SC/46/SM16

Post-Ban Small Cetacean Takes off Peru: A Review

Koen Van Waerebeek [1,2] and Julio C. Reyes [1,3]

ABSTRACT

Information on small cetacean mortality in Peruvian fisheries is reviewed for the 1990–1993 period, i.e. after the national ban on cetacean exploitation. Most ports along the Peruvian coast were sampled during short visits while Cerro Azul, Pucusana, Chimbote, Ancón and San Andrés were more intensively monitored. The ban was found not to be enforced or at best only partially so. Fishermen often avoided overtly landing entire carcasses, which impeded quantification of kills. Large numbers of small cetaceans were caught directly and indirectly in drift and set gillnets, were harpooned or were netted in purse seines (and often landed alive) by vessels operated by the fishmeal industry. Principal species affected included *Lagenorhynchus obscurus*, *Delphinus capensis*, *Phocoena spinipinnis* and *Tursiops truncatus*, although occasional takes of at least six other small cetacean species occurred. Estimated annual kills (±SE) were: 1,651±53 (1990) at Pucusana; 2,118±389 (1992) and 1,927±237 (1992/93) at Cerro Azul; 2,100 (1991) and 1,383±274 (1992) at Ancón; 1,825±220 at Chimbote (1993) and about 470 at San Andrés (1992). Santa Rosa, San José, Culebras, Huarmey and Chancay also accounted for high landings. Although no scientific estimate of the total annual take of cetaceans in the period 1990–1993 can be calculated, the best available evidence suggests it ranged between 15,000 and 20,000 specimens. Albeit illegal, fresh and processed *muchame* type cetacean meat is widely available and openly sold. A new ministerial decree of August 1994 caused a welcome wave of law enforcement action, but its impact and long-term effects still have to be assessed. Recommendations on how to mitigate kills are discussed.

KEYWORDS: KEYWORDS: SOUTH PACIFIC; DIRECT CAPTURE; INCIDENTAL CAPTURE; FISHERIES; MANAGEMENT; DUSKY DOLPHIN; LONG-BEAKED COMMON DOLPHIN; SHORT-BEAKED COMMON DOLPHIN; BOTTLENOSE DOLPHIN; BURMEISTER'S PORPOISE; SHORT-FINNED PILOT WHALE; LESSER BEAKED WHALE; MINKE WHALE; RIGHT WHALE DOLPHIN.

INTRODUCTION

Peruvian artisanal and commercial fisheries operate from some 181 coastal localities, ranging from international seaports with vast fishing fleets such as Chimbote and Paita, to simple beach-heads. Only about 50 of these have some port infrastructure (Wosnitza-Mendo *et al.*, 1988). Small cetaceans have been taken both incidentally and directly in gillnet and harpoon fisheries at least since the early 1970s but until the mid-1980s almost nothing was known of kill levels and even less on the distribution and biology of affected species.

The 'IUCN/UNEP Burmeister's Porpoise Project' implemented in 1985–86 first tackled these issues in a systematic way. Much of the Peruvian and northern Chilean coast was surveyed to identify the sites with highest cetacean landings. Scientific monitoring and a sampling programme was then started at two selected ports, Pucusana and Cerro Azul, south of Lima (Van Waerebeek and Guerra, 1986; Gaskin *et al.*, 1987; Guerra *et al.*, 1987; Read *et al.*, 1988). Volunteers of the Peruvian Centre for Cetacean Studies (CEPEC) in cooperation with the Association for Ecology and Conservation (ECCO) continued this work and despite limited resources, obtained a wealth of information on fisheries interactions (Van Waerebeek and Reyes, 1990a; b; 1994a; García-Godos, 1993; Van Waerebeek *et al.*, 1993; Van Waerebeek, 1993c; Van Waerebeek *et al.*, 1994) and on the biology of the most frequently captured Peruvian small cetaceans, the dusky dolphin *Lagenorhynchus obscurus* (see Manzanilla, 1989; Van Waerebeek, 1992a; b; 1993a; b; Van Waerebeek *et al.*, 1993; Van Waerebeek and Read, In press), Burmeister's porpoise *Phocoena spinipinnis* (see Reyes and Van Waerebeek, 1995), bottlenose dolphin *Tursiops truncatus* (see Reyes, 1993; Van Waerebeek *et al.*, 1990) and the long-beaked common dolphin *Delphinus capensis* (see Van Waerebeek, 1993c; Van Waerebeek *et al.*, 1994).

The Peruvian Ministry of Fisheries (MIPE) estimated the 1985 cetacean kill in Peru at 756 tonnes (MIPE, unpublished data), equivalent to around 10,000 dolphins and porpoises (Read *et al.*, 1988; Van Waerebeek and Reyes, 1994a). The combined takes of the dusky dolphin, Burmeister's porpoise, long-beaked common dolphin and bottlenose dolphin (inshore and offshore populations) accounted for more than 98% of the catch. The majority of animals were taken by artisanal fishermen in drift and set gillnets, together with several species of sharks (blue, mako, hammerhead and mustelid sharks), rays and other large fishes such as bonito (*Sarda chilensis*), dorado (*Coryphaena hippurus*) and cojinova (*Seriolella violacea*). Large numbers were also killed by hand-held harpoons and in nets set by 300–350 GRT purse seiners fishing for anchovy and sardines for the fishmeal industry. Most of the cetacean meat is consumed fresh by people of modest income groups or salt-dried and commercialised as an expensive delicacy (*muchame*).

After 1985, MIPE statistics suggested a decline in total annual take to 426 tonnes (equivalent to about 5,500 specimens) in 1988 and a subsequent peak kill in 1989 of 1,093 tonnes (Ramírez and Zuzunaga, 1991), i.e. about 14,100 specimens. However, sampling of the Pucusana port by CEPEC volunteers showed that the cetacean kill in 1989 had increased roughly by a factor of three compared to 1986 levels and tenfold compared to 1985 (Van Waerebeek and Reyes, 1994a). In 1989 alone, a total of 2,317±117 SE dolphins and porpoises were landed at the Pucusana wharf. Details of the fishery are given in Read *et al.* (1988), Van Waerebeek and Reyes (1990a; b; 1994a), Reyes and Van Waerebeek (1991), Van Waerebeek (1993c), Van Waerebeek *et al.* (1993; 1994) and García-Godos (1993).

[1] *Centro Peruano de Estudios Cetológicos (CEPEC), casilla 1536, Lima 18, Perú*
[2] *Institut Royal de Sciences Naturelles de Belgigue, 29 Rue Vautier, B-1040, Brussels, Belgium*
[3] Present address: *casilla 392, Talcahuano, Chile*

Legal status of cetaceans in Peru

In 1990, the Peruvian government protected small cetaceans by law following increasing concern expressed in Peru and abroad about the long-term survival of these animals. Ministerial resolution No. 569–90-PE of 23 November 1990 (Anon., 1990) outlawed the capture and trade in small cetaceans or products thereof (meat). Responsibility of enforcement lay with the regional governments, regional offices of the Ministry of Fisheries and the National Office of Port Authorities and Coast Guards of the Ministry of Defence. Resolution No. 321–94-PE of 8 August 1994 (Anon., 1994) replaced the 1990 law. The contents are the same but now district and provincial municipalities are also made responsbile for implementing the prohibition. In addition, river dolphins, including the boto (*Inia geoffrensis*) and the tucuxi (*Sotalia fluviatilis*) have been legally protected in Peru since 1973 by decree No. 943–73-AG, which prohibits hunting, capture and trade in all species of the Peruvian Amazon basin.

Subsequently, legislative decree No. 635 (Codigo Penal) of 3 April 1991 in article 308 (paragraph XIII) considers crimes against the Natural Resources and the Environment and stipulates imprisonment for the hunting or commercial exploitation of species of fauna and flora that are legally protected (Cresci, 1993). International trade in cetaceans and cetacean products is subject to regulations set by the Convention on the International Trade of Endangered Species of Fauna and Flora (CITES), signed by Peru. The three most frequently captured delphinids and the Burmeister's porpoise all feature on Appendix II of CITES. Peru joined the IWC in 1979 and adopted its provisions through Ministerial Resolution No. 345–79-PE. In December 1991, the Peruvian Government approved the UNEP proposed 'Action Plan for the Conservation of Marine Mammals in the Southeast Pacific'. The principal objective is to support participating governments (Colombia, Chile, Ecuador, Panama and Peru) to improve the conservation policy of marine mammals in the region (UNEP, 1992). The UN Convention on the Law of the Sea (UNCLOS) will officially come into force in November 1994 after Guyana became the 60th nation to submit its formal ratification to the UN. Article 65 of UNCLOS provides for the international conservation of marine mammals and cetaceans in particular (Cetacean Society International, 1994).

Despite legal protection, limited post-ban sampling by CEPEC suggested that directed takes of small cetaceans, after an initial decline in some ports, had returned to former levels. In 1992, UNEP and the Whale and Dolphin Conservation Society (WDCS) agreed to support a 1993 survey to assess cetacean mortality levels with authorisation from the Peruvian Ministry of Fisheries.

MATERIAL AND METHODS

As noted above, before the 1990 ban on cetacean exploitation, the Ministry of Fisheries recorded cetacean landings in metric tonnes per port (e.g. Ramírez and Zuzunaga, 1991). Albeit crude, for many ports it represented the only available measure of fishery-related kill levels. After the ban, MIPE stopped gathering information on cetacean mortality, presumably because removals should have ceased. This paper reviews information on cetacean mortality collected during the post-ban period (November 1990 – December 1993) by the authors and volunteers of CEPEC (see acknowledgements) as well as unpublished results of the 1990 monitoring at Pucusana. It thus complements the papers by Van Waerebeek (1994) and Van Waerebeek and Reyes (1994a). Complete daily sampling data and a preliminary analysis are given in Van Waerebeek *et al.* (1994).

Data collection was essentially the same as in previous years (see Gaskin *et al.*, 1987; Read *et al.*, 1988; Van Waerebeek and Reyes, 1990a; 1994a). In summary, the authors and collaborators visited ports along the 2,500km Peruvian coast in 1993. A day spent at a particular port was counted as a sampling day only when the entire landing process of takes was observed. Three ports known to have high landings of cetaceans (Chimbote, Cerro Azul and Ancón) were selected for more intensive sampling. San Andrés was monitored by V. Tenicela (Museo Nacional de Historia Natural, Lima) in 1992. The long-term sampling programme at Pucusana had to be discontinued since the activities of the port authorities prevented fishermen landing whole carcasses at the fish terminal (although meat was routinely brought ashore). Fishermen also avoided landing cetaceans overtly in many other ports which greatly complicated our efforts to quantify takes; recorded numbers of animals may thus be lower than those actually captured. At some locations, e.g. Cerro Azul, Chancay and (initially) Ancón, dolphins and porpoises were brought ashore as if no prohibition existed.

Cetacean remains such as heads, flippers, strips of blubber, vertebra etc. found near coastal communities (±5km strip of beach either side) were presumed to originate from fishery interactions unless there was a good reason to believe otherwise. That the density of such material was usually high immediately north of ports and significantly lower or absent south of it, can be explained by the dominant northbound inshore currents. Specimens encountered on the many beach surveys were quantified by means of cranial evidence only, except where only scant remains were found. Informal interviews with hundreds of fishermen and other locals provided useful information on the best places to look for specimens. Several coastal sites could be visited only once or a few times due to their remoteness and our limited resources. The composition of the cetacean take was determined per port and per coastal region for the post-ban years and compared with pre-ban data (where available). The three coastal regions as defined by MIPE are northern Peru (Puerto Pizarro to Culebras), central Peru (Huarmey to Laguna Grande) and southern Peru (San Juan de Marcona to Vila Vila) (see Fig. 1).

Two types of estimates are employed, a 'scientific estimate' based on a random or near-random sample of acceptable size and linked to some measure of error, and a 'tentative estimate' which is an approximation based on the best available evidence but which was not necessarily derived mathematically. Standard errors (SE, further indicated by '±') of mean daily catch rates were estimated as $SE = (SD/\sqrt{n}).\sqrt{(1-\phi)}$ with SD the standard deviation, n the number of days monitored and $\phi = n/N$ the sampling fraction (Snedecor and Cochran, 1980). Standard errors and 95% confidence intervals (CI) of proportions were calculated according the normal approximation rule (Wonnacott and Wonnacott, 1990). To permit a tentative annual (post-ban) catch for Peru to be estimated, we classified ports for which no scientific estimate was available into the most plausible of four categories (Categories B-E) based on survey data and interviews and assigned an average take for each (shown in brackets); to

avoid problems of possible overestimation, Category A status was not assigned to any port unless it was scientifically monitored. The five categories are described below.

