Marine Mammal Research and Conservation

In Sri Lanka
1985-1986

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Marine Mammal
Technical Report Number 1

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PREFACE

Marine mammals have been considered as resources for centuries. However, increasingly sophisticated methods of hunting, growing human populations, pollution and general degradation of and encroachment on habitats have all contributed to their decline. Concern for the plight of marine mammals became widespread in the early 1970s, when whales became a symbol of threats to the environment and of mankind's responsibility towards other species. This concern was formally expressed at the Stockholm Conference on the Human Environment in 1972, where recommendations were made for protecting marine mammals.

In response to the recommendations of the Conference, the Global Plan of Action for the Conservation, Management and Utilization of Marine Mammals was developed between 1978 and 1983, jointly by UNEP and the Food and Agriculture Organization of the United Nations (FAO) in collaboration with other intergovernmental and non-governmental bodies concerned with marine issues, particularly the International Whaling Commission (IWC) and the World Conservation Union, formerly the International Union for Conservation of Nature and Natural Resources (IUCN). In October 1983, the FAO Committee on Fisheries (COFI) endorsed the principles of the Plan, and in May 1984 the UNEP Governing Council followed suit. The IWC endorsed the cetacean component of the Plan at its annual meeting in June 1984, and in November of that year the General Assembly of IUCN endorsed the promotion of the Plan as a matter of high priority. This series of formal endorsements officially launched the implementation of the Plan.

The basic objective of the Plan was to promote the effective implementation of a policy for conservation, management and utilization of marine mammals which would be widely acceptable to governments and the public. The Plan was built around five concentration areas, namely policy formulation, regulatory and protective measures, improvements of scientific knowledge, improvement of law and its application and enhancement of public understanding. Thirty-eight priority actions were recommended as necessary to implement the Plan under these areas.

The Plan was intended to stimulate, guide, assist and where necessary coordinate activities of existing organizations, giving emphasis to international actions, while recognizing the importance of national actions. The main organizations identified as having an important role in the implementation of the Plan included UNEP, FAO, Unesco, other specialized agencies of the United Nations, the secretariats of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS) , the IWC, the Scientific Committee on Antarctic Research (SCAR), IUCN and the World Wide Fund For Nature (WWF) as well as governments and non-governmental organizations in general.

Following the endorsement of the Plan by the UNEP Governing Council, UNEP assumed the role of the Plan's secretariat and initiated its implementation through close cooperation with interested states and international, intergovernmental and non-governmental organizations.

INTRODUCTION

The Indian Ocean Sanctuary

In 1979, following an initiative by the Republic of the Seychelles, the International Whaling Commission (IWC), the international body responsible for the management of whale stocks, voted to set aside the entire Indian Ocean north of latitude 55°S as the Indian Ocean Sanctuary (also referred to hereafter as the IOS or simply the Sanctuary) (Figure 1). In doing so, the IWC prohibited the commercial killing of whales within Sanctuary waters and called for research within the Sanctuary to further the objectives of the IWC. In particular, it expected research in the Sanctuary to provide population estimates of species under its purview, to compare the status of populations in a protected area with those of the same species elsewhere and to include investigations that would be difficult or impossible to conduct in areas where whaling was continuing (IWC 1980). This action by the IWC created the largest sanctuary in history and offered both challenges and opportunities to scientists, conservationists and resource managers with special interest in marine mammals.

Since the IWC action, Sri Lankans have noted with interest and pride that, more than 20 years earlier, the late Prof. Paulus Edward Peiris Deraniyagala, one of Sri Lanka's most distinguished scientists, had proposed that the Indian Ocean be so designated. He wrote:

> "International regulations cannot be enforced according to the present system (regarding the placement of observers on whaling vessels)....the only reliable course will be to declare one ocean a sanctuary and strictly prohibit the entry of whalers into the waters. The Indian Ocean is eminently suitable for this purpose and I would urge that the ocean between longitude 20° E and 118°E inclusive of part of the southern ocean be proclaimed a sanctuary for turtles, the dugong, whales and dolphins, by international agreement" (Deraniyagala 1965a).

The Indian Ocean Sanctuary was originally designated to remain in effect for at least ten years, with provisions for renewal. It was also decided that a meeting should be held during those ten years to review progress to date and to assess the scientific usefulness of the Sanctuary, particularly in meeting the IWC's goal of conducting a comprehensive assessment of the world's whale stocks. That meeting was held in January 1987 in the Seychelles (Leatherwood and Donovan 1990), and in 1989 the IWC voted to renew the Sanctuary for three more years, through 1993 (IWC 1989b).

Soon after the establishment of the Sanctuary, Sri Lankans initiated programs related to marine mammals. In February 1983, the Sri Lankan National Aquatic Resources Agency (NARA) convened a symposium of international experts in Colombo, Sri Lanka, to review the status of knowledge about marine mammals of the Indian Ocean and to outline specific research activities which should be undertaken there, in the spirit of the Indian Ocean Sanctuary, to address both the needs of the IWC (for species agreed to be under its purview) and the needs of Indian Ocean states for information to support informed conservation, management and utilization of marine mammals in the region. The Sri Lankan Minister of Fisheries, Festus Perera, took advantage of the occasion to announce the establishment in

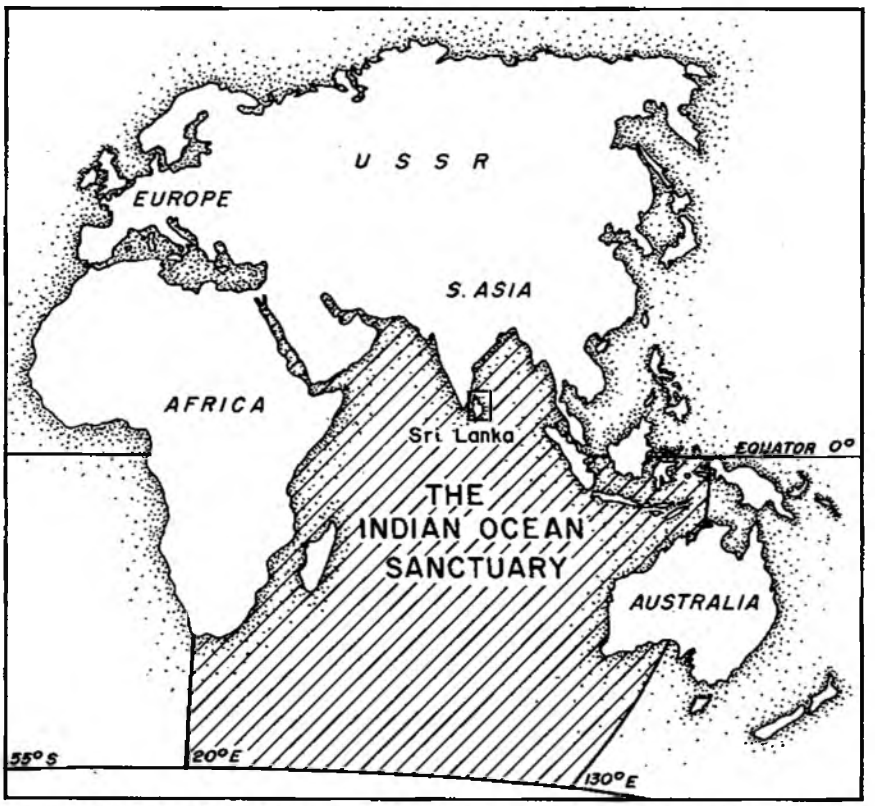


Figure 1. The Indian Ocean Sanctuary (IWC 1980) and waters under Sri Lankan jurisdiction (in box).

Colombo of the Centre for Research on Indian Ocean Marine Mammals (CRIOMM). It was the Sri Lankan view that, located as it is near the center of the Indian Ocean (latitudes 6-10° N, longitudes 80-83° E) (Figures 1 and 2), the country should serve as a focal point for marine mammal research and conservation. CRIOMM was established to provide a facility from which researchers from Sri Lanka's National Marine Mammal Unit (NMMU) and other institutions and workers from elsewhere could carry out relevant work.

Research and conservation are not new ideas to Sri Lanka. In about 300 B.C., Arahat Mihindu is reputed to have written, "O great king, the birds of the air and beasts have an equal right to live and move about in any part of the land as thou. The land belongs to the people and all other beings and thou art only a guardian of it." An inscription attributed to King Nissanka Malla, 12th century A.D., is translated, "Ordering by a beat of drum that no animal should be killed within a radius of 7 gan from the city, he gave security to animals. He also gave security to the fish in the tanks and bestowing (on the region's people) gold and cloth and whatever other kinds of wealth they wished, he commanded them not to catch birds and so gave security to the birds." (Both translations courtesy of the Sri Lankan March for Conservation.)

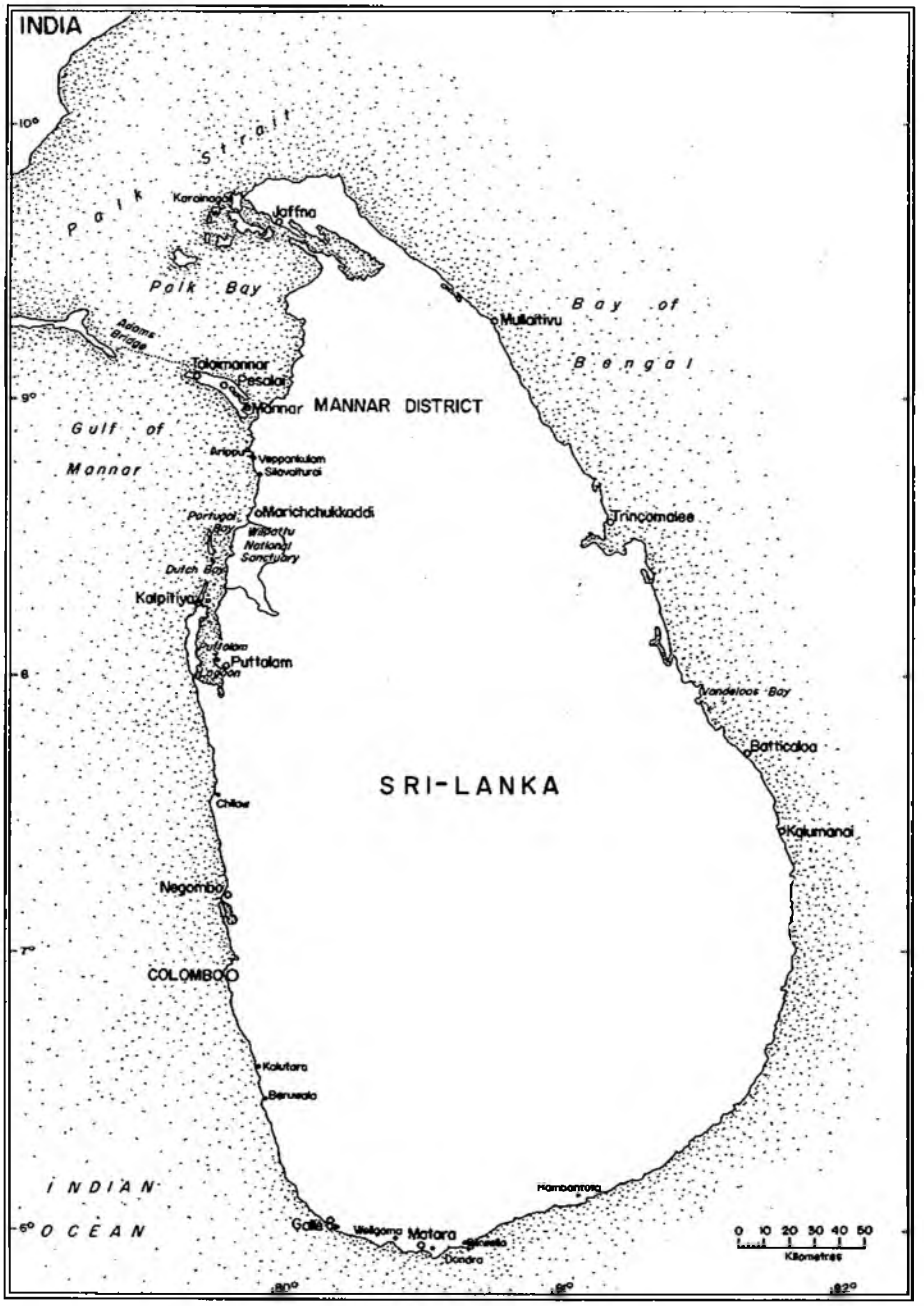


Figure 2. Detail of Sri Lanka, with some important place names mentioned in the text. We have maintained spellings presented by NARA in their reports to UNEP, mindful that spellings often vary among English-language sources.

Specifically in regard to marine mammals, the Whaling Ordinance, Chapter 215 (4 July 1936) and its 1956 revision, covering sperm and baleen whales, expressly prohibited the killing of right whales, females with calves and immature animals. Chapter 469 (1 March 1938) of the Ordinance provided broader prohibitions against the taking of marine mammals, specifically listing dugongs as protected (Anonymous 1970,1978); it was subsequently interpreted more broadly to include other marine mammals as well (P. E. P. Deraniyagala correspondence, Colombo Museum, 1965). In 1984, violations of the ordinance, i.e. killing or possession of dolphins or dugongs, reportedly were punishable by a fine of Rs: 3000/ or 6-months imprisonment (The Weekend, 2 August 1984). The law is administered through the Ministry of Fisheries.

In his opening address at the 1983 Symposium, Hiran Jayewardene, Chairman of NARA, reaffirmed Sri Lanka's commitment to the conservation of her marine mammal resources. He also reminded attendees, however, of pressing needs in developing countries which require a balanced view of the roles of resources, including marine mammals, in human society and which affect ways those resources are used. That view was reiterated by the Minister of Fisheries, who reminded those present that the mandate of his Ministry was to increase fisheries, the most important source of protein in the country, and by the Minister of State, who stated plainly that the conservation of marine mammals must be effected in the context of modern needs and developments (Anonymous 1983).

Participants in the Colombo Symposium took special notice of a meeting held in Zeist, the Netherlands, 28 September-1 October 1981, to plan a general program of research on cetaceans in the Indian Ocean Sanctuary (Holt 1981). The report of that workshop expressed the opinion that the research programs in the Sanctuary, coordinated among Indian Ocean states and other participants, regardless of nationality, should address at least six broad objectives: (1) obtaining information useful to the IWC Scientific Committee on whale distribution and abundance, reproductive behavior and stock status, (2) assessing the economic, cultural and scientific values of living cetaceans, (3) understanding the ecological roles of cetaceans and the impacts of human activities on their populations, (4) developing and applying benign research techniques, (5) describing aspects of communication, navigation, behavior and diving physiology of cetaceans and (6) establishing research centers to promote cooperation among Indian Ocean states.

The extensive and specific recommendations of the Colombo Workshop, not heretofore published or widely distributed (Appendix A), built on the Zeist report but were shaped by recent discoveries that large concentrations of great whales and small cetaceans were found in Sri Lankan waters (Alling *et al.* 1982; Leatherwood and Clarke 1983a,b; Gordon 1983; Whitehead *et al.* 1983) and that small cetaceans were being killed in both directed and undirected fisheries in Sri Lankan waters (Alling *et al.* 1982; Alling 1983; Joseph *et al.* 1983),[1] as well as by awareness of the grave and immediate danger of extirpation for the Indo-Sri Lankan stock of the dugong (Jones 1983). (Marine mammals known or expected to occur in Sri Lankan waters are listed in Table 1.)

[1] By the term *directed harvesting* we mean any harvesting in which cetaceans (or dugongs) are viewed as part of the expected catch. All harpooning is, of course, directed harvesting. So also are those situations in which cetaceans (or dugongs) are considered part of the normal or expected mix of commercially valuable species taken in gillnets. We consider as *undirected harvesting* only those situations in which cetaceans are taken but dumped overboard or in which they are taken so infrequently that they do not figure in the process of deciding where, when or how to fish. In some cases, harvesting that begins as undirected becomes directed as markets are found and developed.

Table1. Classification of marine mammals known or believed to occur in Sri Lankan waters.

