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A PRELIMINARY REPORT OF THE INCIDENTAL ENTRAPMENT OF ODONTOCETES BY SRI LANKA'S COASTAL DRIFT NET FISHERY

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A PRELIMINARY REPORT OF THE INCIDENTAL ENTRAPMENT OF ODONTOCETES BY SRI LANKA'S COASTAL DRIFT NET FISHERY[1]

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(With four text-figures)

Odontocetes are taken by both direct and indirect fisheries off the coast of Sri Lanka. An estimated 38,000 odontocetes are entangled annually in gillnets deployed within 30 miles (48 km) of the shoreline from 26-60' vessels. The two species most frequently taken are spinner, *Stenella longirostris*, and Risso's dolphins, *Grampus griseus*. Ten species of cetaceans were seen in fish-markets by the author in the relative frequencies: spinner dolphin (40%), Risso's dolphin (17%), spotted dolphin, *Stenella* cf. *Stenella attenuata* (13%), striped dolphin, *Stenella coeruleoalba* (8%), bottlenose dolphin, *Tursiops* sp. (7%), Pygmy killer whale, *Feresa attenuata* (4%), dwarf sperm whale, *Kogia simus* (4%), rough-toothed dolphin, *Steno bredadensis* (4%), false killer whale, *Pseudorca crassidens* (1%), Cuvier's beaked whale, *Ziphius cavirostris* (1%), and an unidentified beaked whale (1%). Since the incidental entrapment of cetaceans is a worldwide problem which may be assuming crisis proportions, this report will have application to any fishery which presently catches small odontocetes in gillnets.

Gillnets have been used by fishermen for centuries, but it has not been until the last thirty years that the incidental entrapment and entanglement of cetaceans in tended and untended nets has been extensive enough to be of serious concern (Coleman & Wehle 1983, Wallace 1984). Gear modification, technical advances, and an increase in the number of boats harvesting fish have been primary causes of such mortality (Curry-Lindahl 1982). In particular, the replacement of cotton nets with synthetic nets in the 1950's marked the beginning of an increased take of both target, commercial fish, and non-target marine animals, cetaceans, birds, turtles, etc. (Wallace 1984).

Synthetic nets are composed of plastic webbing which is visually and acoustically invisible to marine mammals (Gaskin 1984). The nets, which are suspended in water by floats and stretched vertically by weights attached to their bottom, hang in the water like "Curtains of Death" (Eisenbud 1984). Not only are the nets undetectable to cetaceans, but the plastic, synthetic fibres are unbreakable, which prevents animals from escaping once caught. Any fishery which utilizes gillnets in the same habitat as cetaceans has the potential to catch these animals that swim blindly into the net and become entangled. Incidental entanglement of cetaceans in gillnet fisheries is now recognized as a world-wide problem, but there is little information about the impact of such fisheries on specific populations.

Preliminary investigations about the location and status of direct and indirect cetacean fisheries indicate that odontocetes are being taken throughout the world, but the number of animals killed is largely unknown (Brownell *et al.* 1978, Mitchell 1975). In addition, the behaviour, ecology, and biology of many of

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the species involved has not been studied, so it remains unclear whether or not whole populations or even species may be endangered. Detailed information about cetacean entrapment in pelagic fishing gear has been documented in purse seine fisheries (Perrin & Oliver 1982, Allen & Goldsmith 1982, Hammond & Tsai 1983) and in pelagic fisheries (Jones 1984, Harwood *et al.* 1984, Kumagai *et al.* 1983, Lear & Christensen 1975, Oshumi 1975). However, there is little information about land based, coastal drift net fisheries and their impact on odontocetes (Alling & Whitehead 1986, Leatherwood 1984, Lien *et al.* 1982). This paper describes the incidental entrapment of odontocetes by coastal drift net fisheries off the coast of Sri Lanka. As there are no existing legislative, administrative, biological or technical means to prevent the incidental mortality of cetaceans by drift net fisheries (Holt 1983), it is hoped that this study will provide a framework for which such problems can be addressed.

