2020, 2,152 franciscanas were recorded stranded	4 years (2015–2020) survey of stranded cetaceans.	PMP-BS (SIMBA)

Table 2. Trace elements concentrations (μg/g) in liver of franciscana dolphins, *Pontoporia blainvillei*, along the FMAII, Brazil.

Author	**Paper**	**Journal**	**Year**	**Local**	**Tissues**	**Trace element**	**X±SD**
Kunito. T. et.al	Concentration and subcellular distribution of trace elements in liver of small cetaceans incidentally caught along the Brazilian coast	Marine Pollution Bulletin	2004	São Paulo and Paraná	liver	V	0.089 ± 0.040
						Cr	0.49 ± 0.60
						Mn	14.8 ± 2.3
						Fe	816.0 ± 280.0
						Co	0.040 ± 0.008
						Cu	44.5 ± 89.0
						Zn	152 ± 82
						Ga	0.003 ± 0.004
						As	1.2 ± 0.4
						Se	9.1 ± 5.5
						Rb	5.34 ± 0.89
Trevizani, T.	Bioacumulação e biomagnificação de metais pesados em teias tróficas de estuários do sul-sudeste do Brasil.	Thesis (Universidade Estadual de São Paulo)	2018	São Paulo and Paraná	Liver and muscle	As, Cu, Cr, Se, Zn and Hg	Different results for male, female, juvenile and adults

Table 3. Persistent organic pollutants analysed in different tissues of franciscana dolphins, *Pontoporia blainvillei*, along FMAII. FI = Immature female; FM = Mature female; MI = Immature male; MM = Mature male; nd = not detected.

Author	Kaijwara et al.				Lailson-Brito J et al.			de la Torre A. et al.					Gago-Ferrero P. et al.								Dorneles, P.R. et al.		Yogui G.T. et al.				
Article	Contamination by persistent organochlorines in cetaceans incidentally caught along Brazilian coastal waters				Organochlorine concentrations in franciscana dolphins, *Pontoporia blainvillei*, from Brazilian waters			Dechlorane-related compounds in **Franciscana** dolphin (*Pontoporia blainvillei*) from southeastern and southern coast of Brazil					First determination of UV filters in marine mammals. Octocrylene levels in **Franciscana** dolphins								High accumulation of PCDD, PCDF, and PCB congeners in marine mammals from Brazil: a serious PCB problem.		Levels of persistent organic pollutants and residual pattern of DDTs in small cetaceans from the coast of São Paulo, Brazil				
Journal	*Archives of Environmental Contamination and Toxicology*				*Chemosphere*			*Environmental science & technology*					*Environmental science & technology*								*Science of the Total Environment*		*Marine Pollution Bulletin*				
Year	2004				2011			2012					2013								2013		2010				
Local (state)	São Paulo e Paraná				São Paulo		Paraná	Paraná				Santa Catarina	São Paulo				Paraná		Santa Catarina		São Paulo	SC, SP, ES e RS *	São Paulo				
Tissues	Bubbler				Bubbler			Liver					Liver								Liver		Bubbler				
N (samples)	8	2	5	5	8	1	1	4	4	1	2	2	2	3	4	1	2	1	6	3	6	14	2	2	1	2	1
	FI	FM	MI	MM	M	F	F	MI	FI	MM	FM	MI	MI	FI	MM	FM	FI	FM	MI	FM	F	M	MI	MM	FI	FM	RN
% lipids	87 (79-95)	79 (72-85)	87 (82-99)	80 (73-86)	74 (70-96)	96	65	7,8 (6,3-9,7)	9,9 (8,7-11,3)	10,2	9,1 (8,7-9,5)	6,5 (6,2-6,7)	-								-		82,4 (81,1-83,7)	85,1 (82,5-87,6)	81,4	90,1 (89,5-92,2)	77,6
∑PCB (ng/g lip)	2200 (970-5000)	2300 (1500-3000)	2100 (320-4900)	5300 (1800-12000)	3463 (909-5849)	1480	996																4045 (1950-6140)	7125 (4540-9710)	1290	3805 (3630-3980)	484
∑DDT (ng/g lip)	2800 (670-3200)	1200 (950-1400)	1700 (580-3600)	9900 (1800-35000)	1638 (264-5811)	460	1890																2035 (1180-2890)	4135 (1380-6890)	2280	905 (790-1020)	304
∑CHLs (ng/g lip)	38 (17-74)	39 (31-47)	40 (4,7-94)	64 (38-110)																			2,5 (<LD-5)	3,5 (<LD-7)	5	3,5 (1-6)	<LD