Category A
Very high annual catches, exceeding 1,500 cetaceans; largely the result of directed takes.

Category B
High annual catches, 500–1,500 (1,000) animals; many caught directly. Large numbers of fresh animals and abundant remains were recorded during limited surveying. Local sources confirm high takes as the norm.

Category C
Moderate annual take, 50–500 (275) animals; predominantly incidental. Some fresh specimens and abundant skeletal material found in the neighbourhood of the port. Local sources admit cetacean takes.

Category D
Low annual take, 0–50 (25) animals. No fresh animals were seen but some skeletal material was retrieved on nearby beaches.

Category E
Virtually no take (0). No fishery that can cause cetacean mortality operates in the area. No specimen evidence (fresh or other) encountered.

'Directed take' means all live-landed and harpooned cetaceans, dolphins caught alive in purse seine nets but not released (probably most) and animals captured in large-mesh driftnets (*animalero* nets). Unusually high numbers of Burmeister's porpoise caught in nearshore small-mesh gillnets in localities where the meat is fully utilised commercially (e.g. San José) are also included. Other takes are considered 'incidental'.

Since 1990, CEPEC members have observed more than 2,000 dolphins and porpoises landed. Due to the haste with which animals are butchered, for most only the locality,

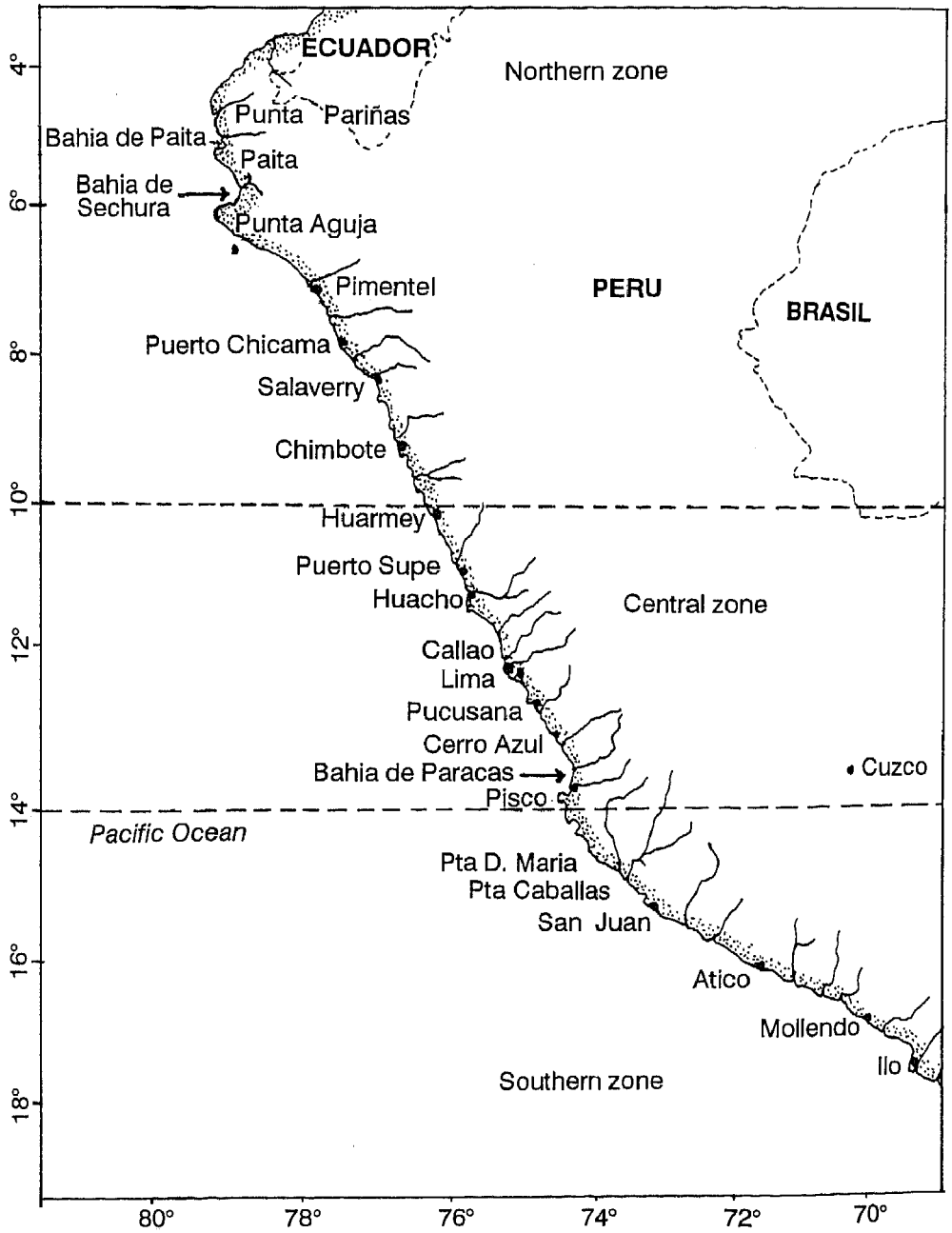

Fig. 1. Map of the region showing place names mentioned in the text.

date, species, sex and total length could be recorded. For a few hundred we documented more or less complete life history data. This and previously collected information will be analysed on a species by species basis and presented at a later date.

RESULTS

Chimbote

Chimbote (420km north of Lima) is one of Peru's few natural harbours and its largest fishing port, hosting several fishmeal factories. A 1985 attempt to set up a sampling programme in Chimbote identified high kills but was discontinued due to adverse conditions (Gaskin *et al.*, 1987).

In 1993, we sampled the artisanal terminal for 53 days, 37 days in summer (January-April) and 16 days in winter (June-August). A total of 265 dolphins and porpoises were observed: 132 *D. capensis* (49.8%, CI 43.8–55.8%); 119 *P. spinipinnis* (44.9%, CI 38.9–50.9%); 13 *T. truncatus* (4.9%, CI 2.3–7.5%); and one unidentified dolphin. Several independent sources reported occasional takes of 'much larger' cetaceans, most likely short-finned pilot whales (*Globicephala macrorhynchus*) or lesser beaked whales (*Mesoplodon peruvianus*). Results are summarised in Table 1. Although the mean daily kill was somewhat higher in summer than in winter, the difference was not significant (Z=-1.48, Mann-Whitney, P=0.14) due to large daily variations. The annual kill estimate for 1993 based on the pooled sample (mean daily take = 5.00±0.60) is 1,825±220 (CI: 1,394–2,256). These numbers refer to recorded animals only, which almost certainly underestimates true kill rates. Indeed, market workers are known to pay bribes and/or hide animals to avoid confiscation. In addition, not all captured cetaceans necessarily pass through the artisanal terminal, some are landed elsewhere and taken straight to markets.

Table 1

Catches at Chimbote in 1993

Period	Days Observed	Days Total	Estimated catch	Mean daily kill
Summer	37	120	672 (513-831)	5.60 ± 0.67
Winter	16	92	334 (179-489)	3.63 ± 0.85

Burmeister's porpoises were typically taken by gillnet boats and small-scale purse seiners (<100 GRT). Most common dolphins were taken by industrial purse seiners (>100 GRT), fishing principally for anchovy and sardine, or small purse seiners which set on a variety of pelagic schooling fishes. A great variety of fish species was marketed at Chimbote. In January 1993, for instance, bonito, mackerel, jack mackerel, cachema, sierra, lorna, cabinza, coco, pintadilla were most often seen; more occasionally flounder, guitar fish, machete, cherlo and castañeta. Due to the often dense crowds at the port, the restricted access to the pier and the huge volumes of catches, it was rarely possible to determine from which boats individual cetaceans were unloaded. No evidence of harpooning was found in Chimbote but many common dolphins had plastic bags or wet paper stuffed into the blowhole and nasal passage, a method often used to suffocate dolphins. We witnessed two battered but live animals being killed this way, while one had its throat slit and was left to bleed to death. Unlike net-killed dolphins, the skin of most dolphins at Chimbote showed extensive bruising suggesting a violent death while out of the water, presumably onboard purse seiners.

Overall there was a solid demand for cetacean meat; carcasses were usually sold within 10–15 minutes after being eviscerated. Cetacean meat in bulk (with bone) was sold for US$0.6–0.7/kg at the terminal although when large numbers were landed, apparently temporarily saturating the market, whole dolphins were reportedly sold by wholesalers for US$6. Much of the meat was bought by fishmongers who resold it on the central market at Chimbote for US$0.9–1.2/kg. Almost as a rule, after 0800hrs little evidence of the illegal trade was visible. Fishmongers commented that by doing so they effectively avoided interference by MIPE personnel 'who rarely show up in the early morning'. We witnessed a few cases of apparent bribery involving marines on patrol (Van Waerebeek *et al.*, 1994).

The large catches of cetaceans have been a persistent problem at Chimbote. In 1986, KVW photographed 11 long-beaked common dolphins, several alive, inhumanely unloaded from a purse seiner. In three days we counted 26 common dolphins, 4 bottlenose dolphins and 1 Burmeister's porpoise at the former artisanal terminal (Read *et al.*, 1988). However, there are also apparently exaggerated claims of high catch levels. Stuart Wilson (Environmental Investigation Agency, unpublished data) claimed that during July/August 1990 catches at Chimbote averaged 200 dolphins per day. Although locals have hinted at occasional huge single-day landings, it is highly unlikely this number reflects daily mean catches over extended periods. Inappropriate extrapolations have led to overestimates of total kills (see Currey *et al.*, 1990).

Pucusana

The general characteristics of the Pucusana small-scale fishery have been described in detail by Gaskin *et al.* (1987), Read *et al.* (1988) and Van Waerebeek and Reyes (1990a; 1994a). During a total of 230 days sampled at the Pucusana artisanal terminal in 1990 we registered 958 small cetaceans: 750 *L. obscurus* (78.3%, CI 75.7–80.9%), 139 *P. spinipinnis* (14.5%, CI 12.3–16.7%), 44 *D. capensis* (4.6%, CI 3.3–5.9%), 21 *T. truncatus* (2.2%, CI 1.3–3.1%), 2 *Globicephala macrorhynchus*, 1 *Lissodelphis peronii* and 1 *Mesoplodon peruvianus*. Landings stratified by month are given in Table 2 and based on this information the 1990 annual take at Pucusana is estimated at 1,651±53 (CI: 1,547–1,755). The majority of dolphins were killed in large-mesh animalero driftnets together with large fishes, but as in earlier years, some were taken in smaller-meshed drift and set gillnets (especially porpoises). In addition, two common dolphins and one dusky dolphin were harpooned on 12 March 1990 by a single boat and there were a few animals for which cause of death could not be ascertained. A shift in the species composition of catches from dusky to common dolphins (Fig. 2) is discussed by Van Waerebeek (1994).

In response to the 1990 legislation, the Pucusana port authorities prohibited the landing of cetaceans at the terminal (and enforced it) which made it impossible to monitor kills. However, fishermen continued taking dolphins but covertly landed and sold their catches. Dolphins are unloaded into anchored boats before docking

at the terminal, or are butchered on the way back from the fishing grounds. Meat hidden in boxes topped with fish is brought to shore and swiftly transferred to cool-storage trucks for transport to Lima markets; although usually this is done at night, we have also observed it during the day. Offal including intestines, blubber, backbones and heads is tossed overboard, often in the bay of Pucusana. Questioned fishermen made little attempt to deny that this occurs. Additional evidence comes from the discovery of tens of skulls and backbones scattered over the bay's seafloor (snorkeling by KVW and others). In 1992, fishermen attempted twice to revert to landing carcasses at the terminal, only to abandon it when they noticed that we resumed taking notes and photographs. In ten days 59 animals were landed (Table 4). There is little reason to believe that actual kills have diminished compared to earlier levels and port officials do not interfere with these illegal operations.

