

MORTALITY OF DOLPHINS AND PORPOISES IN COASTAL FISHERIES OFF PERU AND SOUTHERN ECUADOR IN 1994

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(Received 2 April 1996; accepted 8 August 1996)

Abstract

Of 722 cetaceans captured mostly in multi-filament gillnets and landed at Cerro Azul, central Peru, in 87 days during January–August 1994, 82.7% were dusky dolphin *Lagenorhynchus obscurus*, 12.6% Burmeister's porpoise *Phocoena spinipinnis*, 2.4% long-beaked common dolphin *Delphinus capensis* and 2.4% bottlenose dolphin *Tursiops truncatus*. The total kill estimate for a seven-month period, stratified by month, was 1567 ± 237 (SE) cetaceans. Data collected at 16 other ports showed that high levels of dolphin and porpoise mortality persisted in coastal Peru at least until August 1994 when an unimplemented 1990 ban on small cetacean exploitation was renewed. Circumstantial evidence suggests that, thereafter, increasing enforcement reduced direct takes and illegal trade in meat but also hampered monitoring. The absence of abundance data precludes any assessment of impact on populations. An interview study in October–December 1994 of the extensive multi-filament gillnet fishery from Puerto Bolívar in southern Ecuador indicated, despite a low catch rate per boat, an estimated annual take of 227 bottlenose dolphins in the inner estuary of the Gulf of Guayaquil. This represents some 9% of the resident bottlenose dolphin population, or more than twice its estimated birth rate. Two mono-filament gillnet boats did not report any entangled cetaceans. © 1997 Published by Elsevier Science Ltd.

Keywords: small cetaceans, gillnets, monitoring, Peru, Ecuador.

INTRODUCTION

The landings of small odontocetes at Peru's coastal fishing ports have been documented through annual surveys by scientists of the Peruvian Center for Cetacean

Research (CEPEC) since 1985 (Read *et al.*, 1988; Van Waerebeek & Reyes, 1990, 1994a,b,c; Garcia-Godos, 1993; Van Waerebeek, 1994; Van Waerebeek *et al.*, 1994). Dusky dolphins *Lagenorhynchus obscurus*, long-beaked common dolphins *Delphinus capensis*, Burmeister's porpoises *Phocoena spinipinnis*, bottlenose dolphins *Tursiops truncatus*, and several other species, albeit in much lower numbers, have been captured both incidentally and intentionally in artisanal multi-filament gillnets, in the industrial purse-seine fishery for small schooling fishes, or were killed with hand-held harpoons. In Peru, no cetaceans have been recorded taken in longlines set for sharks and rays, although dolphin meat has been used as bait. The impact of the rapidly expanding, mostly small-mesh, mono-filament gillnet fishery in recent years remains unknown, but indications are that inshore dwelling Burmeister's porpoises in particular are at risk of entanglement.

The Peruvian Ministry of Fisheries (MIPE) first outlawed the exploitation of small cetaceans in 1990 (Decree No. 321-94-PE, 23 November) but this rule remained widely ignored. Total annual catches increased to an estimated 15 000–20 000 per annum in the period 1990–93, up from an estimated 14 100 in 1989 (Van Waerebeek & Reyes, 1994a) and some 10 000 in 1985 (Read *et al.*, 1988). An official report stated that 'the decree had not totally eliminated the capture of small cetaceans in some ports' (Arias-Schreiber, 1995). In 1994, MIPE issued a new ministerial decree (No. 321-94-PE, 5 August), basically reiterating the 1990 ban in stricter terms. Efforts to publicize and enforce this measure were more successful and cetacean meat gradually disappeared from the public market. Two years later a common law (Ley No. 26585, 9 April 1996) went into effect which prohibited all captures and trade for seven odontocete species, including those mentioned earlier plus the short-beaked common dolphin *Delphinus delphis*, and the dolphins of riverine habitat, tucuxi *Sotalia fluviatilis* and boto *Inia geoffrensis*. A subsequent

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amendment (Decreto Supremo No. 002-96-PE, 14 June 1996) exempted live-capture fisheries for delphinaria from the ban.