Types of marine fisheries in Sri Lanka

Sivasubramaniam (1965) categorized the Sri Lankan fisheries into non-mechanized, traditional-mechanized, modern-mechanized and trawling operations. As described by Pajot (1978), non-mechanized vessels (outriggers or canoes) are used by fishermen who work within 1-2 miles of the coast, casting "Beach Seines" on schools of pelagic fish species. This method is restricted to calm waters and, in general, it is only effective for half the year on each coast due to the monsoons. Traditional-mechanized craft consist of Orus, Vallams, or Teppams (vessels with outboard motors) and modern mechanized craft, which are larger, 26-60′ ($3\frac{1}{2}$-$17\frac{1}{2}$ ton) vessels (Sivasubramaniam 1965). These boats harvest pelagic species by using "Pole and Line" techniques, longlines, or gillnets which are set at night as drift nets. Long lines are used for large pelagic species (tuna, shark, spearfish, etc), "pole and line" for the smaller species (tuna and mackerel), and drift nets for both types (Pajot 1978).

The boats using drift nets embark for sea usually in the mid-afternoon. Fishermen motor up to 30 miles (48 km) offshore (usually about 20 miles, i.e. 32 km) where they set their nets until dawn. The duration of time the nets are set depends on the cycle of the moon. During the full moon, for example, nets are used for only a few hours when the night is at its darkest period. (The fishermen claim that fish can "see" the nets unless there is no sun or moonlight). Fishermen also cannot set gillnets during the southwest monsoons (summer) along the east coast, or during the Northeast Monsoons (winter) off the west coast because the seas are too rough. Therefore, they either change gear to work inshore (e.g. fishermen in Trincomalee harvest spawning flying fish during May to August), or they continually move along the coast to avoid the bad weather in order to use their gillnets throughout the year.

Trawlers are used exclusively for deep-sea fisheries. Traditionally, the Government of Sri Lanka operated trawlers on the Wadge and Pedro banks, but by 1964 all the vessels were transferred to the Ceylon Seafoods Corporation, a private enterprise. Now the Law of the Sea gives India rights of resources on or near Wadge Bank which has forced this Company to extend its operations to other pelagic regions (Piertersz 1965). According to the Manager of Ceylon Seafoods in Trincomalee, the vessels remain at sea for two days to two weeks while working approximately 50 miles (80 km) offshore. The fishermen set drift nets at night and they trawl during the day for Tuna, Seerfish, Shark or Marlin.

Department of Fisheries found that there was an annual increase of 6,000 tons of fish harvested (Weerakoon 1963). He attributed this increase to the introduction of mechanized vessels and synthetic gillnets. By 1958 he estimated that almost all the fishermen had switched from using cotton nets to multifilament, nylon gear varying in color (yellow, grey, green, or white), in twine size (21, 24, 27 and 30 ply), in mesh size (4, 5.5, 5.75, 6 and 7 inch) and in overall size (500 to 1,000 by 50 to 150 meshes). These gillnets are used by fishermen who operate the 3½ and 17½-ton vessels or trawlers. In 1982, there were 8,850 3½ and 17½-ton vessels registered in Sri Lanka. (This statistic has not been updated by the Sri Lanka Department of Fisheries). This paper reports on the number of odontocetes taken incidentally by gillnets deployed from these boats.

Past and present commercial utilization of small cetaceans

A dolphin fishery was first reported in Sri Lanka in the late 1800's (Necill 1887). He reported that one species, no larger than 1.7 m and characterized as a fierce animal, was speared and eaten by fishermen. A second species, which Necill called *Delphinus*, was found close to shore and in the lagoons of Kalputti and Trincomalee. Revered as a sacred animal, this species was not killed by the resident Tamil or Sinhalese people, but Indian fishermen specifically hunted and captured these dolphins in nets for food.

In 1953 and 1954, the Sri Lanka Department of Fisheries and the Canadian Government explored the possibility of commercially exploiting dolphins (Lantz & Gunasekera 1955). They identified the Cetaceans as common dolphins (*Delphinus* sp.) and bottlenose dolphins (*Tursiops truncatus*). (However, a photograph included in the article showed a striped dolphin suspended over the deck of the vessel). They noted that fishermen, who were working out of Trincomalee and Negombo harbours, complained of excessive net damage which sometimes forced them to abandon their gillnet fisheries in January and February. It was assumed that this destruction was caused by dolphins. In response to this problem and concern that these animals competed with fishermen for limited food resources, methods were devised to capture and utilize dolphins. The meat was used for human consumption, the Sri Lankan Department of Industries produced two kinds of leather from the skins, oil was prepared as a lubricant, and waste materials were processed into meal. They concluded that commercial utilization of dolphins in Sri Lanka would not only be possible, but beneficial to the fishermen.