Dieldrin (ng/g lip)	18 (0,58-43)	21 (15-26)	28 (11-61)	29 (17-42)																							
HCB (ng/g lip)	10 (5,6-18)	9,2 (6,4-12)	11 (1,4-21)	11 (9,4-13)	38 (10-61)	15	16																43 (33-53)	65 (22-108)	15	12,5 (11-14)	10
HC epox (ng/g lip)	6,2 (2,4-12)	4,4 (4,0-4,7)	7 (3,1-14)	7,8 (4,6-12)																							
HCHs (ng/g lip)	2,6 (1,5-4,6)	4,6 (2,3-6,8)	2,5 (<1-4,3)	3,8 (3,4-5,3)																			2 (<LD-4)	3,5 (<LD-7)	<LD	<LD	<LD
TCPMe (ng/g lip)	6,8 (1,8-18)	5,4 (4-6,7)	3,9 (0,66-7,5)	23 (5,7-72)																							
TCPMOH (ng/g lip)	18 (6,3-47)	12 (7,9-16)	16 (6-38)	40 (14-120)																							
PBDEs (ng/g lip)								107 (70,8-119,1)	25,8 (20,1-56,8)	8,5	27,6 (26-29,1)	22 (14,7-29,4)															
DBDPE (ng/g lip)								2,3 (nd-8,5)	4,4 (nd-2,9)	nd	7,5 (nd-14,9)	3,3 (nd-6,54)															
Mirex (ng/g lip)								25,7 (17-34,3)	23,5 (14,9-30,7)	23,8	20,9 (15,6-26,2)	43,6 (35,4-51,9)											50,5 (46-55)	74,5 (49-100)	53	53 (40-66)	5
CP (ng/g lip)								0,1 (nd-0,24)	0,1 (0,04-0,16)	nd	0,2 (0,11-0,20)	nd															
Dec602 (ng/g lip)								0,3 (0,20-0,62)	0,4 (0,12-0,57)	0,3	0,42 (0,34-0,50)	0,06 (nd-0,12)															
Dec603 (ng/g lip)								0,6 (0,35-1,39)	0,7 (0,31-1,43)	0,46	1,1 (0,7-1,52)	0,5 (0,36-0,72)															
syn-DP (ng/g lip)								0,3 (0,16-0,50)	0,5 (0,17-1,08)	nd	0,9 (0,41-1,37)	nd															

anti-DP (ng/g lip)								0,6 (0,23-1,12)	0,9 (0,46-3,24)	nd	2,8 (0,66-4,89)	0,3 (nd-0,54)															
DP (ng/g lip)								0,9 (0,39-1,61)	1,3 (0,46-3,24)	nd	3,7 (1,07-6,26)	0,3 (nd-0,54)															
Fanti (ng/g lip)								0,6 (0,58-0,70)	0,6 (0,55-0,67)	-	0,7 (0,62-0,78)	0,5 (nd-1,00)															
OCT (ng/g) lip.													50 (nd-100)	264,3 (nd-524)	166,3 (nd-380)	130	64,5 (nd-129)	nd	124,3 (nd-401)	nd							
∑PCDD/DFs pg/g lip.																					448 (162-629)	349 (77,4-1554)					
∑non-ortho PCBs ng/g lip.																					4,2 (1,4-13,1)	2,8 (0,21-8,17)					
∑ortho PCBs ng/g lip.																					139 (61,5-385)	429 (35-3000)					
∑TEQ DRCs pg/g lip.																					86,5 (33,7-164)	103 (38,9-276)					

