

Incidental Catches of Small Cetaceans in the Artisanal Fisheries of Ecuador

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ABSTRACT

During 1993, a study was carried out to try to estimate the incidental mortality of small cetaceans in gillnets of artisanal fishermen along the coast of Ecuador. Two ports were selected as convenient study sites: Puerto López and Santa Rosa. In both ports, a sample fleet of six boats was chosen. From December 1992 until December 1993 the two fleets made a total of 2,764 fishing trips and they caught 217 small cetaceans as bycatch. The Santa Rosa sample index (0.1042 ± 0.012 (SE) dolphins/boat/trip) was significantly larger ($P < 0.01$) than that for the Puerto López sample fleet (0.038 ± 0.007 (SE)). The estimated total catch for the entire Santa Rosa fleet is 1,150 (CI 95% 874–1,426) dolphins/year and that for the entire Puerto López fleet is estimated to be 156 (CI 95% 99–213). If the results are extrapolated to two similar ports nearby the estimated total bycatch is 3,741 (CI 95% 2,784–4,698) dolphins caught in 1993. If similar capture rates apply to the rest of the country, the total national bycatch would be 2 or 3 times higher. By far the most frequently captured species was the common dolphin (86%) followed by the short-finned pilot whale (9%). Occasionally, spotted dolphins (2%) and dwarf sperm whales (1%) are caught.

KEYWORDS: EASTERN TROPICAL PACIFIC; INCIDENTAL CAPTURE; FISHERIES; COMMON DOLPHIN; PILOT WHALE – SHORT-FINNED; SPOTTED DOLPHIN; DWARF SPERM WHALE

INTRODUCTION

Cetacean species are subjected to a number of human induced mortalities, including direct capture, incidental capture, competition for food resources and habitat pollution (IWC, 1992). Of these, perhaps the most important for affected species is the incidental capture in fishing activities which can result in high mortality rates, particularly for coastal species and river dolphins (e.g. Northridge, 1984; Brownell *et al.*, 1989; IWC, 1994).

Almost no published information on the incidental mortality of cetaceans during fishing activities in Ecuador exists. Only the bycatch of cetaceans in the industrial tuna fishery has garnered attention from the fishing authorities. Current regulations forbid fishing on tuna associated with dolphins in Ecuadorian waters¹. As in other developing countries, the potential problem of incidental catches in artisanal fisheries has largely been ignored.

In 1993, a study was undertaken along the coast of Ecuador to determine the magnitude of the small cetacean bycatch in artisanal fisheries. The study was financed by the United Nations Environmental Program (UNEP) as part of the Action Plan for the Conservation of the Marine Mammals of the Southeast Pacific (PNUMA, 1992). The study found that at least four dolphin species become entangled in surface gillnets: the common dolphin, *Delphinus delphis*, the short-finned pilot whale, *Globicephala macrorhynchus*, the spotted dolphin, *Stenella attenuata*, and the dwarf sperm whale, *Kogia simus* (Samaniego and Félix, 1994). Bottlenose dolphin (*Tursiops truncatus*) interactions with deep gillnets set for shrimps and other species in the Gulf of Guayaquil (South of Ecuador) were reported by Van Waerebeek *et al.* (1990) and by Félix (In press). It is unknown whether other small

cetacean species are involved in interactions with other fisheries in Ecuador.

This paper presents the results from the above study with respect to small cetaceans and artisanal fisheries.

DESCRIPTION OF THE ARTISANAL FISHERY

Artisanal fishing represents a major part of Ecuador's economy. In 1992, the total catch for the eight most important ports of the country was 38,633 tonnes (Villón and Balladares, 1993). In the last decade the fishing fleet has increased dramatically, being ten times higher than in 1982 (Contreras and Revelo, 1992). Overall there are about 50,000 artisanal fishermen found in over 70 fishing communities (Campbell *et al.*, 1991). Since 1989, the National Institute of Fisheries (INP) has made a complete inventory of the artisanal fisheries in eight of the most important ports of the country: Esmeraldas, Manta, San Mateo, Santa Rosa, Anconcito, Engabao, Playas, and Puerto Bolívar (Fig. 1) (Martínez *et al.*, 1991; Contreras and Revelo, 1992; Villón and Balladares, 1993). These ports account for some 75% of the total national fishing effort (Carlos Villón², pers. comm.).