At present, the degree to which cetaceans are hunted off Sri Lanka is in question. Mitchell (1975) and Brownell, Schonewald, & Reeves (1978) acknowledged the existence of a dolphin fishery, but urged that more information be obtained. Beginning in 1982, efforts were made to monitor the take of dolphins in several harbours along the coast of Sri Lanka (Alling 1983, Joseph *et al.* 1983). These studies suggested that dolphins may be hunted by some fishermen, but most of the animals are entangled incidentally in gillnets. Similar findings have been recently reported by others as well (Leatherwood 1984, Leatherwood *et al.* 1984) and in 1985 the National Aquatic Resources Agency (a Department within the Sri Lankan Ministry of Fisheries) established a research programme to thoroughly review this fishery. In general, it appears that dolphin meat may be sold for human consumption or for shark bait. Frequently, however, the meat is sold to a buyer who exports it inland or to Colombo (the capital) where it may be sold as

"Mudu-uru". Mudu-uru, known as "sea pig" or dugong, is considered a delicacy and is purchased by those who cannot afford the more expensive fish, by Catholics or Muslims (not Buddhists or Hindus because it is against their religion to eat dark meat), or by people who live inland.

METHODS

A study of this cetacean fishery was carried out in Sri Lanka from March, 1982 to December, 1984. The scope of the project was significantly narrowed because it was conducted in conjunction with an oceanic study of the behaviour and ecology of sperm whales, *Physeter macrocephalus*. However, incidental sightings of cetaceans were recorded while at sea and, when time permitted, harbours were visited to identify odontocetes that were brought into fish-markets. fishermen were interviewed to enquire about direct and indirect cetacean fisheries, and a system was established to monitor the daily take of odontocetes brought into three harbours. In this paper, "odontocetes" refers to all the toothed species found in Sri Lankan waters except for the sperm whale.

The offshore study was conducted from a 9 m sailing vessel, R/V *Tulip*, during the spring (January to May) of 1982-1984. All cetaceans sighted off the coast of Sri Lanka were recorded and their positions are shown in Fig. 1. Since our primary objective during this time was to track and follow sperm or blue whales (*Balaenoptera musculus*), all sightings of other cetaceans are biased to preferred blue and sperm whale habits.

When we were not working at sea, I visited ten fishing harbours in Sri Lanka, which are illustrated in Fig. 1. Equal time was not allotted to each of these harbours because I worked primarily in Beruwala (on the west coast) and Trincomalee (on the east coast). Dolphins brought into each harbour were identified and, when time permitted I measured, determined the sex of, and photographed animals using a standard morphometric form (Norris 1961). Skulls were collected when possible and sent to the Smithsonian Institute. Not all the animals were measured because the fishermen often immediately used the dolphin meat for food or bait. Thus, of the 72 cetaceans seen, 39 animals were measured, 31 were distinguished as "calves" (13 of these animals were recorded as calves and were measured) and 13 observations had missing data. Assessing if an animal was a "calf" could not be quantified, but it is justified because a superficial look at the size of an individual indicated if it was about half the size of a full grown animal.

The daily catch of cetaceans brought into fishmarkets was monitored in Beruwala (May, 1982-August, 1984), Trincomalee (February, 1983-October, 1984) and Valaichenai (March, 1983-January, 1984). One fisherman in each of the three harbours agreed to record the number of odontocetes which were entangled in gillnets and brought into his habour each day. This information was returned to me at the end of each month so as to obtain an estimate of the number of odontocetes taken annually off the coast of Sri Lanka. In this exercise, only a rough calculation could be made due to the following assumptions:

1. The average number of odontocetes taken by 397 3½ and 17½-ton vessels in three harbours reflects the average number of odontocetes taken by all 8,850 registered 3½ and 17½-ton vessels in Sri Lanka. Variability in season or location does not affect the average rate.
2. Only the registered 3½ and 17½-ton vessels set gillnets which entangle cetaceans.
3. Differences in mesh size, twine size, colour,