Table 4. Persistent organic pollutants analysed in different tissues of *Pontoporia blainvillei* along FMAII. F = Female; FI = Immature female; FM = Mature female; M = Male; MI = Immature male; MM = Mature male; JUV= Juveniles; nd = not detected

Author	Leonel J. et al.				Alonso, M.B. et al.									Yogui GT et al.		Alonso, M.B. et al.			Alonso, M.B. et al.	
Article	PBDE levels in franciscana dolphin (*Pontoporia blainvillei*): temporal trend and geographical comparison				Natural and anthropogenically-produced brominated compounds in endemic dolphins from Western South Atlantic: Another risk to a vulnerable species.									PBDEs in the blubber of marine mammals from coastal areas of São Paulo, Brazil, southwestern Atlantic		Pyrethroids: A new threat to marine mammals?			Toxic heritage: Maternal transfer of pyrethroid insecticides and sunscreen agents in dolphins from Brazil	
Journal	*Science of the Total Environment*				*Environmental pollution*									*Marine pollution bulletin*		*Environment international*			*Environmental Pollution*	
Year	2014				2012									2011		2012			2015	
Local (state)	São Paulo				São Paulo				Paraná		Santa Catarina			São Paulo		São Paulo			São Paulo	
Tissues	Bubbler				Liver									Bubbler		Liver			Bubbler	
N (samples)	11	10	8	12	2	3	4	3	2	1	6	3	2	4	4	7	2	3	6	4
	MM	FM	JUV	Calves	MI	FI	MM	FM	FI	FM	MI	FM	ND	M	F	AD	JUV	Calves	FM	Fetus
% lipids	NA													84 (81-87)	85 (78-92)	5,9			84 (79-89)	51 (9-81)
PBDEs (ng/g lip)	289,3 (67,8-763,7)	64,8 (<0,65-227,8)	198,6 (72,8-500,9)	65,1 (31,1-210,4)	74,5 (31,1-118)	275 (46,8-613)	130 (55,7-230)	21,8 (12,6-37,8)	82,4 (7,92-157)	21,8	572 (156-1797)	62,1 (31,5-81,8)	552 (116-988)	101 (10-192)	19,6 (0,8-38,4)					
DBDPE (ng/g lip)					99,1 (<3,63-196)	119 (<3,63-352)	174 (<3,63-347)	68,2 (<3,63-200)	<3,63	2,38	<3,63	<3,63	<3,63							
MeO-BDEs (ng/g lip)					193 (136-251)	235 (132-331)	216 (59,5-359)	74 (41,1-113)	378 (61-696)	141	685 (310-1334)	424 (127-892)	601 (352-849)							
PBBs (ng/g lip)					2,14 (<0,15-383)	15,3 <(0,15-44,9)	3,24 (6,83)	<0,15	7,62 (<0,15-15,4)	7,41	4,03 (<0,15-17,25)	8,04 (<0,15-16,75)	3,66 (<0,15-6,85)							
HBB (ng/g lip)					<0,56	3,37 (<0,56-6,24)	<0,56	<0,56	<0,56	<0,56	<0,56	<0,56	1,09 (<0,56-1,77)							
Tetramethrin (ng/g lip)																5,2 (0,6-5,4)	1 (0,6-1,3)	3,1 (2,4-4,3)	1,4 (0,35-3,4)	7,8 (1,45-18,5)