Van Waerebeek and Reyes (1994b) report on two juvenile southern minke whales, the first confirmed records for Peru, that were butchered at Pucusana after being accidentally caught in gillnets in September and October 1993; the meat was partly consumed locally and partly taken to Lima.

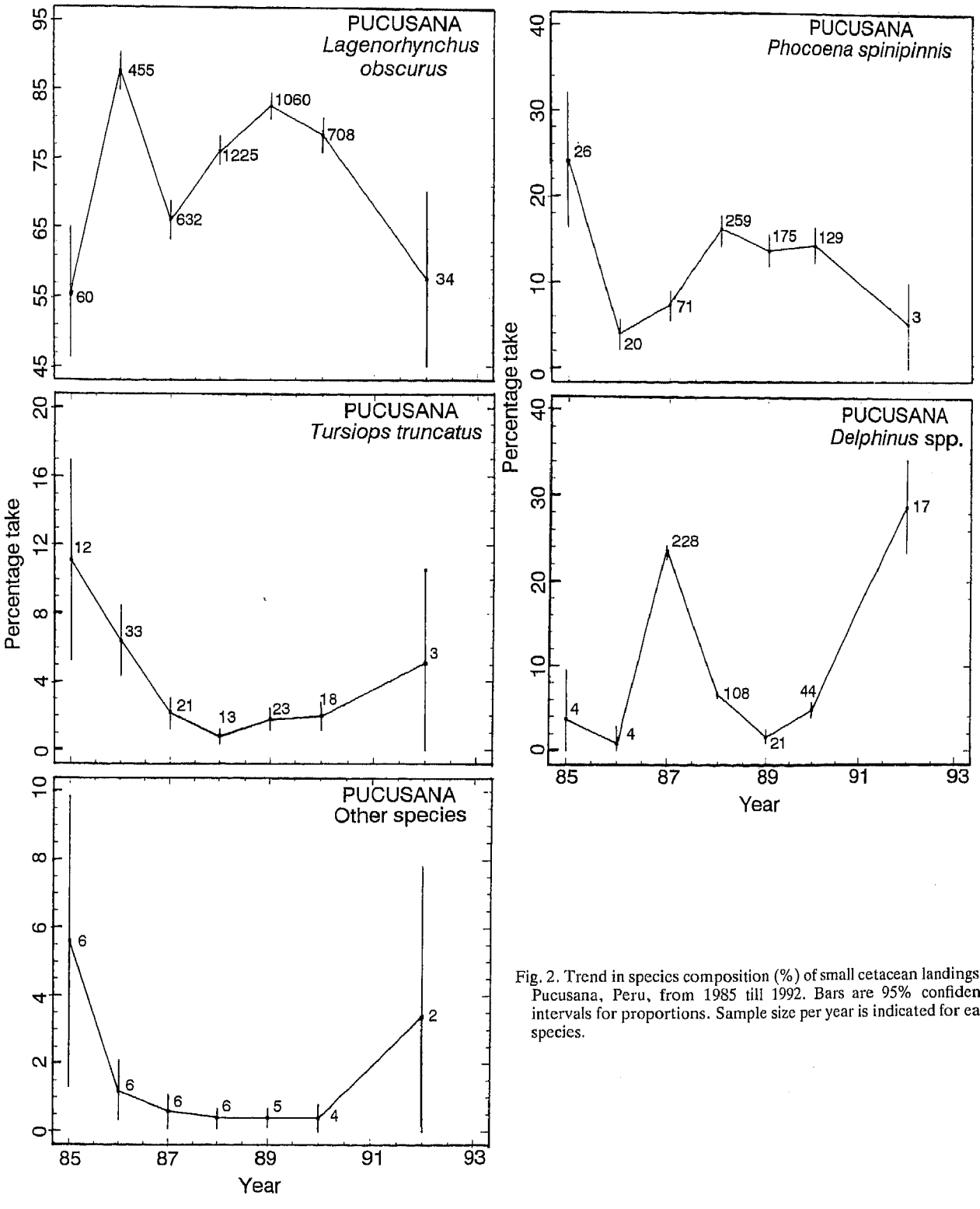

Fig. 2. Trend in species composition (%) of small cetacean landings at Pucusana, Peru, from 1985 till 1992. Bars are 95% confidence intervals for proportions. Sample size per year is indicated for each species.

Table 2

Observed numbers, estimated numbers and standard errors (stratified per month) of small cetaceans landed at the port of Pucusana, central Peru, in 1990. 'Other species' include *Lissodelphis peronii* (Sept.) and *Globicephala macrorhynchus* (Dec.). All numbers are rounded to their nearest integer; some totals may appear erroneous due to this rounding.

Month		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
No. days monitored		25	21	28	30	17	16	9	25	23	9	4	26	230
L. obscurus	OBS	28	34	76	133	49	61	44	47	165	79	8	26	750
	EST	35	45	84	133	89	114	152	58	215	272	60	31	1,289
	SE	3	1	6	0	9	11	27	6	25	17	14	4	44
P. spinipinnis	OBS	13	10	18	17	12	8	5	9	10	7	4	26	139
	EST	16	13	20	17	22	15	17	12	13	24	30	31	230
	SE	3	3	2	0	5	6	11	2	3	10	10	3	21
T. truncatus	OBS	2	2	4	3	4	0	0	0	0	0	1	5	21
	EST	2	3	4	3	7	0	0	0	0	0	8	6	33
	SE	1	1	1	0	3	0	0	0	0	0	6	2	7
Delphinus spp.	OBS	0	2	2	1	11	16	9	1	1	1	0	0	44
	EST	0	3	2	1	20	30	31	0	0	3	0	0	93
	SE	0	1	1	0	4	9	9	1	1	3	0	0	14
Other species	OBS	0	0	0	0	0	1	0	0	1	0	0	2	4
	EST	0	0	0	0	0	2	0	0	1	0	0	2	6
	SE	0	0	0	0	0	1	0	0	1	0	0	1	2
Total	OBS	43	48	100	154	76	86	58	57	177	87	13	59	958
	EST	53	64	110	154	139	161	200	71	231	300	98	70	1,651
	SE	4	3	6	0	11	15	31	6	25	20	18	5	53

Cerro Azul

During January-March 1992 (summer), we sampled the Cerro Azul fish terminal for 41 days and examined 199 small cetaceans; during winter (June-September) 25 animals were recorded in four days. The composition of the take is presented in Table 3. The mean daily catch rate for 1992 is estimated at 5.07 ±1.22 (N=45). While only about half (51.3%) of the catch consisted of *L. obscurus*, a significant decrease from the more than 80% in 1985–90, about 40% were *D. capensis*, an all-year peak (Fig. 3). Of 25 cetaceans seen landed in winter 1992, 21 were *D. capensis*.

In 1993, the fishmarket of Cerro Azul was monitored for 125 days in March-December, during which we observed a total of 684 (1,652 ±128) dolphins and porpoises (Table 3). The mean daily catch rate in 1993 was 5.16 ±0.59 (N=128), practically identical to the rate recorded in 1992 (Mann-Whitney pairs test, Z=0.24, P=0.81). Considering that different seasons were sampled, we feel confident in concluding that catch rates remained stable throughout the entire period. Using a weighted mean daily catch rate (5.28 ±0.65, N=174), the annual take for the 1992–93 period is thus estimated at 1,927 (CI 1,457–2,397) specimens.

Most cetaceans were landed together with rays, blue sharks, mako sharks, hammerheads and, to a lesser degree, with bonito. The gillnets with stretched mesh size of 20–30cm (*animalero* nets) cause by far the highest mortality. About 20 gillnet boats operate from Cerro Azul although the actual number may fluctuate; not infrequently boats from Pucusana are temporarily based at Cerro Azul and vice versa. Fishermen easily switch between nets of different mesh size which impedes estimation of effort data. Each year specimens (at least 3 in 1992) of a presumably resident group of coastal bottlenose dolphins which feed on inshore fishes (especially mullet) close to the pier, are harpooned. In 1993, we documented several harpooned animals (H) or animals killed by an unidentified piercing object (P): 6 *D. capensis* (3H, 3P), 2 *L. obscurus* (1H, 1P), 2 P. spinipinnis (P) and 1 offshore T. truncatus (H). Because we sampled Cerro Azul only part-time, the true numbers of harpooned animals must be higher.

Ancón

A. Garcia-Godos of CEPEC monitored cetacean mortality at the port of Ancón in the course of 1991–92 and carried out a preliminary analysis (García-Godos, 1993).

In 1991, Ancón was sampled for 57 days spread over all months (except April, May and July) during which 608 small cetaceans were recorded. The daily kill rate was significantly higher (Mann-Whitney pairs test, Z=-4.23, P<0.0001) in August-September (winter, mean=15.53, SD=12.55, n=32) than during other months (mean=4.44, SD=3.67, n=25). In summer, mortality is lower as most fishermen set gillnets with small mesh (5–9cm) for juvenile bonito and mackerel, which rarely entangle dolphins. The observed species composition was: 358 (58.9%, CI 55.0–62.8%) L. obscurus, 168 (27.6%, CI 24.1–31.2%) D. capensis and 82 (13.5%, CI 10.8–16.2%) P. spinipinnis. Sampling was insufficient and kills too seasonally variable to allow a scientific estimate of the total 1991 take. A tentative estimate ranges from a minimum of 1,600 animals, prorated from low-season mean daily take, and a high of 2,600, accounting for the two-tier kill rate and assuming a three-month high winter rate. The mean (2,100) is taken as best estimate. From August until September, 172 boat trips were recorded with an average kill per boat of 2.8 (SD=2.11, range=1–16), if trips with no catches are excluded. One bottlenose dolphin was harpooned, but most dolphins were caught in a directed fishery with large-mesh (22–30cm stretched) drift gillnets. Apart from the dolphins, these nets target blue, mako and hammerhead sharks, *Carcharhynus* sp., and rays. Smaller meshed (10–16cm stretched) nets were set for bonito, cojinova and elasmobranchs. Twenty-five boats were involved in the dolphin fishery on a continuous basis and another eight boats captured dolphins occasionally. Over

Table 3

Observed numbers, estimated numbers and standard errors (stratified per month) of small cetaceans landed at the Cerro Azul fish terminal, central Peru, during months sampled in 1992-1993. 'Other species' include *Globicephala macrorhynchus* (Nov.) and *Mesoplodon peruvianus* (Dec.). All numbers are rounded to their nearest integer; some totals may appear erroneous due to this rounding. Line totals are stratified estimates of corresponding period totals (three months for 1992 and ten months for 1993).

		1992				1993										
Month		Jan.	Feb.	Mar.	Total	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
No. days monitored		5	16	20	41	10	9	12	14	13	12	13	11	15	16	125
L. obscurus	OBS	52	54	5	113	29	26	53	20	35	29	6	43	135	19	395
	EST	322	101	8	431	90	87	137	43	83	75	14	121	270	37	957
	SE	185	23	4	186	26	24	27	9	28	21	8	37	75	17	103
P. spinipinnis	OBS	2	4	7	15	0	6	3	7	5	9	0	7	34	79	
	EST	12	7	11	30	0	20	8	15	12	23	0	20	68	16	182
	SE	7	3	4	9	0	7	4	8	16	7	0	11	21	5	32
T. truncatus	OBS	0	3	4	7	0	0	9	8	0	0	0	3	3	8	31
	EST	0	6	6	12	0	0	23	17	0	0	0	8	6	16	70
	SE	0	4	2	4	0	0	12	9	0	0	0	3	4	8	18
D. capensis	OBS	29	35	4	68	8	16	59	29	10	18	0	3	34	0	177
	EST	180	65	6	251	25	53	152	62	24	47	0	8	68	0	439
	SE	64	12	2	65	11	18	35	16	11	16	0	3	21	0	52
Other species	OBS	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
	EST	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4
	SE	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Total	OBS	83	96	20	228	37	48	129	64	50	56	6	56	207	36	684
	EST	514	179	31	724	115	160	320	137	119	145	14	157	414	70	1,652
	SE	196	29	6	197	10	41	46	20	35	31	8	51	81	26	128

the first three days of August 1991, some additional animals may not have been accounted for as we suspect that the fishermen hid some specimens in order to avoid control by MIPE personnel (García-Godos, 1993). During 61 observation days between February and December 1992, 231 cetaceans were caught: 113 *D. capensis* (48.9%, CI 42.5–55.4%), 102 *L. obscurus* (44.2%, CI 37.8–50.6%), 11 *P. spinipinnis* (4.8%, 2.0–7.5%) and five *T. truncatus* (2.2%, CI 0.3–4.0%). The mean daily kill was 3.79±0.75, with no obvious variation over the year. An approximate total kill estimate for Ancón in 1992 is thus 1,383 animals ±274 (CI 846–1,920). The location of the bottlenose dolphin captures suggests that they belonged to the offshore population. The dolphins were either killed by harpoon or captured in large-mesh gillnets.

