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Effectiveness of the use of pingers to reduce the bycatch of Franciscana (*Pontoporia blainvillei*) in artisanal and industrial fisheries of Uruguay

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Summary

The Franciscana *Pontoporia blainvillei* is considered the cetacean species most affected by fisheries in the southwest Atlantic. Throughout its distribution (Argentina, Uruguay and Brazil) gillnets are the largest source of bycatch, although it is also caught in other fishing gears. In Uruguay, the artisanal gillnet fleet and, to a lesser extent, the industrial pair trawl fleet, are the main fisheries affecting this species. Since 2018, DINARA, in collaboration with fishers from both fleets, has been developing a research program to evaluate the bycatch of Franciscana and test, under commercial fishing conditions, the effectiveness of acoustic deterrent devices, or acoustic alarms (pingers), to reduce its bycatch. In artisanal gillnet fishing, *Banana Pingers* to deter dolphins and porpoises are being evaluated in fishing vessels operating in the Río de la Plata and the Atlantic coast of Uruguay. These devices emit sounds from 50 to 120 kHz (145 dB re 1 μ Pa at 1 m). In order to evaluate its effectiveness, two strategies have been implemented: two vessels, one using fishing nets with pingers and the other without pingers, or a single vessel using sections of the nets with pingers and others without pingers. Dolphin Anti-Predation Pingers, which emit high intensity sound signals (175 dB re 1 μ Pa at 1 m; 40 KHz), are being evaluated in industrial pair trawl fleet. In this case, in each participating pair, one of the vessels trawls its net with pingers, while the other does it without pingers. The results obtained present convincing evidence that pingers significantly reduce the bycatch of Franciscana in the artisanal gillnet fishery, while in the industrial fleet they suggest a moderate reduction, although further research effort is still required.

1. Introduction

The Franciscana *Pontoporia blainvillei* is the main cetacean species affected by fisheries in the southwest Atlantic (Secchi et al., 2022, 2002; Secchi and Wang, 2002). This small dolphin, distributed in Brazil, Uruguay and Argentina, is currently listed as Vulnerable by the International Union for Conservation of Nature, IUCN (Zerbini et al., 2017). Although its population is still considered large (tens of thousands of individuals (Zerbini et al., 2022)) compared to other small cetacean seriously threatened to extinction (Brownell Jr et al., 2019), it has suffered high levels of incidental mortality in fisheries during decades (Praderi, 1997; Ott et al., 2002; Secchi et al., 2003). Throughout its distribution bottom set gillnets are the largest source of bycatch, although it is also caught in other fishing gears, such as in trawl fisheries, active gillnetting and small-scale driftnet ((Secchi et al., 2022)and references there in).

In Uruguay, the artisanal gillnet fleet (Franco-Trecu et al., 2009; Praderi, 1997; Szephegyi, 2012) and, to a lesser extent, the industrial pair trawl fleet (Franco-Trecu et al., 2019), are the main fisheries affecting this species. Since 2018, the *Dirección Nacional de Recursos Acuáticos* (DINARA), in collaboration with fishers from both fleets, has been developing a research program to evaluate the bycatch of Franciscana and test, under commercial fishing conditions, the effectiveness of acoustic deterrent devices, or acoustic alarms (pingers), to reduce its bycatch (Jiménez et al., 2021a, 2021b). Preliminary information obtained in the artisanal gillnet fishery (SC/68C/HIM/10) and the demersal pair trawl fishery (SC/68C/HIM/11) was presented at the SC/68C meeting. Here we present an update on the results obtained in these experiments.

2. Materials and Methods

2.1. Artisanal gillnet fishery

The Uruguayan artisanal fishery uses mainly gillnets and bottom longlines. Details on the fleet size, vessels length and fishing zones were provided in SC/68C/HIM/10 (Jiménez et al., 2021b). The bycatch of Franciscana occurs exclusively in gillnets and mainly between the coast of Montevideo, in the Río de la Plata, and the Atlantic coast of Rocha (Franco-Trecu et al., 2009; Szephegyi, 2012), comprising current artisanal fishery zones E (from Montevideo to Punta del Este) and L (from Punta del Este to the border with Brazil).

In this fishery, we conducted an experiment in collaboration with artisanal fishers to test the effectiveness of pingers in reducing the bycatch of Franciscana in gillnets. During October 2019 – November 2022 participated fishers from seven artisanal fishing boats. Three of these boats (length range: 5.3 to 9.0 m) operated in the Atlantic coast from La Paloma port, Rocha, and the remaining four boats (length range: 3.6 to 6.3 m) operated in the Río de la Plata, from Punta Brava and Buceo, Montevideo. The fishing gear was a bottom set gillnet.