Bifenthrin (ng/g lip)																1,1 (0,1-2,6)	0,6 (nq-1,3)	0,8 (0,2-1,2)	2,7 (nd-6,0)	28,3 (nd-55)
Cyhalothrin (ng/g lip)																1,1 (nq-4,1)	2,9 (0,4-5,4)	0,4 (nq-0,8)	nd	8,0 (0,30-29)
Delta/tralomethrin (ng/g lip)																2,3 (nq-5,9)	0,2 (nq-0,3)	1 (nd-2)	1,3 (nd-1,3)	3,7 (nd-3,7)
Fluvalinate (ng/g lip)																0,9 (nq-4,4)	1 (nq-2)	1,1 (nq-3,2)	1,2 (nd-1,2)	nd
Es/Fenvalerate (ng/g lip)																0,2 (nq-1,3)	0,5 (nq-1)	0,5 (nq-1)	nd	20,3 (nd-40,5)
Permethrin (ng/g lip)																18,9 (4,5-41,8)	11 (9,2-12,8)	31,6 (9,1-54,6)	24,8 (4,7-85,5)	312,4 (15-1120)
Cyfluthrin (ng/g lip)																0,6 (nd-1,7)	0,2 (nq-0,5)	1,1 (nq-1,7)	nd	4,2 (nd-4,2)
Cypermethrin (ng/g lip)																3,7 (nq-6,1)	1,6 (1,2-1,9)	4 (3,1-5,8)	5,5 (2-15)	199,8 (30-700)
∑PYR (ng/g lip)																33,9 (7,0-(9,5)	19 (12,5-25,5)	43,6 (21,1-68,4)	29,8 (8-101)	553,5 (54-1965)