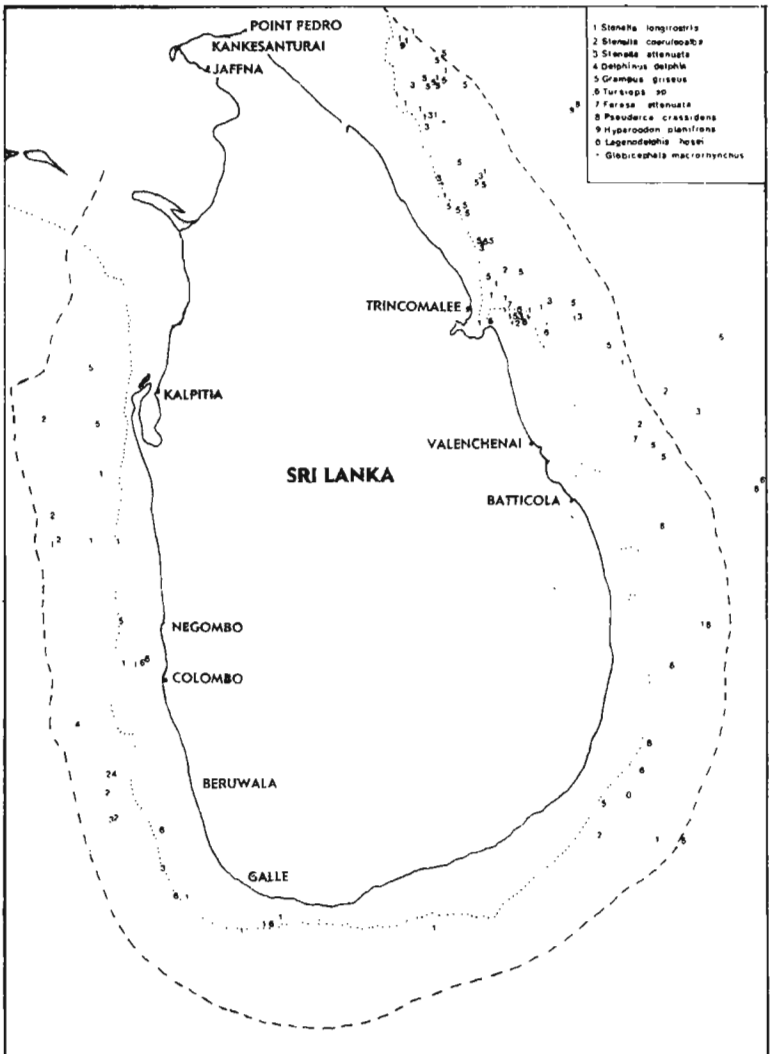

Fig. 1. Positions of odontocetes sighted from R/V Tulip 1982-1984. The slashed line is drawn 30 miles from the coast to represent the maximum distance fishermen will motor to set drift nets. The dotted line is a 1,000 m contour line. Harbours around the coast of Sri Lanka which were visited to determine if odontocetes were being taken by fishermen along the north, south, east, and west coasts.

and overall size of gillnets used by fishermen does not influence the rate of take.

To obtain an estimate of the number of animals which may be killed annually by vessels operating out of all the harbours in Sri Lanka, I used the equation:

$N = R \times B \times 12$ months, where

N = the total estimated number of odontocetes killed annually in Sri Lanka,

R = the rate (average number of dolphins taken by 3½ and 17½-ton vessels per month in Beruwala, Trincomalee, and Valaichenai). and

B = The number of registered 3½ and 17½-ton vessels in Sri Lanka.