In November 1992, as many as 90% of dolphins (n=199) were killed with hand-held harpoons by boat crews which originated principally from Callao and Chorrillos. In an attempt to avoid monitoring, fishermen shifted the landing and eviscerating of cetaceans towards the night. During a short visit on 3–4 August 1993, pejerrey and juvenile bonito were sold at the market, but no cetaceans; allegedly boats from Chancay had been unloading harpooned dolphins in the early morning. Support for continued kills comes from the fact that processed *muchame* type dolphin meat was available at US$7.50 per kg (wholesale price).

San Andrés

Artisanal fishermen operate mostly from San Andrés, a few kilometres south of Pisco while the industrial fishery is based further south at Paracas. Tenicela (1993) visited the port of San Andrés seven days per month for six months in 1992 (January, May, June, August, October-November). In 42 days 23 *Delphinus* sp., probably mostly *D. capensis*, (42.6%, CI29.4–55.8%), 17 *P. spinipinnis* (31.5%, CI 19.1–43.9%), 7 *L. obscurus* (13%, CI 4.0–21.9%) and one Risso's dolphin *Grampus griseus* (1.9%, CI 0–5.4%) were seen at the fishmarket.

The mean daily kill rate at San Andrés in 1992 was 1.29 specimens, suggesting a minimum annual take of 470 specimens. No SE can be estimated since Tenicela (1993) did not provide a *per diem* landing record. As in other places, the numbers cited are probably underestimates considering that the hiding of animals may be widespread. In addition, fishermen have been known to land cetaceans on surrounding beaches or at the El Chaco jetty. In January 1992, for instance, locals claimed daily takes were as high as 3–4 specimens (Van Waerebeek *et al.*, 1994) while sampling showed a daily catch estimate of only 2.5.

Most cetaceans were gillnet victims but some harpooning almost certainly occurs. Carcasses are either landed clandestinely or butchered offshore. Offal is tossed into the sea and often strands on nearby beaches. There was a significant and progressive decrease in total landings from January until November 1992 (chi-square=16.9, df 5, P=0.005) although the reason for this is unknown. No dusky dolphins were landed during winter while the single Risso's dolphin (female, 320cm) was caught in summer. Locals reportedly consume both fresh cetacean meat and prepare *muchame*. Some of the meat is transported to Lima.

Industrial purse seiners fishing for anchovy, sardines and bonito (the latter for canning) dock at private wharves and could not be inspected. However, it seems likely that non-negligible numbers of common and dusky dolphins are caught, as is generally true for Peruvian purse seine operations. Tenicela (1993) found remains of *Delphinus* sp. and *L. obscurus* near the Paracas fishmeal factories. Within the Paracas reserve, the fishing communities of Lagunillas and Laguna Grande (see below) also account for an unknown take. In 1993, cranial and fresh specimens were encountered during short visits (Table 4) but were not sufficient to enable estimation of total mortality.

Table 4

Summary results of scientific monitoring of cetacean fishery mortality at Peruvian ports in post-ban period. Type information: landings of fresh animals (L) and non-fresh remains (R). *L. obs.* = dusky dolphin; *D. cap.* = long-snouted common dolphin; *P. spi.* = Burmeister's porpoise; *T. tru.* = bottlenose dolphin.

Port	Date	Type	*L. obs.*	*D. cap.*	*P. spi.*	*T.tru.*	Other	Comments
Northern coast								
Puerto Pizarro	1 April 93	L,R	0	0	0	0	0	Small cetaceans said to be caught infrequently
La Cruz	1-2 April 93	L,R	0	0	0	0	0	Few interactions occur; shrimp fishery with trawlers and scoop nets (larvae)
Zorritos	21 February 93	L,R	0	0	0	0	0	Dolphins caught in gillnets; reportedly spotted dolphins present
Cancas	21 February 93	L,R	0	0	0	0	0	Fishermen use harpoons to take swordfish, sailfish and possibly dolphins
Mancora	19-22 Feb. 93	L,R	0	0	0	0	0	Common dolphins and porpoises are taken; also see Orozco (1988)
Los Organos	20 Feb 93	L,R	0	0	0	0	0	Fisherman described how he harpooned dolphins from bowsprit
Talara	16-17 Jan 93	L,R	0	0	0	0	0	Porpoises are said to be caught but landed furtively for fear of confiscation
Negritos	17 Jan 93	L,R	0	0	0	0	0	Landed takes transported to Talara
Paita	21-22 Feb, 28 Sept 93	L,R	0	0	0	0	1	Strip of blubber of unident. small cetacean found at terminal
Parachique	18-20 Feb 93	R	0	2	4	1	0	Tail and flipper of bottlenose dolphin; 0 fresh landings
	27,29,31 Sept 93	L	0	0	0	0	0	Pilar Tello (pers. comm. to KVW, 25 Oct 1993)
San José	14-16 Jan 93	R	0	3	6	0	1 *Ziphiid*	Also 2 backbones of *D. cap.* and 1 of *P. spi.* dump & south beach
	17 Jan 93	R	0	4	35	1	0	Tursiops vertebra only, on *ca.* 6kmof northern beach
	15,16,18 Feb 93	L	0	0	2	0	0	Fresh heads, blubber and intestines
	15,16,18 Feb 93	R	0	4	13	1	1 *G. macro.*	Also non-fresh blubber and a mummified porpoise
Santa Rosa	13-18 Jan 93	L	0	1	0	0	0	Dolphin landed on 15 January
	17 Jan 93	R	0	16	5	0	0	Beach between Santa Rosa and Pimentel
Pimentel	12 Jan 93	L,R	0	1	0	0	0	Freshly cut blubber on beach
	15-16 Jan 93	L,R	0	0	0	0	0	Large amounts of bonito landed; no full monitoring days
Eten	18 Jan 93	L,R	0	2	4	0	1 *Grampus*	One fairly fresh blubber piece of a porpoise; on beach north of the port
Pacasmayo	15 Jan 93	L	0	0	2	0	0	Juveniles (KVW-2379, -2380) caught in gillnet with rays, dogfish and robalo
	15-16 Jan 93	R	0	5	0	1	0	Northern and southern beach
Salaverry	10-11 Jan 93	R	0	2	5	0	1 *Ziphius*	Skulls
	20 Jan 93	L	0	0	1	0	0	Fresh head and testicles
	19 Dec 93	L	0	0	3	0	0	Fresh head and viscera found (D. Montes, pers. comm. to KVW, 16 Jan 93)
Chimbote	Jan-Aug 93	L	0	132	119	13	0	53 sampling days (see Van Waerebeek *et al.* 1994)
Coishco	20-21 Jan 93	R	0	1	0	1	0	Only about 100m of beach was accessible
Besique	22 Jan, 18 Mar 93	R	1	5	2	1	0	Found stranded on beach
Samanco	9 Jan 93	R	0	2	0	0	0	Decomposed carcasses, dorsal musculature removed
Los Chimus	10 Jan 93	R	0	1	9	0	1 *Grampus*	Skulls found on beach near fish terminal
Casma	25-26 Oct 92	R	0	1	1	1	0	Vertebrae of *Tursiops*
Culebras	21-25 Oct 92	R	0	0	0	0	Unident.	No cetaceans seen landed; abundant vertebrae
	11 Feb 93	R	0	1	0	0	0	Head and backbone, landed: dorado, dogfish, rays and squid
	12 Feb 93	L	0	0	0	0	0	Abundant dogfish and hammerhead; 23 gillnet boats, 10 small purse seiners
	26 Feb 93	L	0	2	0	0	0	Harpooned dolphins;
	27 Feb 93	L	0	2	4	0	0	Harpooned; fishery of bonito and mackerel declining
Regional total:			1	187	215	20	5	

/cont.

Table 4 (cont.)

Port	Date	Type	*L. obs.*	*D. cap.*	*P. spi.*	*T.tru.*	Other	Comments
Central coast								
Huarmey	21,22,24 Oct 92	R	1	12	0	0	0	
Supe	19-21 Oct 92	L,R	0	0	0	1	0	Mandibula; no fresh cetaceans seen landed
Huacho	18 Oct 92	L	2	0	0	0	0	AGG-G11, -612; taken in bonito nets by different boats
	19 Oct 92	L	0	0	0	0	0	No cetaceans landed; unident. remains of *Delphinus* or *L. obs.*
	10 Feb 93	L,R	1	0	0	0	0	Skull on beach; no animals seen landed
	11 Feb 93	L	?	?	?	?	?	Meat of 2-3 unident. animals disembarked clandestinely
Chancay	16 Oct 92	L	0	0	0	0	0	No cetaceans landed
	17 Oct 92	L,R	3	1	1	0	0	Skulls found on beach; no fresh animals seen
	9 Feb 93	L	0	0	4	0	0	Taken with dogfish and cojinova
	10 Feb 93	L	0	0	0	0	0	Small fishes were landed; one live *Dermochelys coriacea*
	9-10 Feb 93	R	3	1	0	3	0	In addition 12 backbones of either *Delphinus* or *L. obs*
	25 Oct 93	L	6	0	0	0	0	Landed with rays, blue and hammer shark (gillnet; 1 boat)
	26 Oct 93	L,R	8	24	2	0	4	Skulls state 2-4; around fish terminal; no fresh animals
	6 Nov 93	L	26	5	0	0	0	6 *L. obs* butchered in terminal; others kept in cool storage room
	7 Nov 93	L	0	0	0	0	0	No boats returned to port
Ancón	1991	L	358	168	82	0	0	57 sampling days (see García-Godos, 1993; Van Waerebeek *et al.* 1994)
	1992	L	102	113	11	5	0	61 sampling days (see García-Godos, 1993; Van Waerebeek *et al.* 1994)
Pucusana	28 Apr 92	L	6	0	1	0	0	Gillnetted
	29 Apr 92	L	6	6	0	0	0	Gillnetted
	1 May 92	l	7	5	0	0	0	Gillnetted
	3 May 92	L	0	4	0	1	0	
	4 May 92	L	0	1	0	0	0	
	5 May 92	L	0	1	0	1	1	*Globicephala macrorhynchus*
	6 May 92	L	8	0	0	1	1	*Grampus griseus*
	10 Oct 92	L	0	0	2	0	0	KVW-2352, -2353
	14 Oct 92	L	2	0	0	0	0	KVW-2354, -2355
	15 Oct 92	L	5	0	0	0	0	Dusky dolphins seized by port authority
Cerro Azul	20 Mar 91	L	1	0	5	0	0	JCR-1928 till -1933
	1992	L	117	89	15	7	0	45 sampling days (see Van Waerebeek *et al.* 1994)
	1993	L	395	177	79	31	2	128 sampling days (see Van Waerebeek *et al.* 1994)
San Andrés	Jan-Nov 92	L	7	23	17	6	1	42 sampling days (see Tenicela 1993)
	8 Jan 92	R	0	0	1	2	0	Fresh heads; coastal *Tursiops*, one collected
	16 Jul 92	R	0	5	1	0	0	Skulls on the beach near the port
	5 Nov 92	R	0	0	3	0	0	Skulls on the beach near the port
	10 Apr 92	R	3	1	0	0	0	Freshly butchered dusky dolphins; state 3 *Delphinus* head
Tambo de Mora	8 Oct 93	L	0	0	2	0	0	Landed together with rays
	9 Oct 93	L,R	0	0	0	1	0	Skull on beach close to wharf; no fresh animals
Laguna Grande	5 Nov 92	R	2	6	18	3	0	Skulls near jetty (Antigua rancheria)
Regional total:			1,069	642	246	62	2	
Southern coast								
S.J. de Marcona	17-18 Aug 93	R	4	0	1	0	0	Osteological material
Lomas	18-20 Aug 93	R	8	0	1	2	0	Skulls
Matarani	12,13,21 Aug 93	L,R	0	0	1	0	0	Blubber floating in harbour
Llo	405 Aug 93	L,R	0	0	1	0	0	Skull on beach, possible stranded; no fresh animals
Meca-lte	6 Aug 93	L,R	0	0	1	0	0	Weathered skull on beach; no fresh animals seen
Regional total:			12	0	5	2	0	