Annex 1 – Mortality estimates for Franciscana management area II

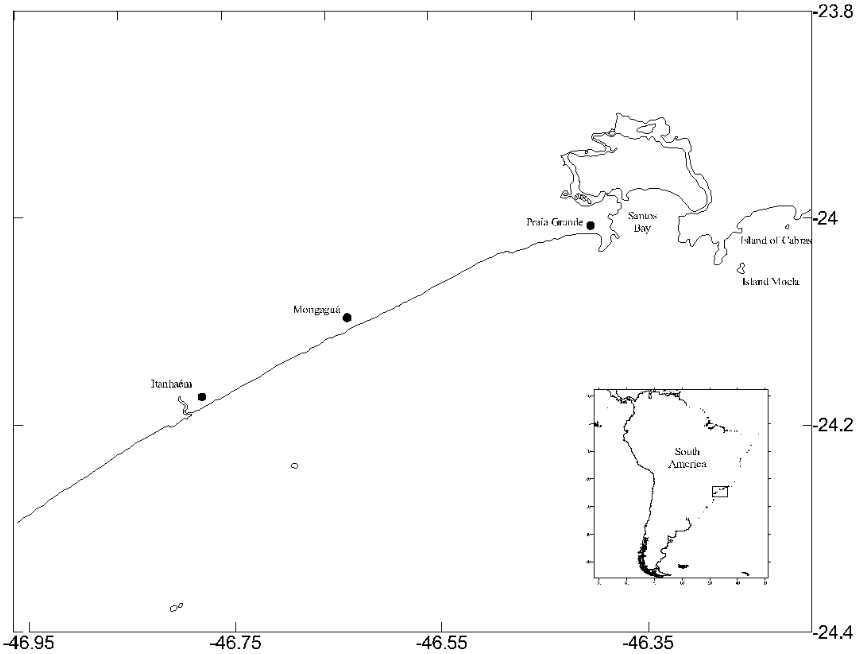
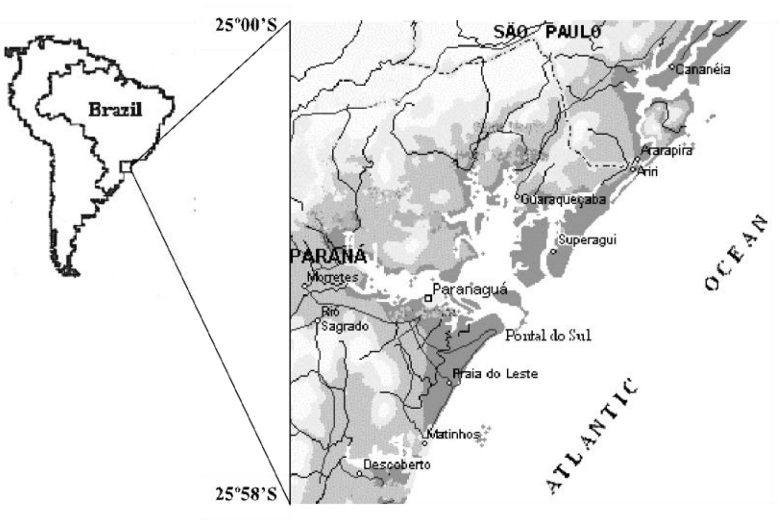
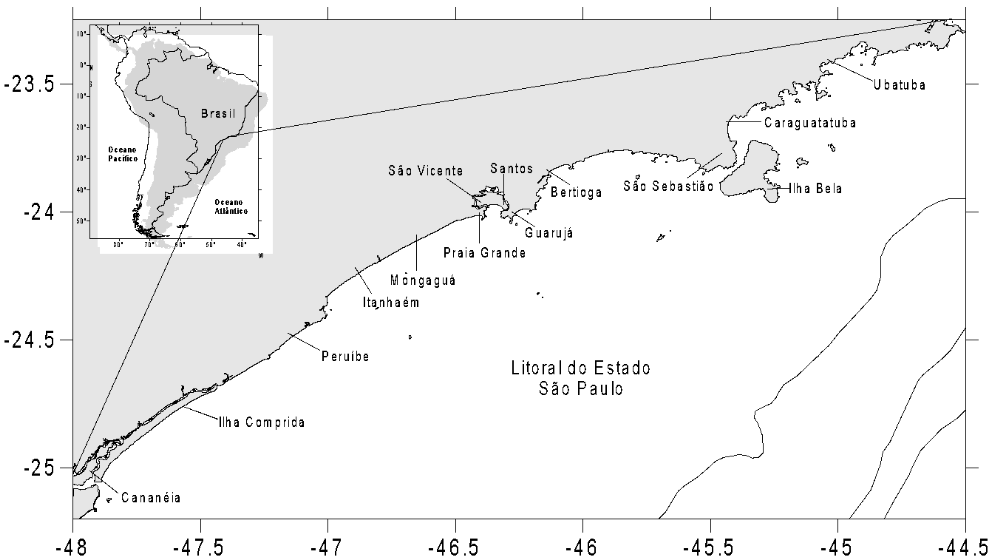
<table>
<tr><td>Topic</td><td>Description</td></tr>
<tr><td>Survey region</td><td>Bertozzi & Zerbini, 2002 - Franciscana management area (FMA) II, Praia Grande, São Paulo state, Brazil.


Figure 1. Study area – central São Paulo State coast (lat = S, long = W).</td></tr>
<tr><td>Sampling period</td><td>August 1998 – June 2001</td></tr>
<tr><td>Data collection</td><td>The fishing community of Praia Grande was systematically monitored through interviews at the landing port, or through onboard observations. Interviews were carried out three times per week, while onboard observations were conducted at least twice per month. All fishing boats were monitored at least once. Data on fishing gear and boat characteristics, fishing grounds, target species and information on incidental mortality of non-target species were collected as recommended by the International Whaling Commission (IWC, 1994; Annex E). The relatively small size of the fleet operating in the area allowed all fishing boats (n=6) to be monitored. Therefore, the number of Franciscana catches recorded in this study is considered absolute for the area and period the fishery was monitored.</td></tr>
<tr><td>Data processing</td><td>Effort was calculated as a function of the length of the net and the soaking time (hrs./day) and was expressed as km of net x day. Franciscana catch per unit of effort was expressed as number of dolphins captured x 1000 (km of net x day)$^{-1}$.</td></tr>
<tr><td>Modeling approach</td><td></td></tr>
<tr><td>Parameter estimates</td><td>Annual Catch per Unit of Effort (CPUE) values (dolphins x 1000 x (km of net x day)$^{-1}$)
<table>
<tr><th>Region</th><th>Period</th><th>CPUE</th><th>Source</th></tr>
<tr><td>Northern Rio de Janeiro, Brazil</td><td>1987-1996</td><td>2.7-7.7</td><td>Di Beneditto et al., 1998</td></tr>
<tr><td>Praia Grande, São Paulo, Brazil</td><td>1999-2001</td><td>5.0</td><td>This study</td></tr>
<tr><td>Southern Rio Grande do Sul, Brazil</td><td>1994</td><td>6.6</td><td>Secchi et al., 1997</td></tr>
<tr><td>Uruguay</td><td>1975-78; 1980-82</td><td>2.3-5.6</td><td>Crespo et al., 1986</td></tr>
</table></td></tr>
<tr><td>Recommended estimates</td><td>Extend the estimate to other areas and include the industrial fleet.</td></tr>
<tr><td>Caveats</td><td>Study carried out in a single fishing location</td></tr>
</table>