In 1994, we could conduct only limited surveys along the c. 2500 km Peruvian coastline. We intensively monitored Cerro Azul, well-known for its directed dolphin takes, and point-sampled another 16 ports, the results of which are presented here. In Ecuador, although some opportunistic information has been gathered since at least 1986 (Van Waerebeek *et al.*, 1990; Haase & Félix, 1994), systematic monitoring to quantify the extent of cetacean interactions with fisheries in coastal waters did not start until 1993 (Félix & Samaniego, 1994).

The annual incidental mortality combined for two ports of southwest Ecuador, namely Santa Rosa (Guayas province) and Puerto López (Manabí), was grossly estimated at about 1300 small cetaceans in 1993. Four species were found entangled in gillnets, the short-beaked common dolphin (86%), an undetermined species of pilot whale *Globicephala* sp., probably *G. macrohynchus* (9%), the pantropical spotted dolphin *Stenella attenuata* (2%) and the dwarf sperm whale *Kogia simus* (1%) (Félix & Samaniego, 1994). These authors stressed the need to investigate landings at the important fishing port of Puerto Bolívar (03°16'S, 79°59'W), situated in the inner Gulf of Guayaquil close to the Peruvian border. Here we discuss an interview survey in this port carried out in the spring of 1994.

Methods

Distinct survey approaches were required in the two study countries reflecting their different realities. In Peru, until about August 1994, most captured cetaceans were brought to port to supply an established market in small cetacean meat for human consumption (Read *et al.*, 1988; Van Waerebeek & Reyes, 1994a). After that date (in some ports since 1990) the estimation of fishing effort and dolphin and porpoise landings became increasingly difficult. Fishermen, wholesalers and market workers generally refused to provide information out of fear of the stiff fines linked to the banned trade in cetaceans.

We monitored the artisanal port of Cerro Azul (13°00'S, 76°34'W) on the central coast of Peru for a total of 105 days in the period 4 January–28 November 1994. Following enhanced enforcement by port authorities after August 1994, captured dolphins and porpoises were usually cut up in the boats away from scrutiny and filleted meat was landed clandestinely. This reduced the number of fully effective survey days to 91. In addition, one to several randomly timed visits were made to 16 fishing ports along the Peruvian coast, from Santa Rosa (06°56'S, 79°57'W) in the north to Vila Vila (18°05'S, 70°40'W) in the south.

All field work was done by the authors. In rare exceptions we relied on information from a few trustworthy locals. As a rule, quantification of skeletal specimens encountered during beach surveys was based on

cranial evidence only. Van Waerebeek *et al.* (1994) argued that practically all beach-cast cetacean material around ports in Peru originated from fisheries interactions.

Mean daily catch estimates (MDC), stratified per month, and standard errors (SE) were calculated as in earlier studies (see Read *et al.*, 1988; Van Waerebeek & Reyes, 1990).

In Ecuador, at least until recently (see below), accidentally captured dolphins, considered useless, are discarded at sea. Since people rarely consume dolphin meat, carcasses lack commercial value and a well-designed interview survey may yield a reasonably accurate picture of incidental take. Lien *et al.* (1994) showed that repeated face-to-face contacts with fishing crews resulted in the most reliable, comprehensive estimates. Two Ecuadorean biology students, Rosana Mejía and José Loaiza of the Fundación Ecuatoriana para el Estudio de Mamíferos Marinos, supervised by one of us (F.F.), visited Puerto Bolívar in southwest Ecuador each week over a three-month period (1 October–31 December 1994).

Selected fishermen were briefed extensively on the purpose of the study and were instructed how to identify the more common small cetaceans of the area. Individual crew members of five boats using multi-filament drift gillnets were interviewed weekly on their fishing trips, target species and any interactions with cetaceans. Fishermen proved very cooperative once assured that the investigation had official backing and that no legal actions would be taken against them (Félix and Samaniego, 1994). From 5 November till 15 December 1994, two mono-filament gillnet boats were included in the survey.

The operational factor (OF) of the Puerto Bolívar artisanal fishing fleet was estimated as the total number of days spent fishing summed for each sample boat, divided by the sum of the total number of days each boat was sampled. To estimate the relative effort for each fishing method (multi-filament, mono-filament or longlines), three censuses were organized, totalling 180 boat-days.

