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Assessing effectiveness of upcycled plastic bottles to reduce franciscana dolphin (Pontoporia blainvillei) bycatch in bottom set trammel nets in southern Brazil: Preliminary results

Federico Sucunza, Gabriel G Larre, Leonardo M Pinheiro, Daniel Danilewicz, Paulo H Ott, Lorenzo Von Fersen, Nick Tregenza, Per Berggren

INTERNATIONAL
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Assessing effectiveness of upcycled plastic bottles to reduce franciscana dolphin (*Pontoporia blainvillei*) bycatch in bottom set trammel nets in southern Brazil: Preliminary results

Federico Sucunza[1,2], Gabriel G Larre[1], Leonardo M Pinheiro[1,3], Daniel Danilewicz[1,2,4], Paulo H Ott[1,5], Lorenzo von Fersen[6], Nick Tregenza[7], Per Berggren[8]

[1]Grupo de Estudos de Mamíferos Aquáticos do Rio Grande do Sul, Torres, Brazil
[2]Instituto Aqualie, Juiz de Fora, Brazil
[3]Programde de Pós-Graduação em Ecologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil
[4]Universidade Estadual de Santa Cruz, Ilhéus, Brazil.
[5]Universidade Estadual do Rio Grande do Sul, Unidade Litoral Norte, Osório, Brazil
[6]YAQU PACHA e.V., Nürnberg, Germany
[7]Chelonia Ltd, Cornwall, UK
[8]School of Natural and Environmental Sciences, Newcastle University, Newcastle-upon-Tyne, UK

Correspondence: fsucunza@gmail.com and per.berggren@ncl.ac.uk

ABSTRACT

Mortality due to fisheries bycatch in gillnets is the main threat to marine mammals globally. Gillnet fisheries is also the main challenge for the conservation of franciscana dolphins (*Pontoporia blainvillei*), the most threatened cetacean in the western South Atlantic Ocean. The purpose of this study was to evaluate the effectiveness of upcycled plastic drink bottles as echolocation reflectors and low-cost mitigation method to reduce franciscana dolphin bycatch and their potential impact on target species catch in bottom set trammel nets, in southern Brazil. Observed trials with (treatment) and without (control) plastic bottles in trammels nets recording dolphin bycatch and target species catch were conducted between November 2020 and December 2022. A total of 108 sets (59 control and 49 treatment) resulted in bycatch of two franciscana dolphins and two bottlenose dolphins (*Tursiops* sp.) in control sets and no dolphin bycatch in treatment sets. GLM results showed a statistically non-significant negative effect on dolphin bycatch using plastic bottles (z-value = 0.007, p = 0.994) and a significant positive effect on target fish catch using plastic bottles (z-value = 2.824, p = 0.0047). Passive acoustic monitoring (using F-POD) was conducted on 44 sets (32 treatment and 12 control) and showed that franciscana dolphins and other cetaceans were present and that there was no difference in detection positive minutes per set for treatment and control sets. These preliminary results indicate that upcycled plastic bottles used as acoustic reflectors in bottom set trammel nets may reduce the bycatch of dolphins (including franciscana) and have a positive effect on target species catch compared to control sets. These preliminary results require continued trials with additional sets to confirm the trends.

INTRODUCTION

The restricted distribution of franciscana dolphins (*Pontoporia blainvillei*) to shallow coastal waters of Brazil, Uruguay and Argentina makes the species vulnerable to incidental mortality in fishing gear, especially coastal gillnets (Secchi et al. 2003; Danilewicz et al. 2009). The franciscana is regarded as one of the most threatened cetacean species in the western South Atlantic Ocean due to likely unsustainable fisheries bycatch (Secchi et al. 2021). The species is currently listed as Vulnerable (VU) by the IUCN Red List of Threatened Species (Zerbini et al. 2017), and as Critically Endangered (CR) by the Brazilian Ministry of the Environment (MMA/ICMBio 2022).

Bycatch has been reported as a major threat to the franciscana in southern Brazil since at least the early 1980s (Ott et al. 2002). Mortality estimates from the early 2000s ranged from several hundred to a few thousand dolphins (Ott et al. 2002), highlighting the need for immediate conservation and management actions. A number of approaches to reduce franciscana bycatch have been attempted, including the use of electronic alarms (pingers), increased acoustic reflectivity of gillnets by infusion of barium sulphate ($BaSO_4$), increased flexural stiffness of the gillnet nylon twine and other modifications of the fishing techniques (Bordino et al. 2002, 2013; Berninsone et al. 2020). Although the use of electronic pingers resulted in a reduction of franciscana dolphins bycatch events (Bordino et al. 2002), they have not been implemented across the small-scale fisheries along the species' range. The cost of purchasing and maintenance of the pingers have been identified as the primary barriers to their implementation (Bordino et al. 2013; Berninsone et al. 2020).