Order Cetacea	
Suborder Odontoceti	
Superfamily Delphinoidea	
Family Monodontidae	
Subfamily Orcaellinae	
Orcaella brevirostris	Irrawaddy dolphin, pesut
Family Phocoenidae	
Subfamily Phocoeninae	
Neophocaena phocaenoides	finless porpoise
Family Delphinidae	
Subfamily Steninae	
Steno bredanensis	rough-toothed dolphin
Sousa chinensis	Indo-Pacific hump-backed dolphin
Subfamily Delphininae	
Grampus griseus	Risso's dolphin
Tursiops truncatus	bottlenose dolphin
Stenella attenuata	pantropical spotted dolphin
Stenella longirostris	spinner dolphin
Stenella coeruleoalba	striped dolphin
Delphinus delphis	common dolphin
Lagenodelphis hosei	Fraser's dolphin
Subfamily Globicephalinae	
Peponocephala electra	melon-headed whale, electra dolphin
Feresa attenuata	pygmy killer whale
Pseudorca crassidens	false killer whale
Orcinus orca	killer whale
Globicephala macrorhynchus	short-finned pilot whale
Superfamily Ziphioidea	
Family Ziphiidae	
Mesoplodon densirostris	Blainville's beaked whale
Mesoplodon ginkgodens	ginkgo-toothed beaked whale
Ziphius cavirostris	Cuvier's beaked whale
Hyperoodon planifrons	southern bottlenose whale
Superfamily Physeteroidea	
Family Physeteridae	
Physeter catodon	sperm whale
Family Kogiidae	
Kogia breviceps	pygmy sperm whale
Kogia simus	dwarf sperm whale
Suborder Mysticeti	
Family Balaenopteridae	
Subfamily Balaenopterinae	
Balaenoptera acutorostrata	minke whale
Balaenoptera borealis	sei whale
Balaenoptera edeni	Bryde's whale
Balaenoptera musculus	blue whale
Balaenoptera physalus	fin whale, finback
Subfamily Megapterinae	
Megaptera novaeangliae	humpback whale
Order Sirenia	
Family Dugongidae	
Dugong dugon	dugong

The NARA/UNEP Program

History

In November 1983 NARA, on behalf of the NMMU, requested support from UNEP for its planned and ongoing research on marine mammals of Sri Lanka. For this proposed two-year effort, NARA offered to (1) determine numbers and habitat preferences of the various species of marine mammals within Sri Lankan waters, (2) attempt to reduce entrapment of marine mammals in fishing gear and (3) establish a marine mammal sighting network. Other important objectives of the program, unstated at the time, were to (1) improve levels of expertise of Sri Lankan nationals in skills necessary to study and conserve marine mammals, (2) improve the management of the nation's resources and (3) emphasize non-consumptive uses of cetaceans found in national waters. This last objective included promotion of a whale-watch industry, for profit, off the northeast coast near Trincomalee, a notion supported by the former president, J.R. Jayewardene, who developed a keen interest in the nation's whale resources and several times went to sea to observe them, and by foreign organizations which planned natural-history excursions around the availability of a diverse cetacean fauna close to shore. The approach NARA proposed for the project was to use international consultants to train the Sri Lankan scientists and assist them with their research assignments.

The proposed project (Project ST/5103/85/01), modified slightly from the original proposal, was funded by UNEP through the UN Conservation Stamp Fund. In its endorsement of the program, UNEP noted:

> "Marine mammal resources in Sri Lankan waters are extensive and diverse. Recent research surveys (Alling *et al.* 1982, 1983; Leatherwood and Clarke 1983) have spotlighted large populations of whales, particularly the blue, the sperm and the Bryde's in the north eastern part of the Island and more than 15 species of dolphins around the island. Apart from these cetaceans, the only surviving sirenian in the Indo-Pacific, the dugong, which once abounded in large numbers in the northwest of the island, has been decimated to virtual extinction.
>
> "Sri Lanka has taken the initiative to develop her facilities in the field of marine mammals. The pivotal position which Sri Lanka geographically occupies in the Indian Ocean and the rich marine mammal resources in the vicinity qualifies her as an ideal location for the Centre for Research on Indian Ocean Marine Mammals (CRIOMM)."

Organization and Conduct

The NARA/UNEP project began on 1 January 1985 and ended on 31 March 1986. It was administered through the NMMU in Colombo and conducted using facilities of CRIOMM in Colombo and at Clappenberg Bay, Trincomalee. CRIOMM is administered by a Director, Associate Executive Director, International Associate Director and Senior Scientific Coordinator (who formed the board of 4), assisted by six Associate Directors, for whales, dolphins and porpoises, dugongs, behavioral studies, conservation and law and policy.

Initially, the project was subdivided into 10 discrete tasks (Figure 3), conducted by the NMMU staff listed in the following summary.

Fisheries History: A review of the history of Sri Lankan fisheries, with special emphasis on modernization of the country's fishing fleet and methods and on the introduction of synthetic gillnets (in the 1950s) and the problems resulting from that step. (Rohan Gunaratna)

Marine Mammal Mortality: Two separate but supporting subprojects designed to characterize both coastal small-boat fisheries and the commercial fisheries which operate farther offshore and to assess the numbers of marine mammals (by species, area and season) killed, both intentionally and incidentally/accidentally, in each. (W.P. Mahendra, Sujiva Senanayake, W.P. Prematunga)

Net Manipulation: Experiments to reduce mortality of marine mammals in net fisheries by manipulating various elements of the fishing equipment and/or techniques. (W.P. Prematunga)

Socio-economics: An evaluation of attitudes towards and utilitarian values of marine mammals, by village and region. (Anouk Ilangakoon)

Systematics/Biology: A study of the biology of Sri Lankan marine mammals, principally small cetaceans, as a basis for detecting impacts of fisheries on stocks and for ascertaining the relationships of species and stocks occurring there to those known from elsewhere. (Chandana Mendes, Asoaka Gamage)

Information Network: Development of programs to collect data on sightings and strandings of marine mammals in Sri Lankan waters. (Chitrongali Dissanayaka, Ameen Afzal)

Identification Guide: Preparation of a guide to assist fishermen and other lay persons with identification of Sri Lankan marine mammals. (Rohan Gunaratna)

Dugong Assessment: Attempts to determine the present status of the critically endangered dugong in Sri Lankan waters. (Rohan Gunaratna, Ameen Afzal)

Public Awareness: A campaign to raise public awareness about marine mammals and their plights in Sri Lanka and through the campaign to gain grass-roots support for necessary conservation measures. (Nihal de Abrew, Palitha Gunewardene, Kanthi Subasinghe)

In November 1985 an eleventh task was added to study cetacean distribution and migrations, particularly on the southwest and south coasts. From that date onward most of the NMMU staff refocused their attention to this project.

We emphasize that NMMU staff members shared offices and usually travelled in groups to conduct their field work. They were encouraged to collect and share with fellow team members information pertinent to all subtasks. Therefore, although results are reported here by task and attributed to the project coordinators, all project members can share the credit for any significant results.

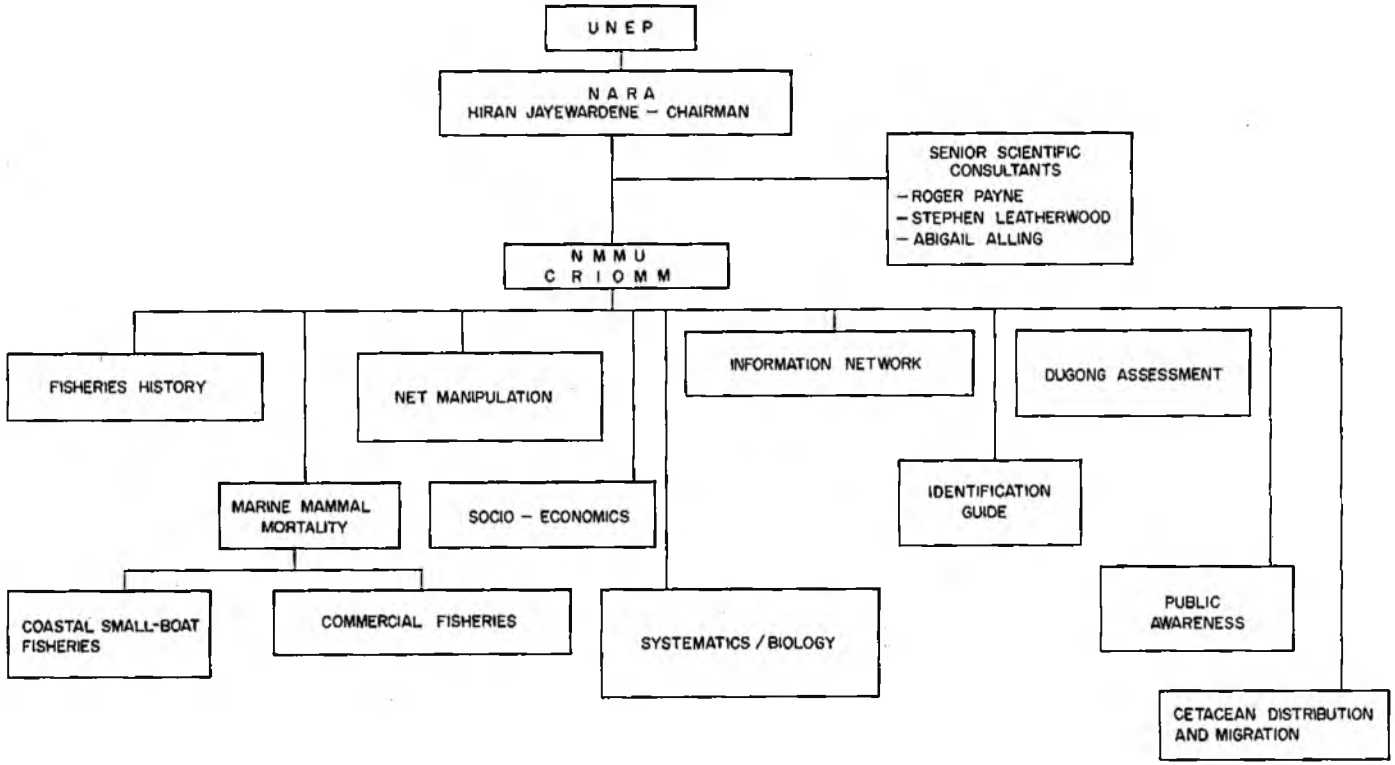


Figure 3. The management structure of the NARA/UNEP marine mammal program.

The NARA/UNEP program was conducted with the advice of volunteer scientific consultants Roger Payne, Abigail Alling and Stephen Leatherwood, who visited Sri Lanka periodically during 1982-1986, especially in 1985 and 1986, to train NARA staff in techniques of data collection and analysis and to assess their progress to date. However, all work represented in this report, including data collection and analysis and preparation of the various reports to UNEP, was accomplished by the project team members at the NMMU.

The management of NARA filed four technical reports with UNEP under this project: "half-yearly" progress reports for the periods 1 January through 31 May 1985 (Anonymous 1986a), 1 June through 30 September 1985 (Anonymous 1986b) and 1 October 1985 through 31 March 1986 (Anonymous 1987a) and a "Terminal Report" covering the entire contract period, 1 January 1985 through 31 March 1986 (Anonymous 1987b). The proposed field guide was not completed. Net-manipulation experiments were not conducted for reasons discussed in this report. Some progress was made on the remaining nine subprojects. That progress is reviewed in the following sections. We, the editors, have prepared this report largely from the four NARA documents, supplemented with some published literature, correspondence from colleagues in Sri Lanka and, where applicable, observations by the consultants. We have not examined the original data; therefore, we inadvertently may have perpetuated errors which appeared in the reports. We have noted some inconsistencies. For most projects, the results available after what was only a short period of work on an ambitious assignment are, at best, a foundation for further work. Few of the projects can be considered completed or adequate to support far-reaching conclusions.

Irrespective of the program's management structure, after examining the available reports we concluded that the various tasks could best be represented in this report by treating work under the following basic headings: Fisheries - background and description (an edited version of Gunaratna's report); the socio-economics of marine mammal harvesting (Ilangakoon's edited report); the biology and status of Sri Lanka's marine mammals (including work of Chandana Mendes, W. P. Prematunga and Asoaka Gamage on cetaceans and the editors' summary of information available on cetaceans and dugongs); the information network; and the public awareness campaign.

RESEARCH REPORTS

Fisheries

Brief Overview of Sri Lanka's Fisheries to 1980 by Rohan Gunaratna

[A brief summary report on Sri Lankan fisheries was prepared for the NARA/UNEP project, largely from unattributed sources, by Rohan Gunaratna. This report was included in its entirety in Anonymous (1987b). We present here only edited portions of Gunaratna's report, supplemented by our own additions (in italics) where we think they clarify the presentation for an uninitiated reader. We have also illustrated the section, as we feel it helps the reader visualize, here and elsewhere, the context of marine mammal interactions with fisheries. The goal has been to extract from the complex story of how Sri Lanka's fisheries have developed and grown only the information relevant to the present and probable future impacts of these fisheries on marine mammals.]

Sri Lankans prefer fish over other sources of animal protein, and they generally prefer marine fish over fish from inland waters. Balachandran (1983) estimated that over 50 percent of the animal protein consumed by the population *[60 percent according to Atapattu (1987)]* is supplied by the marine fishing industry and that that proportion is increasing annually. *Therefore, any attempt to understand the role(s) of marine mammals in the ecosystem or to manage and conserve them in Sri Lanka must be made in the context of current conditions and trends in the country's marine fisheries. In this regard, the two most important components of the history of Sri Lankan fisheries are the modernization/mechanization of the fleet(s) and the introduction and increasing use of gillnets made of synthetic fibers.*

Fishing Craft

There are three basic types of traditional craft, all made of timber, and five types of introduced craft fishing off Sri Lanka at present (Anonymous 1984:2-4; Balachandran 1983):

Traditional Craft

Log rafts (*theppams* and *kattumarams*) (Figure 4a-c) consist essentially of three to five logs lashed together. They operate in inshore waters and lagoons and are propelled by oars or sails. Recently, some have been equipped with outboard motors.

Dugouts with a superstructure are called *orus* or *thonies* (Figure 4d,g,h); those without a superstructure are called *vallams*. These craft, some of which have outriggers, are propelled by oars, sail or, very recently, outboard motors. They operate in inshore waters and lagoons.

Flatbottomed craft (*parus* and *pathais*) are for beach-seining in the *madel* fishery. *Madel parus* (Figure 4e), some with an outrigger and a few with both an outrigger and a mast for a sail, are used on the west and south coasts; *madel pathais*, on the north and east coasts. Some large *madel vallams* (Figure 4f) also are used for beach-seining on the east coast. It is technically difficult to classify the use of these craft by geographic and ethnic use.

Figure 4. Some traditional fishing craft used in Sri Lankan marine fisheries: theppam and kattumaram (a-c); small oru (d); madel paru and madel vallam (e,f); and large oru (g,h). Mechanization is affecting progressively more of Sri Lanka's traditional fishing fleet, such as the outboard-outfitted kattumaram (c) and oru (h). [P.A. Folkens in Negombo Lagoon (b) and S. Leatherwood at Negombo (a,g), Myliddy (c), Yala (d), Weligama (e) and Trincomalee (f,h)].

Figure 4 continued on next page.

(a)

(b)

(c)

(d)

Figure 4 *continued from previous page.*

(e)

(f)

(g)

(h)

Introduced Craft (Figure 5)

1. Non-mechanized, fiberglass-reinforced plywood (FRP) boats , 19-21 ft. long which fish in inland rivers and lakes and very near shore in the sea
2. FRP open skiffs, 17.5-23 ft. long and powered mostly by 6-15-horsepower outboard motors, which fish 10-15 miles offshore
3. Timber and/or FRP vessels, 28-32 ft. long, with a superstructure and powered by 30-40-horsepower inboard engines which fish, mostly with drift nets and longlines (some also troll *en route* to or from the grounds), 25 miles or more offshore or trawl for prawns nearshore. These are the so-called 3.5-ton boats
4. FRP inboard-powered vessels of the basic type described above but which are 34-38 ft. long and operate closer to shore, within about 10 miles
5. Ferrocement vessels, 42-46 ft. long and equipped with a 56-horsepower motor, which troll between harbor and the grounds and then fish with gillnets and longlines on grounds 40 miles or more offshore. These are the so-called Northwest and Abu Dhabi "Trawlers".