Topic	Description
Survey region	Rosas et al., 2002. Franciscana Management Area (FMA) II, Cananéia, State of São Paulo, and Paraná Brazil.  Figure 1. Map of study area. The coast of Paraná and southern São Paulo states are shown in detail.
Sampling period	January 1998 to October 1999 – southern São Paulo July 1997 – June 1999 Paraná
Data collection	In order to characterize the fishery, information on the time of year, target species, position of the nets in the water, stretched mesh size (distance between opposite knots), size of the nets, distance from the coast, fishing area, number of nets in the community and the vessel horsepower were recorded. The fishing effort in the study area could not be estimated.
Data processing	
Modeling approach	
Parameter estimates	Average annual mortality for 1 industrial boat in the south of São Paulo = 11 franciscanas / year. Average mortality of the small-scale fleet in the State of Paraná = 10 franciscanas / year
Recommended estimates	Calculate catch values per unit of fishing effort (CPUE)
Caveats	Study carried out with only one vessel on the south coast of São Paulo.

Topic	Description
Survey region	Bertozzi, 2009. Franciscana Management Area (FMA) II, State of São Paulo, Brazil. 

Sampling period	June 2004 to April 2005
Data collection	First stage: survey of the number and characteristics of the gill fishing fleet in the state of São Paulo, based on direct observations and interviews. Second stage: systematic monitoring of fishing effort and incidental catches in fishing locations in Ubatuba (22o 53'S), Praia Grande (24º00'S), Mongaguá (24º05'S) and Itanhaém (23º59'S).
Data processing	The fishing effort, expressed in km of net x fishing day, was calculated for each fishing community through the average fishing effort per vessel multiplied by the total number of vessels operating in the locality. From the estimate of the average fishing effort per vessel, the average effort for the entire gillnet fleet in the state of São Paulo was extrapolated. Using the average CPUE value obtained from the monitored fleet and the estimated total fishing effort of the state, it was estimated a total **Franciscana** mortality for the São Paulo coast.
Modeling approach	
Parameter estimates	Number boats = 1.192 Total fishing effort = 4.684,981 km x fishing day Ave. CPUE = 0.00008 Mortality estimate = 372 franciscanas / year (2004-2005)
Recommended estimates	Perform fishing mortality estimates separately by type of fleet (small and industrial)
Caveats	Average CPUE value used to estimate annual mortality was based only on the monitoring of catches by the small-scale fleet and extrapolated to the industrial fleet.

Topic	Description
Survey region	Rosas, 2019. Franciscana Management Area (FMA) II, State of São Paulo, Brazil.
Sampling period	1999 - 2015
Data collection	Summary data on the incidental capture of franciscanas by gillnets in São Paulo state, between 1999 and 2015.