Vessel types

The fleet comprises some 7,000 vessels of various types (Campbell *et al.*, 1991), ranging from small rafts for 2–3 fishermen, through long wooden canoes with 25–50HP outboard motors for 3–4 fishermen, to open boats made of wood or fibreglass of up to 10m long equipped with 75–100HP outboard motors (Massay, 1987).

Target species

The target species are mainly large pelagic fish including the 'dorado' (*Coryphaena hippurus*); tuna (*Thunnus albacares*, *T. obesus*, *Katsuwonus pelamis*); swordfish (*Xiphias gladius*); 'picudos' (*Makaira* sp., *Istiophorus albicans*); sharks (families Alopiidae, Carcharhinidae, Lamnidae, Sphyrnidae and Triakidae) and deep water fish (families Bothidae, Carangidae, Lutjanidae, Serranidae,

* The paper presented to the meeting originally had two parts. The second part is now Haase and Félix (1994).

¹ Ministerial Agreement No. 203, May 10, 1990. Ministerio de Industrias Comercio Integración y Pesca (MICIP).

² Instituto Nacional de Pesca INP, Fisheries Resources Department.

Sciaenidae). Crustaceans (*Penaeus* sp.) and various species of molluscs are also taken (Herdson *et al.*, 1985; Martínez, 1987). Artisanal fishing takes place within 40 n.miles of the coast (Martínez, 1987).

Techniques

Longlines (palangre or espinel)

These comprise a large number of down hanging sublimes with hooks (100–1,500) connected via a horizontally placed, long thick nylon mother line of between 4.5–11km in length, with signal flags and floats on each end (Cedeño, 1987; Martínez *et al.*, 1991). The use of longlines and handlines is more common along the north coast of Ecuador (Cedeño, 1987; Campbell *et al.*, 1991).

Gillnet (red agallera or trasmallo)

Two types of gillnets are used: (1) surface gillnets of up to 3km in length and 15m in depth, with a large mesh size (7.5–13cm); (2) deep gillnets between 300–400m in length, used to catch deep water species such as slabs, lobsters and shrimps (Cedeño, 1987; Martínez *et al.*, 1991). Gillnets are used mostly by fishermen in the central and southern part of the country.

MATERIAL AND METHODS

By mid-November 1992, all ports in the four coastal provinces had been visited to determine the use of gillnets along the coast. We selected two ports to be representative (Fig. 1): Puerto López, in the province of Manabí (01°34'S, 80°W) and Santa Rosa, in the province of Guayas (02°12'S, 80°54'W). Fishermen in these ports showed interest in the project and in general cooperated willingly.

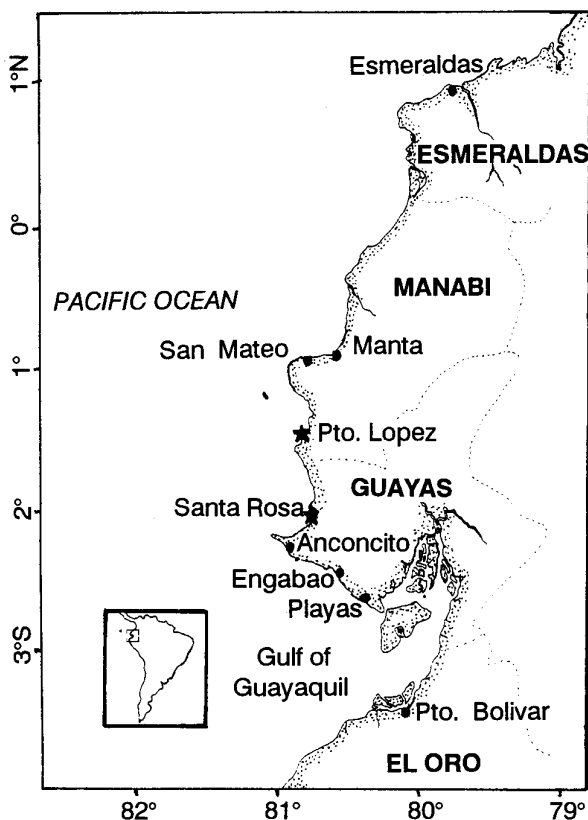


Fig. 1. Main artisanal fishing ports on the Ecuadorian coast.