Fishing Methods (See Figures 6 and 7)

Numerous fishing methods are used in Sri Lankan marine waters. They include: trapping (mostly in weirs), hand-lining, and stake-, hand- and cast-net fishing in lagoons and along calm coasts; beach-seining, using *parus*, *pathais* and *vallams*, in the Hambantota, Amparai, Mullativu, Trincomalee and Jaffna areas; trawling, for prawns and bottom fish, by some 28-32-ft. boats and by large *orus* with sails, in the Gulf of Mannar, Chilaw, Negombo and Jaffna areas; longlining and trawling for pelagic species, from large *orus* and from some 28-32-ft. boats, in many areas; hand-lining, from *orus*, *vallams*, *theppams* and *kattumarams*, in all areas; pole-and-line fishing, from the larger, sailing *orus* and from 28-32-ft. boats, primarily for tunas, along the southwest coast and in the Trincomalee and Batticaloa areas; and gillnetting, using nets with mesh sizes of 2 inches or less to 15 inches or more deployed from some traditional craft, usually very near shore or in lagoons from 17.5-23-ft. outboards, and from 28-32-ft. inboards, in many areas. The larger boats of the trawler fleet use both longlining and gillnetting to take pelagic fishes, primarily off the south and southwest shores, but often troll *en route* to the grounds. Gillnetting is by far the most important method in the country in terms of total production. In 1980-1982, it accounted for about 70 percent of the total fish production in the coastal fisheries and for over half of the total production in the growing offshore and deep-sea fisheries.

Categories of Marine Fisheries

There are three major categories of marine fisheries in Sri Lanka, defined by area: those conducted up to 25 miles offshore (coastal fisheries) and those conducted in the areas of the Extended Economic Zone (EEZ) (Figure 8) between 25 and 60 miles (offshore fisheries) and over 60 miles (deep-sea fisheries) offshore. In 1980, coastal fisheries, conducted by over 27,000 vessels, accounted for about 88 percent of the nation's total fisheries production. The especially heavy fishing from the Negombo, Puttalam, Mannar and Jaffna areas (Figure 2) collectively accounted for 50 percent of all marine fish taken (Balachandran 1983). Pelagic

(a)

(b)

(c)

Figure 5. The three principal introduced fishing craft in Sri Lanka: 17.5-ft. outboard-powered skiffs (a), 28-32-ft. boats, the so-called 3.5-tonners (b), and "trawlers" of the Northwest and Abu Dhabi fleets (c). [S. Leatherwood at Chilaw (a) and off Matara (b) and P.A. Folkens off Trincomalee (c)].

(a)

(b)

Figure 6. *Some traditional methods of fishing in Sri Lanka: cast-netting (a), trapping, such as with weirs (b), beach-seining (c), trawling under sail (d) and hook-and-line or net fishing (e) from orus. [S. Leatherwood in Negombo Lagoon (a, d) and off Jaffna (b) and P.A. Folkens from Trincomalee (c,e)].*

Figure 6 *continued on next page*

(c)

(d)

Figure 6
continued.

(e)

(a)

Figure 7. Methods replacing traditional fishing practices in Sri Lanka: trolling under power - note the single line from near the starboard stern (a). (Many vessels use outriggers to troll up to 10 lines simultaneously); jigging, mostly for yellowfin tuna (b); gillnetting with synthetic-fiber nets of many different mesh sizes deployed from many different classes and sizes of vessels (c); and longlining and gillnetting in pelagic waters with the aid of power winches (d). Gillnetting succeeds in catching many target species, such as this billfish (e), but it also catches many non-target species as well. [S. Leatherwood off Dondra (a) and at Negombo (c), J. Gordon off Trincomalee (b) and S. Senanayake on the "southern grounds" about 50nm south of Mirissa (d, e)].

(b)

Figure 7 continued on next page.

Figure 7 continued.

(c)

(e)

(d)

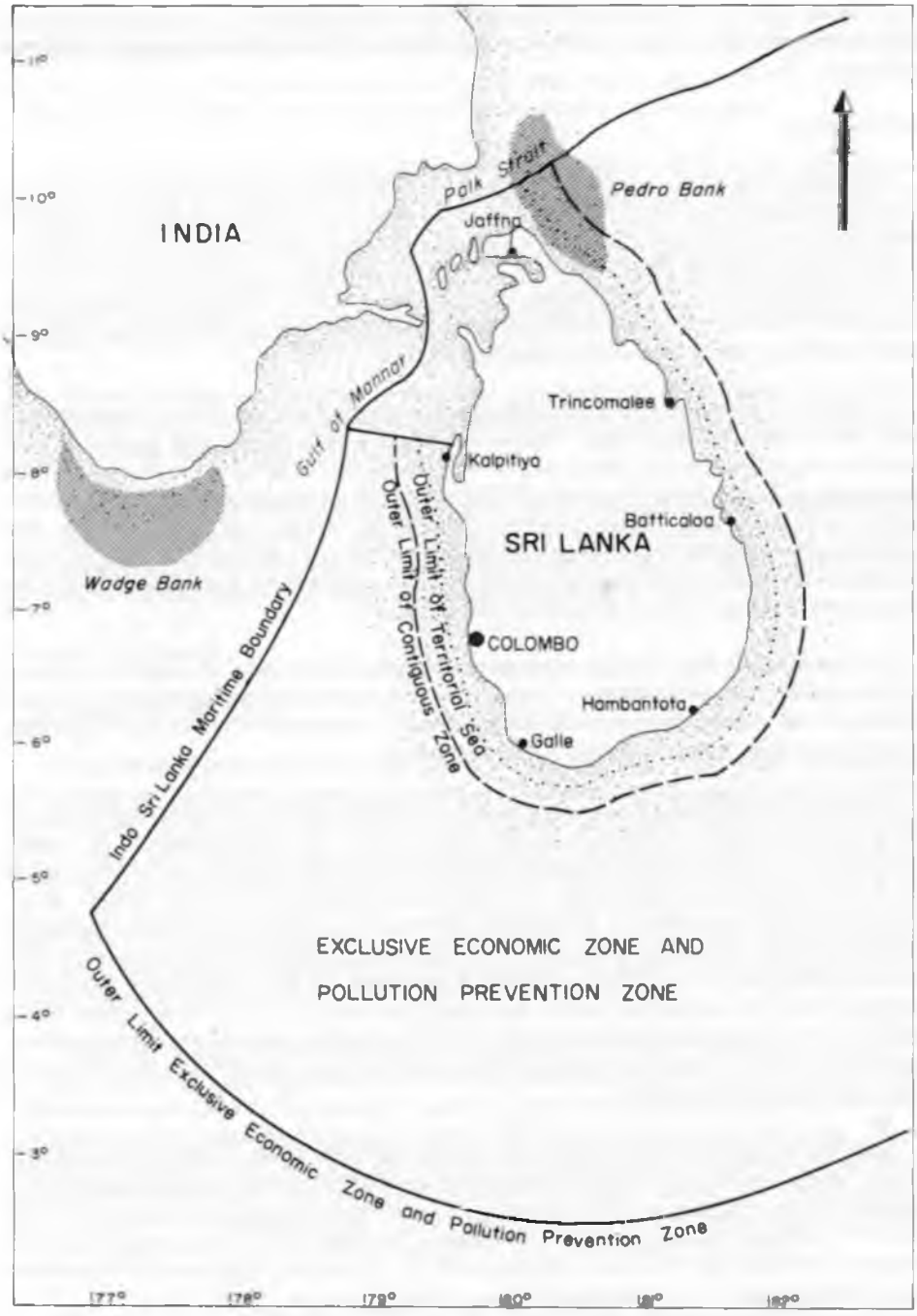


Figure 8. Sri Lanka's Extended Economic Zone (from Atapattu 1987).

species taken in the growing offshore and deep-sea fisheries accounted for about 70,000 tons, mostly of yellowfin tuna (*Thunnus albacares*), bigeye tuna (*Thunnus obesus*), skipjack (*Katsuomus pelamis*) and sharks.

Mechanization

Sri Lanka's fishing industry underwent a revolution in the 1960s following the introduction of mechanization in 1959. Prior to this time, the indigenous traditional fishing craft could operate only up to about 10 miles off the coast, and the catch was far from sufficient to meet the island's fish demand. Most fishermen, located on the west and south coasts, fished only for about six months of the year; during the southwest monsoons they were reluctant to go to sea and some of them migrated to the east coast. Also, fish were sometimes in an advanced stage of putrification by the time they reached market.

Sri Lankan fishermen, like their counterparts in much of the world, are conservative of habit. The country's fishing fleet became mechanized only slowly and gradually. The fishermen were accustomed to deep-sea fishing with the aid of a sail fixed to an *oru* or *vallam*. The *kattumarams* and *theppams* were steered and rowed using traditional mechanisms to avoid harmful reefs and rocks. Some fishermen viewed the heavily mechanized vessels with suspicion as they believed that all high sea-going vessels should carry a sail. To this date some fishermen in the south use their mechanized boats with sails on them. Some find it mysterious that a vessel could go to sea at all without an outrigger.

The push for mechanization was heavily influenced by the report of a team of Japanese experts claiming that mechanization would make the country self-sufficient in fish. Mechanization of craft, training, research and development of the necessary infrastructure featured in the ten-year plan formulated by the Japanese team.

During 1959-1963 Rs:43 million was invested, mainly to launch 2,000 mechanized boats. Fish production nearly doubled to 65,460 tons by 1963. The Government of Sri Lanka introduced an incentive scheme in about 1965 which provided new gear such as free nylon drift nets and more powerful engines. The incentive scheme continues to the present, with a subsidy of up to 50 percent for an outboard motor. As a result of such encouragement, mechanized boats, and gill nets, have become widely distributed in the coastal villages of the country. Motorizing of the traditional fleet also occurred. In fact, by 1980 there were more traditional craft with outboard motors operating than there were 17.5-ft fiberglass boats. Small mechanized *orus* and *kattumarams* with drift nets are not uncommon. Thus modified for greater efficiency, these traditional craft are used to a large extent in some of the same fisheries as some modern craft.

The efficient 3.5-ton [28-32-ft] inboard-powered vessels and the relatively inexpensive 17.5-foot fiberglass outboard-powered boats introduced by the government are popular with fishermen because they are relatively cheap to run and require no special anchorage. In 1979 there were 2,870 3.5-ton boats, and 3,970 fiberglass 17.5-foot boats with outboard motors. By the end of 1984 there were 3,731 and 7,430, respectively. Clearly, the high cost of fuel is a major factor in the operation of the motorized boats. Ideally, however, these 3.5-ton and 17.5-ft. modern vessels and motorized traditional craft are able to go further out to sea in search of

more productive fishing grounds and to bring back a higher output in a shorter time than were the unmechanized traditional craft; thus, they are to be preferred, assuming the balance between catch and value on the one hand and costs of operation (obviously higher for mechanized than for non-mechanized craft) on the other remain favorable.

According to figures presented by the Marga Fishing Survey of 1980, the relationship between the average cost of a pound of fish brought in by a 3.5-ton boat and the average costs of fuel required to catch that pound of fish was such that costs of operation consumed 10 percent of total production for the more efficient boats, 23 percent for the average boat. For the 17.5-ft. fiberglass boats those values were 15 and 31 percent, respectively. Interestingly, for mechanized traditional boats, such as the *oru*, those figures were 12 percent in the more efficient craft and 30 percent in the average craft.

The fuel cost per pound of fish is about the same for the 17.5-foot fiberglass boats as for the 3.5-ton boats. This is probably due to the fact that 3.5-ton boats bring in a greater quantity of fish to offset their higher total fuel costs.

Today over 63 percent of the inshore marine fishery production is by mechanized craft. The total fishery fleet of Sri Lanka operating in the inshore belt (16-40 km from shore) numbered over 25,000 vessels in 1984. *According to Atapattu (1987) 70 percent of the total marine fisheries production from coastal waters was by mechanized craft in 1985.*

History of Fisheries

The Traditional Phase: to 1930

Since 1898, the Government of Sri Lanka has played a supervisory and regulatory role in the country's fisheries. Initially, all fisheries matters were the responsibility of the Director of the Colombo Museum, who from 1907 functioned in the capacity of the marine biologist. In this role, he advised the government concerning the exploitation of pearl resources. In 1912, with the liquidation of the Pearl Fisheries Co., the administration of the pearl fishery came under his direct control. By about 1915, there had been a slight change of attitude and emphasis. With the declining economic importance of the pearl fishery, attention shifted to the development of food fisheries. According to census figures, there were 32,554 active fisherman in 1910, and this had been reduced to 23,154 by 1921.

The first Biological Survey of the littoral waters of Ceylon commenced in 1920. The objectives were to investigate the resources of the coastal waters and search the shallow-water plateau around Ceylon for possible trawling grounds. For the purpose of this survey, provision was made in the Expenditure Estimates, 1920-21, under a separate head: "Department of Fisheries". This led to the creation of the Department of Fisheries. The survey was started with the trawler *Lilla* in 1921-1923 and was later continued with the vessel *Nautilus*. By 1926 the entire shallow area off Cape Comorin had been investigated. Two promising trawling grounds were identified, Wadge Bank and Pedro Bank (Figure 8).

Commercial trawling began in 1928. The Government of Ceylon operated two modern coal-burning, steam-driven, 325-ton trawlers with mechanically refrigerated holds. These

were the *Tongkol* and the *Bul Bul*. Annual landings were three million pounds of fish, 65 percent of which were edible. This production constituted 5 percent of the nation's total landings of fresh fish. Blegvad (1951) noted that only 52 men were engaged on the two trawlers while it required 50,000 fishermen to produce the other 95 percent of Sri Lanka's fish. The relatively greater efficiency of trawling is thus evident.

Since fish is one of the few generally acceptable forms of animal protein in the diet of Sri Lanka's 18 million citizens, the catch found a ready market and commanded a high price. Trawling proved very profitable. The catch regularly included snappers (family *Lutjanidae*) and groupers (*Epinephelus* sp.).

The first organized attempt at collection of fisheries statistics was made in 1925. Seasonal inquiries were made by government agents at fishing centers along Colombo-Matara and Colombo-Puttalam for collection of data. The administrative reports of the Marine Biologist for this period also indicate that consideration had been given to devising ways of improving the methods of fishing used by local fishermen in inshore waters.

However, no production figures are available for this period except those relating to fish transported to Colombo from different parts of the country by rail. Some 5,028 tons were transported to Colombo in 1926, 17,048 tons in 1929 and 18,000 tons in 1931. Unfortunately, the collection of even these data was discontinued in 1932. During this period, domestic fish consumption appears to have increased markedly as fish imports rose from 14,045 tons in 1923 to 30,850 tons in 1930.

The Foundation Stage: 1931-1950s

The period 1931-1960 is perhaps best described as the "Foundation Stage" of Sri Lanka's modern fishing industry. During this time the development of food fisheries was undertaken on a large scale as part of the general social and economic development of the country.

The first attempt to organize and manage fisheries was made in the late 1930s. Fisheries Ordinance No. 24 of 1940 was passed by the State Council in 1939 and came into force in June 1941. It was designed to amend and consolidate the laws relating to fisheries and to the taking and protection of fish in Ceylon waters. It also provided for the registration of fishing boats. An important innovation which started during this period with the promulgation of the ordinance was the constitution of the Fisheries Advisory Board to advise the Director of Fisheries. This step was intended to promote the participation of all interested parties, from the grass-roots level up, in the fisheries development program.

The principal fishery-based export during the 1920s and 1930s was chanks (conch shells). By the late 1930s, however, other items such as bêche-de-mer (trepang or sea slugs) and shark fins were exported in modest quantities. In 1939 the value of fishery-based exports was Rs:100,700. The annual average of edible fish imports at this time was around 30,000 tons.

During the Second World War the importance of the domestic fishing industry was greatly enhanced due to curtailment of imports.

Four important developments occurred during the 1920s and 1930s. Firstly, the importance of locally produced fish as a source of protein and as an item of food became widely accepted, and concerted attempts were made to make fish available at reasonable prices. Secondly, it was conclusively accepted that the fishing industry had to be assisted directly in areas such as production credit, marketing credit and provision of inputs. Thirdly, numerous welfare measures were introduced, and basic infrastructure facilities were provided at state expense. The quality of life of the fishermen was thus improved substantially. Fourthly, the beginnings of fisheries management took shape during this period.