RESULTS

Port of Cerro Azul, Peru

Fishing effort

As in preceding years (see Read *et al.*, 1988; Van Waerebeek & Reyes, 1994a), small cetaceans were taken mostly by open, wooden boats which set wide-mesh multi-filament gillnets, so-called *animalero* nets, targeting several species of sharks, rays (especially *Myliobatis* spp.) as well as protected species including several coastal dolphin species, Burmeister's porpoises, green turtles *Chelonia mydas* and leatherbacks *Dermochelys coriacea*. The number of boats operating daily from

Cerro Azul in 1994 with chiefly but not exclusively *animalero* nets varied widely between one and 18 (*mean* = 4.9 boats; not including days without sorties). Although it is likely that a few cetaceans were incidentally entangled in medium-sized mesh drift gillnets set for bonito *Sarda chiliensis* and cojinova *Seriotelella violacea*, as had occurred before (Read *et al.*, 1988), this could not be confirmed. Two harpooned bottlenose dolphins were documented in January 1994. Additional cases most likely went unregistered since fishermen took great care to conceal harpooning.

Occasional massive landings of dusky dolphins at Cerro Azul indicated intentional gillnet sets on dolphin pods, confirmed by some fishermen. For instance, in four non-contiguous days, landed kills of 119 (8 June), 81 (24 June), 63 (26 March) and 62 (7 July) dolphins were counted, 97% of which were dusky dolphins. Together these equalled 45% of the total number of small cetaceans seen landed during the entire study period. Although impossible to ascertain, some of the lesser single-day kills may have also been intentional.

Cetacean landings

We present monthly stratified dolphin and porpoise catch data for Cerro Azul, with estimates of total takes for a seven-month monitoring period in 1994 (Table 1) and mean daily catch rates of (pooled) small cetaceans landed for each month monitored (Table 2). Pooled species data are useful for comparisons with historical fisheries statistics which recorded only total number or weight of small cetaceans.

Of 722 cetaceans examined in 87 days, 597 (82.7%) were dusky dolphins, 91 (12.6%) Burmeister's porpoises, 17 (2.4%) long-beaked common dolphins and 17

(2.4%) bottlenose dolphins. The estimated total take at Cerro Azul for the seven months monitored (January–March and May–August), after stratification by month, was 1567 ± 237 (SE) animals, or 1272 dusky dolphins, 224 Burmeister porpoises, 45 long-beaked common dolphins and 42 bottlenose dolphins. The overall mean daily catch rate (MDC) was 8.25 ± 1.49 (SE) dolphins and porpoises.

A random sample of 167 boat sorties in January–August 1994 resulted in 396 small cetaceans landed, i.e. a mean catch per boat sortie of 2.37 specimens, which combined both directed and truly by-caught captures. No error estimate can be computed because, for most days, only the total number of animals and the number of boat sorties are known.

Although cetaceans were no longer openly landed at Cerro Azul in late 1994, fresh dolphin heads, entrails, and slabs of blubber that washed ashore just north of the wharf indicated that carcasses continued to be eviscerated, albeit at an unknown scale. It was widely rumoured that meat, hidden in boxes, was brought ashore under cover of the night. Nevertheless, from September 1994 onward and continuing into 1995, the mounting public pressure against dolphin takes, and the difficulty to sell dolphin meat, undermined incentives for directed takes. Cetacean mortality presumably was cut down to accidental entanglement in drift and demersal gillnets, the extent of which needs to be determined in future research.

Other Peruvian ports

Apart from Cerro Azul, 16 other Peruvian fishing ports were monitored in 1994, although much less intensively (Table 3). Overall we found that dolphin and porpoise

Table 1. Total numbers of cetaceans seen landed during monitoring of the port of Cerro Azul, central Peru, in 1994 Observed (OBS) and estimated (EST) numbers, and standard errors (SE) have been rounded to nearest integers. Number of days monitored per month is shown in brackets. The month of April is not included in estimated totals (for 7 months) because of small sample size. Hiding of catches by fishermen made reliable monitoring impossible in September–December.