The nets were 50 m long and 1.75-3.5 m deep with a mesh size from 14 to 30 cm. They were deployed in strings, usually of 2 – 3 nets in the Río de la Plata and 10 – 40 nets in the Atlantic coast. In these zones, daily effort per boat usually ranged from 8 to 18 nets and 23 to 80 nets, respectively. In Montevideo nets with mesh size of 14 – 16 cm and 24 – 30 cm were employed to target Whitemouth croaker (*Micropogonias furnieri*), and Black drum (*Pogonias courbina*) and Flounder (*Paralichthys orbignyanus*), respectively. In Rocha, nets with mesh size of 18 cm and 24 – 30 cm were employed to catch Whitemouth croaker, and Angular angelshark (*Squatina guggenheim*) and Flounder, respectively. The soak time of the fishing gear usually was 20-24 hours, but in some circumstances, mainly due to strong winds and storms, nets remained in the water for up to 72 hours (Jiménez et al., 2021b).

2.1.1. Experimental design for the artisanal gillnet fishery

The acoustic devices used are Banana Pingers (Porpoise & dolphin deterrent pinger 50-120 kHz; SPL: 145 dB re 1 μ Pa at 1 m, ping duration: 300 ms with randomized ping intervals between 4 and 12 s; <https://www.fishtekmarine.com/product/deterrent-pinger-50-120/>) (Omeyer et al., 2020). The experiment and protocol were detailed in SC/68C/HIM/10 (Jiménez et al., 2021b). Briefly, the protocol considered nets with (experimental treatment) and without pingers (control treatment). Two experimental configurations were applied: 1) one boat deployed the experimental strings with pingers and the other boat deployed the strings with the control treatment, and 2) a single boat deployed both the strings with the experimental treatment and the control treatment. For analyses purposes, the string with the control treatment and that with the experimental treatment were considered as individual fishing sets, even when the two treatments occurred in a single fishing event. The fishing set was considered the sample unit for analyses. On average, the spacing between two pingers was 195 m.

All data were obtained by participating fishers and reported either in fishing logbooks or during frequent visits (1-3 times per week). For each fishing event the available data were boat name, date (hence, month and quarter), location (latitude and longitude), fishing zone, number of strings/nets with and without pingers, the soak time, mesh size and number of bycaught Franciscana. In addition, we obtained depth (bathymetric data at 15 arc sec resolution) and distance from the coastline using GEBCO dataset (https://www.gebco.net/data_and_products/gridded_bathymetry_data/gebco_2020/) and Sea Surface Temperature, SST, using a near-real-time dataset (dataset ID: jplMURSST41; <https://coastwatch.pfeg.noaa.gov/erddap/griddap/jplMURSST41.html>; NASA/JPL, 2015), one day latency and 0.01 degree grid of spatial resolution.

2.1.2. Data analysis for the artisanal gillnet fishery

Here, we followed a similar statistical approach to that used in Jiménez et al. (2021a). The effect of pingers on the capture of Franciscana was evaluated after accounting by ancillary variables. Generalized Additive Mixed Models (GAMMs) with Tweedie error structure were employed to examine the effects of several combinations of covariates on the bycatch rate per unit of effort (BCPUE: dolphins x km of nets⁻¹) of Franciscana. We firstly performed Tweedie Generalized Additive Models (GAMs) with the function `tw` (library 'mgcv' version 1.8-31 (Wood, 2017)) to estimate p during fitting, setting to 1.01 and 1.99 the lower and upper limit on p for optimization. Then we employed the function `Tweedie` (library 'mgcv' version 1.8-31 (Wood, 2017)) with the obtained p values to fit the GAMMs. Several covariates were initially considered, including spatial, temporal, environmental and fishing-related variables (see Jiménez et al. 2021a). Correlated covariates were included in the model formulation one at a time. We fitted the GAMMs including the individual boat as a random factor. The model selection process was carried out considering the objective of isolating the effect of the use of pingers. Parsimony and the diagnostic information about the fitting procedure were used in combination to select the final model. The statistical computing environment R (R Core Team, 2020) was used for all statistical analyses.

2.2. Industrial pair trawl fishery

The demersal pair trawling fishery targeting mainly the Whitemouth croaker (*Micropogonias furnieri*) is comprised by 33 licensed vessels (mean length about 20 m). This fleet operates year-round within the Argentinean-Uruguayan Common Fishing Zone, mainly in the Río de la Plata and adjacent Atlantic coastal waters up to the 50m isobath. The experiment is being conducted from October 2019 in collaboration with skippers of this fleet. Here, we present data until November 2022.

2.2.1. Experimental design for the pair trawling fishery

The pingers being tested are Dolphin Anti-Depredation Pinger (40 kHz; <https://www.fishtekmarine.com/product/dolphin-anti-depredation-pinger/>) from Fishtek Marine. These pingers emit higher intensity sound signals (175 dB) than deterrent pingers frequently used to reduce bycatch of dolphins and porpoises in fishing gears (<150 dB; (Dawson et al., 2013)). The experiment was described in SC/68C/HIM/11 (Jiménez et al., 2021a). We worked closely with three vessels of the fleet. During the study period, these vessels formed pairs with several vessels of the fleet. To date, a total of nine individual fishing vessels have participated forming eight different pairs. The protocol considers a control treatment (trawl net without pingers) and an experimental treatment with pingers. Three pingers were attached at the headline (floatline), two at the extremes and one at the middle,

with a spacing between pingers of about 20m. One vessel of the pair conducts trawl sets with pingers and the other without pingers. Trawl sets are usually alternated between vessels depending on the fish catch, completing each vessel on average seven trawl set per fishing trip (each lasting about a week). Data on the bycatch of Franciscana were collected by participating skippers. Data on date, location, fishing effort, depth and fish catch were reported to DINARA in fishing logbooks.