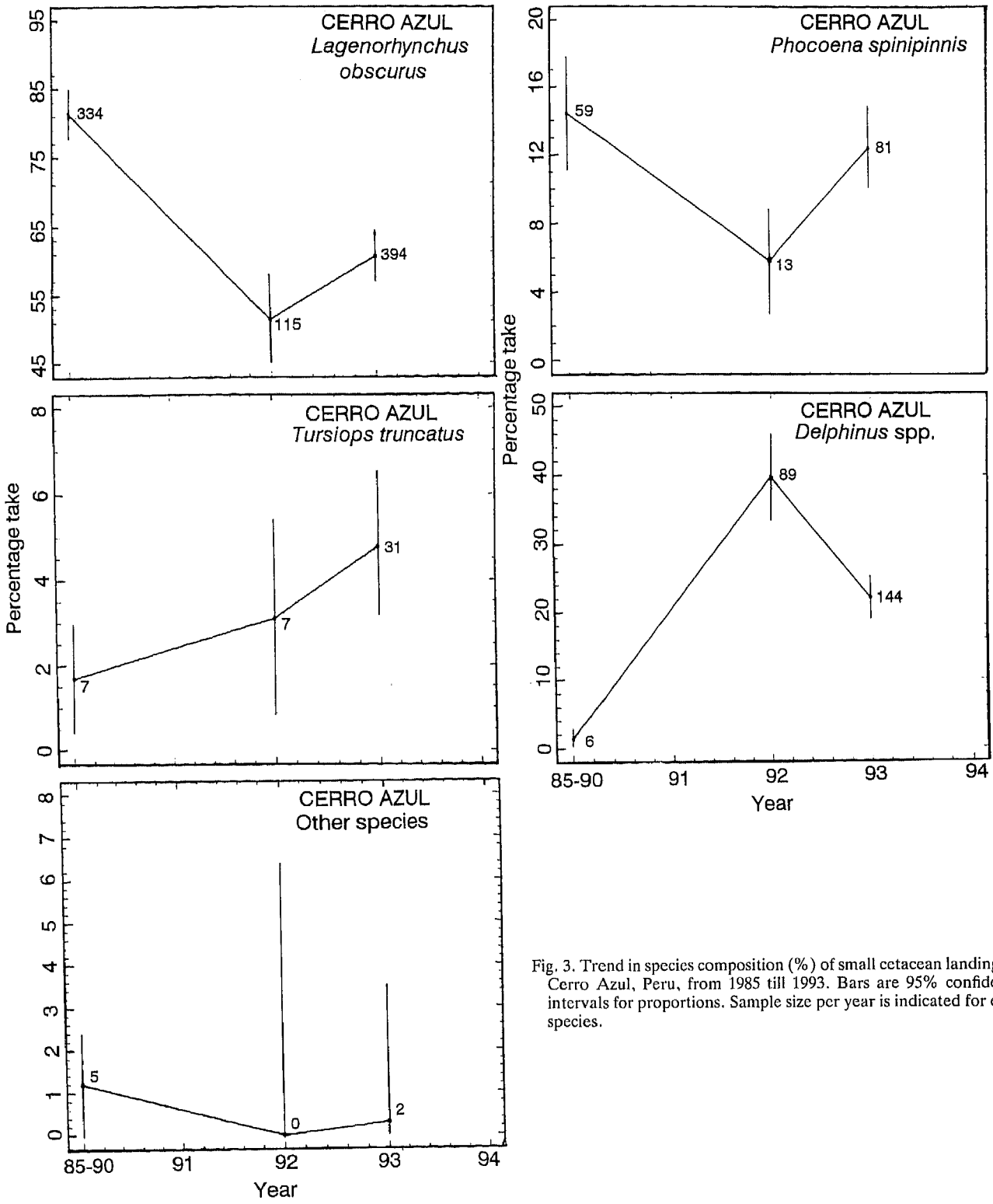

Fig. 3. Trend in species composition (%) of small cetacean landings at Cerro Azul, Peru, from 1985 till 1993. Bars are 95% confidence intervals for proportions. Sample size per year is indicated for each species.

OTHER PORTS

Below we discuss evidence of post-ban cetacean catches at less intensively surveyed Peruvian ports. Additional information can be found in Van Waerebeek *et al.* (1994). Information and sampling dates are summarised in Table 4.

Puerto Pizarro (03°29'S, 80°28'W)

This port is home to some 120 mostly gillnetting boats, apart from a few small purse seiners. Several fishermen use monofilament gillnets. Reportedly small cetaceans are caught incidentally and brought to port infrequently. If landed, they are often given away for free because they have little value compared to the still abundant commercial fish species. No cetacean remains were found in the environs of the disembarking site.

La Cruz (03°37'S, 80°37'W)

Industrial vessels trawl for shrimp (*Penaeus panameniae*) and local fishermen gather shrimp larvae with individual scoop nets. Some line-fishing also occurs. Beaches north and south of the pier were examined over a distance of about 3km but no cetacean material was found. This suggests that few, if any, interactions occur.

Zorritos (03°41'S, 80°35'W)
Some 50 boats operate out of Zorritos using both gillnets and longlines. Dolphins are caught 'at times' (two independent sources). One fisherman was familiar with 'dolphins with white dots', identifiable as the pantropical spotted dolphin, *Stenella attenuata*, frequently seen close inshore in southern Ecuador (Ben Haase, Centro Informativo Natural Peninsular, unpub. data). No direct evidence of cetacean captures was found.

Cancas (03°53'S, 80°55'W)
Moreno (1988) discussed the artisanal fishery at Cancas. The prevalent fishing methods are long-lines (47% of unit effort) and gillnets (20% UE), the latter set primarily for flounder and dogfish. Many boats carry a bowsprit which permits harpooning of swordfish and sailfish and at least occasional kills of dolphins must be expected (see Los Organos). About 50 boats, including small purse seiners, operate from Cancas.

Máncora (04°05'S, 81°04'W)
Some 50 fishing boats are based at Máncora, and deploy both gillnets (typically 10cm mesh) and longlines depending on target species. Hand-held harpoons are carried by most boats and are said to be used for harpooning swordfish and large tuna. Orozco (1988) named dogfish (*Mustelus whitneyi*), conger, sierra, dorado, bonito and thresher shark as the main commercial species and reported takes of unspecified small cetaceans in late 1986. Interviews with fishermen by one of us (KVW) using photographs of Peruvian cetaceans suggested that common dolphins, Burmeister's porpoises and, rarely, pilot whales are taken. Fishermen also recognised the bottlenose dolphin but not the dusky dolphin, as expected from their known distributions. Various sources claimed that 'dolphins' (probably bottlenose) occasionally swim in large groups close to shore. No cetacean remains were found on nearby beaches.

Los Organos (04°11'S, 81°07'W)
Catches of a large variety of fish species by more than 80 boats are unloaded daily at a tiny wharf. Both gillnets and longlines are used. One fisherman described how he regularly harpooned 'long-beaked dolphins', presumably common dolphins, from the bowsprit of his boat. Cetacean meat is consumed locally by fishermen and their families. Inshore swimming (bottlenose?) dolphins were mentioned.

Talara (04°35'S, 81°25'W)
We counted 40 small purse seines and some 45 wooden boats equipped with mast and sail used in a nearshore hook-and-line fishery at this major fishing centre of northern Peru, but from interviews it was clear that many more boats were out at sea. Porpoises are caught and consumed at Talara but are not openly sold to avoid confiscation. Our general impression was that control was fairly strict, more so than in any other port visited. This probably helps to explain why no evidence of cetaceans was encountered during our stay.

Negritos (04°36'S, 81°15'W)
This is an anchorage site just south of Talara for small sailing boats that fish mostly nearshore. Fish is transported to and sold at the Talara market. There was no evidence of any dolphin take.

Paita (05°05'S, 81°10'W)
Moreno and Mendieta (1988) studied the artisanal fishery at Paita during 1986–88. Of the total fishing effort, 13% was accounted for by gillnetting (for dogfish and suco), 52% by small purse seines (sardines, suco, cachema) and 35% by longlining (dorado, blue and mako sharks). Landings of cetaceans were confirmed but not quantified (Moreno and Mendieta, 1988). During our two visits, only a strip of blubber from an unidentified small cetacean was found, although the importance of this fishing port suggests that considerable bycatches probably occur. Paita should be monitored more closely in the future.

Yasila (05°07'S, 81°10'W)
A small group of fishermen reside at Yasila, a tiny resort south of Paita. They mostly gather shellfish although a few gillnet boats and purse seiners were seen. We found no cetacean remains on nearby beaches.

Caleta Constante
A small beach-head without infrastructure. No cetaceans were landed in the period 25–30 September 1993 (Pilar Tello, pers. comm., 25 October 1993). On the first day, three bottlenose dolphins were sighted swimming close inshore in a southerly direction.

Parachique (05°44'S, 80°52'W)
Meléndez (1988) reported in some detail on fishing effort in Parachique: 80% consists of small-scale purse seining (for sardine, mullet, suco, cachema), 7% gillnetting (for dogfish, bonito, suco), 8% longlining, 2% bottom trawling (for *Penaeus* spp.) and 3% diving. Gillnets are either polyfilament (No. 12, 18, 24) or monofilament (No. 50) with mesh-size 7.6–12.7cm. Fishermen admitted an incidental take of Burmeister's porpoises but no fresh specimens were seen landed during two visits in 1993. However, in two hours of beach-combing north of Parachique, skeletal remains of *P. spinipinnis, Delphinus* sp. and (probably) *T. truncatus* were found. A group of 6–7 bottlenose dolphins were sighted very close to shore on 19 February 1993. The community of Matacaballo has a small jetty a few kilometres north of Parachique where divers land mostly shellfish.

San José (06°46'S, 79°58'W)
The San José fishing community specialises in an inshore set-gillnet fishery for several species of rays, guitarfish, dogfish and flounder (rays and guitarfish are salted and dried for the production of a popular local dish (*chinguirito*)). This fishery results in relatively high levels of mortality of *P. spinipinnis* and other small cetaceans (Table 4).

Pimentel (06°45'S, 79°55'W)
The fishermen's community at Pimentel is fairly small compared to that at neighbouring Santa Rosa: some 263 fishermen (7% of the Lambayeque total) are registered. Annual harvest of fishery products in 1992 was 4.56% of the regional total, equivalent to 1,740 tonnes (Anon., 1993). Gillnetting is the prevalent fishing art at Pimentel. There is evidence of at least occasional catches of *Delphinus* sp. (Table 4) but no estimate of total kills is available.

Santa Rosa (06°56'S, 79°57'W)
With 2,200 registered fishermen this is by far the largest artisanal fishermen's community of the Lambayeque region (55% of total). In 1992, IMARPE officials recorded

a total volume of 33,949 tonnes of marine products (Anon., 1993). During our visit, about 80 large boats were operative. Fishing trips may last up to three days. Large numbers of bonito have been taken for two years using typical gillnets extending 36.6–54.9 deep and stretching 512m in length. The net maze used is 3.8–4.4cm wide. Several fishermen admitted capturing dolphins with some regularity. However, since the ban, dolphins have been butchered in the boats and the meat taken to shore hidden in baskets. A beach survey from Santa Rosa north to Pimentel yielded abundant cranial material of *D. capensis* and *P. spinipinnis* (Table 4). No cetacean material was found south of Santa Rosa which suggests that remains are dumped at the port and are swept to the north by inshore currents.

Puerto de Eten (06°57'S, 79°52'W)
This tiny community of 50 fishermen contributes only 1% of the total regional catch (Anon., 1993). Beach seines are set from the pier to trap inshore fish, mostly mullet. Line-and-hook fishermen claimed no dolphins are seen. Although locals did not report cetacean bycatches, on a beach search north of Eten we encountered skeletal material of six specimens (Table 4). A check of the southern 'Media Luna' beach yielded only one Burmeister's porpoise vertebra and one vertebra of an unidentified small delphinid, besides a weathered vertebral fragment of an unidentified large whale.