Species		Month (no. days)							Totals (85)	
		January (9)	February (12)	March (17)	April (2)	May (10)	June (16)	July (14)		August (7)
<i>L. obscurus</i>	OBS	3	4	158	4	19	245	126	38	597
	EST	10	9	288		59	459	279	168	1272
	SE	4	4	71		26	172	90	91	227
<i>D. capensis</i>	OBS	0	1	1	0	6	1	7	1	17
	EST	0	2	2	0	19	2	16	4	45
	SE	0	2	1	0	7	1	7	4	11
<i>P. spinipinnis</i>	OBS	16	16	24	1	10	7	14	3	91
	EST	55	37	44		31	13	31	13	224
	SE	17	15	9		8	4	13	8	30
<i>T. truncatus</i>	OBS	2	6	1	0	2	2	4	0	17
	EST	7	14	2	0	6	4	9	0	42
	SE	4	9	1	0	5	3	5	0	13
All species	OBS	21	27	184	5	37	255	151	42	722
	EST	72	63	334		115	478	337	168	1567
	SE	14	18	74		37	173	96	98	237

Table 2. Mean daily catch rates of pooled small cetaceans (MDC), with standard deviation (SD), standard error (SE) and number of days monitored (*n*), landed at Cerro Azul, central Peru, in 1994

	January	February	March	May	June	July	August	Mean 1994
MDC	2.33	2.25	10.76	3.70	15.94	10.79	5.43	8.25
SD	1.58	2.93	14.57	4.60	33.8	15.74	9.52	17.7
SE	0.44	0.64	2.38	1.20	5.77	3.12	3.17	1.49
N	9	12	17	10	16	14	7	87

carcasses, or their meat, continued to be offered for sale despite the ban. This occurred generally away from public scrutiny (e.g. at Pucusana and Ancón) but at times openly such as at the fishing towns of Salaverry, Chancay and Tambo de Mora. Cetacean offal, severed heads and entire specimens bearing obvious marks of human interference were ubiquitous on beaches near ports and wharves (Table 3), not different from earlier years. Skulls were collected and deposited as voucher specimens at the CEPEC coastal station in Pucusana. After 5 August 1994, the insistence from MYPE, conservation NGOs and public opinion (e.g. Balaguer, 1994; Zileri, 1995; Howard, 1996) to enforce the exploitation ban further

increased. MYPE distributed poster warnings at wharves and offices of port authorities and commissioned advertisements in all major newspapers.

At the ports of San José, Pimentel and Santa Rosa, near Chiclayo, we found remains of long-beaked common dolphins and Burmeister's porpoises in about equal numbers. Three-quarters of 73 cranial specimens recovered at the wharf of Salaverry, the port of Trujillo, were Burmeister's porpoises. This concurred with claims of locals that porpoises are the most frequently entangled cetacean, as well as with field results obtained in 1993 (Van Waerebeek *et al.*, 1994; Van Waerebeek & Reyes, 1994a).

Table 3. Summary of small cetacean specimens encountered, either as fresh carcasses or cranial remains, in 16 fishing ports along the coast of Peru in 1994

Days of monitoring are indicated below each locality. For three ports with $n > 25$, percentage species composition is given (2nd line). *L. obs*, dusky dolphin; *D. cap*, long-beaked common dolphin; *P. spi*, Burmeister's porpoise; *T. tru*, bottlenose dolphin; Uniden, unidentified, including fresh animals reported by a reliable local source but not examined by a scientist. Unidentified specimens are excluded from percentage values. Detailed information and voucher specimens deposited at CEPEC station, Pucusana, Peru.

Locality, sampling days	<i>L. obs</i>	<i>D. cap</i>	<i>P. spi</i>	<i>T. tru</i>	Uniden	Total
San Jose						
21 Sept	0	2	5	0	0	7
Pimentel						
20,21 Sept	0	0	0	0	0	0
Santa Rosa						
19,20,21 Sept, 4 Dec	0	4	2	0	0	6
Salaverry	2	9	54	7	1	73
7-8 May, 21-22 Sept, 4-5 Dec	2.8	12.5	75	9.7		100
Chimbote	21	20	2	6	3	52
8-11 May, 3-6 Oct, 5 Dec	42.9	40.8	4.1	12.2		100
Culebras						
12 May, 6-8 Oct	4	52	0	1	0	56
Huarmey (Pto. Grande)						
12 May, 7 Oct	5	15	0	0	0	20
Huacho						
8 Sept	3	0	1	0	0	4
Chancay	3	0	1	0	0	4
18-20, 26 Mar; 11-13, 29-31 July; 7-9, 23-25 Sept	57.7	0	42.3	0		100
Ancon						
5,11 June; 16-18 Sept; 14-16 Oct	16	0	3	0	0	19
Callao						
14 Oct	0	0	0	0	0	0
Chorrillos						
23 March; 3,6 Sept	0	0	2	1	0	3
Pucusana						
20-21 Apr; 31 May; 29 Dec	1	5	1	1	0	8
San Andres						
1-3 Oct	0	0	6	4	1	11
Tambo De Mora						
4-5 Oct	0	0	4	0	0	4
Vila-Vila						
14 Sept	0	0	3	0	0	3