The purpose of this report is to present preliminary results on trials testing the effectiveness of upcycled plastic drink bottles as echolocation reflectors and a low-cost method (Berggren et al. 2020) to reduce franciscana dolphin bycatch in bottom set trammel gillnets and their potential effect on target species catch off Torres and Passo de Torres, southern Brazil.

METHODS

This research was conducted in the small and medium-scale fishing community of Torres

and Passo de Torres (29º19'S, 49º43'W, Fig. 1), southern Brazil, and was focused on coastal bottom set trammel nets. These nets have been identified as the major threat to franciscana dolphins in the area (Ott et al. 2002; Danilewicz 2007; Larre et al. 2019). The fishing community includes a total of 55 vessels (ranging from 9.2 to 20.4 m in length, and from 40 to 366 hp in engine power) and currently fishing mainly with gillnets and is regarded as one of the main small and medium-scale fishing fleets of southern Brazil (Moreno et al. 2009; Larre et al. 2021).

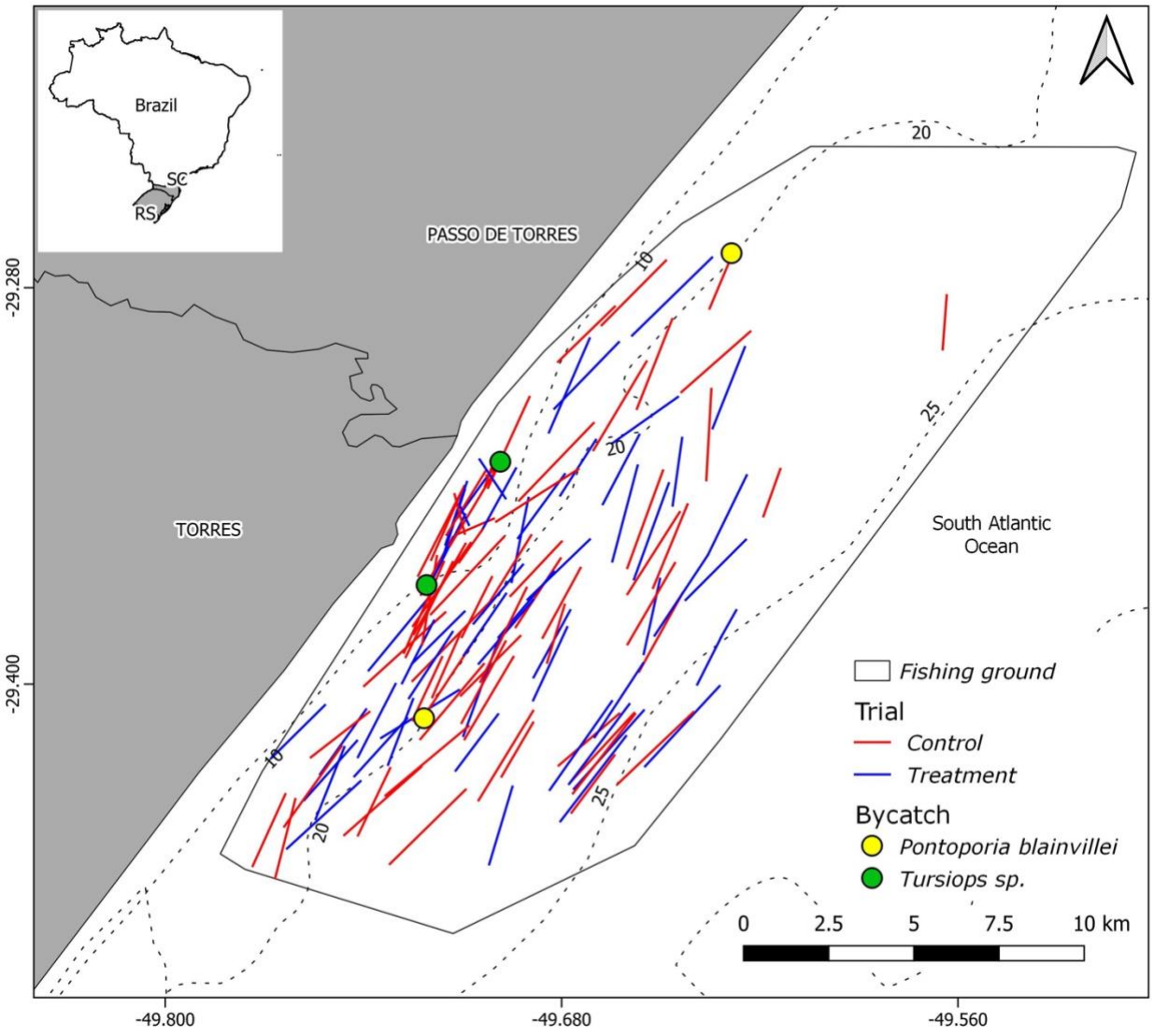

Figure 1. Map of the study area showing the fishing ground of one small-scale 9 m gillnet fishing vessel monitored during experimental trials conducted off the northern coast of Rio Grande do Sul (RS) and southern coast of Santa Catarina (SC) states, southern Brazil. Control (no plastic bottles on the net) and treatment (plastic bottles attached to the net) sets monitored

by onboard observers are shown by the red and blue lines, respectively. Dots indicate bycatch events of franciscana dolphins (yellow) and bottlenose dolphins (green) reported in this study.