In order to obtain an idea of the bycatch levels, six boats that used surface gillnets were selected for each port. Between them, the twelve boats made a total 2,764 trips between 15 December 1992 and 15 December 1993. The boats (fibreglass, 7m in length, outboard engine of 75–85HP) and their gear (polyfilament nylon nets, 1,500m long and 15m wide) were similar. Fishing techniques were also similar with the boats leaving port in the afternoon and returning on the following day in the early morning. The nets were set at night for a period of 8–10 hours.

Once back in the port, each crew member was asked to report any interaction with dolphins. Information on the number of captured animals, the species, the distance off the coast where they had been fishing and general information on the journeys was recorded. For 64 trips (2.3%) J.S. and volunteers of the Ecuadorian Foundation for the Study of Marine Mammals (FEMM) were on board as observers. The information obtained from these trips is compared to that for trips without observers later in this paper.

The relevant authorities gave special permission for the fishermen participating in the study to bring the bycatch to land. The animals were photographed and examined, and biological data and other information recorded, including species, sex, weight and external measurements. In addition, the animals were sampled for teeth, reproductive organs, stomach contents and parasites, etc. The samples are being analysed at present.

For practical reasons, not all the dolphins were brought to port. At the beginning of the project the animals were identified on return to port from photographs shown to the fishermen, and quite soon they were able to identify most cases without problems. These animals were not measured and their total length was estimated by the fishermen; this information was excluded from statistical analysis. However, the common dolphins (*Delphinus delphis*) and spotted dolphins (*Stenella attenuata*) were subdivided as: (1) calves, small animals of less than 1.2m; (2) immature of between 1.2m and 1.8m; and (3) adults animals > 1.8m.

Information on the number of artisanal boats, the number of operative boats and the fishing techniques used in Santa Rosa and seven other ports during 1993 were provided by the INP (Table 1). This information was based on comments by nearly 10,000 fishermen interviewed during 1993 and was used to extrapolate the results of our study to the entire fleet in order to obtain estimates of dolphin mortality rate for each port. Non-active boats and those using different techniques were subtracted from the total fleet (Table 1). In addition, as no boats operated

Table 1
Fishing methods of the artisanal fleet in eight ports during 1993.

Ports	Total fleet	Operative fleet (%)	Fishing gear	
			Longline (%)	Gillnet (%)
Esmeraldas	196	21	95	5
Manta	563	36	60	40
San Mateo	210	12	100	-
Santa Rosa	235	41	60	40
Anconcito	370	43	60	40
Engabao	163	6	100	-
Playas	96	48	100	-
Puerto Bolívar	383	87	10	90

Source: Artisanal Fishing Project INP/CISP/MLA. National Institute of Fisheries (Instituto Nacional de Pesca). 1994.

Table 2
Number of monthly trips made by the sample fleet of Santa Rosa, 15 December 1992 - 15 December 1993.

Boat	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I	14	24	20	23	24	24	22	24	22	20	24	23	11	275
II	15	24	20	24	26	26	26	26	24	22	26	26	11	296
III	14	23	19	23	24	24	22	24	20	20	24	22	11	270
IV	15	24	20	24	26	26	26	26	25	23	26	26	11	298
V	14	23	20	24	26	26	26	26	24	22	26	26	11	294
VI	14	20	20	23	22	24	22	21	22	20	24	23	11	266

Table 3
Number of monthly trips made by the sample fleet of Puerto Lopez, 15 December 1992 - 15 December 1993.
G: Gillnet/L: Longline.

Boat	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
A	10	16	15	16	15	14	16	18	14	15	13	G/L 04/10	G/L 05/06	171
B	10	17	15	15	17	16	18	19	12	20	12	G/L 10/07	G/L 00/10	181
C	10	16	16	18	18	17	17	19	13	17	14	G/L 09/10	G/L 05/06	189
D	10	17	14	17	16	16	17	18	9	17	13	G/L 08/09	G/L 04/07	176
E	9	16	14	16	17	16	16	19	10	16	14	G/L 09/09	G/L 05/06	177
F	9	16	15	16	16	16	14	17	14	16	13	G/L 04/12	G/L 05/06	171

every day of the year, it was assumed that the average number of fishing days in the year for the sample fleet could be applied to the entire fleet.

The number of boats of the Puerto López fleet that used gillnets was determined by the authors. The percentage of operative boats in that port was considered the same as that for Santa Rosa.