Pacasmayo (07°20'S, 79°35'W)
Two juvenile Burmeister's porpoises were photographed when hauled onto the wharf together with rays, dogfish and robalo. The porpoises, sold together for about $15, were eviscerated at the end of the pier. Remains were pitched into the sea except for the head, kept with the meat to prove the species identity to port authority personnel. For some unknown reason, porpoises are permitted to be used commercially but not *Delphinus* spp. This situation existed long before the 1990 ban came into effect (Van Waerebeek and Reyes, unpub. data). Abundant skeletal material, especially of *Delphinus*, was found on nearby beaches (Table 4).

Pto. Chicama, Malabrigo (07°40'S, 79°15'W)
This is a small port with factories for fishmeal and canned fish. During our visit, 13 small-scale purse seiners, 8 gillnet boats and one industrial purse seiner were anchored. Sharks, guitarfish, mullet and suco were landed. A MIPE employee admitted that porpoises are caught. Fishermen prefer to keep cetacean meat for their own consumption rather than risk having it seized by port authorities who, apparently, enforce the dolphin protection law. No skeletal material was found along the shores.

Salaverry (08°14'S, 78°59'W)
According to a watchman at the industrial seaport of Trujillo, industrial seiners often land cetaceans. Fishermen claimed to catch more porpoises than dolphins and 'almost daily'. The takes were confirmed by the finding of skulls of eight cetaceans, including an adult Cuvier's beaked whale (*Ziphius cavirostris*). Monitoring showed *P. spinipinnis* is regularly captured.

Puerto de Santa (08°58'S, 78°38'W)
This is an impoverished fishing community at the mouth of the Santa river, some 20km north of Chimbote. Thirteen small boats, two with gillnets, were anchored in the bay during our visit. Beach seines were observed. No cetacean remains were found along the beach, but neither was any fish offal. Sources confirmed that landings from Santa are usually taken to Chimbote by road. On one occasion a Burmeister's porpoise was seen being unloaded in Chimbote from a small truck which came from Santa.

Coishco (09°04'S, 78°37'W)
Fishmongers at Chimbote reported that large numbers of dolphins were landed at Coishco, a small town close to an industrial fishery complex with private wharf and several fishmeal processing units. About 50 purse seiners (100–350 tonnes) were reportedly fishing for anchovy. Mr. Felipe Velásquez of COPES claimed no dolphins were captured by his company's purse seiners and granted us access to the wharf. One worker stated that, although company regulations did not allow dolphins to be unloaded on the dock, they were simply landed on the beach nearby and sold in Chimbote. This was supported by the fact that a fresh piece of blubber with a dorsal fin, a partial backbone and several loose vertebra, most likely from *Delphinus* sp., were retrieved on a 100m strip of the beach.

Besique (09°11'S, 78°30'W)
This resort in the Bay of Samanco is frequented in summer by tourists from Chimbote. Beach seining for a variety of inshore fishes is widely practised. Beaches were searched during several visits in 1993 and abundant small cetacean material was retrieved (Table 4), probably originating from dolphins caught by purse seiners and gillnet boats docking at Samanco. Groups of six and three coastal bottlenose dolphins were sighted from the beach on 18 and 24 March 1993 respectively.

Samanco (09°16'S, 78°30'W)
This is an industrial complex with a modern, private pier, serving three companies principally dedicated to fishmeal production. CEPEC members visited the complex several times in 1993, each visit lasting a few hours. About 20 purse seiners were landing anchovy round the clock. According to workers, a single purse seiner occasionally may land 10–15 'long-beaked dolphins', presumably common dolphins. The latter are butchered at the wharf and the meat is either distributed locally or sold in Chimbote. The few artisanal gillnet boats present mostly set nets for small inshore fishes. On 8 January we observed four purse seiners disembarking anchovy and (as we were told the next day) two dolphins. Later, two somewhat decomposed *Delphinus* sp. carcasses, with dorsal musculature removed, were seen stranded close to the pier. For monitoring to be effective, a 24hr/day presence is required.

Los Chimus (09°20'S, 78°28'W)
This small resort and fishing town south of Samanco has a newly-built fish terminal that was not in use when we sampled the port. Thirty-four small fishing boats (29 with gillnets, five with diver air compressors for mollusc gathering) were anchored beyond the surfzone. On *ca.* 1km of beach we found 11 small cetacean skulls (Table 4), more than 25 carapaces of green turtles (*Chelonia mydas*) and unusually large numbers of *Otaria byronia* skulls. All specimen remains are thought to originate from fishing interactions.

Tortugas (09°22'S, 78°25'W)
This is a small fishermen's settlement at the southern end of the Los Chimus Bay. Fishery activity is limited to shellfish and octopus extraction. Locals stated that no dolphins were killed; no cetacean bones were found in the vicinity.

Casma (09°28′S, 78°19′W)
This is home to both an artisanal and industrial fishery fleet. Local fishermen stated that they 'occasionally' capture cetaceans in gillnets and this was confirmed by small cetacean bones found along nearby shores (Table 4). Long-term monitoring is needed because Casma has the potential to account for high cetacean mortality.

Culebras (09°56′S, 78°13′W)
Although no fresh dolphin remains were found, we discovered large numbers of vertebrae from small delphinids near this port in 1992. Local sources referred to high dolphin kills both by gillnets and harpoon (up to 5–10 animals per boat) especially in winter. Four harpooned *D. capensis* were registered in four days of monitoring in February 1993 (Table 4) and it seems possible that high *D. capensis* mortality occurs; this port should be monitored more thoroughly.

Huarmey, Puerto Grande (10°04′S, 78°10′W)
Artisanal fishermen land catches directly onto the beach close to the industrial wharf. No fresh cetacean remains were found but large amounts of skeletal material, especially from *D. capensis*, was collected on the beach in 1992–93 (Table 4). This substantiates reports by fishermen that dolphins are regularly taken, including by harpoon. Purse seiners reportedly have landed 30–40 animals at once on occasion. Much of the meat is sold locally and sells for $1.7/kg – comparable to the cheaper cuts of beef.

Puerto Chico (10°44′S, 77°47′W)
This beach, close to Barranca, has no infrastructure but is used as a disembarking site. On our visit only lorna was brought ashore by gillnet fishermen but cetaceans are reported to be landed occasionally; no remains were found.

Puerto Supe (10°48′S, 77°46′W)
During our visit we counted 21 wooden boats, 10 small purse seiners and 10 industrial purse seiners. We found one bottlenose dolphin mandibula during a short beach search. Fishermen admitted to landing and selling dolphins in the knowledge that it was illegal but, curiously, notified port authorities before doing so. Dolphins killed in purse seines were said to be tossed on the beach where they were quickly used by locals.

Caleta Vidal (10°50′S, 77°44′W)
This is a tiny fishing community 5km south of Supe from where approximately ten boats operate. Catches are landed directly on the beach and taken to Puerto Supe or Barranca for sale, which may explain why no cetacean remains were found.

Huacho (11°07′S, 77°37′W)
Both an artisanal and industrial purse seine fleet are based at Huacho. Large catches of *L. obscurus* were recorded in winter 1985 (Gaskin *et al.*, 1987). We found both freshly landed animals and skeletal remains during short visits in 1992 and 1993 suggesting that gillnet mortality persists (Table 4), but no kill estimates can be made. Meat was sold at $1.3/kg. Industrial purse seiners 'occasionally' land *L. obscurus* and *Delphinus* sp. (Engineer Ayala, Instituto del Mar del Perú, pers. comm. to A. García-Godos, CEPEC).

Chancay (11°37′S, 77°16′W)
Chancay is home to an important purse seiner fleet and some 60–70, mainly gillnet-equipped, wooden boats. Gaskin *et al.* (1987) reported large catches of *L. obscurus* in winter 1985. During several visits in 1993 large numbers of fresh cetaceans and skulls were encountered (Table 4). The species composition (n=82) was: 52.4% (CI 41.6–63.2%) *L. obscurus*, 36.6% (CI 26.2–47.0%) *D. capensis*, 7.3% (CI 1.7–13.0%) *P. spinipinnis* and 3.7% (CI 0–7.7%) *T. truncatus*. Interviews suggested that 'moderate to large' catches, interspersed with periods of low or zero kills, occur year-round. Several port workers blamed the industrial fishery for high takes of common dolphins. Most dusky dolphins seen were caught in gillnets. Although port authorities are known to seize dolphins they do not do so systematically.

Tambo de Mora (13°30′S, 76°11′W)
During our short visits only a few *P. spinipinnis* were seen landed here and only a bottlenose dolphin skull was found (Table 4), however, the relative inaccessibility of the wharves impeded adequate sampling. Reportedly cetaceans are 'often' landed but so far there is no indication that a true dolphin fishery has developed as had been feared (Van Waerebeek and Reyes, 1994a). Much of the meat is said to be processed into *muchame* and is probably sold in nearby Chincha where it has been readily available for a long time (Dr. Robert Clarke, Pisco-Peru, pers. comm., 2 April 1994). CEPEC observers sighted bottlenose dolphins swimming close to the piers on two consecutive days.

Laguna Grande (14°10′S, 76°13′W)
This is a squatters' fishing community situated in the Paracas Marine Reserve which has its roots in the scallop exploitation boom of the early 80s. A single visit in 1992 yielded large numbers of cetacean bones on the beach in the proximity of a jetty (Table 4).

San Juan de Marcona (15°20′S, 75°09′W)
About 60, mainly outboard-powered, gillnet boats operate from this port. Before the ban 'very few dolphins and porpoises have been landed' (P. Majluf, cited in Gaskin *et al.*, 1987). Carlos Castañeda (pers. comm. to A. García-Godes, CEPEC, 17 August 1993) resident at San Juan during the summer of 1992–93 reported an averaged daily take of three small cetaceans during that period and had witnessed landings of live animals. The presence of skeletal material on the shore around the port supports claims of persisting catches (Table 4).

Lomas (15°32′S, 74°50′W)
Gillnet boats and small purse seiners were said to net dolphins 'at times'. Fairly abundant skeletal remains of *L. obscurus, P. spinipinnis* and *T. truncatus* was found in the immediate vicinity of the port (Table 4). From partly burned cranial and vertebral remains of a balaenopterid whale only the atlas was collected.

Chala (15°32′S, 74°50′W)
Chala harbours about a dozen boats which mainly extract molluscs and crustaceans. Inshore fishes are captured with handlines. No longlines are deployed. Two partial backbones of small dolphins (either *Delphinus* sp. or *L. obscurus*) and a few loose vertebra were found around the wharf and the beach to the north of it. Fishermen admitted they sometimes take dolphins accidentally.

Ocoña/La Planchada (16°26'S, 73°08'W)
Ocoña features a fishmeal factory and a large wharf where the purse seiners dock. Artisanal fishermen extract mostly shellfish, especially abalone (*Concholepas concholepas*). However, some gillnetting activity occurs and locals commented that at times dolphins are caught and eaten. Due to rough weather little fishing occurs during winter months.

Matarani (16°58'S, 72°07'W)
This medium-sized port has three fishmeal and canning factories which rely on the purse seine fishery for anchovy and sardines. Some 35 longline and gillnet boats and 25 diving-equipped shellfish boats operate from Matarani. Fishermen, fully aware that the capture of small cetaceans is prohibited, maintain that port authorities exert control. However, the blubber of a freshly skinned Burmeister's porpoise was seen floating in the harbour. A few locals admitted they occasionally ate dolphin meat. Several stated also that bottlenose dolphins and large whales, probably southern right whales (see Van Waerebeek *et al.*, 1992), are sighted from the pier with some regularity. The port of Mollendo (17°02'S, 72°01'W) has been closed for years.

Ilo (17°38'S, 71°20'W)
Ilo hosts three fishmeal factories. Small scale fishermen extensively use longlines since shellfish production has dropped. In summer, gillnets are set for bonito and cojinova, resulting in most of the annual mortality of small cetaceans. On a three hour beach survey south of the port a single skull of *P. spinipinnis* was found. Locals said the animal had stranded about a month ago and its meat had been used for bait. Remains of an as yet unidentified balaenopterid whale were found south of Ilo. Allegedly the whale was hauled onto the beach when it entered very shallow water and locals started butchering it before it died.