Experimental trials were conducted aboard one small-scale 9 m gillnet fishing vessel (Fig. 2). The vessel conducted single day fishing trips and fished with bottom set trammel nets (60 panels of 50 m length each, 3,000 m total length, 2 m height and mesh size of 18 or 20 cm of the inner netting between two layers of 60 cm). The fishing ground is located close to Torres and Passo de Torres and has an area of 324 km^2 between the coast and the isobath of 25 m (Fig. 1, Larre et al. 2021). Upcycled plastic 250 ml bottles were tested as acoustic reflectors to enhance the acoustic backscatter of the nets and detectability by the dolphins (Berggren et al. 2020). Bottles (empty but with air) were attached every 150-170 m on the headline of the bottom set trammel net (Fig. 2). In addition, one F-POD (Chelonia Ltd.) was attached at the ends of the net to record acoustic behavior of franciscana dolphins near the net in presence/absence of plastic bottles (Fig. 2). F-POD data were processed using F-POD.exe software and KERNO-F classifier (Chelonia Ltd., 2022) and exported as detection positive minutes (DPM).

Each fishing trip had an independent onboard observer that recorded the fishing location (lat/long), soak time, environmental conditions and catch of target and non-target species. Trial effort was randomized per each fishing trip (control = no bottles on the net or treatment = upcycled plastic drink bottles attached to the net) by tossing a coin prior to the trip (Berggren et al. 2020). The randomization was done in pairs so if the first coin toss resulted in a control trip, then the following trip was a treatment. However, due to environmental conditions and/or to practical work of the fishers, treatment net could not be used in some sets resulting in a higher effort with control sets.

Generalized Linear Models (GLM) with binomial and negative binomial distributions, respectively, were used to statistically investigate potential effect of nets fitted with plastic drink bottles (treatment) on dolphin bycatch and target fish catch compared to nets without bottles (control).

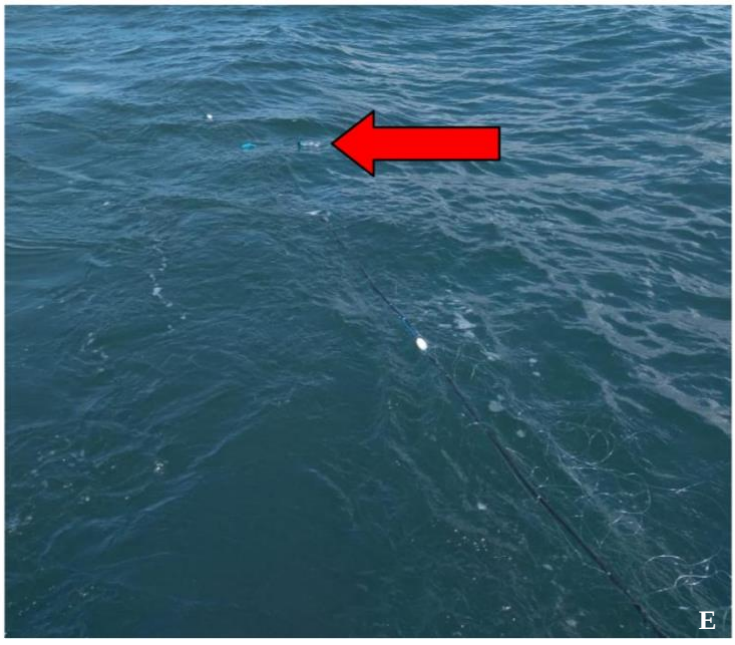

Figure 2. A *and* B – Gillnet fishing vessel monitored during experimental trials to assess the effectiveness of upcycled plastic 250 ml bottles to reduce franciscana dolphins bycatch rates, C – fisher preparing to cast the F-POD, and D *and* E– fisher preparing to cast a net with plastic bottles attached, and the net with the bottle indicated by the red arrow.

RESULTS

In the trial, a total of 129 sets with bottom set trammel nets were monitored by onboard observers between November 2020 – December 2022 (Fig. 1). Treatment sets could not be conducted between March 2021 and December 2021 because the fishing boat had a problem, and 21 "control" sets monitored during this period were removed from the analysis, reducing the dataset for analysis to 108 sets (Table 1). Each set had total mean net length of 2,917 m (SD = 505 m), and targeted catch of flounders (*Paralichtys* spp.) and the whitemouth croaker (*Micropogonias furnieri*) (Table 1).