RESULTS

Fishing effort

Fishing effort from both ports occurred in all months of the year (Tables 2 and 3) although the mean numbers of trips differed by port. The fishing grounds for the two ports differed considerably. Boats of the Puerto López fleet operated between 11 and 33 n.miles offshore (mean=22.2, SD=5.8), while those from Santa Rosa generally operated further offshore, between 14 and 56 n.miles off the coast (mean=32, SD=7.5).

Santa Rosa

INP data revealed that the Santa Rosa fleet comprised 235 boats, of which 96 (41%) were operative. On average throughout the year, around 38 (40%) used surface gillnets (Table 1). As shown in Table 2, the six sample boats operated for an average of 283 days in the year (SD 14.4). Thus the total number of trips estimated for this fleet is 10,754.

Table 4
Incidental catch for the sampled Santa Rosa fleet.

Boat	No. of trips	Dolphin catch	Capture index dolphins/boat/trip
I	275	21	0.0764
II	296	39	0.1318
III	270	27	0.1000
IV	298	38	0.1275
V	294	32	0.1088
VI	266	20	0.0752
Totals	1,699	177 ^a	0.1042

Puerto López

Our census of Puerto López revealed that the entire fleet comprised 89 boats of which 56 (63%) used surface gillnets. Assuming, as for Santa Rosa, that 41% of the fleet operated implies that 23 boats operated using gillnets in 1993. The Puerto López sampled boats carried out an average of 178 trips in 1993 (SD 6.8). Thus the total estimated fishing effort for 1993 is 4,094 trips.

Mortality of small cetaceans

Santa Rosa

The Santa Rosa sample fleet caught 177 dolphins in 1993 (Table 4), with between 21 and 39 dolphins per boat, giving an annual average per boat of 29.5 (SD=8.2). The average capture rate per trip was 0.1042±0.012 (SE). The capture rate from boats carrying observers on board (n=35, 2%) was 0.286±0.131 (SE), 2.7 times higher than the boats without observers (Table 6). The species caught were the common dolphin (*Delphinus delphis*) 90%, the short-finned pilot whale (*Globicephala macrorhynchus*) 7%, the dwarf sperm whale (*Kogia simus*) 1%, the spotted dolphin (*Stenella attenuata*) 0.6% and unidentified dolphins 1% (Fig. 2).

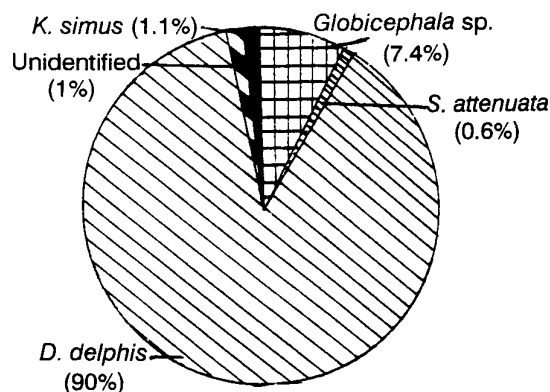


Fig. 2. Composition of the cetacean bycatch in Santa Rosa.

Using the estimated numbers of trips for the entire fleet obtained above gives a total estimated bycatch of 1,150 (CI 95% 874–1,426) dolphins assuming the total average capture rate or 3,157 (CI 95% 320–5,994) dolphins if the capture rate for boats with observers is used.

Puerto López

During 1993, the crew of the Puerto López sample fleet reported a bycatch of 40 dolphins (Table 5). The number of animals caught per vessel varied between 2 and 12, with an annual average of 6.7 (SD=3.4). The mean capture rate per trip was 0.038 ± 0.007 (SE) dolphins (Table 5), was significantly lower than in Santa Rosa (ANOVA, $F_{1,5}=30.35$, $P<0.01$). The capture rate from boats carrying observers on board ($n=29$, 2.7%) was similar to that for boats without observers 0.034 ± 0.033 (SE) (Table 6). The species composition was: common dolphin 67.5%; short-finned pilot whale 17.5%, spotted dolphin 10%; and non-identified 5% (Fig. 3). Using the estimated number of trips for the Puerto López fleet obtained above gives an estimated total bycatch of 156 (CI 95% 99–213) dolphins in 1993.

Other ports

No direct study of the incidental mortality of dolphins for other ports was made. However, we believe that it is instructive to extrapolate the Puerto López and Santa Rosa

Table 5
Incidental catch for the sampled Puerto Lopez fleet.

