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Small cetacean captures in Peruvian artisanal fisheries: High despite protective legislation

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ABSTRACT

We detail the first direct, at sea monitoring of small cetacean interactions with Peruvian artisanal drift gillnet and longline fisheries. A total of 253 small cetaceans were captured during 66 monitored fishing trips (Gillnet: 46 trips; Longline: 20 trips) from the port of Salaverry, northern Peru (8°14′S, 78°59′W) from March 2005 to July 2007. The most commonly captured species were common dolphins (*Delphinus* spp.) (47%), dusky dolphins (*Lagenorhynchus obscurus*) (29%), common bottlenose dolphins (*Tursiops truncatus*) (13%) and Burmeister's porpoises (*Phocoena spinipinnis*) (6%). An estimated 95% of common dolphin bycatch was of long-beaked common dolphins (*Delphinus capensis*). Overall bycatch per unit effort for gillnet vessels (mean ± sd) was estimated to be 0.65 ± 0.41 animals.set^{-1} (range 0.05–1.50) and overall catch (bycatch and harpoon) was 4.96 ± 3.33 animals.trip^{-1} (range 0.33–13.33). Based upon total fishing effort for Salaverry we estimated the total annual average small cetacean bycatch by gillnet vessels as 2412 animals.year^{-1} (95% CI 1092–4303) for 2002–2007. This work indicates that, in at least one Peruvian port, bycatch and harpooning of small cetaceans persist at high levels and on a regular basis, particularly in driftnet vessels, despite the existence since the mid-1990s of national legislation banning the capture of marine mammals and commerce in their products. It is concluded that the coast of Peru is likely still one of the world's principal areas for concern regarding high small cetacean bycatch and there is clearly an urgent need to increase the geographic scope of observer effort to elucidate the full magnitude of this issue.

1. Introduction

Small scale coastal, or artisanal, fisheries make up the vast majority of global fishers, produce about half of global annual fish catch and provide most of the fish for human consumption in the developing world (Berkes et al., 2001). These fisheries are typically highly dispersed and are particularly prevalent in developing nations where regulations to monitor or manage these fisheries are frequently underdeveloped, unenforced or non-existent (Berkes et al., 2001). Despite their size and importance, however, artisanal fisheries remain under-studied in comparison with large scale industrial fleets (Berkes et al., 2001; Lewison et al., 2004; Pauly, 2006; Soykan et al., 2008).

Fisheries bycatch has been of growing concern in recent decades (Brothers, 1991; Northridge, 1991; Perrin et al., 1994). The bycatch of long-lived, late maturing, low fecundity species like marine mammals, seabirds, and sea turtles have received particular attention and it is now clear that fisheries interactions pose one of the greatest risks to the survival of many populations (Spotila et al., 2000; Lewison et al., 2004; Read, 2008). While initial attention was often primarily focused on bycatch by large industrial fleets like tuna purse-seines, and high seas driftnets (Hall et al., 2000), efforts have been intensifying to estimate the rates and evaluate the impacts of bycatch in artisanal fisheries (D'Agrosa et al., 2000; Moreno et al., 2006; Peckham et al., 2007, 2008; Alfaro Shigueto et al., 2008) and those working in coastal seas (D'Agrosa et al., 2000; Slooten, 2007).

Due to their circumglobal and coastal distributions, small cetaceans are subject to human exploitation both from bycatch and direct take (Jefferson and Curry, 1994; Reeves et al., 2003; Read et al., 2006; Clapham and Van Waerebeek, 2007; Read, 2008). National and international legal measures to ban the take of dolphins and

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porpoises in fisheries are meant to act as a protective measure to reduce declines of cetacean populations (Northridge and Hofman, 1999). However, cetacean bycatch remains a concern worldwide (Reeves et al., 2003; Lewison et al., 2004; Read et al., 2006; Read, 2008). Moreover, artisanal fisheries may contribute significantly to cetacean mortality (Read et al., 2006). Gillnet fisheries in particular have been cited as probably the most significant cause globally of small cetacean mortality (Jefferson and Curry, 1994; Dawson and Slooten, 2005; Read et al., 2006).

Independent onboard observer programs have been widely used as an effective means to quantify bycatch (e.g. Gales et al., 1998; Beerkircher et al., 2002; Carretta et al., 2004; Rogan and Mackey, 2007), and have been specifically recommended in the case of small cetacean captures in Peru (Reeves et al., 2005). Updated data on numbers of cetaceans caught and the spatio-temporal distribution of cetaceans and bycatch are essential in defining the scale of any problem and in designing appropriate national and regional management strategies (Reeves et al., 2003, 2005). Moreover, the IUCN Cetacean Specialist Group (CSG) and the IWC Scientific Committee have both listed the Peruvian dusky dolphin and Burmeister's porpoise as priorities for cetacean bycatch reduction.