Meca-Ite (17°54'S, 70°58'W)
This beach-head has about ten inshore fishing boats. In summer, boats from Ilo are said to operate in the area. Local fishermen reported occasional entanglements of porpoises and bottlenose dolphins in their nets. A weathered skull of *P. spinipinnis* was found along the shore and bones of an unidentified whale were found along the rocky beach of Punta San Pablo.

Vila-Vila (18°08'S, 70°36'W)
Longlines are set principally between October and January. Some 27 boats were counted on our visit, including 15 equipped with compressors for gathering shellfish by divers. In three days, two *P. spinipinnis* were reportedly entangled in inshore gillnets, but the animals were not seen by the CEPEC observers. The broken skull of a large whale was found at Boca del Rio but no other cetacean material was discovered.

CHARACTERISTICS OF POST-BAN CETACEAN EXPLOITATION

Species composition
The species composition of cetacean catches for northern, central and southern Peru in the post-ban period is summarised in Table 5. Off northern Peru, most of the mortality comprises Burmeister's porpoises (about 50%) and long-beaked common dolphins (44%). The virtual absence of dusky dolphins off northern Peru is consistent with known distribution limits (Van Waerebeek, 1992a; b) and the two dusky dolphin skulls found by A. García-Godos and J. Alfaro (CEPEC) in Salaverry (08°14'S), currently represent the most northerly record of the species. In central Peru, dusky dolphins (53%) and long-beaked common dolphins (32%) are the most important species. The sample from southern Peru is too small to allow comparison with other areas and the absence of *D. capensis* in the present sample is probably an artifact. Combined landings of the lesser beaked whale, short-finned pilot whale, short-beaked common dolphin (*D. delphis*), Risso's dolphin, southern right whale dolphin, Cuvier's beaked whale and southern minke whale account for only a few percent of the total Peruvian take and can be considered as a true incidental catch.

Table 5

Species composition of post-ban cetacean kill in Peru per coastal region. Standard error (SE) and lower and upper 95% confidence intervals (CI) are indicated.

Coastal region		*L. obs.*	*D. cap.*	*P. spi.*	*T. tru.*	Other	Total
North	No. specimen	1	187	215	20	5	427
	%	0.2	43.8	50.4	4.7	1.2	100
	SE(%)	0.2	2.4	2.4	1.0	0.6	-
	Lower CI	0	39.1	45.6	2.7	0.2	-
	Upper CI	0.7	48.5	55.1	6.7	2.2	-
Central	No. specimen	1,069	642	246	62	2	2,021
	%	52.9	31.8	12.2	3.1	0.1	100
	SE(%)	1.1	1.0	0.7	0.4	0.1	-
	Lower CI	50.7	29.7	10.7	2.3	0	-
	Upper CI	55.1	33.8	13.6	3.8	0.2	-
South	No. specimen	12	0	5	2	0	19
	%	63.2	0	26.3	10.5	0	100
	SE(%)	11.1	0	10.1	7.0	0	-
	Lower CI	41.5	0	6.5	0	0	-
	Upper CI	84.8	0	46.1	24.3	0	-

The worrying decline in the percentage of dusky dolphins in landings over time (Figs 2 and 3) is discussed by Van Waerebeek (1994) who suggested that this may reflect an increase in the relative abundance of *D. capensis* of central Peru.

Total annual take
Ironically, since small cetaceans acquired legal protection, it has become even more difficult to accurately estimate total annual takes. Based on the best available evidence for each Peruvian port, we have tried to categorise them in terms of their post-ban landings below.

Category A: Chimbote (1,825 for 1993); Pucusana (1,651 for 1990); Cerro Azul (1,927: mean catch of 1992/1993); Ancón (1,740: mean catch of 1991/1992). Estimated combined annual take: 7,140.

Category B: (mean = 1,000 p.a.): Santa Rosa, San José, Culebras, Huarmey, Chancay. Extrapolated take p.a.: 5,000.

Category C: (mean = 275 p.a.): Máncora, Paita/Yacila, Los Organos, Talara, Supe, Pacasmayo, Salaverry, Coishco, Los Chimus, Casma, Chicama, Huacho, Callao (?), San Andrés (470 for 1992), Tambo de Mora, San Juan de Marcona, Lomas. Extrapolated take p.a.: 4,870.

Category D: (mean = 25 p.a.): Puerto Pizarro, Zorritos, Cáncas, Parachique, Pimentel, Eten, Santa, Puerto Chico, Vidal, Chorrillos, Laguna Grande, Chala, Ocoña/La Planchada, Matarani, Ilo, Meca/Ite. Extrapolated take p.a.: 400.

Category E: (0 take): La Cruz, Punta Mero, Acapulco, Negritos, Matacaballo, Caleta Constante, Besique, Tortugas.

By combining the category totals (17,400), we estimate the total yearly take for Peru in the period 1990–93 to range between 15,000–20,000 small cetaceans, i.e. higher than the estimated peak catch for 1989 (14,100 animals) based on MIPE data (1,093 tonnes, Ramírez and Zuzunaga, 1991). Landings at Pucusana in 1990 were lower than in preceding years but landings at Cerro Azul have greatly increased (see Read *et al.*, 1988; Van Waerebeek and Reyes, 1990a; b; 1994a). No comparisons can be made for other ports due to lack of information for earlier years.

In the absence of abundance data and reliable stock delineation, assessing the impact of catches is impossible: sighting surveys are urgently needed. However, the high levels of mortality are already a cause of concern in many cases. IWC (1994) states that removals of the southeastern Pacific dusky dolphins are probably not sustainable. Similar concerns seem warranted for *D. capensis* and *P. spinipinnis*.

Fisheries and attitudes

Artisanal fishermen are surprisingly mobile and frequently travel along the coast in search of the best fishing grounds. Due to the proximity of Chancay and Ancón, for instance, fishermen of both towns often operate from each other's home port. A similar pattern is observed at Pucusana and Cerro Azul.

With a few obvious exceptions, interview feedback from fishermen agreed well with our view obtained from monitoring and beach surveys. In general, fishermen from northern Peru were more communicative than those from central and southern coasts and showed no reticence to talk about dolphin catches. We found that virtually all fishermen were aware that small cetaceans are protected but very few were receptive (and those almost certainly out of politeness) when we explained why the ban must exist. Although they routinely cited 'economic difficulties' to justify killing cetaceans, rarely are those difficulties as acute as claimed. Their view rather reflects a general sense of uncertainty about their short-term future due to the genuine unpredictability of harvest and dangerous working conditions and, it seems to us, a refusal to plan ahead. The opportunistic approach of small-scale fishermen reflects the short-term view that prevents many artisanal fishermen from investment or taking decisions which would be to their clear benefit in the medium or longer-term. Unless this attitude can be changed by improving their real (and, more importantly, perceived) security, ecological arguments will remain irrelevant and cooperation unlikely. This will require a dedicated and thoughtful policy towards artisanal fishermen and much patience.

The apparent unwillingness/inability of MIPE to enforce the ban, in part reflects the truly complex nature of the problem and in part the unfortunate but widespread perception of environmental issues as low-priority. It also must be said that the poor level of education of policing personnel and the armed forces, combined with economic factors such as insufficient pay which render them susceptible to bribery, certainly compound the problem.

However, short of a fully enforced, outright ban of all gillnet and harpoon fisheries and strict control of purse-seine operations, neither of which can be achieved overnight (if ever), there is no practical panacea to this problem (see also Jefferson and Curry, 1994). Unfortunately, time may be short for several stocks of Peruvian small cetaceans and some measures that can be expected to significantly mitigate mortality rates are discussed in the recommendations section.

One possible longer term solution concerns the changing of fishing techniques. A 1992–1993 IUCN/WDCS study has shown the high potential of fish-baited longlines to partly replace gillnets in the shark and ray fishery, and thus reduce cetacean mortality (Reyes, 1993). Additional data collected at Pucusana further confirms the feasibility of longline fishing. During six fishing trips (four in November and two in December 1993) one boat equipped with a small longline (150 hooks) reportedly caught, on average, about 300kg (200–400 kg) blue sharks and 118kg (80–200 kg) mako shark, using a variety of low-value fish species as bait. In the December trips, an additional 175kg of dorado (*Coryphaena hippurus*) was also caught. The mean net income after subtraction of all costs (fuel/subsistence) was about $153 per two-day trip. This amount is customarily divided between the two fishermen (each 25%), and the owners of the boat and longline (each 25%), often the fishermen themselves. These earnings compare favourably with the minimum guaranteed monthly wage in Peru of US$61 and typical labourer/employee monthly wages of US$90–140.

However, should the use of longlines be promoted, the process should be supervised to ensure no unforeseen and counterproductive results arise. For example, uncontrolled South American longline fisheries in Venezuela, French Guiana and southern Ecuador have used dolphin meat as bait (Agudo and Romero, 1990; Van Waerebeek, 1990; Felix and Samaniego, pers. comm., February 1994). Although the present price of dolphin meat in Peru is too high for its use as bait, increased demand might encourage fishermen to harpoon additional animals when out fishing. Dolphin offal such as blubber and intestines from the dolphin fishery is not used as it is alleged to be ineffective. Long-line interactions with non-target species do occur but apparently are rarely lethal. During test sets, South American fur seals *Arctocephalus australis* and an unidentified albatross became hooked when trying to steal bait, but escaped without much harm (Reyes, 1993). No cetacean mortality has been reported in longlines off Peru, although the stealing of the catch from the hooks by marine mammals can lead to directed kills by fishermen.

Problems of humane killing

The principal cause for concern with respect to humane killing is the live-landing of animals, especially by industrial purse seine vessels, and the use of hand-held harpoons to catch bottlenose, dusky and common dolphins; harpooning is particularly prevalent off central and northcentral Peru. One of the worst recorded infractions occurred in November-December 1992 when over a 23-day period, 178 harpooned common and dusky dolphins were landed (besides netted ones) at the wharf of Ancón. Visiting fishermen from Callao (5 boats) and Chorrillos (1 boat) were mostly responsible for the harpooning, although one boat from Ancón had also participated (see García-Godos, 1993). When this was drawn to the attention of the Ministry of Fisheries, the only measure taken was an 'interrogation of locals and fishermen' who claimed not to have caught any cetaceans. This illustrates the urgent need for more rigorous control and the application of penalties.

There is sufficient evidence to state that the commercial purse seine fishery for anchovy and sardines off Peru for the fishmeal industry is responsible for large, albeit unknown, kills of dolphins. The most heavily affected species in the Chimbote area is *D. capensis*, but data in Tenicela (1993), as well as its distribution, suggests that *L. obscurus* is also involved off central Peru.

Muchame

Muchame (also known as *Buchami* or *musciame*) is the salt-dried dorsal muscle of small cetaceans prepared according to a recipe of Italian origin. A black market may still exist in northern Italy (G. Notarbartolo di Sciara, Tethys Res. Institute, pers. comm., 13 Nov. 1993) and this raises the question as to whether some Peruvian muchame is illegally exported. Although it has been around for decades in Peru, indications are that in recent years its illegal trade and consumption of *muchame* have increased considerably. A market study in June-July 1993 revealed its wide availability in the shops and supermarkets of Lima and Callao (Van Waerebeek *et al.*, 1994). Ancón, Pucusana, Chincha and Arequipa are other towns where it can be purchased without difficulty. Its availability may well be explained by the huge profit margins: prices range from $7.5 to $35.9 /kg whilst fresh cetacean meat sells for $0.7–2.0 /kg).

RECOMMENDATIONS

It is clear that the 1990 law protecting Peruvian small cetaceans from exploitation was, depending on the locality, only at best partially enforced. Recent field work by CEPEC members suggests that the law of August 1994 is having more effect so far (November 1994). Authorities regularly seize landed cetaceans, at least at some ports, while pressure from impending penalties and public opinion is higher. Despite this, unknown quantities of cetacean meat are still used commercially and there is no direct evidence that the mortality rate is really down. We recommend that a number of measures be taken to further alleviate the situation.