Boat	No. of trips	Dolphin catch	Capture index dolphins/boat/trip
A	171	9	0.053
B	181	12	0.066
C	189	7	0.037
D	176	7	0.040
E	177	2	0.011
F	171	3	0.017
Totals	1,065	40	0.038

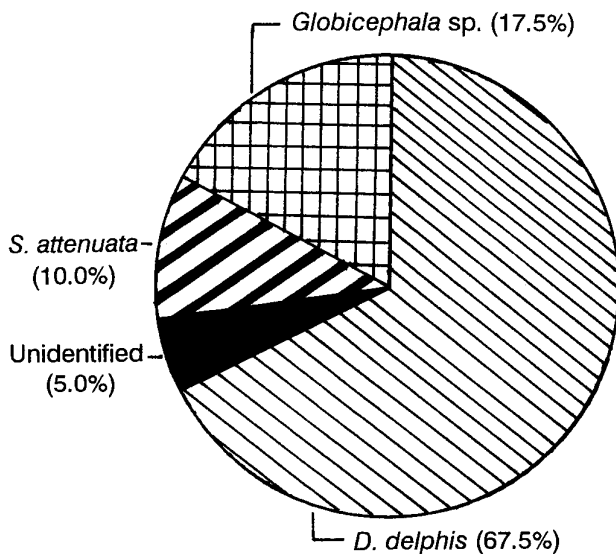


Fig. 3. Composition of the cetacean bycatch in Puerto López.

Table 6

Incidental catch of small cetaceans of boats with observers.

Port	No. of trips	Dolphin catch	Capture index dolphins/boat/trip
Puerto Lopez	29	1	0.034
Santa Rosa	35	10	0.286
Totals	64	11	0.172

data for two other important nearby ports: Manta and Anconcito. Manta is situated 70km to the north of Puerto López and Anconcito is 12km south of Santa Rosa. Both ports have similar characteristics to the monitored ports in terms of gillnet use and operative boats. Their locality suggests that they probably exploit the same fishing area. To give an idea of possible mortality we used the Puerto López data for Manta and the Santa Rosa data for Anconcito. The resultant mortality estimates are 548 (CI 95% 350–746) and 1,887 (CI 95% 1,461–2,313), respectively. Despite the large number of assumptions involved, the potential scale of bycatches indicates the need to monitor the problem in Ecuador.

Seasonality of the bycatch

Both ports exhibited a similar pattern in incidental captures with two peaks in the year. In Puerto López the bycatch increased between March and August, decreased from September to November and then increased again in December and January (Fig. 4). In Santa Rosa, catches increased between May and September, decreased in October and November and then increased again in December (Fig. 5). Although the study began in December, the first bycatch by the Santa Rosa sample fleet was not reported until February 1993, possibly because the fishermen were initially suspicious. If this is the case, our estimated bycatch for that port may be an underestimate.

Use of the bycatch

All but two (0.9%) dolphins that were released alive, were found dead. They were usually not taken on board, but were freed or cut loose outside the launch and left behind.

However, from July until November in Puerto López, some boats (not of the sampling fleet) brought the bycatch

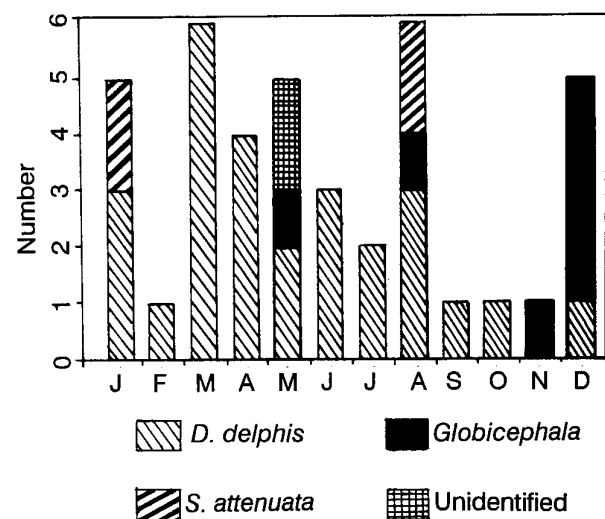


Fig. 4. Monthly cetacean bycatch by the Puerto López sample fleet.