Results and Discussion

1. *Incidental take of small cetaceans by traditional and modern mechanized vessels.*

While working in fishing harbours for two days in 1982, 48 days in 1983 and 18 days in 1984, I saw 72 odontocetes brought into fish markets. Of these animals, all were identified, 52 were measured, sexed, or photographed, and six skulls were collected and sent to the Smithsonian Institution. The ten different species which I identified (Table 1) were spinner dolphin, *Stenella longirostris* (40%), Risso's Dolphin, *Grampus griseus* (17%), spotted dolphin, *Stenella* cf. *Stenella attenuata* (13%), striped dolphin, *Stenella coeruleoalba* (8%), bottlenose dolphin, *Tursiops* sp. (7%), pygmy killer whale, *Feresa attenuata* (4%), dwarf sperm whale, *Kogia simus* (4%), rough-toothed dolphin, *Steno bredadensis* (4%), false killer whale, *Pseudorca crassidens* (1%), Cuvier's beaked whale, *Ziphius cavirostris* (1%), and an unidentified beaked whale (1%). It appears that *Kogia brevicauda*, pygmy sperm whale (Leatherwood 1984), and *Orcaella brevirostris*, Irrawaddy dolphin, may also be taken incidentally in gillnets (Joseph *et al.* 1983).

TABLE 1
THE RELATIVE FREQUENCIES OF ODONTOCETES OBSERVED IN SRI LANKAN FISH MARKETS IN 1982, 1983 AND 1984

Species	Frequency of observations %
Stenella longirostris	40
Grampus griseus	17
Stenella cf. *Stenella attenuata*	13
Stenella coeruleoalba	8
Tursiops spp.	7
Feresa attenuata	4
Kogia simus	4
Steno bredadensis	4
Pseudorca crassidens	1
Ziphius cavirostris	1

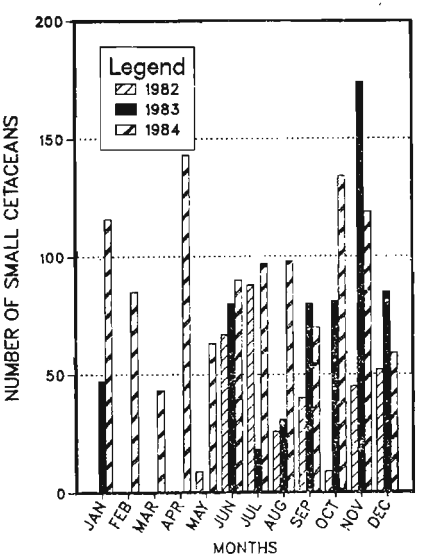

Fig. 2. The number of small cetaceans entangled in gillnets and brought into Beruwala Harbour, May 1982-December 1984.

Beruwala was monitored for 28 months (1982-1984), Trincomalee for 23 consecutive

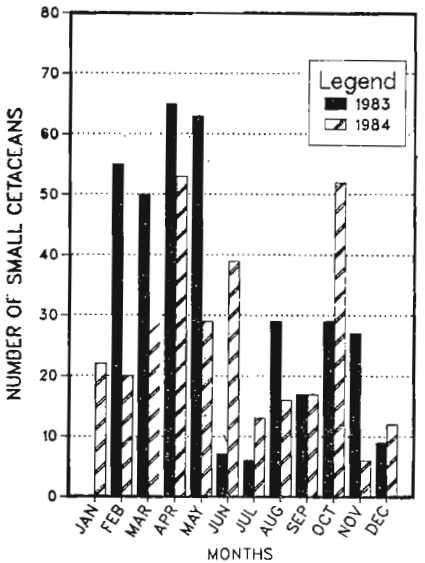

Fig. 3. The number of small cetaceans entangled in gillnets and brought into Trincomalee Harbour, February 1983-December 1984.

months (1983-1984), and Valaichenai for 11 consecutive months (1973-1984). The number of odontocetes taken each month in these three harbours is illustrated in Figs. 2, 3, & 4. Of the harbours I visited around the island (Fig. 1), fishermen in each harbour take odontocetes accidentally in gillnets. It appears, then, that the incidental catch of cetaceans occurs along the entire coast of Sri Lanka and is not a problem only on the east and west coasts.

Thus, these data suggest that 38,000 dolphins could be killed by the 3½ & 17½-ton vessels operating off the coast of Sri Lanka each year. This estimate, however, must be recognized as a necessary, but preliminary, step in assessing the impact gillnet fisheries has on odontocete mortality in Sri Lanka.

The catch of odontocetes appears to be seasonal, increasing during the spring and fall and decreasing slightly during the winter and summer. This fluctuation is probably a result of the monsoon winds. Between the northeast and southwest monsoon seasons, the seas are calm and fishing effort increases. It would be expected, then, that the number of cetaceans entangled in nets would increase when more boats are fishing offshore during the months of March, April, May, October, and November. In general, Figs. 2, 3 & 4 show a slight increase in the number of animals taken during these inter-monsoon periods.