(1) Dolphins accidentally captured in purse seines should be released. Independent observers, backed by new *ad hoc* regulations, should investigate the issue in detail, determine precise circumstances of captures and suggest practical solutions. The Inter-American Tropical Tuna Commission (IATTC), which has long-term expertise with monitoring of large-scale seining operations, should be consulted as an advisory body.
(2) Fishermen should be required to declare bycatches immediately after docking. Port officials should proceed to confiscate and register the animals by species. The consumption of fresh cetacean meat should be permitted if it is derived from such registered animals and the meat is distributed for free among locals and institutions of public utility. Any form of commerce in cetacean products should remain banned.
(3) Inspecting personnel should be trained in the recognition of species and signs of fishery mortality.
(4) Scientists should have priority access to specimens for study and biological sampling.
(5) The use of large-mesh gillnets (*animalero* nets) that cause the highest rates of directed mortality among dolphins, should be phased out as soon as possible.
(6) Small scale long-lines, which are not known to cause cetacean mortality in Peru, should be promoted as a cost-effective and superior alternative to large-meshed gillnets in the Peruvian shark and ray fishery, provided adequate monitoring takes place.
(7) A feasibility study should be carried out to assess the potential of dolphin-watching (ecotourism) as an alternative source of income for some groups of artisanal fishermen in areas of high cetacean density (and high takes).

ACKNOWLEDGEMENTS

This work would not have been possible without the dedication of CEPEC volunteers Joanna Alfaro, Ruth Bello, Aquiles García-Godos, Karina Ontón and Dr. Marie Van Bressem, who all spent many days monitoring fish markets and digitising data, for which we thank them dearly. We also thank Mark Chandler, Laura Chávez, Monica Echegaray, Ben Haase, David Montes, Pilar Tello, Victoria Tenicela and Patricia Vargas for participation in some surveys or for the use of unpublished information. This study was carried out under Peruvian Ministry of Fisheries Permit No. 064–93-PE/DNE, issued to the Asociación de Ecología y Conservación (ECCO). Field research was funded in part by the United Nations Environment Programme (UNEP), the Whale and Dolphin Conservation Society (WDCS) and the King Leopold III Fund for Nature Research and Conservation. Drafting of this paper was aided by a small grant from Marine Education and Research (Bristol, England). Greenpeace International provided travel funding to KVW to attend the 46th IWC Scientific Committee meeting. We dedicate this paper to Dr P.J.H. van Bree (University of Amsterdam) for many years of advice, encouragement and literature support. This paper constitutes contribution No. 3 of the Peruvian Centre for Cetacean Research, Pucusana, Peru. The comments of G. Donovan (to whom we owe a Guinness or two) and an anonymous reviewer are acknowledged.

REFERENCES

Agudo, I. and Romero, A. 1990. Dolphins killed for use as shark bait in Venezuela. Newsletter of the Cetacean Specialist Group: 6.
Anonymous. 1990. Prohiben la extracción de diferentes especies mamíferos menores durante las faenas de pesca. Diario El Peruano, Normas Legales. Lima, 29 Noviembre 1990:91715.
Anonymous. 1993. Caleta Santa Rosa reúne a la mayoría de los pescadores de Lambayeque. *El Comercio* 22 December 1993.
Anonymous. 1994. Prohiben la extracción, procesamiento y comercialización de diversos recursos hidrobiológicos existentes en aguas de jurisdicción peruana. Diario El Peruano, Normas Legales. Lima, 8 Agosto 1994: 125162.
Cetacean Society International. 1994. LOS treaty ratified by requisite 60 states. *Whales Alive* 3(1).
Cresci, G. 1993. Quo vadis, delfín? *Verde* 1(3) Lima, Peru: 5.
Currey, D., Lonsdale, J., Thornton, A. and Reeve, R. 1990. *The Global War Against Small Cetaceans*. Environmental Investigation Agency, London. 57pp.
García-Godos, A. 1993. Captura estacional de cetáceos menores en al caleta de Ancón. *Memoria X Congreso Nacional de Biología, Peru* 2–7 Agosto 1992:273–9.
Gaskin, D.E., Read, A.J., Van Waerebeek, K., Reyes, J.C. and McKinnon, J.S. 1987. Exploitation and biology of small cetaceans in the coastal waters of Peru and northern Chile. Final Report to UNEP/IUCN, June 1987 (unpublished). 98pp.
Guerra, C., Van Waerebeek, K., Portflitt, G. and Luna, G. 1987. The presence of cetaceans off the northern Chilean coast. *Estud. Oceanol.* 6:87–96.
International Whaling Commission. 1994. Report of the Workshop on Mortality of Cetaceans in Passive Fishing Nets and Traps. (Published in this volume.)

Jefferson, T.A. and Curry, B.E. 1994. A global review of porpoise (Cetacea:Phocoenidae) mortality in gillnets. *Biol. Conserv.* 67(2):167–83.

Manzanilla, S.R. 1989. The 1982–1983 El Niño event recorded in dentinal growth layers in teeth of Peruvian dusky dolphins (*Lagenorhynchus obscurus*). *Can. J. Zool.* 67(9):2120–5.

Meléndez, R. 1988. La pesquería artesanal en la caleta de Parachique agosto 1986 – Diciembre 1987. pp. 31–43. *In:* C. Wosnitza-Mendo, M. Espino and M. Veliz (eds.) *La pesquería artesanal en el Perú durante Junio de 1986 a Junio de 1988.* Instituto del Mar de Perú. 93pp.

Moreno, C. 1988. La pesquería artesanal en la caleta de Cancas Junio 1986 – Junio 1988. pp. 14–6. *In:* C. Wosnitza-Mendo, M. Espino and M. Veliz (eds.) *La pesquería artesanal en el Perú durante Junio de 1986 a Junio de 1988.* Instituto del Mar de Perú. 93pp.

Moreno, C. and Mendieta, A. 1988. La pesquería artesanal en la caleta de Puerto Nuevo (Paita) Julio 1986 – Junio 1988. pp. 22–30. *In:* C. Wosnitza-Mendo, M. Espino and M. Veliz (eds.) *La pesquería artesanal en el Perú durante Junio de 1986 a Junio de 1988.* Instituto del Mar de Perú. 93pp.

Orozco, R. 1988. La pesquería artesanal en la caleta de Máncora, Mayo 1986 – Junio 1988. pp. 18–21. *In:* C. Wosnitza-Mendo, M. Espino and M. Veliz (eds.) *La pesquería artesanal en el Perú durante Junio de 1986 a Junio de 1988.* Instituto del Mar de Perú. 93pp.

Ramírez, P. and Zuzunaga, J. 1991. Report on catch of cetaceans. Document SC/43/ProgRep Peru presented to the Scientific Committee, May 1991 (unpublished). 4pp.

Read, A.J., Van Waerebeek, K., Reyes, J.C., McKinnon, J.S. and Lehman, L.C. 1988. The exploitation of small cetaceans in coastal Peru. *Biol. Conserv.* 46:53–70.

Reyes, J.C. 1993. Re-introduction of longlines in the Peruvian shark fishery: an alternative to reduce small cetacean mortality. Final Report, IUCN Cetacean Specialist Group, Species Survival Commission and Whale and Dolphin Conservation Society. 21pp.

Reyes, J.C. and Van Waerebeek, K. 1991. Peru. Progress report on cetacean research, 1984–1989. *Rep. int. Whal. Commn* 41:250–2.

Reyes, J.C. and Van Waerebeek, K. 1995. Aspects of the biology of Burmeister's porpoise from Peru. *Rep. int. Whal. Commn* (special issue 16):In press.

Snedecor, G.W. and Cochran, W.G. 1980. *Statistical Methods.* Seventh Edn. The Iowa State University Press, Ames, Iowa.

Tenicela, M.V. 1993. Interacción de cetáceos menores y la pesquería artesanal en el puerto de San Andrés, Ica. Informe a CONCYTEC del proyecto de investigación no. 0642–12–91-OAI, Lima, Perú. 14pp.

UNEP. 1992. Plan de Acción para la Conservación de los mamíferos marinos en el Pacífico Sudeste. Informes y Estudios del Programa de Mares Regionales del PNUMA no. 143. 13pp.

Van Waerebeek, K. 1990. Preliminary notes on the existence of a dolphin by-catch off French Guiana. *Aquat. Mamm.* 16(2):71–2.

Van Waerebeek, K. 1992a. Population identity and general biology of the dusky dolphin, *Lagenorhynchus obscurus* (Gray, 1828) in the Southeast Pacific. Ph.D. Thesis, Institute for Taxonomic Zoology, University of Amsterdam. 160pp.

Van Waerebeek, K. 1992b. Records of dusky dolphins, *Lagenorhynchus obscurus*, (Gray, 1828) in the eastern South Pacific. *Beaufortia* 43(4):45–61.

Van Waerebeek, K. 1993a. External features of the dusky dolphin *Lagenorhynchus obscurus* (Gray, 1828) from Peruvian waters. *Estud. Oceanol.* 12:37–53.

Van Waerebeek, K. 1993b. Geographic variation and sexual dimorphism in the skull of the dusky dolphin, *Lagenorhynchus obscutus*, (Gray, 1828). *Fishery Bulletin* 91:754–74.

Van Waerebeek, K. 1993c. Mortality of long-snouted common dolphins and other small cetaceans in coastal fisheries off Peru. Contract report to Marine Mammal Division, Southwest Fisheries Science Center, La Jolla, California, USA (unpublished). 7pp.

Van Waerebeek, K. 1994. A note on the status of the Dusky dolphin (*Lagenorhynchus obscurus*) off Peru. (Paper SC/46/SM26 published in this volume).

Van Waerebeek, K. and Guerra, C. 1986. Review of the distribution and status of the Burmeister's porpoise in Chile. Cetacean Survey in II Region of Chile, August-September 1986. Instituto de Investigaciones Oceanológicos, Universidad de Antofagasta, casilla 170, Antofagasta, Chile (unpublished). 13pp.

Van Waerebeek, K. and Read, A.J. In press. Reproduction of dusky dolphins, *Lagenorhynchus obscurus*, from coastal Peru. *J. Mammal.*.

Van Waerebeek, K. and Reyes, J.C. 1990a. Catch of small cetaceans at Pucusana port, central Peru, during 1987. *Biol. Conserv.* 51(1):15–22.

Van Waerebeek, K. and Reyes, J.C. 1990b. Trend in the Peruvian small cetacean gillnet fishery: boom or bust? Abstracts, IWC Symposium on Mortality of Cetaceans in Passive Fishing Nets and Traps, La Jolla, California, 20–21 October 1990 (unpublished). 50pp.

Van Waerebeek, K. and Reyes, J.C. 1994a. Interactions between small cetaceans and Peruvian fisheries in 1988/89 and analysis of trends. (Paper SC/O90/G54 published in this volume).

Van Waerebeek, K. and Reyes, J.C. 1994b. A note on incidental mortality of southern minke whales off western South America. (Paper SC/46/SH19 published in this volume).

Van Waerebeek, K., Reyes, J.C., Read, A.J. and McKinnon, J.S. 1990. Preliminary observations of bottlenose dolphins from the Pacific coast of South America. pp. 143–54. *In:* S. Leatherwood and R.R. Reeves (eds.) *The Bottlenose Dolphin.* Academic Press, San Diego. 653pp.

Van Waerebeek, K., Reyes, J. and Aranda, C. 1992. Southern right whales (*Eubalaena australis*) off southern Peru. *Mar. Mammal Sci.* 8(1):86–8.

Van Waerebeek, K., Alfaro, J., Bello, R., Echegaray, M., García-Godos, A., Ontón, K., Reyes, J.C. and Van Bressem, M.F. 1993. Legislative measures fail to protect small cetaceans in Peru. Paper presented to the Tenth Biennal Conference Biology on Marine Mammals, Galveston, Texas, 11–15 November 1993 [Abstract].

Van Waerebeek, K., Van Bressem, M.-F., Reyes, J.C., García-Godos, A., Alfaro, J., Ontón, K., Bello, R. and Echegaray, M. 1994. Illegal exploitation of small cetaceans in Peru. Final Report, United Nations Environment Programme, Nairobi and Whale and Dolphin Conservation Society, Bath, UK. 76pp.

Wonnacott, T.H. and Wonnacott, R.J. 1990. *Introductory Statistics.* Fifth Edn. John Wiley & Sons.

Wosnitza-Mendo, C., Espino, M. and Véliz, M. (eds.). 1988. Informe No. 93. *La Pesquería Artesanal En El Perú Durante Junio De 1986 a Junio De 1988.* Instituto Del Mar Del Perú, Callao. 144pp. [In Spanish].