The establishment of Fisheries Cooperation in 1941 was a significant contribution in the areas of marketing and distribution. Cooperatives were set up especially with the objective of eliminating middlemen by having the fish produced by members sold directly to consumers. The first cooperative stall was operated in 1941, and by 1944 purchasing centers were opened by the Department of Fisheries in all important producing areas. Marketing advances were given to net owners and traders, on condition that their catches be made available to the Department of Fisheries. About Rs:4.87 million was issued as marketing credit during 1940-1947. With the end of the war, the marketing advances were discontinued.

The most important step taken to provide direct assistance to fishermen was the provision of production credit, commencing from 1942. Under this scheme, loans were given to individual fishermen, unregistered groups of fishermen and fisheries cooperative societies. During 1941-1950, nearly Rs:10.3 million was granted by way of these loans. Since the success of loans and other schemes of assistance to fishermen depended on the extent to which the fishermen could obtain essential production inputs and sell commodities at fair prices, a number of fisheries stores were set up at important fishing centers. Further direct measures of assistance included the supplying of timber at concessionary rates for boat construction. The Department of Fisheries also introduced and encouraged the use of twisted yarn and nylon gear and tested new types of hooks and gears with a view to increasing production in later years.

Various other measures were taken to enhance fisheries production. The construction of roads to and from fishing centers began in 1944, and in 1946 a special vote was created for this purpose. By 1950 about 18 miles of new road had been built, and over 20 miles of existing road had been repaired. Other facilities included small fishery harbors at Kariyoon and Passiycor. Obstacles to navigation were removed at or close to landing centers, and beacons were installed. During the 1940s, four ice plants were set up by the department to improve the distribution and marketing of fish, and attempts were made to open curing yards to improve product quality.

From a fisheries-management point of view, the establishment of a separate Department of Fisheries in 1941 was of great significance. Since the Head of the Department of Fisheries was until then also the Director of the Museum, there was no proper direction of the work of the Department. The appointment of a separate Director of Fisheries demonstrated the importance assigned to fisheries by this time. Under the Soulbury Constitution and the Cabinet System, the Department of Fisheries passed from the Ministry of Local Government to the Ministry of Industries and Fisheries. A Preventive Ordinance Unit was created in 1949 to enforce the provisions of the Fisheries Ordinance relating to protection of species,

conservation and management of resources. It is noteworthy that there was no fishery for pearl oysters or window-pane oysters during this period.

Production figures are available only for 1949 and 1959. According to these, the 1949 total landed catch was 36,257 tons and the 1959 catch, 41,688. Considering that approximately 17,000 tons of fish were transported to Colombo by rail in 1929, there does not appear to have been a dramatic increase in production from 1930 to 1959. Fish imports varied from 26,482 tons at a cost of Rs:13.8 million in 1942 to 32,100 tons at a cost of Rs:40.2 million in 1959. The major items imported were dried, processed and tinned fish. The value of exports reached a high of Rs:369,000 in 1949 compared with a low of Rs:231 in 1943. The most important items exported in order of importance were chanks, bêche-de-mer and shark fins.

The First Modernization Phase: 1950-1965

Two reports published in 1964 (Anonymous 1964a and b) provide some insight into the background and progress of attempts to introduce outboard motors into Sri Lanka. According to these accounts, in 1951 in Sri Lanka there were hardly any harbors, and not a single mechanized fishing vessel. Until then, most fishing was done from dugout canoes and rafts. Then, outboard motors were widely introduced in the early- to mid-1960s as part of the "Freedom from Hunger Campaign," because (1) they were simple, (2) they could be attached to traditional craft, (3) they permitted exploitation of new fishing grounds, (4) outboard-powered boats needed no harbors and (5) fish could be returned to port in fresher condition than they could by unmotorized traditional craft.

The following example from Anonymous (1964a) is evidence of the eventual success of the motorization conversion. "Eighteen months after he put an outboard on his *kattumaran* one fisherman had enough profits to pay off his motor and build a modern house. Six months later his motor had earned him enough profits for him to buy a modern diesel-powered boat and triple his fishing nets." By 1964 the 860 outboard-powered vessels reportedly in operation caught three times the amount of fish caught by unmechanized traditional craft.

The period of the 1950s and early 1960s can be called the era of modernization. The administrative system was reorganized, mechanized boats were introduced widely, increasing numbers of indigenous craft became motorized, the use of nylon and other synthetic gear became widespread, regular and organized training programs for fishermen commenced, new trawlers were procured, cold storage capacity increased etc.

With the goals of modernizing the fleet and conducting research of practical benefit to the industry, the Department of Fisheries was reorganized in 1951 under three divisions: Administration and Socio-Economics, Development and Research. In 1958 a new unit was created to handle extension activities. The marketing functions and facilities of the department were handed over to the Co-operative Fish Sales Union created in 1952, and the fishing operations and vessels of the department were taken over by the newly-created Ceylon Fisheries Corporation in 1965.

Fish production increased from 38,810 tons in 1955 to 92,740 tons in 1965. This increase was due to a combination of factors, including the introduction of 1,978 inboard mechanized craft, motorization of 449 indigenous craft, use of new vessels such as *Bracoghen* from 1952 and

Maple Leaf from 1953, use of nylon nets and the work of the extension unit. The assistance provided in the form of production credit was also instrumental in increasing production. During the period 1955-1965, production credit provided to individual fishermen as well as cooperative societies amounted to Rs:3,730 million.

The mandate of the Ceylon Fisheries Corporation, established in 1964, was to: engage in deep-sea fishing operations such as trawling, process fish and manufacture by-products, market and distribute fish at both wholesale and retail levels, construct and maintain harbors and shore installations including cold rooms, import and export fish and construct and repair boats. In 1965-1966 the Fisheries Corporation took over from the Department of Fisheries the department's vessels, the Mutwal Fishery Harbour, the Cold Storage Plant, the by-products factory and the three ice plants at Karaiyoar, Pesalai and Batticaloa. The corporation also took over the fish marketing and distribution activities of the Co-operative Fish Sales Union in 1965.

Important support was received during this modernization phase from the governments of Japan and Canada. Japan helped establish a fisheries training center in Negombo in 1963. Canada provided a cold storage plant, a fishing harbor, a by-products factory at Mutwal, laboratory equipment for the Fisheries Research Centre and the trawler *Maple Leaf* and two motor fishing vessels.

Most of the welfare-oriented schemes and measures described earlier, with the exception of welfare stores, were continued in this period. Road construction received high priority, and during 1950-1965, about Rs:5.5 million was spent on the construction and repair of roads. The roadwork greatly benefited the fishing community by facilitating marketing of their produce and by bringing the fishing hamlets into contact with the outside world. The most important welfare-oriented measure initiated during the period, however, was the construction of houses for fishermen, a program which began in 1955-1956. Under the six-year plan a total of Rs:6 million was earmarked for house construction. From 1956 to 1965 a total of Rs:5 million was spent on the construction of houses. By the end of this period, an insurance scheme for fishermen was developed in consultation with the Insurance Corporation.

Mechanization

Six Danish seiners of 22-ft. and 20-ft. length equipped with diesel engines were purchased in 1952. FAO-supplied marine diesel engines were installed on Jaffna boats in the same year. Fishing trials conducted with these vessels resulted in substantial catch increases, and more engines were ordered. In 1953 two Canadian 40-ft. vessels, *North Star* and *Canadian*, were used for experimental fishing. Mechanization of the fleet received a great impetus with the gift of 40 Canadian marine engines offered to fishermen on hire-purchase terms. The issue of mechanized boats under a regular program commenced in 1959 when 85 boats of the now popular 23-ft., E-26 design were completed by an FAO boat builder (Table 2, item 1). This design was accepted as standard and made available to other boat builders.

Issues of outboard motors, especially for indigenous craft (Table 2, item 2), on hire-purchase terms commenced in 1962 after the initial trails proved conclusively the advantages of mechanization. Issue of outboard motors for replacement purposes also started in 1962,

and by 1965, 85 engines had been issued. The process of mechanization was greatly assisted by the work of the newly formed Extension Unit and the Negombo Training Centre.

Nylon Nets

Nylon drift nets of various mesh sizes were introduced in 1962. They boosted production levels in the small-scale fishery. The use of drift nets required only limited knowledge of the sea, whereas the use of longlines and hand-lines required more precise knowledge of the distribution and movements of demersal fish. The inability to find suitable bait and the extra expenses associated with obtaining bait caused some fishermen to adopt drift nets in place of longlines. Within two decades nylon nets had become so popular that cotton or hemp nets were almost nonexistent apart from their use as beach-seines and in some specialized small-scale operations.

The Second Modernization Stage: 1966-1980

During the second stage of modernization, 1966 to about 1980, the fisheries sector grew rapidly. This was a period of consolidation. Increasingly during this phase, nylon drift-netting replaced longlining as the preferred fishing method. Vessels constructed during this period were fitted with engines having greater power than earlier releases and were issued some 20 pieces of nylon net.

Two highlights of the consolidation were the creation of a separate Ministry for Fisheries in 1970 and the formulation of the Master Plan, a comprehensive program for developing the fishing industry in 1979-1983. The period also witnessed an impressive increase in production of fish, particularly in the coastal fisheries sub-sector; a parallel increase in the issue of mechanized boats and outboard motors for mechanizing indigenous craft under generous producer-subsidy schemes; expansion of training programs with a high priority accorded to inland fisheries; a series of marine resource surveys; and expansion of the fisheries welfare program.

In 1978-1979 the Ministry of Fisheries underwent a major reorganization. The Department of Fisheries was eliminated in favour of an integrated Ministry with 11 specialized divisions. The new divisions set up after 1970 were Planning and Programming, Coast Conservation, Extension and Regulation, Inland Fisheries, Fisheries Welfare, Fisheries Training and Institute of Fish Technology. In 1974 Ceylon Fishery Harbours Corporation was set up under the State Industrial Corporation Act with responsibility for constructing and managing fisheries harbors.

The production of fish increased from 103,636 tons in 1966 to 180,816 tons in 1980, an increase of about 75 percent. The coastal fishing sector continued to account for 85 percent of the total production (Table 2, item 3). However, there was little or no improvement in production by offshore and deep-sea fishing. One reason is that by the mid-1970s the tuna boats and trawlers of the Ceylon Fisheries Corporation were in need of constant repair, and replacement parts were difficult to obtain. However, with the issue of 38-ft. vessels by the Asian Development Bank, this sub-sector's contribution rose gradually after 1978. The relative contribution of traditional fishing methods declined. For example, the *madel* fishery

Table 2. Some statistics on growth, modernization and mechanization of Sri Lanka's fishing industry.

Year	1	2	3				4	5			6	
			A	B	C	D	Rs.M	A	B	C	A	B
1959	85											
1960	251											
1961	362											
1962	382											
1963	313	71										
1964	213	281										
1965	92	197										
1966			2,913	91,535	9,127	103,636		85	615	24	68,141	1,645
1967			3,896	100,666	9,900	113,963		113	283	16		
1968			4,074	129,587	8,595	142,056		92	571	48	66,550	
1969			4,200	87,629	6,923	98,752		200	879	18		
1970			3,207	85,234	8,167	96,608		159	849	41	41,061	4,776
1971			2,498	73,363	8,036	96,608		162	383	124		
1972			2,517	69,288	8,105	83,897		219	1,035	59	92,157	11,436
1973			2,347	89,874	6,895	100,110	11.14	104	310	23		
1974			2,195	99,213	7,539	108,952		37	538	48	50,018	26,796
1975			955	113,054	13,097	127,106	58.65	117	738	48		
1976			539	120,849	12,343	135,731		225	1,301	82	29,283	75,458
1977			307	123,411	12,868	136,581		181	1,191	43		
1978			2,903	134,744	16,474	154,121	75.00	245	2,163	50	33,983	233,040
1979			2,066	146,507	17,150	165,723	125.08	292*;418	3,157	41	192,096	309,671
1980			2,316	158,000	20,000	180,316	236.04	537*,1520**,189	1637	62		
1981			2,100	172,300	29,100	203,500						
1982			1,100	179,700	32,800	213,600						

1. Number of mechanized boats issued each year under the hire-purchase scheme;
2. Outboard motors issued for motorization of indigenous craft;
3. Fish production in tons (A=Deep sea; B=Coastal; C=Inland; D=Total);
4. Increased allocations granted to fisheries in the National Budget to develop fisheries as a major industry;
5. Issues of mechanized boats and engines: (A=Mechanized boats, lengths 28-32ft., 17 1/2ft*, and 15**; B=Outboard engines; C=Inboard engines);
6. Imports and exports of fish [A=value of imports (Rs: million); B=value of exports (Rs: million)].

alone was responsible for the production of 30 percent of the total catch in 1975, 9 percent in 1978, and only 5 percent in 1979. This trend has continued, and production of the *madel* fishery is now negligible.

With the creation of a separate ministry and the government's declared intention to develop fisheries as a major industry, increased allocations were granted to Fisheries in the National Budget (Table 2, item 4).

A number of attempts were made to formulate long-term programs for fisheries development. In 1965/66, the Ceylon Fisheries Corporation formulated an ambitious plan to increase production in the coastal fishery from 131,000 tons to 216,000 tons, but it was never seriously implemented. Another 5-year Development Plan was prepared for the period 1972-1976, but it suffered essentially the same fate as the Ceylon Fisheries Corporation Plan. The Master Plan for Fisheries Development of 1979-1983 embraced all aspects of the industry. Its objectives were to increase annual per capita consumption of fish to 44 lbs. by 1983, to raise the incomes and standards of living of the fishermen, and to maximize employment opportunities in the fisheries sector. The Plan aimed at increasing fish production from the 1978 level of 150,000 tons to 300,000 tons by the end of 1983. This target was to be achieved by increasing production in:

(i) coastal fisheries from 131,000 tons to 216,000 tons,
(ii) offshore and deep-sea fisheries from 3,000 tons to 34,000 tons and
(iii) inland fisheries from 16,000 tons to 50,000 tons.

The Master Plan relied more heavily on the private sector for financing than had earlier fisheries development plans. The public sector was to concentrate on infrastructure development. To stimulate participation by the private sector, incentives were provided. For example, producer subsidies, liberal credit arrangements and tax holidays were made available for deep-sea fishing, and for ice plants, boatyards and fishing-gear factories. A Local Advisory Committee was established for sanctioning and monitoring investments. The response by the private sector has been positive, and many ice plants and boatyards have been developed.

The mechanization program which began during 1950-1965 was intensified and accelerated during 1966-1980 (Table 2, item 5). A major change in policy took place in 1970, when issuance of mechanized boats was restricted to Fisheries Co-operative Societies. The performance of these cooperative organizations in the operation of these boats left much to be desired, however, and ownership of the boats was transferred to the shippers in 1977-1978. Subsequent developments proved the preferability of this arrangement. Since 1978, the boat-issue and mechanization program has been implemented under new schemes of subsidies and liberalized bank credit. Co-operative Societies have been given higher rates of producer subsidies.

Fishermen's earnings have been affected positively by mechanization. According to a study by the Marga Institute in 1980, owners and crewmen of powered vessels earned 70 percent more and 100 percent more, respectively, than owners and crewmen of traditional craft. The owner of a 17.5-foot fiberglass boat with an outboard motor earned as much as Rs:46,026 and a crewman Rs:20,132 per year, whilst the owner of a 3.5-ton mechanized boat

earned as much as Rs:79,182 and a crewman Rs:21,428. The popularity of the 3.5-ton boats is at least partly due to the fact that they bring the owner and crew a higher net income than do the 17.5-foot boats or any traditional fishing craft.

The fisheries sector had become a major foreign exchange earner by the late 1970s (Table 2, item 6). In 1966-1968 the total annual value of fisheries-based exports was about Rs:2 million, deriving largely from bêche-de-mer, shark fins, shells and shellfish. Export value rose to Rs:26.8 million by 1974, and between 1974 and 1979 the value increased by more than 10 times, to Rs:310 million. The principal items have been prawns and lobsters. During 1966-1978 imports of edible fish products were at relatively low levels, with the exception of 1972. This was due to the non-availability of foreign exchange in the first half of the period and to the non-availability of dried fish in the traditional sources of supply during the last part of the period.