In Peru, previous research into small cetacean captures has focused on the monitoring of landings of carcasses and fishmarkets for the presence of small cetacean products (Read et al., 1988; Van Waerebeek and Reyes, 1990, 1994; García-Godos, 1992; Van Waerebeek, 1994; Van Waerebeek et al., 1997, 2002; Majluf et al., 2002). Captures of small cetaceans were thought to have peaked in the period 1990–1993 when estimates of total take by artisanal and commercial fisheries ranged between 15,000 and 20,000 animals per annum (Van Waerebeek and Reyes, 1994), making it one of the largest small cetacean takes in the world. Ministerial decrees (1990 and 1994) reinforced by a national law in 1996 (Anonymous, 1996), prohibit the intentional take, landing and sale of small cetaceans in Peru (reviewed in Van Waerebeek et al., 1994), but this legislation is not fully enforced and the capture and trade of small cetaceans continues (e.g. Van Waerebeek et al., 2002). The legislation did, however, have the effect of reducing reported landings and pushing the continuing trade in small cetaceans into the black market which was much more difficult to monitor (Van Waerebeek et al., 1997, 2002). In addition it was expected that, unlike before, at least some fishermen would simply discard cetacean bycatch offshore so as to avoid any problems with landings of legal fish catches. As a result, other methods are required to quantify the continuing catch of small cetaceans. Here we report on recent at sea observations of artisanal gillnet and longline activities allowing the first direct effort-corrected estimates of bycatch for artisanal fisheries operating from an important Peruvian port.

2. Materials and methods

2.1. Onboard observer scheme

From March 2005 to July 2007 observers monitored a total of 66 artisanal fishing trips (480 sets; 439 fishing days) for small cetacean bycatch. Artisanal fisheries are defined here, according to Peruvian fisheries regulations, as containing boats with a maximum of 32.6 m^3 of storage capacity, less than 15 m of length, and principally based on the use of manual work during fishing operations (Ley General de Pesca, 2001). Trips monitored were on gillnet and longline vessels originating from the port of Salaverry (8°14′S, 78°59′W), an artisanal port in northern Peru and home to over 100 fishing vessels (Alfaro-Shigueto et al., unpublished results). Skippers ($N = 21$) upon whose vessels observers operated were voluntary participants in the project. Observers did not take part in fishing activity. Observers worked in all months of the year over a total period of 29 months, in order to account for possible seasonal variation in magnitude and spatial patterns of effort.

2.2. At sea observers

All observers were biologists and were trained in relevant data collection methods including marine mammal identification. Data were gathered on specific gear used (longline or gillnet), the timing and position (using GPS) of each set and any bycatch occurring. All observers were equipped with cameras and photographed unusual or unidentifiable captures for later species identification. Common dolphins *Delphinus* spp. were not identified to species in the boats, nor were *Tursiops truncatus* assigned to inshore/offshore morphotype, considering there was a degree of uncertainty about positive identification among observers.

Photos of *Delphinus* spp. ($n = 38$) examined by the authors indicated bycatch of 36 long-beaked common dolphins *Delphinus capensis* (94.7%) and two short-beaked common dolphins *Delphinus delphis* (5.2%). This composition estimate is used in our extrapolation to the wider estimate of take (Table 4). The overwhelming preponderance of *D. capensis* found here is broadly consistent with the more than 99% of *Delphinus* catches belonging to *D. capensis* in Peru based on a sample of 1067 common dolphins taken in coastal fisheries in the period 1984–1993 (Van Waerebeek, 1994).

2.3. Shore-based observers

Shore-based observers were employed in Salaverry to monitor daily fishing activity from September 2001 to March 2008. Observers collected data on the total number of fishing trips departing and returning per day and per vessel type, locations of fishing activity and associated catch and bycatch. Data collection was based upon daily interviews with fishermen and monitoring of dockside activity. Respondents were informed that the information would be kept anonymous and be used strictly for research purposes. Fishermen returning from fishing trips were queried regarding vessel type, fishing effort, target catch, and incidents of bycatch of small cetaceans, sea turtles or seabirds. Resulting data therefore are a census of fishing effort by gear type over the study period.

2.4. Data analysis

All observer data were managed in a Microsoft Access database. Bycatch per unit effort (CPUE) was calculated on a per trip and per set basis for both fishing gears. For gillnet vessels, CPUE was also presented per length (km) and per area (km^2) of net set. Descriptive statistics are presented as mean ± standard deviation (SD) or with 95% confidence intervals (CI) unless specified otherwise. Statistical tests were performed using SPSS 15.0 and Genstat 10. For temporal analyses of total bycatch we used General Linear Models (GLMs) with normal errors, where CPUE was the dependent variable with season and year as factors. In this instance CPUE was calculated on a trip by trip basis by dividing the number of bycatch incidents by the number of sets made. When it came to analysis of the bycatch for individual species the date distributions departed significantly from normality and there were significant differences in variances among groups. We therefore used raw count data as our dependent variable, with number of sets included as a covariate (to account for variation in effort across seasons/years) along with season and year as factors. We also employed GLMs for these analyses but fitted them with Poisson errors and a log link function. Season was divided as follows: season 1 = November–January; season 2 = February–April; season 3 = May–July; season