The average number of odontocetes taken per month for each harbour and for each boat

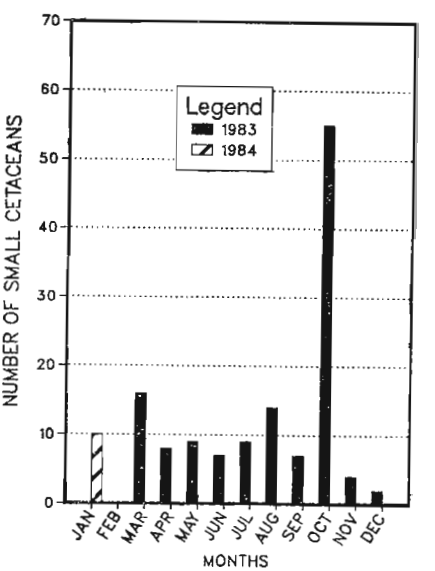

Fig. 4. The number of small cetaceans entangled in gillnets and brought into Valaichenai Harbour, March 1983-January 1984.

is listed in Table 2. Valaichenai and Trincomalee (two harbours on the east coast) take an average of 0.156 dolphins per boat each month whereas Beruwala (a harbour on the west coast) takes an average of 0.559 dolphins per boat each month. Trincomalee, the largest harbour in Sri Lanka, may have been one of the first areas to provide fishermen with synthetic gillnets. It is possible that there are fewer odontocetes on the east coast because populations have been subjected to incidental exploitation for a longer period of time. Alternatively, the difference in the number of animals taken in each harbour may simply reflect the ecology of the area or the types of gear used (e.g. Beruwala fishermen may be using nets that are newer and hence more effective).

TABLE 2

THE NUMBER OF ODONTOCETES THAT WERE BROUGHT INTO FISHMARKETS WAS MONITORED IN BERUWALA, TRINCOMALEE AND VALAICHENAI DURING 1982, 1983AND 1984. THIS TABLE LISTS THE NUMBER OF REGISTERED 3½ AND 17½-TON VESSELS, THE NUMBER OF ODONTOCETES TAKEN PER MONTH PER HARBOUR AND PER MONTH PER BOAT FOR EACH OF THE THREE HARBOURS

	Average # dolphins taken per month per harbour			Average # dolphins taken per month per boat			Number of 3½ and 17½-ton vessels
Harbours	1982	1983	1984	1982	1983	1984	1981
Beruwala	42	74.5	93.1	0.336	0.596	0.745	125
Trincomalee	—	32.5	25.8	—	0.163	0.129	200
Valaichenai	—	12.8	—	—	0.178	—	72

2. *Offshore sightings.*

While working off the coast of Sri Lanka (1982-1984), the crew of R/V *Tulip* recorded sightings of cetaceans. The frequency that these different species were seen at sea is listed in Table 3 and the position of each sighting is illustrated in Fig. 1. The slashed line in this figure is drawn 30 miles (48 km) from the coast to indicate the maximum distance fishermen will motor offshore to set drift nets from the 3½ and 17½ ton vessels. Spinner (34%) and Risso's (23%) dolphins were the most abundant species seen within 30 miles (48 km) of Sri Lanka's coastline.

Overall, there appeared to be a correlation between the frequency that a species was seen in a fishmarket and its relative abundance in coastal waters where nets are set. Points of difference could be largely due to a bias in sampling techniques (e.g., there was no stan-

TABLE 3

THE RELATIVE FREQUENCY WITH WHICH EACH SPECIES WAS SEEN OFF THE COAST OF SRI LANKA, JANUARY THROUGH MAY (1982-1984). THE TOTAL NUMBER OF SIGHTINGS WAS 126