Extensive research and development activities were undertaken during this period, including all major marine resource surveys conducted in Sri Lanka, with the exception of the survey of demersal fish resources on Wadge and Pedro banks. These included surveys by the Soviet research vessel *Optimist* in 1973, a survey of skipjack tuna in the offshore by FAO/UNDP in 1973, a study of distribution of demersal fish in January/February 1975 on the Japanese vessel *Hoyo Maru* and three surveys of Sri Lanka littoral waters conducted by the Norwegian research vessel *Dr. Fridtjof Nansen* in 1978, 1979 and 1980. The conclusions of the Norwegian survey were the basis for the Master Plan's production targets. Follow-up work has been done on the availability of demersal fish resources and on methods other than bottom trawling for exploiting them.

Special projects for development on a regional basis were funded by foreign governments or agencies during this period. The Asian Development Bank funded the South West Coast Fishery Project beginning in 1976. This was followed by the North West Project funded by the Abu Dhabi Fund, the East Coast Project financed by the Netherlands Government, and the West Coast Project funded by the Asian Development Bank. Integrated District Development Projects were initiated for fisheries development in the Matara, Hambantota and Puttalam districts (Figure 9).

The Ceylon Fishery Harbours Corporation constructed harbors at Galle, Myliddy, Beruwala and Mirissa and designed harbors/jetties at such places as Mannar, Wellamankara, Kalmunai, Kalpitiya and Chilaw during this period. The Harbours Corporation also carried on studies relating to construction of beach-landable vessels which could obviate the need to build expensive harbors. Cey-Nor Foundation of Sri Lanka, a fisheries development agency, started its activities in the South by establishing boatyards, ice plants, fish-net factories, offshore fishing operations and fish-processing facilities.

Conclusions

The graded development of Sri Lanka's fisheries saw the establishment of the Ministry of Fisheries in 1956, Ceylon Fisheries Corporation in 1968 and the Fisheries Harbour Corporation in 1972. Mechanization of traditional craft (except those used in the *madel* fishery) continues, and mechanized introduced vessels are replacing traditional craft increasingly.

Figure 9. The fish-landing districts in Sri Lanka.

Even *madel* boats will likely be either adapted for mechanization or replaced by mechanized vessels as the younger generation prefers the use of mechanized vessels. Nylon gillnets, first introduced in 1962, are used increasingly as the method-of-choice in Sri Lankan marine fisheries.

As the foregoing section demonstrates, the modernization and expansion of fisheries in Sri Lanka has been pursued as a national priority during the past several decades. Sri Lankan citizens generally have been encouraged to eat more fish; in turn, Sri Lankan fishermen have been heavily subsidized in their efforts to satisfy a growing demand for fish and fish products within their country. Foreign aid to Sri Lanka has consistently been directed at helping to increase fish production and consumption. In view of these realities, it must be recognized that conservation of marine mammals (and for that matter, the fish stocks) is a pursuit that goes against the grain of government planning and contradicts the message embodied in virtually all aid programs. Also, at least superficially, it appears to work against the immediate interests of low- and middle-income Sri Lankans, whose expectations of a higher standard of living hinge in part on the availability and affordability of palatable, high-protein sea products.

Marine Mammal Involvement with Fisheries

Background

Involvement of marine mammals in fisheries is not new in Sri Lanka. For example, there as elsewhere in the tropics, fishermen have long used dolphins, especially oceanic species, to locate schools of tuna and other fish, which can then be caught using hook-and-line or netting techniques. In the bargain, dolphins sometimes have run afoul of the fishing gear and been captured. The incidental entanglement of dolphins in Sri Lankan fishing gear has been a feature of Sri Lankan fisheries for many years. However, as long as nets were made of natural fibers (e.g. jute and cotton), cetaceans of all species probably usually escaped, leaving behind a damaged net and perhaps a disgruntled fisherman. Now the nets are made of stronger materials from which the animals usually cannot escape. Only recently, then, has the scale of cetacean mortality in the net fisheries become a major cause for concern.

Various reports refer to the unpopularity of cetaceans in the eyes of Sri Lankan fishermen. In a report indicating that dolphins were killed and eaten in a fishery in Sri Lanka, Nevill (1887, not Necill 1887 as often cited), quoting "Mr. MacGrindle's translation of Schwanbeck's edition of *Aeolian's Account of the Dolphins of Taprobane*," characterized the dolphins as about 1.7m long and fiercely aggressive animals which terrorized the fishermen in the sea and tidal waters. Medcof (1963), referring to a manuscript filed by W. Mitchell with the Sri Lankan Department of Fisheries in 1950, stated that dolphins often interrupted or interfered with hook-and-line fisheries. The dolphins' arrival supposedly frightened the fish schools away, and the dolphins were said to "steal" netted fish from the webbing of nets. Medcof also noted that small cetaceans which had followed fish inshore sometimes were caught and killed in beach seines. (From skulls, he identified animals taken in beach seines on Karaitivu Island as bottlenose dolphins.) Blegvad (1951) noted fishermen's reports that dolphins damaged their nets and suggested that the way to deal with the problem was with harpoons, including modern harpoon guns.

Lantz and Gunasekera (1955) reported that dolphins (which they identified as common and bottlenose dolphins, based on conversations with P.E.P. Deraniyagala, Colombo Museum) taking fish from gillnets were robbing the people of valuable protein and damaging or destroying the fishermen's nets. Thus, small cetaceans were regarded locally as "the vermin of the sea". Some dolphins were captured in the gillnets and used for human food. According to Lantz and Gunasekera, the competition and damage were severe in some places and at some times. For example, off Negombo in January and February, the abundance of "common dolphins" required temporary abandonment of gillnetting. It is of interest to note that fishermen in Negombo and Chilaw still complain that dolphins tear their nets, and some of them harpoon dolphins as a routine practice (W.P. Mahendra, September 1985 report). As dolphins "have been and still are used as food in some places... in Ceylon" and harpooning had recently been shown to be feasible (by experimental hunt in 1953), Lantz and Gunasekera (1955) recommended the establishment of a commercial dolphin fishery in Sri Lanka. This, they felt, would reduce the interference with fisheries, provide a much-needed source of protein and offer additional income through production of bone meal and "porpoise leather".

Marine mammals, especially small cetaceans, are currently harvested in Sri Lanka in both directed and undirected fisheries. Until recently, those activities were not monitored; nor were their possible effects on the populations of small cetaceans addressed. However, threats to marine mammals from escalating world fisheries in general are a matter of grave, immediate and growing international concern, and recent revelations in Sri Lanka have focused attention on small cetaceans there. Alling (1983) and Joseph *et al.* (1983) reported finding cetaceans at Sri Lankan fish-landing sites, and that at least some of the animals had been taken in gillnets. Since then, workers have estimated the number of small cetaceans killed in gillnets annually in the entire country at 8,400 (Joseph and Siddeek 1985), 13,500 (Alling 1983) and 42,480 (Alling 1985a,b). Alling *et al.* (1982) and Alling (1983) also reported seeing fishermen off Negombo in 1982 trying to harpoon Risso's dolphins, and thereby gave notice of the existence of a harpoon fishery as well. Alling (1985 a,b) noted that at least 1,500 animals were being harpooned each year and expressed her opinion that the actual number was likely much higher. Josephs (1986) reported NARA's growing concern over such takes and their estimate that as many as 1,000 dolphins per month might be being harpooned for use as food or as bait in longline fisheries.

There is every reason to suppose that comparable levels of mortality occur in other ocean areas where high-density gillnetting and abundant populations of small cetaceans overlap. This killing deserves immediate and intensive study leading to corrective actions which are sensitive to human needs and to the importance of conserving wildlife. It was altogether appropriate, therefore, that NARA include in its marine mammal program a major effort to assess and, if possible, mitigate effects of fisheries on marine mammals. A first step was to understand the context and assess the magnitude of the problem within Sri Lanka.

A proposal to study marine mammal interactions with fisheries in Sri Lankan waters was given "very high priority" by an IWC working group which met to plan the use of UNEP funds earmarked for cetacean studies (IWC 1983). The group's emphasis was based on concern that increasing numbers of cetaceans, dugongs, pinnipeds, turtles and seabirds are dying annually in net fisheries around the world. It was hoped that knowledge gained from studying Sri Lankan fisheries could be applied to fisheries in other areas less amenable to study.

It was stressed that the scientists studying Sri Lankan marine mammal/fisheries interactions should seek to (1) determine the magnitude of the take; (2) collect the following information from incidentally caught dolphins: measurements, photographs, teeth, gonads, stomach contents, parasites and other data necessary to assess biology and feeding habits; (3) interview fishermen to determine where, when and by what kinds of boats and nets (and where in the nets) dolphins are caught; and (4) determine the best seasons and areas for net modification or other actions designed to mitigate the problem.

Methods for Taking Marine Mammals

Gillnetting

We have already mentioned accounts indicating that some cetaceans were taken in fishing nets off Sri Lanka even before the introduction and widespread use of synthetic nets (e.g., Lantz and Gunasekera 1955; Medcof 1963). Nevill (1887) even noted that "...some of the fishermen from the coast of India, who have reached Ceylon within the last century, or so, not only eat them, but have nets specially made for the capture of ... porpoises." The entanglement which now appears a common occurrence in Sri Lankan gillnet fisheries is reminiscent of that in scores of fisheries and localities, world-wide (e.g., Mitchell 1975a, b; Perrin 1988; Northridge and Pilleri 1986; Read *et al.* 1988). The dolphins, and other cetaceans, appear to blunder into the nets, become inextricably entangled and die, usually of suffocation/drowning. In most areas and fisheries, such takes of small cetaceans are inadvertent or accidental, and the fisheries for them, therefore, are undirected. In some parts of Sri Lanka entangled dolphins are unwanted. But in others the establishment of markets to accommodate these by-catches has created directed fisheries for dolphins in which drift gillnetting is the fishing method. Many older fishermen in southern villages repeated the same story: 15 or more years ago no dolphins were brought in, no market existed for cetacean products and some Sri Lankans believed that killing the dolphins which helped fishermen find tuna would bring bad luck.

Harpooning

We have found only one bit of evidence that Sri Lankans historically harpooned dolphins prior to the middle of the 20th century.[2] Nevill (1887), responding to Ball's "Indian Antiquary for October 1885," commented that "*daeti-muwâ*, or toothed beasts of the Sinhalese, and the *vêlam* of the Tamils...frighten the fishermen [in Batticaloa Lake] by coming near the canoes, as if to attack them... [and that]... small ones up to five feet long are speared and eaten." The practice of harpooning dolphins may well have begun in earnest in the Negombo area in the early 1950s, with the counsel and encouragement of outside advisors. In 1953, Captain F. Homer of the R/V *Canadian* introduced Sri Lankans on the west coast to the standard harpoon used by fishermen on the U.S. Pacific coast to take swordfish. The detachable harpoon head, usually made of brass or steel, is attached to a line and a float and delivered by means of a wooden pole tipped with a metal shaft (Lantz and Gunasekera 1955: figs. 3 and 4). Homer demonstrated to fishermen in Negombo that from the bow of a powerboat they could harpoon up to 10 or 12 dolphins before a herd dispersed, and that they could take up to 28

[2]We use the term "dolphins" here and elsewhere in this report broadly. In the case of harpooning, takes probably include most species of small cetaceans around Sri Lanka which ride boat waves and even some which do not but which can be approached sufficiently closely (about 5m) for a harpoon to be delivered effectively.

animals in a single day. *Oru* fishermen given harpoons were not successful, owing mostly to the fact that their vessels lacked the speed and maneuverability required to attract dolphins to the bow and remain with them (Medcof 1963).

Dolphins and other small and medium-sized cetaceans are harpooned regularly in some parts of west, southwest and south Sri Lanka today. The equipment in use is almost identical to that described and illustrated by Lantz and Gunasekera (1955)(Figure 10), although the harpoon heads differ somewhat among areas . For example, harpoon heads in Negombo are made of steel, are shaped "like the dart used in a spear gun" (Ilangakoon, July 1985 report) and are 4-5 inches long (Senanayake, July 1985 report). They sold for Rs:35-50/ in 1985 (Senanayake, August 1985 report). Though the harpoons are 6-7 inches long and triangular in all three villages, those in Beruwala apparently differ from those used in Dondra and Mirissa in being broader and made of much lighter metal. In 1985 harpoons in Mirissa sold for Rs:100-150/.

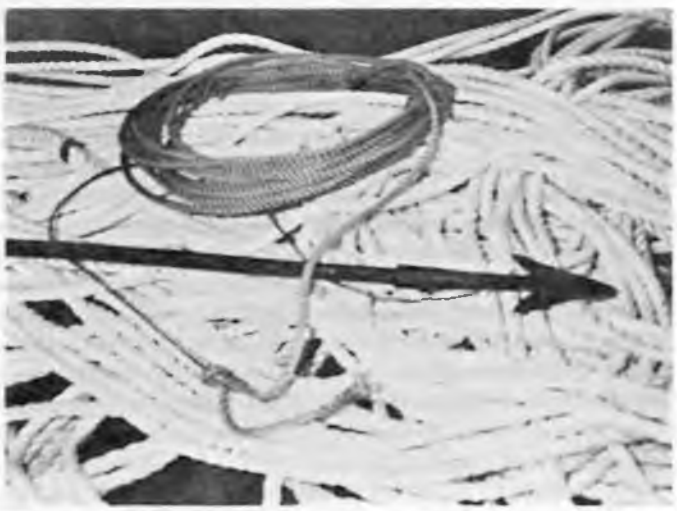


Figure 10. Harpoon shaft and head at Mirissa (top) and demonstration of how the harpoon is held for throwing at Dondra (bottom). (S. Senanayake).

Harpooning apparently has been practiced at Negombo for "many years" but only began at Mirissa and Dondra in 1981 or 1982. The practice is now widespread among fishermen in all three areas (Senanayake, July and December 1985 reports). Ilangakoon (Sept. 1985 report) observed that the harpooning of dolphins in Negombo could be entirely due to high consumer demand for dolphin flesh. Harpooning of dolphins and other small cetaceans takes place in at least two circumstances:

Fishermen aboard 3.5-ton boats from the following villages are known to harpoon dolphins: Chilaw, Negombo, Mirissa, Wadduwa, Dondra and Beruwala. They may do so at anytime as part of routine fishing practice (Figure 10). Dolphins also are harpooned from the so-called trawlers, either for use as bait on longlines or to be taken to shore and sold. The methods of harpooning are the same for both types of vessels. The boat is maneuvered until the animal can be approached closely or voluntarily rides in the bow wave. The harpooner, stationed at the bow, waits until a dolphin is within range (less than 4-5m) and throws the harpoon. The harpoon head enters the animal and then disengages from the shaft, which floats. The animal is either pulled in immediately (if dead) or the float is thrown over the side, the animal is allowed to tire, and it is then pulled in and killed

Fisheries Currently Taking Marine Mammals

Background

There are essentially two categories of fisheries which currently take marine mammals in Sri Lanka. One is referred to as the coastal small-boat fishery, the other as the commercial fishery. Some elements of both employ gillnetting, and some are involved in harpooning dolphins. Great whales generally tear through the nets and escape. As evidence, an approximately 25-ft. fin whale landed at Negombo 4 August 1985 was the first baleen whale seen at that site in six years (Leatherwood journal, July-August 1985). Fishermen at Tangalle, Hikkiduwa, Mirissa and Dondra advised that when they see great whales near the area(s) where they intend to fish, they set their nets elsewhere because the whales tear holes in the nets or take them away altogether (Leatherwood journal, May-June 1985). Nevertheless, some great whales, such as the fin whale noted above, are killed. Reeves *et al.* (1990) describe and illustrate a humpback whale taken in a gillnet off Chilaw in 1981. Leatherwood *et al.* (1984) and Leatherwood (1985) reported landings of sperm whales at Negombo. In 1983 (month unspecified) a sperm whale became fouled in a gillnet and was brought ashore at Balapitiya. In addition to oil taken from the head, the whale reportedly yielded some ambergris, which was sold in Colombo (Leatherwood journal, May 1983). Ambergris appears to be widely recognized as valuable by fishermen in many parts of Sri Lanka (Leatherwood, unpublished data).