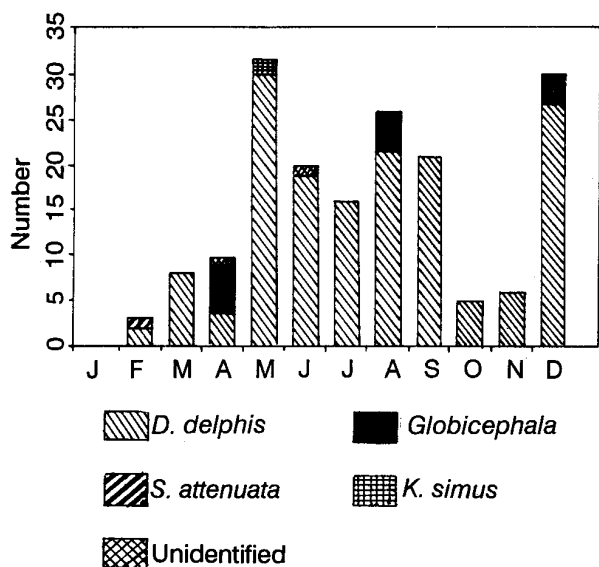


Fig. 5. Monthly cetacean bycatch by the Santa Rosa sample fleet.

to shore and sold it to longline fishermen for bait. This appears to be an increasingly common phenomenon with prices of US \$75 for large carcasses being mentioned. Although the harbour authorities were informed and some boats were inspected, there are no clear regulations forbidding this practice. Local fishermen informed us that this trade had begun soon after the arrival at Puerto López of two visiting launches from Puerto Bolívar (in the south of the country), who seemed often to use dolphin and whale meat as bait. This could not be confirmed because we have not surveyed the bycatch situation in Puerto Bolívar.

Fishermen consider both dolphins and whales as fish but not as food. However, the blubber is occasionally used as medicine to cure asthma and other illness.

Examined specimens

Of the 217 caught animals, 33 (15%) were taken ashore to be examined; 27 common dolphins, 5 spotted dolphins and the head of a dwarf sperm whale. Fig. 6 shows the lengths of the common dolphins examined (mean 1.25m, SD=0.32). Most corresponded to animals in their first year of life. The five spotted dolphins were slightly longer, measuring an average of 1.7m (SD=0.5). Tables 7 and 8 show the age class composition of the dolphin bycatch. However, this information is of limited value since only seven dolphins came from boats with observers and large

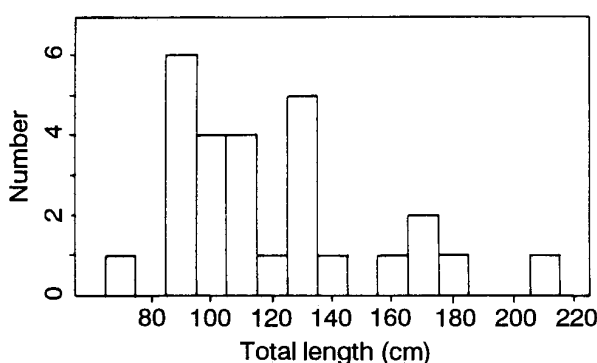


Fig. 6. Frequency distribution of the total length in the common dolphins examined (n=27).

Table 7
Composition of the bycatch per age class in Santa Rosa.

Species	Calves		Young		Adults	
	n	%	n	%	n	%
<i>Delphinus delphis</i>	79	49	52	33	28	18
<i>Globicephala</i> sp.	2	15	6	46	5	39
<i>Stenella attenuata</i>			1	100		
<i>Kogia simus</i>					2	100
Unidentified			1	50	1	50

Table 8
Composition of the bycatch per age class in Puerto Lopez.

Species	Calves		Young		Adults	
	n	%	n	%	n	%
<i>Delphinus delphis</i>	13	48	11	41	3	11
<i>Globicephala</i> sp.			2	29	5	71
<i>Stenella attenuata</i>	1	25			3	75
Unidentified			2	100		

animals were probably not brought back to port because of the effort of getting them on board and the fact that they would occupy space that could be used for fish.