Two dusky dolphin skulls retrieved near the Salaverry disembarkation site (08°12'S) and deposited in the CEPEC collection (García-Godos *et al.*, 1994) moved the known world-wide northern range for this species, formerly set at Chimbote (09°05'S) (Van Waerebeek, 1992), some 100 km to the north.

In nine days of observations of landing activities at the Chimbote terminal, 52 cetaceans were counted (Table 3), typically in the early morning. Most were taken by the industrial purse-seine fishery and, although based on a small sample, the MDC of 5.78 was comparable to the 5.6 (summer) and 3.63 (winter) MDC of 1993 (Van Waerebeek *et al.*, 1994), suggesting little if any change. However, species composition was unusual: 21 (42.9%) of the animals examined were dusky dolphins. These were landed in early October, coinciding with the low spring sea surface temperature and in congruence with the cold-water preference of this species (Gaskin, 1968; Würsig & Würsig, 1980). Evidence for a mere five dusky dolphins was available for the period 1956–1976, while none was recorded between 1985 and 1993 despite regular study visits (Van Waerebeek, 1992; Van Waerebeek & Reyes, 1994b). Whether the numerous recent dusky dolphin specimens at Salaverry and Chimbote are the result of cumulating search effort in the area rather than a temporal northward distribution shift remains inconclusive.

Two survey days at the ports of Culebras and Huarney (Puerto Grande) yielded a count of 67 skulls of long-beaked common dolphin and nine dusky dolphin skulls scattered on the beaches north of the wharves (Table 3). Abundant skeletal remains of the same species had also been encountered in 1992–93 (Van Waerebeek & Reyes, 1994b). Several locals independently blamed a large by-catch in the anchovy purse-seine fishery which supplies the fishmeal industry. Some dolphins may also have been harpooned, a not unusual practice among fishermen at these ports (Van Waerebeek *et al.*, 1994).

At Chancay, in 15 monitoring days (MDC = 1.7), a little more than half of cetaceans landed were dusky dolphins, as in 1993 (Van Waerebeek & Reyes, 1994a). However no long-beaked common dolphins were recorded, contrasting with their 37% presence in 1993. The same pattern was observed in Ancón (Table 3).

Our team recorded few complete specimens and fresh remains at the Pucusana fish terminal and beaches compared to earlier years (Read *et al.*, 1988; Van Waerebeek & Reyes, 1990) but enough to demonstrate

that the utilization of cetaceans had not ceased. The presence of the CEPEC coastal station at Pucusana seemed to incite fishermen to hide animals. Also, the use of longlines slowly gained ground as a result of a successful 1993 gillnet replacement project (Reyes, 1993), which probably translated into a lower MDC rate. Oscar Mendoza, a reliable member of the fishermen community, stated that parts of dolphins by-caught in nets were being utilized as bait in long-lines or were suspended from the corkline of wide-mesh drift gillnets to attract sharks.

The relative importance of the long-beaked common dolphin in landings at Cerro Azul also dropped from 25.8% in 1993 (Van Waerebeek, 1994) to 2.4% in 1994.