Two franciscana dolphins and two bottlenose dolphins (*Tursiops* sp.) were recorded as bycatch in the control sets and no dolphin bycatch was recorded in treatment nets with bottles (Table 1). The GLM analysis showed a statistically non-significant negative effect on dolphin bycatch using plastic bottles (z-value = 0.007, $p = 0.994$). Target fish catch statistically increased in nets equipped with plastic bottle (mean = 169 kg, SD = 188 kg) compared to control nets (mean = 94 kg, SD = 80 kg) (GLM, z-value 2.824, $p = 0.0047$).

Sets with the F-POD attached to the net corresponded to 41% (n = 44) of the total, varying between control (n = 12) and treatment (n = 32) sets, and logged 1,182 h. The acoustic presence of franciscana dolphins and other cetaceans was recorded, and there was non-significant difference in DPM per set for treatment and control sets ($p > 0.05$). No bycatch was recorded in nets when the F-POD was attached.

Table 1. Total number of fishing sets, average net length in meters, average fishing hours, average catch of target species in kilograms and total bycatch of franciscana dolphins (*Pontoporia blainvillei*) and bottlenose dolphins (*Tursiops* sp.) recorded in the trial testing effectiveness of plastic bottles (treatment) to reduce bycatch on bottom set trammel nets in southern Brazil. Standard deviation (SD) in parenthesis. Control = no plastic bottles attached to the net.

Trial	Sets	Mean (SD) net length	Mean (SD) fishing hours	Mean (SD) target species	#Franciscana bycatch	#Bottlenose dolphins bycatch
Control	59	3,002 (470)	31 (21)	109 (92)	2	2
Treatment	49	2,816 (531)	34 (20)	166 (200)	0	0

DISCUSSION

Initial results indicate that upcycled plastic bottles in bottom set trammel nets may reduce the bycatch of franciscana and bottlenose dolphins and increase target species catch compared to control sets without bottles. The use of acoustic monitoring whose initial purpose was to indirectly investigate the presence of franciscana dolphins in the vicinity of the nets, indicated the presence of franciscana dolphins and other cetaceans (e.g. *Tursiops* sp., *Steno bredanensis*) with the same prevalence in control and treatment sets. These preliminary results require continued trials with additional sets to be confirmed. Using the observed bycatch rate in control nets (no bottles attached) during the entire study period (Including 21 sets removed from the dataset for analysis – see results section) result in 0.04 (=3/80) franciscana dolphins caught per set. Using these data, the number of sets needed to have sufficient power to detect a bycatch reduction of 95% is estimated at ~240 sets of each control and treatment set and 480 sets in total (using the power.prop.test function in R).

Bycatch events of bottlenose dolphins recorded by onboard observers are rare off the Southwest Atlantic Ocean, and most of the evidences of mortality due to bycatch comes from stranded individuals (Fruet et al. 2016). Bottom set gillnets are indicated as the main threat for

bottlenose dolphins in southern Brazil, however it is currently unclear what impact the bycatch may have on the dolphin populations in the area (Fruet et al. 2016). To investigate this a comprehensive assessment is needed using onboard observers or REM video to estimate total bycatch in the fishery and to compare this to population size estimates. It is noteworthy that the study area is a known sympatric area for two subspecies/ecotypes of *Tursiops truncatus,* the Lahille's bottlenose dolphin, *T. t. gephyreus*, and the common bottlenose dolphin, *T. t. truncatus* (Wickert et al. 2016; Simões-Lopes et al. 2019). Although it was not possible to identify the bycaught animals at the subspecies/ecotype level, these results indicate that the impact of bycatch mortality of bottlenose dolphins should not be neglected (Fruet et al. 2016).

Bycatch in artisanal and industrial fisheries is currently the main conservation problem for franciscana dolphins throughout the species range (Secchi et al. 2003; Secchi et al. 2022). Although bycatch events have been recorded in trawl fisheries, active gillnetting and small-scale driftnet (Secchi et al. 1997; Bertozzi et al. 2002; Cappozzo et al. 2007), bottom set gillnets are the major threats to franciscana dolphins (Secchi et al. 2022). Current estimates of annual bycatch are not available for franciscana dolphins in southern Brazil, however actual mortality due to bycatch is probably higher than the computed Potential Biological Removal (PBR, Wade 1998) of 63 individuals per year for this area (Sucunza et al. 2020). In this sense, mitigation strategies to minimize bycatch events of franciscana dolphins are urgently needed and low-cost methods can be a viable option, especially to artisanal fisheries that do not have the means to buy and maintain available commercial mitigation devices.

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