Species	February, 1982-May, 1984 (%)
Spinner dolphin	34%
Risso's Dolphin	23%
Bottlenose Dolphin	14%
Spotted Dolphin	9%
Striped Dolphin	9%
Common Dolphin	2%
Pygmy Killer Whale	2%
False Killer Whale	2%
Pilot Whale	2%
Southern bottlenose whale	2%
Fraser's dolphin	1%

dard offshore survey conducted to obtain information about the distribution and abundance of cetaceans, and observations of odontocetes brought into the fishmarkets were made almost entirely in only one harbour, Trincomalee). In addition, the ability to detect animals at sea may vary between species, and behavioural or physiological traits may also affect the likelihood that a species will become entangled in a net. For example, Pilleri, Gihr & Kraus (1981) suggested that the directivity of the frontal sector of a dolphin's sonar field is different for each species which may enable some species to detect nets more easily than others. Pryor & Norris (1978) contend that some *Stenella* species are particularly 'high-strung, active, and nervous' and in comparison with other cetacean species (in particular the bottlenose dolphin) they are 'behaviourally maladaptive to obstacles'.

The frequency that calves were seen out of a total of 57 animals is listed in Table 4. The high percentage of spinner (52%), Risso's (100%), and spotted (75%) dolphin calves that are taken may be of grave concern. Such high infant mortality could depress the recruitment rate which would be of serious concern for populations that are already depleted. Reasons for a high calf mortality are not known, and may simply be dependent upon the fact that fishing effort increases during the inter-monsoonal periods which may coincide with peak calving periods. For example, if the spinner and spotted dolphins off the coast of Sri Lanka have similar fall and spring calving peaks as Pacific populations (Norris & Dohl 1980, Perrin 1976), then these peaks would coincide with the calm, inter-monsoonal seasons (February-March and September-November). It would be expected, then, that a large percent of calves would be caught, especially if a period of growth is needed before a calf develops physiological mechanisms to avoid nets or learns to adapt behaviourally as shown to occur with Pacific spinner and spotted dolphins in purse-seine nets (Pryor & Kang 1978).

On the other hand, complex social structures within herds may affect the probability that a particular age class will be taken. Pryor & Kang (1978) found that individual aggregations of spinner and spotted dolphins were not disrupted when the animals were entrapped by purse-seine nets and that large aggregations were often composed of groups of animals stratified by age. Their findings are interesting because observations #5, 7, and 8 (appendix 1) are all of calves taken in a single net without adults being entangled as well. As a corollary to this, 8 large spotted dolphins were taken in one net (#9) without the presence of a single calf. Are these observations completely random, or are they indicative of some social structure within a group? It is also curious that spotted and spinner dolphin calves were found in a single net (#7) as well as Risso's dolphins and pygmy killer whales (#4). If the different species were not schooling together, one would expect that the presence of a dead animal in a net would deter a herd of cetaceans from approaching, or at least alert them to danger. Will the entrapment of one animal, then, increase the chance that others will be atracted to it consequently, causing them to be caught? Such observations are curious, but at present it is not known what effect the behaviour, herd structure, distribution, and feeding ecology may have on odontocete entrapment in gillnets.

3. *Incidental catch by non-mechanized vessels.*

There is an incidental catch of odontocetes by the traditional, non-mechanized vessels, but I was unable to determine its extent. Once while walking along a beach in Trincomalee at

dusk, I saw three severed dolphin heads near two beached canoes. Although I am not positive that these particular animals were brought onto shore by fishermen who use these boats, I was told by fishermen that men working from traditional vessels do catch dolphins in nets.

4. *Incidental catch by trawlers.*

The managers of the Trincomalee and Kalpitiya Ceylon Seafoods Corporation did not know how many dolphins were caught a year by their fishermen, because the dolphins are seldom brought back to shore. A dolphin that is entangled in a net which is deployed from a trawler at night, will be used the next day for long line bait or it will be discarded because the storage space is needed for the harvest of commercial fish. Each manager estimated that a total of 200 or more dolphins are taken while the vessels are working in their respective harbours. Trincomalee has 5-6 trawlers working offshore during a 4-5 month period, which would suggest that each trawler catches approximately 6.6-10 odontocetes per month which is about 1,100-1,700 odontocetes per year.