Puerto Bolívar, Ecuador

Fishing effort

Mr William Revelo of the Instituto Nacional de Pesca, Departamento de Recursos Pesqueros (pers. comm.) in Guayaquil, Ecuador, estimated that the artisanal fishing fleet of Puerto Bolívar (03°14'S, 80°00'W) in 1994 comprised 425 boats. The main fishing techniques included: (1) nylon multi-filament drift gillnets of about 1500 m length, 15 m deep and 10–15 cm mesh width, set for sharks, rays and sciaenid fishes; (2) nylon mono-filament bottom gillnets of 1000–1500 m length, 5 m deep and 5 cm mesh size, mostly used to catch penaeid shrimp; (3) longlines typically equipped with 100–200 hooks (Martínez *et al.*, 1991). The relative effort by fishing method in 1994 was estimated as follows: 52% multi-filament, 46% mono-filament and 2% longlines (Table 4).

On a total of 357 sample boat-days, 157 were actually spent fishing by the five multi-filament gillnet boats surveyed, i.e. an operational factor (OF) of 0.44. They made 1–2 sorties a week and spent 2–4 days at sea. Nets were set in the afternoon through the night for 10–12 h, mostly within the inner estuary of the Gulf of Guayaquil and only occasionally further than 20 nautical miles from the coast. The two mono-filament gillnet boats surveyed had an OF = 0.40. They fished closer to shore in shallow, 5–10 m deep water, leaving port before dusk and returning the following day at noon.

Cetacean takes

During the study period only one cetacean was reportedly captured by the sample multi-filament gillnet boats, from the descriptions of the trained fishermen identifiable

Table 4. Number of boat sorties equipped with one of three fishing methods registered in three census days at Puerto Bolívar, southern Ecuador, in late 1995

Fishing Method	Census 1 (8 October)	Census 2 (5 November)	Census 3 (10 December)	Total n	%
Multi-filament	16	41	37	94	52
Mono-filament	4	31	47	82	46
Longline	2	2	0	4	2
Total no. boats sampled	22	74	84	180	100

as a bottlenose dolphin. The mean daily catch per boat (157 boat-days) was then estimated as 0.0064 ± 0.0064 (SE) dolphin/boat/day. Extrapolated to the entire multi-filament fleet the annual by-catch is estimated at 227 bottlenose dolphins (95% CI: 0–665). This figure may be somewhat biased downward due to underreporting, although field workers thought the collaborating fishermen had played fair. No cetaceans were caught by the monofilament gillnet boats, but the sample was not sufficiently large to permit any firm conclusions about frequency of interactions.

Fishermen from Puerto Bolívar claimed that incidentally captured dolphins were normally dumped offshore or, whenever possible, were sold to Peruvian fishermen at sea. Unauthenticated reports suggested that at least one boat based at Puerto Bolívar harpooned dolphins to provide bait to the local longline fishery. Months before the census, a fisherman from Puerto Bolívar related to one of us (F.F.) how he, with others, harpooned a bottlenose dolphin, for bait, near Puná island in the Gulf of Guayaquil. This is the first indication that a limited but intentional capture of coastal dolphins may exist, or be developing, in Ecuador.

DISCUSSION

Although monitoring effort was insufficient to estimate total cetacean mortality in Peru during 1994, available information did not deviate noticeably from comparable data for the period 1990–1993 (Van Waerebeek *et al.*, 1994; Van Waerebeek & Reyes, 1994a). The overall MDC rate for Cerro Azul (8.25 ± 1.49 (SE)), the only port with a statistically representative sample for 1994, was not significantly different ($p > 0.05$) from the 5.28 ± 0.65 weighted MDC registered in 1992–93 (Van Waerebeek & Reyes, 1994a).

The rapidity by which the initial effects of the renewed ban on the fishing communities progressed from detection avoidance to compliance varied from port to port, depending on their size, distance from Lima and the past record of trade in dolphins. Intentional gillnet sets on dusky and common dolphins at ports such as Cerro Azul and Ancón presumably lessened quickly due to the greater effort and cost of illegally landing and selling large numbers of dolphins. Ports of resort towns, especially those close to Lima, underwent higher pressure because of the link between visiting tourists and public opinion.

There was no indication of dolphin mortality reduction in industrial purse-seine fisheries that operate almost year-round in Peruvian coastal waters and are known to take large numbers of long-beaked common dolphins (e.g. Van Waerebeek *et al.*, 1994). Several industrial fishing and fishmeal factory companies have a track record of avoiding control measures, including closed fishing seasons, set quota, and legal environmental regulations for plant sewage treatment.