DISCUSSION

This is the first survey of cetacean bycatches in Ecuadorian artisanal fisheries that attempts to quantify the incidental mortality. However, as only two ports in the centre of the country were sampled, it is not possible to provide a national estimate. It would be inappropriate to extrapolate the results from the sampled ports to the entire artisanal fleet, not the least because the capture rate was different in both sample ports and this could be true for other sites. To obtain better estimates more ports should be examined, especially in the south of the country where more gillnets are used. INP data (Table 1) show that Puerto Bolívar has both the highest number of gillnets and the highest percentage of its fleet operating. The potential is there, therefore, for the incidental capture of dolphins from this port to be high and an investigation of that fleet should be given high priority. By contrast, the artisanal fishermen of the north's fishing ports use fewer gillnets and more longlines, and one would expect the incidental capture of cetaceans to be less.

Despite the problems in the extrapolation procedure, the estimated bycatch in 1993 for the fleets in Puerto López and Santa Rosa, and the other two ports (Manta and Anconcito) shows that the incidental mortality of cetaceans is high, perhaps between 2,500-5,000 animals. If mortality levels are similar in other artisanal ports in Ecuador, the total bycatch in 1993 may have been 2-3 times greater than this, i.e. greater than the annual capture in Perú, where a directed dolphin fishery has existed for many years (e.g. Read *et al.*, 1988). In Perú some species of dolphins show signs of being over exploited due to the high bycatch levels (Van Waerebeek *et al.*, 1994).

Our study has only included boats for the pelagic fishery that used wide mesh surface gillnets. However, interactions of small cetaceans (e.g. the bottlenose dolphin, *Tursiops truncatus*) with other types of nets used in Ecuador, such as the nylon monofilament nets used for catching shrimp and other benthic species in coastal

waters, have been reported by Van Waerebeek (1990) and Félix (In press). In this regard it should be noted that the Puerto López sample boats that used both longlines and gillnets in November and December did not report any capture of small cetaceans in longlines.

The two peaks in incidental captures reported (March-September, December-January) coincide with the peaks in catches of small pelagic fish (French *et al.*, 1988; Aguilar and Santos, 1993). This suggests that the dolphins may be more abundant at those periods due to food availability. Unfavourable environmental conditions such as turbid water, swell and current could affect the ability of the small cetaceans to detect and to avoid nets (Jefferson *et al.*, 1991). The highest bycatch of the sample fleet was recorded in August and October when the south trade winds occur and produce strong surf (on one occasion 10 dolphins were caught in one net). The number of dolphins (as reflected by capture rate) also seems to vary geographically but it is not clear if this reflects greater abundance in the south (Santa Rosa) or offshore (Santa Rosa boats operated further from shore).

Variation in bycatch composition was also seen. Although the most affected species was the common dolphin (*Delphinus delphis*) for both fleets, the Puerto López fleet caught proportionally more spotted dolphins (*Stenella attenuata*) and pilot whales (*Globicephala macrorhynchus*) than the Santa Rosa fleet. The Puerto López fleet is more active in coastal waters i.e. where the coastal spotted dolphin is more frequently found (Perrin *et al.*, 1985). Although pilot whales are a deep water species, the higher bycatches at Puerto López can be explained as most occurred when the fleet made longer and (probably) more distant trips in December 1993.

It is noticeable that the trade of (incidentally caught) dolphins was discovered during the time when the whitebait that is used by longline fishermen was scarce. The fishermen know that dolphin meat is excellent bait on their longlines and they are willing to pay a lot of money for bycatch. Haase and Félix (1994) report that sperm whale meat is occasionally used for bait in Ecuador. They note that this might result in deliberate capture of this species unless action is taken by the authorities.

ACKNOWLEDGEMENTS

The authors thank the Santa Rosa and Puerto López fishermen and the harbour authorities for their valuable cooperation. About 50 students from the Catholic University of Quito and the University of Guayaquil have participated as field assistants during this study. We appreciate the collaboration of the Instituto Nacional de Pesca (National Institute of Fishing) for permission to use unpublished information about the artisanal fishery in 1993, in particular to Dr. Sheyla Massay and to the biologist Carlos Villón of the Fishing Resources Department. To Julio Reyes and to the personnel of the Centro Peruano de Estudios Cetológicos (CEPEC) for their cooperation during the stay in Perú of J. Samaniego. To Koen Van Waerebeek who made valuable comments to the first draft of this report. To Ben Haase and Deidre Platt who helped us with the translation from Spanish to English. G. Donovan and an anonymous reviewer made useful comments on the manuscript.

This project was financed by the United Nations Environment Program (UNEP) with an additional aid of ECOCIENCIA-WCI's Grants for Conservation Program, Quito.

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