Below, we generally describe the methods by which small cetaceans are taken, describe the fisheries and their operations and present the information obtained during the NARA/UNEP program on the probable magnitude of the take of small cetaceans.

Most of the information obtained directly by the NARA/UNEP program on operation and extent of these fisheries is for Trincomalee on the northeast coast and for landing sites

from Puttalam to Kirinda on the west, southwest and south coasts. Therefore, our discussion deals primarily with those areas (Figure 2).

Coastal Small-Boat Fisheries [3]

These fisheries are conducted with inboard-powered craft operating all around the coasts (see Figures 5 and 7, Tables 2, 3 and 4). The vessels, the so-called 3.5-ton boats, 26 to about 32 feet long, set gillnets to fish for tuna, sharks and other pelagic species. Some also fish by trolling 2-10 lines 15-40 yards behind the vessel exclusively or while travelling between port and the principal fishing grounds. The 3.5-ton boats initially were provided with 19 sets of longlines, 25 hooks and 2 tolls of synthetic (Kurlon) rope as fishing gear. Nets are generally set at dusk or after dark. They are set so that the top is at a depth of 12-18 feet, depending on target species and behavior. Ordinarily, flotation consists of one large buoy per piece at the surface and smaller floats every 2-3 m on the submerged "cork line". Spacing of the floats depends on the type of net and the principal species sought. The net panels are held taut by stone or lead weights, at 40-50 m intervals. The spacing of the weights is altered periodically to account for changes in drift and wind speed and direction. Failing to alter the weights to account for these conditions would result in the nets' rotating and wrapping on deployment. When the nets are hauled in the early morning, they sometimes contain dolphins, small whales and occasionally even large whales which have entangled and drowned during the night.

On the west and south coasts of Sri Lanka, gillnetting is conducted year-round, though effort is greatest during the southwest monsoon period of May-October. The majority of gillnetters carry 25 to 35 pieces of net (range 15 to 45) with mesh of 3.75 to 7 in. (Amarasiri and Joseph 1985). Mesh sizes of 4.75 to 8.75 in. are the most popular, being used by 79.9 percent of the fishermen on the south and 87.2 percent of those on the west and southwest coasts (Joseph and Moyiadeen 1985). As many as 1,800 inboard vessels may be involved between Puttalam and Kirinda at peak fishing season.

Off northeast Sri Lanka, in general, gillnet fishing takes place principally during the inter-monsoon periods. Though a few boats may fish all year, most boats from Trincomalee set nets from January through the onset of the southwest monsoons in late May or early June. They begin again in September, fish at sustained high levels in October and November and reduce effort in December, as weather is usually rough. For most boats operating from Trincomalee, nets consist of 30 separate "pieces" or bundles of net, each 25-30 m long and 90-100 meshes deep, laced together end-to-end to form one long net. Five- to six-inch mesh is preferred; so, assembled nets are commonly 750-900 m long and 37.5 to 50 ft. deep. As many as 570 3.5-ton and an unassessed number of 17.5-ft. vessels may be involved at peak fishing periods in the Trincomalee Fishing District (Ministry of Fisheries; Table 3). The 17.5-ft. vessels are at least occasionally involved in gillnetting of dolphins (Figure 11).

[3] The majority of information on this fishery in NARA reports was compiled by W P Mahendra from his own work and that of Sujiva Senanayake, supplemented by notes from other NMMU team members and Leatherwood.

Table 3. Number of inboard-powered fishing boats operating in Sri Lanka in 1984, by fishing center and month.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
Colombo	58	48	48	46	99	55	75	33	93	67	29	29	56.7
Kalutara	138	148	161	180	156	170	133	133	133	142	145	149	149.0
Galle	104	98	56	92	46	46	152	162	159	99	11	145	97.5
Matara	331	264	265	210	177	161	299	222	320	255	261	299	255.3
Tangalle	118	113	190	184	215	115	199	169	149	179	151	144	160.5
Kalmunai	33	26	321	217	266	190	201	187	189	191	18	26	155.4
Batticaloa	13	22	16	16	16	14	19	13	13	3	0	0	12.1
Trincomalee	241	296	344	402	571	281	174	147	192	231	179	189	270.6
Mullaittivu	177	231	232	197	122	138	0	0	0	0	0	0	91.5
Jaffna	798	789	667	615	500	220	547	614	668	511	680	655	605.3
Mannar	382	729	479	0	0	0	166	129	153	158	247	240	223.6
Puttalam	688	967	743	356	262	855	386	456	458	444	389	308	526.0
Chilaw	101	0	0	365	358	358	76	76	76	76	76	76	136.5
Negombo	259	0	0	429	427	178	217	211	159	193	186	187	203.8
Total	3,441	3,731	3,522	3,309	3,215	2,781	2,644	2,552	2,762	2,549	2,372	2,447	2,943.8

Table 4. Total number of fish landing sites included within each fishing center (=district)(A), and number of sites from which sea-going vessels of the types known to take small cetaceans operate(B). (Source: Ministry of Fisheries, District Fisheries Extension Officers' monthly reports)

	1981-82		1983		1984		1985		1986	
	A	B	A	B	A	B	A	B	A	B
Colombo	14	6	11	8	11	6	11	6	11	6
Kalutara	21	6	21	7	19	8	21	9	20	9
Galle	40	5	34	11	33	9	34	9	33	8
Matara	27	17	26	11	27	18	27	18	26	18
Tangalle	23	7	26	7	18	7	21	7	25	7
Kalmunai	19	5	20	9	17	7	20	7	20	7
Batticaloa	80	6	59	4-13	54	12	55	11	59	NA
Trincomalee	36	12	41	15	35	21	38	21	41	21
Mulaittivu	18	6	18	3	19	8	18	8	18	NA
Jaffna	82	34	86	41	93	40	NA	NA	28	NA
Mannar	25	14	27	17	27	17	26	17	27	16
Puttalam	32	10	36	9	13	9	34	9	30	9
Chilaw	45	19	33	4	37	17	31	5	31	5
Negombo	28	17	23	11	28	11	27	11	25	11

NA = data not available

Commercial Fisheries [4]

The "commercial fishery" is conducted with the so-called trawlers, nicknamed Northwest and Abu Dhabi after the economic development programs under which they were financed. Boats in this class (11 meters and powered by 56-horsepower inboards) began to be issued to fishermen along the southwest coast late in 1982. The 10-boat fleet operating at the beginning of 1983 grew to 41 at the start of 1985 and 80 or more at the start of 1986 (Ministry of Fisheries Statistics). There is no indication that growth has stopped; so, impacts by these vessels on marine mammal populations can reasonably be expected to continue increasing.

Initially, the trawlers are issued 60 pieces of 5-, 5.5- and 6-inch-mesh gillnet, in equal proportions, and 100 baskets of longline gear. Details of the fleet's operation through 1984 were presented by Joseph and Moyiadeen (1985). At that time, the trend was away from 1-day trips (37.8 percent) to trips of 2 (31.2 percent), 3 (30.1 percent) or 4-6 (10.8 percent) days. The average numbers of fishing days per boat per month in 1984 were about 9 (January, February, May, June and August), 10 (April, September and November), 11 (October and December), 12 (July) and 14 (March). Some boats in the fleet migrate among harbors seasonally, such that fishing in 1984 spanned 12 months off the south coast, 10 off the west, 9 off the southwest, 7 off the northwest and 6 off the northeast.

The boats fish by trolling *en route* to and from the grounds and by gillnetting and longlining on the grounds. They often either buy dolphins in the market to take along with them or harpoon dolphins on the way to the fishing grounds to use as bait. The fishermen

Figure 11. *The landing of these 2 dolphins at Pitipana, Negombo, 14 August 1985, by the boat shown in this photograph demonstrates that the 17.5-ft vessels do sometimes take dolphins. (S. Leatherwood).*

[4] Data on the commercial fisheries were compiled primarily by Sujiva Senanayake.

prefer dolphin to fish as bait because it (a) is easier to preserve, (b) lasts longer on the boat (24 hrs +), (c) attracts sharks, presumably because of the blood and (d) is generally cheap. As evidence of this last, dolphin is not sold for bait at Balaya or Kellawalla because it has a high commercial value for human consumption. Once on the fishing ground, the fishermen usually set only the gillnet the first night, especially if they do not have enough bait, and on subsequent nights they set the gillnet first and the longlines second.

Data on Fishing Effort and Numbers of Animals Taken [5]

Background

One important goal of the NARA/UNEP program was to estimate mortality of dolphins resulting from activities of the various fisheries in Sri Lanka. The requirements for making such an estimate are quantitative information for a sample of the landing sites on (1) fishing effort and (2) the numbers of animals landed. Two rudimentary estimates of dolphin mortality using such data were made available during the course of this project.

Alling (1985 a, b) examined 72 small cetaceans during her monitoring of landings at Beruwala (May 1982-August 1984), Trincomalee (February 1983-October 1984) and Valaichenai (March 1983-January 1984), a total of 2 days of observation in 1982, 48 in 1983 and 18 in 1984. She used these data in the following manner to estimate total numbers of small cetaceans killed in Sri Lanka. First, she determined, from records of the Ministry of Fisheries Statistics Division, that there were totals of 125, 200 and 72 3.5-ton and 17.5-ft. vessels registered at the three sites, respectively. She then calculated average rates of catch-per-boat-per-day for each of the three sites and averaged these three rates. She determined, also from records of the Ministry of Fisheries, that there were 8,850 registered vessels of these types throughout Sri Lanka. Assuming that all 8,850 vessels fished with gillnets, fished year-round in areas where there are dolphins, and expended effort comparable to that in the fisheries she had monitored, she then multiplied the catch-per-boat-per-day by the number of boats and by 12 months. With this approach, Alling (1985a, b) estimated that 42,480 small cetaceans may have been killed per year in gillnets off Sri Lanka during 1983-1984. Problems with the assumptions in this study resulted in unassessed bias, believed to produce an overestimate (IWC 1986).

Joseph and Siddeek (1985) took a similar approach but with very different assumptions leading to very different results. They sampled a total of 56 days at the landing sites at Negombo and Beruwala between January and November 1985. Using estimates of 92-203 inboard boats using gillnets at the two sites combined and the total of 129 animals landed, they computed an average catch-per-boat-per-day of 0.01514 and an annual estimated by-catch by boats operating from these two sites of 1,155. They then multiplied the catch rate by 2,284 (the number of boats they estimated were involved in gillnetting throughout Sri Lanka in 1985 in areas and at times such that they "had a possibility of a marine mammal by-catch") and by the estimated average number of fishing days per year, producing an estimate of 9,129 dolphins killed per year. They concluded that fisheries accidentally catching dolphins in Sri Lanka posed no threat to the dolphin populations, although they presented no information on status of the stocks affected as a basis for this conclusion. Further, problems with the data

[5] This section was prepared by the editors from published sources, reports filed with UNEP by NARA (Anonymous 1986a,b;1987a,b) and unpublished data in Leatherwood's files.

and assumptions in this exercise, discussed below, mean that Joseph and Siddeek (1985) probably underestimated mortality in the sample they examined and the fishery overall.

Both analyses had significant technical shortcomings that led to low confidence in their accuracy. For example, in reviewing Alling's (1985b) estimate, the IWC Scientific Committee (IWC 1986) noted that to reduce probable bias one should (a) increase sample size to overcome biases inherent in small samples, (b) stratify samples by such factors as area, boat capacity and season, (c) correct figures on numbers of registered vessels to account for boats registered but not fishing and for new or otherwise unregistered boats actually fishing but not included in the statistics and (d) account for dead animals lost at sea when they fall out of nets or are thrown over the side because they are too large or surplus to abundant catches of more desirable products.

There is even less published information on the harpooning of dolphins beyond the acknowledgment in several reports and publications that it takes place (Alling *et. al.* 1982; Alling 1985a,b; Leatherwood *et al.* 1984; Gunaratna *et al.* 1985). Alling (1985b) noted that of the 72 animals she observed, only 4 bore deep wounds ("from harpoons?"). She concluded that although some fishermen do take dolphins, the take "does not appear to be extensive," owing to a presumed dislike of the meat. However, she estimated, based on interviews with fishermen, that the 10 boat crews from Trincomalee Town that admitted to harpooning dolphins might account for 31-62 (mean about 45) cetacean deaths each spring (April-June). Joseph and Siddeek (1985) observed that "all marine mammals in this study area [Negombo and Beruwala] were landed as by-catch from the gillnet fisheries and none were harpooned." From this observation they concluded that harpooning was negligible. However, these two accounts notwithstanding, in his memorandum to the Parliamentary Conservative Committee of Fisheries in April 1986 NARA Chairman Hiran Jayewardene estimated that over 1,000 dolphins per month were being harpooned by longline fishermen aboard trawlers between Chilaw and Kirinda for use as bait (25 percent) or human consumption (75 percent) (Josephs 1986). Clearly, the findings of the NARA program were officially being interpreted as cause for concern.

Also, NARA reported in April 1986 that 5-45 dolphins are sold daily at the Pettah Wholesale Fish Market and the main market in Kandy, alone (Josephs 1986). Regardless of whether these dolphins were killed in gillnets or harpooned, this suggests an annual landed catch of at least 1,825-5,475 dolphins taking account of only two market places. More work was needed to clarify the extent of small cetacean casualties in Sri Lankan fisheries.

The Fisheries Statistical System

For the compilation of fisheries statistics, Sri Lanka is divided into 14 reporting areas, each representing a discrete stretch of coast and each containing a series of fish-landing sites (Balachandran 1983) (Figure 9). (Not all the sites are used by vessels of the types which regularly kill marine mammals - Table 4). District Fisheries Extension Officers (DFEOs) are stationed at each of the major sites and monitor all sites under their jurisdiction. The monthly reports by DFEOs to the Ministry of Fisheries list, by fish-landing site, the catches of fish by species and the total number of boats in the following three categories which are known to have operated from or landed fish at that site during that month: non-mechanized craft,

outboard-powered craft and inboard-powered craft. Although some small cetaceans are killed by some other vessels (see references above to harpooning from 17.5-ft. outboards and occasional takes from traditional craft), it is the inboards which are of interest here, as they account for most deaths of marine mammals. As of January 1987, there were no provisions in this statistical system for logging data on marine mammals landed.

The most recent year for which detailed fisheries statistics, certified by the Ministry of Fisheries, and detailed data on other important aspects of the Sri Lankan fisheries were available to us was 1984. In that year, 2,372 to 3,731 inboard vessels were involved in coastal, offshore and deep-sea fisheries each month (mean = 2,943.8) (Table 3). These boats were widely distributed around the coast, and many migrated among fishing centers seasonally in response to monsoon conditions, to fish in lee shores most suitable to their operations.

To obtain information on fishing effort for the years 1985 and 1986, staff of the NMMU, particularly Sujiva Senanayake and W.P. Mahendra, compiled summaries from the Ministry of Fisheries Statistical Division on numbers of inboards operating by month and area. At the time they were examined, the records from these two years had not been verified or completely tabulated; so, it was not possible to obtain for the entire fishery for these two years the detail available for 1984 and earlier years. However, by examining some original DFEO reports and preliminary tabulations, it was possible to (1) determine that an average of 3,147 and 3,210 inboards were operating per month in 1985 and 1986, respectively, and (2) ascertain details of fishing effort for some periods and areas for which NMMU staff were able to obtain independent estimates of fishing effort and dolphin mortality.

For example, by investigating the original records used by the Ministry of Fisheries to compile the summaries, it was possible for 1985 and 1986 to determine the minimum numbers of boats operating from Trincomalee, Chilaw, Negombo, Mirissa, Beruwala, Hikkiduwa, Dondra, Galle and Tangalle at selected times of the year. We have used those data as the uncorrected measures of fishing effort in our attempts to estimate catch rates for periods when NMMU staff were present at these landing sites monitoring the dolphin by-catch (Table 5).

To correct these basic measures, it was necessary to consider what proportion of these registered vessels fish with gillnets rather than simply with longlines and/or trolling lines, and therefore are likely to take marine mammals. Amarisiri and Joseph (1985) estimated that over 71 percent of the 10,329 vessels fishing for tuna between Tangalle and Puttalam fished with gillnets. Joseph (pers. comm. to Leatherwood, May 1986) indicated that all except a few of the 3.5-ton inboards and larger trawlers operating in that area had and used gillnets, at least part time. W.P. Prematunga (pers. comm. to Leatherwood, March 1985) indicated that the same was true for Trincomalee. Thus, we can assume the figures for inboards approximately represents gillnets which might catch marine mammals.