3. Results

3.1. Artisanal gillnet fishery

During August 2019 – November 2022 data from 841 fishing events and 10,031 nets (501.6km) were obtained. A total of 4815 and 5216 nets distributed on 382 and 459 fishing sets were sampled for the experimental (pingers) and control treatments, respectively. A total of 62 Franciscana dolphins were captured in the experiment, 52 (0.1994 dolphins km⁻¹) of them in the control treatment and 10 (0.0415 dolphins km⁻¹) in the experimental treatment, indicating a reduction of 79.2% in the nominal BCPUE. After considering relevant ancillary variables (i.e. depth, SST, mesh size, soak time) and the fishing boat as random effect, the result of the GAMM indicated a significant reduction in the bycatch of Franciscana in the treatment with pingers, in comparison to nets without pingers (**Fig. 1A**). This model predicted that the standardized mean BCPUE decreased by 95% on the presence of pingers. A secondary result to this study, and expected, was that bycatch rates were significantly higher during those fishing events with extended soak time (**Fig. 1B**). Bycatch rates tend to be higher with large mesh size (24 – 30 cm) than those observed in medium size (14 – 18 cm); yet this difference was not statistically significant (**Fig. 1C**). Finally, bycatch rates significantly increased towards colder and deeper waters.

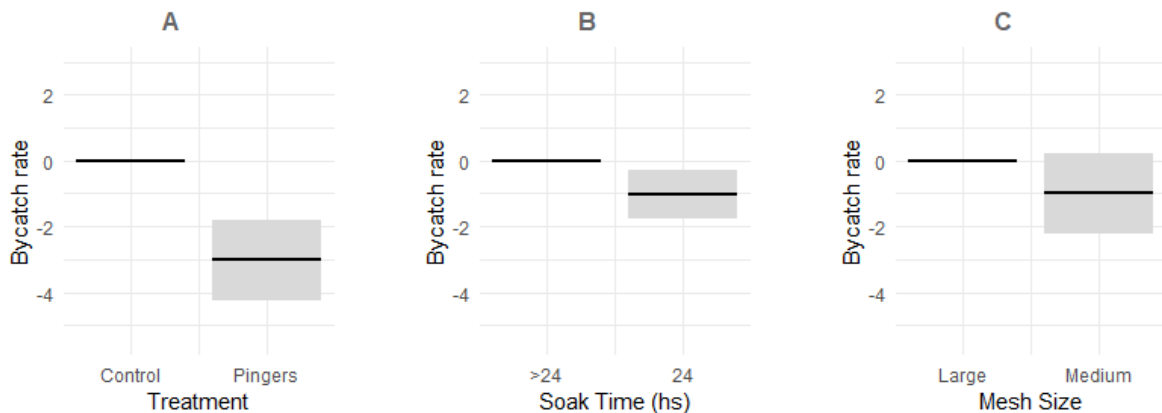


Figure 1. Results of GAMM on the effect of (A) pingers on the bycatch rate of Franciscana dolphin taking into account ancillary variables (Soak Time, Mesh Size, Depth and SST) and

fishing boat as random effect. The effect of two relevant covariates is also shown: (B) soak time and (C) mesh size. Each plot illustrates the relative bycatch rate effect size (on the scale of the linear predictor) between levels, setting to 0 the reference category. Bands represent the 95% confidence intervals. Sample size = 841 fishing sets.

3.2. Industrial pair trawl fishery

During November 2019 – November 2022 data from 62 pair-vessel trips (124 individual vessel trips) and 1039 fishing sets were obtained. During each trip, a member of the pair used the pingers; Therefore, the effort with pingers and without pingers was approximately equal, with 538 and 501 sets in each treatment, respectively. A total of 26 Franciscana dolphins were captured during 20 trawls (1.92%) of the experiment. Eighteen of these Franciscana (0.0359 dolphins/sets) were captured during 15 trawls without pingers (Control Treatment) and the remaining eight dolphins (0.0149 dolphins/sets) were captured during five trawls with pingers (Experimental Treatment). This result suggests a moderate reduction of 58.5% in the nominal bycatch rate.

4. Discussion

Our study in the Uruguayan artisanal gillnet fishery finds convincing evidence that pingers reduces the bycatch of Franciscana. These results are potentially applicable to other gillnet fisheries interacting with this dolphin in the southwest Atlantic, and even other small cetaceans affected by this type of fishing gear elsewhere.

In the Uruguayan pair trawl fishery, our ongoing study with data from November 2019 to November 2022 shows promising results, suggesting that the used pingers reduces the bycatch of Franciscana. However, this reduction seems to be moderate, not as had been preliminarily observed at the beginning of the experiment (November 2019 - December 2020) with eight dolphins in the control treatment and just a single Franciscana in the experimental treatment with pingers. In order to confirm current results, we considered that further research effort is still required in this fleet.

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