Year	Total fishing sets monitored	Fishing set surface nets	Fishing set bottom	Captured **Franciscana**
1999	1337	595	739	9
2000	1787	722	1054	22
2001	1226	445	775	11
2002	2377	578	1735	10
2003	1940	549	1295	3
2004	2925	582	2035	33
2005	1258	363	707	43
2006	1077	392	520	16
2007	1771	583	1119	25
2008	2298	976	1233	17
2009	1022	454	534	2
2010	37	20	17	0
2011	1411	515	871	14
2012	2199	691	1491	9
2013	2223	549	1665	5
2014	2091	293	1795	37
2015	1711	215	1328	21

Data processing	GLMs (Generalized Linear Models) following the methodology of zero-inflated models (Zero Inflated Models). Capture ratio (Rc) (MOAN, 2016): Rc = Tcapt / Ctons where Tcapt is the number of franciscanas caught and Ctons are the tons of fish landed in each period, from the fishing statistics data available on the *Instituto de Pesca* website (https://www.pesca.sp.gov.br/). Next, the estimated number of captured franciscanas (i.e. estimated Bycatch, Be) was calculated using the formula: Be = Rc * nv where nv is the number of fishing trips made in the same period.

<table>
<tr><td></td><td>$IC = [Be - 1.96 * EP, Be + 1.96 * EP]$
The calculation of CIs and CVs was done by bootstrapping. Due to the rarity of incidental catches, data were aggregated only for months per year (N = 12). Thus, 16 random observations were selected for the bootstrapping with replacement for each of the 17 years of the time series, with these selected observations replicated 1000 times for each year (MOAN, 2016).</td></tr>
<tr><td>Modelling approach</td><td></td></tr>
<tr><td>Parameter estimates</td><td>Incidental mortality (1999 – 2015) = 1404 franciscanas
<table>
<tr><td>Year</td><td>Estimative</td><td>IC_{95}</td><td>CV</td></tr>
<tr><td>1999</td><td>25</td><td>19-31</td><td>1,36</td></tr>
<tr><td>2000</td><td>52</td><td>41-63</td><td>1,23</td></tr>
<tr><td>2001</td><td>23</td><td>18-28</td><td>1,36</td></tr>
<tr><td>2002</td><td>20</td><td>16-24</td><td>1,07</td></tr>
<tr><td>2003</td><td>17</td><td>11-23</td><td>2,25</td></tr>
<tr><td>2004</td><td>128</td><td>111-145</td><td>0,82</td></tr>
<tr><td>2005</td><td>150</td><td>119-181</td><td>1,27</td></tr>
<tr><td>2006</td><td>57</td><td>49-65</td><td>0,86</td></tr>
<tr><td>2007</td><td>83</td><td>72-94</td><td>0,82</td></tr>
<tr><td>2008</td><td>48</td><td>37-59</td><td>1,45</td></tr>
<tr><td>2009</td><td>16</td><td>10-22</td><td>2,27</td></tr>
<tr><td>2010</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>2011</td><td>140</td><td>110-170</td><td>1,32</td></tr>
<tr><td>2012</td><td>61</td><td>42-80</td><td>1,89</td></tr>
<tr><td>2013</td><td>43</td><td>27-59</td><td>2,25</td></tr>
<tr><td>2014</td><td>325</td><td>265-385</td><td>1,15</td></tr>
<tr><td>2015</td><td>216</td><td>185-246</td><td>0,86</td></tr>
</table></td></tr>
<tr><td>Recommended estimates</td><td>Perform fishing mortality estimates separately by type of fleet (small and industrial)</td></tr>
<tr><td>Caveats</td><td>The landed catch data (Ctons) and the total number of trips made in the period, obtained together with the Fisheries Institute of São Paulo refer to the total gillnet fishing fleet, including the small and large scale, however the data of accidental capture are essentially derived of the small-scale fleet. Thus, the mortality estimate may be underestimated, if the industrial fleet has CPUE values higher than the small-scale fleet.</td></tr>
</table>