Table 5. Estimates of catch rates of small cetaceans (catch-per-boat-per-day) at some west-, southwest-, and south-coast fish-landing sites, 1985-1986. [Sources: NARA monthly project reports (A) and reports filed by volunteer observers (B)].

Landing Site	Months (days monitored)/Year	Cetaceans Landed	Boats Operating		Catch Rate	Source	
			1	2		A	B
Chilaw	10(2) and 12(2)/85	3	105		0.007	●	
Negombo	6(2), 7(3), 8(3), 9(26), 10(17), 11(1) and 12(1)/85	156	81.3		0.036	●	
	10(19), 11(25), 12(23)/85 and 1(24)/86	245		51.1	0.053		●
Beruwala	6(3), 7(7) and 8(2)/85	60	130		0.039	●	
Ambalangoda	11(31)/85	23		7.8	0.095		●
Hikkiduwa	6(2)/85	6	37		0.081	●	
	10(20) and 11(8)/85	16		9.7	0.059		●
Galle	5(1), 6(2) and 7(5)/85	9	14		0.167	●	
Mirissa	7(2), 8(1), 9(6) and 11(2)/85	51	86		0.054	●	
Dondra	6(1), 9(4) and 10(1)/85	12	68		0.029	●	
	10(24), 11(21) and 12(18)/85	182		65.7	0.044		●
Tangalle	5(2)/85	3	16		0.094	●	
Range					0.007-0.167		
Mean					0.063		

1 = The average of the number of inboards reported as registered at those sites in months indicated (Source: Ministry of Fisheries, Statistics Division)
2 = The average of the number of boats actively fishing on the days of observation (Source: Volunteer Observers' Data Sheets)

Observed Numbers of Takes of Marine Mammals

By Gillnetting

Fishermen in some areas, e.g. Mutwal and Kalpitiya, claim that entanglement of small cetaceans in nets is rare in their fishing experience and that the few dolphins and small whales that do entangle usually manage to break free. In other areas, however, fishermen admit that they do kill dolphins, even if they are not in the habit of using the animals they take. Some of these latter fishermen even offer estimates of the total numbers of animals taken. During interviews in northern Sri Lanka in March 1983, for example, fishermen reported that they sometimes landed up to 5 animals per day at Myliddy, 1 to 2 per month at Poliyandi and a few on "rare" occasions at Karainagar, especially during summer. Though larger "dolphins" also were caught by fishermen in all three villages, they were usually cut adrift because they were too large to bring aboard for transport (Leatherwood *et al.* 1983). In Myliddy fishermen said they would welcome higher catches of this valued source of meat. Similarly, during interviews at villages in southern Sri Lanka in 1984-1986, fishermen reported that boats from Tangalle generally take 10-25 dolphins per day during the period March through July, for a total of up to 4,500 per year (Leatherwood 1985; unpublished data).

Staff of the NMMU collected enormous amounts of this sort of anecdotal information on levels of fishing mortality. However, it is not possible to use such information to estimate total mortality quantitatively in any given area, let alone in the entire country. The reports too often contain guesses and approximations or are affected to varying degrees by the fishermen's concerns that information they provide may lead to government interference in or regulation of their activities. In the north, for example, fishermen interviewed at four villages in 1983 were aware that it was illegal for them to take dolphins and reported that if they do not dump them at sea the carcasses are often confiscated at the beach by the army (Leatherwood *et al.* 1983). The Director of Fisheries (Marine), A. R. Atapattu, expressed to Leatherwood the candid opinion that one is unlikely to receive accurate reports of dolphin deaths from fishermen as there is fear that the government will prosecute violations (pers. comm., 8 August 1985). What were needed, then, were direct accounts by NMMU staff and associates of the numbers of animals taken by boats operating from selected, representative locations.

No direct observations of gillnetting of small cetaceans were made by NMMU staff aboard working vessels at sea. There were trips in 1985 aboard 3.5-ton boats operating from Beruwala 18-19 June (by Leatherwood and Senanayake) and 6-7 August (by Senanayake) and from Mirissa 22-23 October (by Senanayake). There were also trips in 1985 aboard Northwest Trawlers operating from Mirissa 16-20 September and 16-19 October (by Senanayake). However, no small cetaceans were taken in gillnets by any of these vessels on the days sampled, although during each period some small cetaceans were taken in gillnets by other boats fishing nearby and were subsequently landed at Beruwala and Mirissa. There were, of course, occasional anecdotal reports from fishermen of how many animals they had taken during a given fishing trip, but these were difficult to verify and were subject to the same probable biases described above for other anecdotal information. Without data collected aboard the vessels, it was necessary to depend on monitoring at fish-landing sites. Landings do not account for animals killed but used or discarded at sea; so, totals from landings often are biased downward to an unknown degree. Three sets of data were obtained on numbers of small cetaceans landed, two for the area from Puttalam to Kirinda and one for Trincomalee.

Between June and December 1985, NMMU staff made a total of 108 visits to 13 landing sites on the west, southwest and south coasts during which they recorded information on cetaceans landed. Volunteer observers at four landing sites (Negombo, Ambalangoda, Hikkiduwa and Dondra) were provided data forms on fishing effort and landings and instructions on how to complete them. The observers were selected by NMMU staff because they were personal friends or acquaintances, were active in the fishery (as fishermen, buyers at various levels or officials), showed considerable interest in the marine mammal program and could be counted on to provide reliable information. Collectively, these observers logged and submitted data on landings of cetaceans for a total of 213 days from October 1985 through January 1986. Their tallies probably account for all or almost all animals landed as they seldom left the sites before the last boat had landed its catch on a given day.

The main fish market at Trincomalee serves 17-20 landing sites in three sub-districts (Trincomalee Town, Trincomalee West and Trincomalee North); six or seven of those sites routinely are bases for inboard vessels of the sort which take small cetaceans (see Table 4). W. P. Prematunga was stationed permanently in Trincomalee and worked almost daily at the main fish market. From 1984 through 1986 he obtained information directly from the fishermen and buyers on the number of small cetaceans landed. He collected these data independently from 1 January 1984 through 30 April 1985 and again from 1 January through 31 December 1986 and as an NMMU employee from 1 May through 31 December 1985.

Dolphins are also taken by trawlers, both in gillnets and by harpooning, and are used on board as bait or are brought ashore and sold. There was little direct monitoring of the trawler fleet under the NARA/UNEP program Senanayake did manage to make two voyages aboard working trawlers to observe their activities first-hand, and his observations and conversations with the fishermen provide what appears to be the most reliable information. Senanayake reported in 1985 as follows:
16-20 September aboard *NW51*, south (165° Mag) of Mirissa on the "Southern Fishing Grounds", 50-70 miles offshore. Trolling for tuna was conducted in both directions between Mirissa and the grounds during daylight hours and on the grounds. The longlines and gillnet were set nightly 17-19 September; there was no catch of small cetaceans in the gillnet.

16-19 October aboard *NW48* on the Southern Fishing Grounds. The longlines were put out nightly 16-18 October, the gillnet only on the 17th and 18th. No small cetaceans were caught.

By Harpooning

Fishermen aboard 3.5-ton boats in some areas reported that they harpoon dolphins occasionally as part of their routine practice. Boats from Mirissa and Dondra, at least, also sometimes set to sea when weather is calm and fish catches are particularly low deliberately to harpoon dolphins. Working individually or in groups of 10 or more, boats, mostly 3.5-ton inboards but also including some 17.5-ft. outboards, from a given village might take 15-20 dolphins on a successful hunt. For example, on 6-7 September, when fishing was otherwise poor, 21 harpooned dolphins, taken by an unspecified number of boats, were landed at Dondra.

The only direct observations of harpooning from 3.5-ton and 17.5-ft. boats were made by Senanayake, who went to sea aboard the F/V *Masuda* 23 October 1985. *Masuda* was accompanied by three other boats. Collectively, the four boats harpooned 19 dolphins (12 spinner, five spotted and two bottlenose). A competition was established among the boats to see which could land the most dolphins. (In Feb. 1986 Leatherwood learned of competition among six 3.5-ton boats in Mirissa which collectively accounted for 33 dolphins on a single voyage 5 Feb.). Upon returning to port, Senanayake learned that a total of 21 harpooned dolphins and 4 net-caught spinner dolphins had been landed at Mirissa that day (Senanayake, Oct. 1985 report).

Senanayake also provided the only direct accounts of harpooning from trawlers. On 18 September *NW51* diverted from its course to intercept a group of 150-200 spinner dolphins spotted at a position 145° at 53-63 miles from Hambantota; three adults were harpooned. They were to have been used as bait but were instead taken back to Mirissa and sold. On 16 October, *en route* to the fishing ground, the crew of *NW48* tried unsuccessfully to harpoon spinner dolphins from a group of about 60, one of which bore a wound apparently from a recent harpooning. On the 18th, they tried twice to harpoon spinner dolphins. The second time, they took one spinner, which was used as bait that night (Senanayake, Oct. 1985 report).

Josephs (1986) reported NARA's concern over "increased killing of dolphins" by the trawler fleet and NARA's preliminary estimate that the trawlers take a total of 1,000 dolphins per month between Chilaw and Kirinda. Of these, 75 percent were believed to be sold for human consumption, 25 percent used at sea as bait. The former would be accounted for in monitoring at landing sites. Concerning the latter, NMMU staff were told repeatedly and by various sources that each trawler takes an average of 2 dolphins per day on each fishing trip. On a visit to Mirissa 6 February 1986, Leatherwood interviewed fishermen aboard 4 trawlers just back from trips of 3 or 4 days. All carried harpoons, and two had taken one spinner each and used it as bait at sea. One of the others had bought a spinner at sea from another trawler. The fourth had not taken any dolphins its previous trip (Leatherwood journal, 28 Jan. - 8 Feb. 1986).

At Tangalle harbor 6 March 1986, crews aboard 3 of 4 38-ft. trawlers at the dock agreed they use an average of two dolphins per 5-day trip. The crew of one boat said they did not take dolphins by harpoons, as used to be the practice, because harpooning was now illegal. However, there were two harpoons on this vessel and the spinner dolphin it landed that day had a harpoon hole in its back (Leatherwood journal, 6 March 1986).

Catch Rates and Estimates of Mortality

There are few written estimates of catch rates (catch-per-boat-per-day) of dolphins in the Sri Lankan fisheries. Those that do exist are highly variable, and estimates for the same locality and approximately the same period are substantially different, depending on the assumptions made. For example, the estimates by Alling (1985b) for Beruwala are 19.5 times greater than those of Joseph and Siddeek (1985). We are unable to evaluate these two sets of estimates in any detail. However, we do note that Alling, like the NMMU staff and volunteers, remained in the villages throughout the day for the primary purpose of locating and examining small cetaceans and thus probably accounted for all or almost all small cetaceans

landed, while visits by Joseph and Siddeek tended to be more brief and involved several activities to which collecting data on dolphin mortality were incidental. We know, for example, that on the 7 occasions when both teams were present at a landing site on the same day, NMMU staff consistently logged animals overlooked by Joseph's crew. It is also pertinent to note that accounts by Joseph *et al.* (1983) and Joseph and Siddeek (1985) contained some misidentifications, e.g. young Risso's dolphins logged as "snubfin dolphins" (=Irrawaddy dolphins) and young spotted dolphins as bottlenose dolphins. Further, in extrapolating observed catch rates to estimates of total kill for Sri Lanka, Joseph and Siddeek (1985) assumed dolphins were not taken in areas near Jaffna where animals are, in fact, killed and landed or killed and dumped at sea (Leatherwood *et al.* 1983)

The information on takes reported in the preceding section was used, along with estimates of fishing effort, to calculate catch rates. The volunteer observers probably most accurately accounted for fishing effort as they logged only the number of boats actually fishing on a given day. From their data, one obtains estimates of 0.044 to 0.167 small cetaceans-per-boat-per-day (average = 0.063) (Table 5, items marked B).

The NMMU staff did not record the number of boats actually fishing. Therefore, to calculate catch rates from their data one must use as a measure of effort figures from the Ministry of Fisheries Statistical Division on the number of registered boats at those sites during the months in question. We know that these figures overestimate fishing effort because they include some boats not active that day or season and others fishing in other districts all or part of the reporting period. Therefore, catch rates calculated from the NMMU data (Table 5, items marked A) probably underestimate catch rates to an unknown degree. These estimates range from 0.007 (for a brief visit to Chilaw) to 0.167 (average = 0.063).

W. P. Prematunga monitored catches by a resident fleet of 103 registered inboard boats in the Trincomalee area. He did not, however, record the number of boats actually fishing on a given day. Therefore, as measures of fishing effort for Trincomalee one must use the figure 103 or the number of appropriate vessels registered at the sites during the months in question, as described in the above paragraph. Average catch rates calculated in this way range from 0.083 to 0.282 (Table 6). We have no way of assessing the applicability of those estimates to other areas.

All attempts to estimate mortality of cetaceans in Sri Lankan fisheries from the data available are compromised in significant ways. Complete statistics on fishing effort are simply not available for most periods of this study during which landings of small cetaceans were monitored. Furthermore, official statistics are often inconsistent from one report to the next. Estimates of catch rates generally cover very limited times and places and therefore contain some of the same kinds of biases as previously reported estimates (Alling 1985a, b; Joseph and Siddeek 1985). In addition, we have little confidence in our ability to determine reliably the proportion of inboard boats and 17.5-ft. outboard boats actually involved in marine mammal mortality and the number of those boats actually fishing per unit of time. The best we could do for this report was to calculate a series of estimates using conservative assumptions and present the basis and details for those estimates in sufficient detail that they can be recalculated as more information becomes available.

Table 6. Some estimates of catch(of small cetaceans)-per-boat-per-day at Trincomalee, 1981-1986. Estimates are based on landings examined by W.P. Prematunga (see Table 12), and on total inboard-powered boats registered in the Trincomalee district (A) and in sites landing catches at Trincomalee Town in 1981 (B) and the number of inboard-powered boats for which landings were routinely monitored (103) by Prematunga, 1984-1986 (C).

	1984[a]			1985			1986			AVERAGE		
	A	B	C	A	B	C	A	B	C	A	B	C
January	.095	.183	.223	.021	.040	.049	.025	.048	.058	.047	.070	.110
February	.068	.175	.194	.132	.342	.379	.010	.026	.029	.070	.118	.201
March	.090	.292	.300	.081	.264	.272	.070	.226	.233	.080	.149	.269
April	.124	.338	.485	.057	.155	.223	.132	.358	.515	.105	.181	.408
May	.164	.221	.272	.019	.087	.107	.060	.268	.330	.043	.089	.236
June	.142	.800	.388	.057	.320	.155	.028	.160	.078	.076	.168	.207
July	.086	.263	.146	.408	1.246	.689	.023	.070	.039	.172	.313	.291
August	.109	.222	.155	.408	.833	.583	.122	.250	.175	.213	.323	.304
September	.084	.200	.165	.068	.153	.126	.042	.094	.078	.066	.105	.123
October	.238	.688	.534	.121	.313	.272	.065	.188	.146	.142	.251	.317
November	.045	.138	.077	.017	.052	.029	.022	.069	.039	.028	.051	.049
December	.058	.143	.107	.138	.338	.252	0[b]	0[b]	0[b]	.065	.108	.120
Average	.095	.282	.251	.099	.294	.261	.055	.161	.143	.083	.247	.218

[a] The most recent year for which complete statistics certified by the Ministry of Fisheries are available.
[b] Monitoring incomplete for these periods; so, calculation not made.

We consider the catch rates reported by Joseph and Siddeek (1985) to be underestimates for the reasons already discussed. The catch rates calculated from data obtained during the present investigations do not account for dolphins which died but were not recovered or were discarded at sea; thus they underrepresent the catch in the sample. On the other hand, they may have been based on over- or under-estimates of fishing effort. The best documented catch rates are those calculated from reports by volunteer observers. We note that the average of these catch rates and the average catch rate from the samples by the NMMU staff are identical. Thus, we have used this value (0.063) in many calculations. The estimated catch rate for Trincomalee is well supported, and the lowest rate calculated (0.083) is similar to that from the west, southwest and south coasts. Thus, this value (0.083), too, is used for several calculations.