The increasing tendency of fishermen to hide fresh carcasses and refuse to cooperate, a negative side-effect of the ban, hampered our efforts to monitor catches and assess fishing effort in the course of 1994. A comparable effect, following recently introduced legislation, was reported from the Philippines (Louella Dollar in Reeves & Leatherwood, 1994) and India (Lal Mohan, pers.-comm.), which also have a history of intense exploitation of small cetaceans in their coastal waters. To assess the longer-term outcome of the ban in Peru, and to evaluate the extent of strictly incidental take (which obviously has not been reduced), intensive monitoring will be required. A system with special permits to land by-caught animals granted to a group of fishermen who have been duly briefed, and whose fishing activities are closely monitored, may yield reliable, effort-based by-catch rates as well as the necessary specimens to continue life history studies.

We conclude that while there are reasons to believe that intentional takes of small cetaceans in Peru most likely have been diminishing since 1994, due to the legal protection status they received, truly accidental entanglement in coastal gillnets and purse-seine nets obviously have not. Additional and yet to be determined measures will be needed to mitigate these.

With a total lack of abundance estimates for all species, the impact of fisheries is unknown. A significant decline found in the proportion of dusky dolphins versus other odontocetes landed between 1985 and 1993 on the central coast may reflect a true decrease in the abundance of dusky dolphins but also a number of natural ecological phenomena (Van Waerebeek, 1994).

The surveys in Ecuador suggest that, although fishing methods are similar, cetacean by-catches in nets set by Puerto Bolívar fishermen are some 5–15 times lower than equivalent mortality at Santa Rosa and Puerto López which have a MDC/boat of, respectively, 0.104 and 0.034 (Félix & Samaniego, 1994). Boats from the latter two ports in peninsular southwest Ecuador fish in fairly deep, oceanic waters and a variety of species become entangled, including the short-beaked common dolphin *Delphinus delphis*, pantropical spotted dolphin *Stenella attenuata* and a pilot whale *Globicephala* sp.

Puerto Bolívar fishing boats predominantly ply the Gulf of Guayaquil, i.e. estuary waters mostly < 30 m deep, and it seems that only the coastal population of bottlenose dolphin suffers losses from entanglement. Félix (1994) estimated the total bottlenose dolphin population of the inner Gulf of Guayaquil at about 2500 animals and its annual reproductive rate 3.6%. If, despite the small sample, the estimated 227 bottlenose dolphins killed in nets each year reasonably reflect reality, it would mean an unsustainable 9% annual removal rate, or 2.5 times the birth rate. In the Gulf this species is socially organized in communities of some 120 dolphins, each unit having a well-defined home range in the inner estuary (Félix, 1992, 1994). The communities

living closer to Puerto Bolívar are thought to be more affected than those living in the central or northern parts of the Gulf.

The use of nylon mono-filament nets is on the rise both in Peru and Ecuador, but its impact on small odontocetes is unclear. In the Gulf, bottlenose dolphins are said to swim into set mono-filament gillnets with some regularity (see also Van Waerebeek *et al.*, 1990) but thanks to their bulk usually succeed in breaking through the nets and release themselves.

Off central Peru, when Pacific sardines *Sardinops sagax*, jack mackerel *Trachurus symmetricus* or other fish of low commercial value are in short supply for longline bait, fishermen reportedly have resorted to using cetacean meat and offal. The Puerto Bolívar case cited above surely warns against unmonitored or massive promotion of longlining, since a real danger exists of dolphin harpooning for bait becoming widespread when a shortage of traditional fish bait arises, as has occurred in some communities in Pacific Colombia (Mora-Pinto *et al.*, 1995).

ACKNOWLEDGEMENTS

We sincerely thank R. Mejía and J. Loaiza for their conscientious survey work in Puerto Bolívar and Ray Gambell and B. N. K. Davis for reviewing the manuscript. We are greatly indebted to Karen Geysen and family, J. Van Goethem, Steve Leatherwood, Vassili Papastavrou, Randy Reeves and Bill Rossiter for help with fund raising and encouragement. Field work was supported by the Belgian Agency for Development Aid (AGCD), Cetacean Society International, Greenpeace International, Leopold III Fund for Nature Research and Conservation, Marine Research and Education, Pro Delphinus and WDCCS.

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