TABLE 4

THE FREQUENCY (%) THAT CALVES WERE SEEN IN THE FISHMARKETS: (NUMBER OF ANIMALS RECORDED AS CALVES/THE NUMBER OF ANIMALS WHICH APPEARED TO BE FULL GROWN)

Species	Number of calves/total number of observations
Spinner Dolphin	52% (11/21)
Spotted Dolphin	75% (6/8)
Striped Dolphin	20% (1/5)
Bottlenose Dolphin	0% (0/3)
Risso's Dolphin	100% (12/12)
Dwarf Sperm Whale	0% (0/2)
Rough Toothed Dolphin	0% (0/3)
False Killer Whale	0% (0/1)
Cuvier's beaked whale	100% (1/1)

The extent to which cetaceans are taken

5. *Direct Fisheries.*

directly by fishermen is questionable. Although some fishermen harpoon dolphins, the catch does not appear to be extensive, nor is it a question of subsistence hunting, because the meat is not used for the survival of a community and the hunt is only practised by a few. Of the 72 cetaceans that I observed in fish markets, only four had deep wounds. It was unclear in my discussions with fishermen, however, if they had actually killed the animal or if the marks were made while the men hoisted it on to their boats with the help of a gaff or spear. Since there is little commercial incentive to kill dolphins, fishermen apparently hunt them only for sport or shark bait. I was told that Hindu and Buddhist fishermen do not hunt cetaceans and such skills will only be practised by Catholic and Muslim people.

In 1982, the crew of R/V *Tulip* witnessed a dolphin hunt while working offshore near a fishing village, Negombo (7°17'N, 79°40'E). We were following a school of Risso's dolphins, when two fishing boats approached us returning towards Negombo at 0830. Hand harpoons were brought out on both vessels and unsuccessful attempts made at harpooning the dolphins. On 15 March, 1983, a Cuvier's beaked whale calf was brought into the Trincomalee market with two large holes in the lower jaw and many smaller holes around the head and on the back in front of its dorsal fin. One man explained that fishermen actively take "these" animals during the months of March, April, and May for shark bait. "These" is in quotes because I could not establish if he referred only to the larger, beaked whales, or included other odontocetes as well. He estimated that there are ten boats which work out of Trincomalee Harbour that actively hunt these animals, killing 1-2 every three days for shark bait. Therefore, these boats may take 30-60

animals outside Trincomalee Harbour during the spring. Since there are 200 boats in Trincomalee town, ten boats represent 5% participation of fishermen directly killing cetaceans during the spring season.

6. *Habitat Modification.*

Populations of cetaceans off the coast of Sri Lanka may be threatened not only by indirect and direct exploitation, but also by habitat modification. As Sri Lanka becomes more industrialized, marine pollution (organic, inorganic and noise) will increase. Trincomalee Harbour is a good example of such changes. Undoubtedly it will become a major international and national port in the future. In addition, the largest river in Sri Lanka, the Mahaweli Ganga, flows northeast into Trincomalee harbour. This river, recently dammed to irrigate inland dry zones, now carries a vast amount of sediment and fertilizer. This murky plume entends out beyond Trincomalee harbour into the sea, directly altering the marine environment. For species that utilize these inshore waters, this habitat modification may be adversely affecting local populations.

Conclusion

The incidental entrapment of odontocetes by drift net fisheries is a global concern with substantial legal, biological, ethical and administrative problems.

Although this study focuses on the incidental entrapment of odontocetes in gillnets off the coast of Sri Lanka, it is clear that populations of cetaceans are threatened, endangered or at least harassed by gillnet fisheries wherever such nets and these animals occur together. Since the successful introduction of synthetic nets by FAO in Sri Lanka, these nets are now being utilized throughout the world (Eisenbud 1984). Yet, are these nets acceptable? Not only are animals (cetaceans, birds, turtles, fish, etc) entangled in nets while fishermen are using them, but entire nets, or parts of the gear are also lost at sea and continue to kill marine life indefinitely (Wallace 1984).

An international effort must be made to either replace gillnet fisheries with alternative fishing techniques, or to change the nets substantially so that non-target animals will avoid the nets. Gear experiments are presently being tested with drift net fisheries to decrease the incidental catch of Dall's purpoise, *Phocoenoides dalli*, in salmon gear (Kumagai *et al.* 1983), but more work needs to be done on an international scale. If we do not alter these nets or prevent their use, these nets may fish some populations of marine animals to extinction. Gillnet fisheries are multispecies operations. We have a moral obligation to stop the wasteful, useless and irresponsible catch of non-target animals by these nets, even if the consequence is economic loss.

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