Total mortality was estimated for two areas, the first from the south side of Adam's Bridge (Mannar District) through Kalmunai District, the second for the north side of Adam's Bridge (Jaffna District) through Batticaloa District (Table 7; see also Figure 9). Each estimate is based on different assumptions, detailed in the footnotes. In general, we have assumed that:

1. 60.7 percent of the registered vessels of the types involved in killing small cetaceans are in the former district, 39.3 percent in the latter. (This is based on the proportions in those districts in 1984, the last year for which we had complete statistics certified by the Ministry of Fisheries.).
2. 80 percent of the registered inboard-powered vessels are fishing in such a way that they might well catch small cetaceans.
3. to remain in business, boats must fish 50 to 75 percent of the available days.

The resulting calculations suggest that 25,000 to as many as 45,000 small cetaceans may have been landed at Sri Lankan fish-landing sites annually in 1985-1986, after dying in gillnets or being harpooned (Table 7).

As a postscript to the above, W. P. Prematunga observed that mortality of small cetaceans was unusually high during the first three months of 1987 (W. P. Prematunga *in litt.*, 17 June 1987).

Clearly, there are many such sets of calculations which could be undertaken, each based on different sets of assumptions. At the moment, however, the information available on fishing effort and takes of marine mammals in Sri Lankan fisheries is piecemeal and does not justify more in-depth treatment. The situation might be improved for selected sites by using bidder's books, logs kept at some landing sites, which contain tallies of dolphins purchased and the prices for which they sold. To date, however, merchants have been unwilling to make their bidder's books available to NMMU staff researchers for examination. Until all the data called for by the IWC (IWC 1986) and proposed under the NARA/UNEP project can be collected in a more thorough and systematic way, it will not be possible to assess reliably the magnitude of takes of small cetaceans in Sri Lankan coastal small-boat fisheries.

Mortality by the commercial fleets also remains unassessed. That by the trawler fleet, i.e. animals taken by gillnet or harpoon but used at sea and therefore not accounted for in the

Table 7. Some rough estimates of the total numbers of small cetaceans landed by Sri Lankan fishermen annually. The general assumptions are described in the text. The particular assumptions of each calculation are given in detail in the footnotes.

A. Mannar District to Kulmanai District					B. Batticaloa District to Jaffna District					C. All of Sri Lanka				
Est. No.	Catch Rate	No. of Boats Fishing	No. of Fishing Days	Estimated Annual Mortality	Est. No.	Catch Rate	No. of Boats Fishing	No. of Fishing Days	Estimated Annual Mortality	Est. No.	Catch Rate	No. of Boats Fishing	No. of Fishing Days	Estimated Annual Mortality
1	0.01514[a]	1385[a]	274 (75%)	5,745[*]	1	0.01514[a]	899[a]	274 (75%)	3,729[*]	1	0.01514[a]	2284[a]	274 (75%)	9,474[*]
2	0.0630[b]	1385[a]	183 (50%)	15,967	2	0.0630[b]	899[a]	183 (50%)	10,365	2	0.630[b]	2284[a]	183 (50%)	26,332
3	0.0630[b]	1812[c]	183 (50%)	20,891	3	0.063[e]	1173[e]	183 (50%)	13,524	3	0.630[b]	2985[m]	183 (50%)	34,415
4	0.0630[b]	1528[d]	183 (50%)	17,616	4	0.083[f]	990[f]	183 (50%)	15,037	4	0.63[b]-0.83[f]	2518[m]	183 (50%)	32,653
5	0.0630[b]	1558[e]	183 (50%)	17,962	5	0.083[f]	1010[f]	183 (50%)	15,341	5	0.63[b]-0.83[f]	2568[m]	183 (50%)	33,303
6	0.0630[b]	1558[e]	274 (75%)	26,894	6	0.083[f]	1010[f]	274 (75%)	22,969	6	0.63[b]-0.83[f]	2568[m]	274 (75%)	49,863

Footnotes

(a) The catch rate (from samples at Negombo and Beruwala) and the number of boats (x 0.607) thought to be fishing in such a way that they might catch dolphins, as estimated by Joseph and Siddeek (1985) (see text for discussion); (b) the mean catch rate from NMMU monitoring and volunteer observer reports, Chilaw to Kirinda, during 1985-1986(see Table 5); 80 percent of 60.7 percent of all boats operating in 1984 (c), 1985 (d) and 1986 (e); (f) the lowest catch rate estimated for Trincomalee from data collected by W.P. Prematunga; 80 percent of 39.3 percent of all boats operating in 1984 (g), 1985 (h) and 1986 (i); (m) totals of the 2 areas. *These appear to be unrealistically low, for reasons discussed in the text. We have no basis for evaluating relative merits of the remainder.

landed catch, has been estimated crudely as 3,000 (based on NARA's reckoning, basis unreported, that 12,000 were killed annually and that 25 percent of those were used as bait). However, from the data on catch-per-day and fishing days reported in this document, the number of animals taken annually appears to be higher than 12,000; further, from reports to Senanayake, the proportion used as bait appears to be higher than 25 percent. Therefore, mortality caused by commercial boats may also be significant. There is no information on the number of animals which die but are not recovered.

Conclusions

Fishing pressure on Sri Lanka's marine resources is increasing. Small cetaceans (and a few large cetaceans) are being taken in both directed and undirected fisheries. Well-established distribution routes for landed small cetaceans (see following section) are creating and sustaining a demand for cetacean flesh, sold as itself or as dugong. Gillnetting is firmly established as the fishing method of choice, and gillnetters continue to replace a progressively higher proportion of pole-and-line and troll boats each year. Gillnets kill small cetaceans. So do harpoons. The continuing growth of the Northwest Trawler Fleet is increasing the demand for bait. To the extent that trawler fishermen prefer dolphin meat over other sources of bait, the pressure on dolphin populations will increase. The practice of harpooning dolphins from 3.5-ton and 17.5-ft. vessels when fish catches are low is spreading, at least on the west, southwest and south coasts. If recent declines in catch-per-unit-of-effort in tuna fisheries (Joseph and Moyiadeen 1985) signal declines in fish stocks and over-fishing in general, directed takes of dolphins also can be expected to increase to make up for the shortfall in tuna landings. Also, judging from the increasing amount of nets and other fishing debris found along beaches and in the water at and near fishing centers, Sri Lanka will suffer increasingly from the effects of "ghost-fishing", the continued catching of animals by lost or discarded fishing gear. Effects in Sri Lanka, as elsewhere, could be serious. Finally, the widening perception by fishermen that they may be prosecuted for taking dolphins is leading to increased secretiveness and perhaps even to dumping of dolphins at sea where they benefit no one. Dondra fishermen, for example, said on 9 March 1986 they had taken all dolphins caught the previous day and dumped them 2-3 miles off Dondra Head to avoid prosecution by a government official they learned would be visiting (Leatherwood journal, March 1986).

After reviewing preliminary reports on deaths of marine mammals in Sri Lankan fisheries (Alling 1985b), the Small Cetacean Subcommittee of the IWC's Scientific Committee (1986) noted "that there is an urgent need for continued intensive monitoring of the cetacean by-catch [and]...a high priority for funding within the concept of the UNEP global plan." Though work conducted under the NARA/UNEP program has done little to increase the precision of the estimates of numbers of animals being killed each year in Sri Lankan fisheries, it has clearly demonstrated that the taking of small cetaceans is widespread and growing. Nothing has occurred to change the IWC Scientific Committee's urgent call for monitoring or to reduce the need for further action to moderate kills.

Incidental capture of marine mammals, especially small cetaceans, is a worldwide problem which may well have assumed crisis proportions. Pressure, particularly in the so-called developing countries, to expand fisheries, both to meet growing domestic demands

and to broaden economic bases through exports of renewable marine resources, is not likely to lessen the problem. It is imperative that solutions with broad applications be sought (Leatherwood and Alling 1985).

Experiments to Reduce Takes

The original terms of reference from UNEP to NARA were interpreted broadly in light of the IWC recommendations to include work on experimental manipulations of nets as one possible means of reducing levels of undirected takes of marine mammals. Because of background data available for the area, it was agreed that Trincomalee would be an ideal site for such work. The gillnet fishery there operates very close to shore, as oceanic waters can be found 1-10 nm off the beach. This situation facilitates monitoring of the fishery and deployment of experimental nets. Data were available for three full years on rates of catch by a sample of boats at one major landing site, Trincomalee Town, which receives catches from at least five fishing villages which accommodate 3.5-ton inboard vessels. The worker responsible for collecting those data (W.P. Prematunga) was a full-time resident of Trincomalee and was able to work on the water front with the fishermen daily. Finally, and vitally, fishermen in Trincomalee have readily agreed to permit a team under W.P. Prematunga's direction to conduct experimental modification of their nets, provided there is no obvious and long-term reduction of their takes of fish.

Accordingly, as part of the NARA/UNEP project, a proposal for a two-year research program was prepared (by S. Leatherwood and W.P. Prematunga) and submitted to the Center for Environmental Education, Washington, D. C., and Greenpeace International's Office of Small Cetaceans, Gainesville, Florida. It was also submitted to UNEP as a proposed extension of the contract described in this document. The objectives of the proposed project were:

(a) to monitor a representative sample of at least ten gillnet fishing boats for 6 months to characterize the fishing effort and takes of fish, dolphins and other organisms.

(b) From that sample, to identify circumstances (e.g., geographical location, water depth, type of net, size of mesh and net panels, location in net, sea state, weather, associated fish species) in which dolphins were most frequently killed.

(c) By manipulating fishing nets and fishing methods for a randomly selected sample of halfthe monitored boats (focusing on the histories and kill profiles of the boats and their net-types in particular or those of either class, in general), to attempt to reduce dolphin entanglement and mortality without significantly decreasing fish catches.

(d) By widely applying to gillnet fisheries in Sri Lanka and elsewhere any techniques found to be successful at meeting objective (c), to effect the conservation of dolphins (and perhaps other air-breathing animals) without undermining fish catches.

It was hoped that this project would result in one or several devices which would reduce mortality of dolphins in drift gillnets while not significantly reducing catches of target

species. The work plan and reports were meant to provide a basis for installing such devices as widely as possible in Sri Lanka and in comparable drift gillnet fisheries in many countries. Such devices should then be further tested in net fisheries elsewhere which catch dolphins.

The rationale of the program was simple. Small cetaceans, which have good vision and sophisticated biosonar, probably can detect and avoid natural-fiber nets of the sort traditionally used. This may be one reason there were, until recently, so few reports of small cetaceans being taken in set nets. (An alternative explanation is that they were able to rip the nets and escape even when they did become entangled.) On the other hand, many gillnets made of synthetic materials are invisible (visually and acoustically) to small cetaceans and strong enough to hold an animal once it becomes entangled.

It is reasonable to suppose that if dolphins were alerted to the presence of nets, even synthetic ones, and if these nets were acoustically-enhanced allowing dolphins to detect them, at least some dolphins would avoid entanglement. An assumption behind the proposed research is that the acoustically-sophisticated dolphins may well respond to novel sounds (e.g., from pingers, bamboo clackers, whistle buoys) in their environment by echolocating on the source. If echolocation signals were to strike a net whose acoustic properties have been modified in some suitable way (with echo-enhancers, such as hollow monofilament strands woven into the net or small, airfilled fiberglass spheres), the echolocating dolphin may be able to avoid becoming entangled. Luminescent features incorporated into such net modifications may add visual stimuli to enhance further the animals' ability to detect and avoid the nets.

The proposed approach involved the following steps:

1. Collect and analyze data on fish and dolphin catches by a representative sample of drift-gillnet boats for 6-12 months.
2. Analyze the above to determine whether the observed entanglements of dolphins occurred at different rates according to: fisherman, boat or boat type, net type, net size (mesh, length or depth), fishing location, fish species sought and/or taken or measured environmental conditions.
3. If no pattern was found, conduct broadly-designed experiments involving net modification. If patterns were found, target experimental net modifications at the specific circumstances in which most mortalities occur.

Unfortunately, the Sri Lankan net manipulation study was not conducted, as no funds were received and increasing civil strife in Trincomalee in 1985 and 1986 made long-term research commitments in that area impractical and unsafe. We strongly urge that as soon as stability returns to the region and funds become available, some version of this research project be conducted.

A Socio-Economic Study of Cetacean Harvesting in Sri Lanka
by Anouk D. Ilangakoon[6]

This study was designed to answer basic questions about social and economic aspects of cetacean harvesting in Sri Lanka. Although dolphins and small whales (occasionally also medium-sized and large whales) are harvested in many parts of Sri Lanka, directly by harpooning and indirectly in fishing nets, my work was centered along the south and west coasts between Chilaw and Kirinda (Figure 2). The fishing villages and landing sites visited by me during 1985-1986 are listed in Table 8. The work reported here was conducted from May 1985 to March 1986. The report is divided into four main sections, as follows:

1. An analysis of harvesting effort, by village or landing site and by season;
2. An analysis of factors affecting the distribution and cost of cetacean meat;
3. A description of how cetacean products are processed and used;
4. Case studies in which I follow the fates of two dolphins from capture to consumption.

Harvesting Effort by Site and Season

Because of the nature of my study, which was to make repeated but brief visits to various fish-landing sites, it is necessary to extrapolate from impressions gained during small samples of direct observation. The reader is cautioned that these qualitative remarks may not be representative for entire periods between visits to a particular landing site, or for different years before or after my study. In addition to my own observations, I include unpublished information from other NMMU staff and consultants, as appropriate.

Northern Sri Lanka

Fishermen at three sites visited near Jaffna (Poliyandi, Myliddy and Karainagor) caught and landed dolphins primarily during summer. Dolphins entangle often in the Mannar area, but they are not brought in because no one eats them (Leatherwood *et al.* 1983). Therefore, at such sites even direct monitoring of landings would not have accurately accounted for deaths.

Chilaw

In December I found that the fishing boats from Chilaw which had migrated further north (to the vicinity of Kandakuliya) at the time of my last visit (August) had now returned. Therefore, deep-sea fishing was underway at Chilaw, resulting in a by-catch of dolphins.

In February most of the Chilaw boats were engaged in catching prawns near shore, and only about three boats were engaged in deep-sea gillnetting. As a result, hardly any dolphins were being landed.

Negombo

Effort at Negombo was low in December, as there were few fish. Only about six boats came in with a morning catch (very poor) on the day of my visit. In the afternoon about 20 boats arrived with slightly better catches, consisting mainly of sharks and rays. There were few tuna taken. The fishermen told me that they caught very few dolphins when tuna abundance was low, since the dolphins are commonly found associating with schools of tuna.

[6] Prepared by the editors from Ilangakoon's monthly reports in Anonymous (1986a,b, 1987a,b).

Tab'e 8. Sites visited and observed landings of cetaceans. (Compiled by the editors from Ilangakoon's monthly reports.)

SITE	DATE(S) VISITED († = unspecified)	CETACEANS LANDED	TYPE OF VESSEL	METHOD OF CAPTURE	DOCKSIDE[1] VALUE (Rs)	USE[1]
Chilaw	Jul 85†					
	mid Aug 85†	None				
	1 day, Dec 85	1 Bottlenose dolphin	?	Gillnet		
	Feb 86†	?	Only about 3 boats going deep-sea fishing			
Negombo	Jul 85†					
	4 Jul 85	1 Melon-headed whale	?	?	?	
	4 Aug 85	1 Fin whale[2] (est. 23-25 ft)	Trawler	Gillnet	5,000	HF
	14 Aug 85	5 Bottlenose dolphins	?	Drift gillnets	?	HF
		1 Spinner dolphin	?	Drift gillnets	?	HF
	Dec 85†	1 Spinner dolphin	Tunaboats	?		
		1 Striped dolphin	Tunaboats	?		
	15 Feb 86	1 Bottlenose dolphin (96 in.)	26-ft boat	Harpooned	760	B
		1 Risso's dolphin (102 in.)	?	Drift gillnet	400	.
		1 Striped dolphin	?	Drift gillnet	.	.
	1 day, Mar 86	1 Risso's dolphin (4.5-ft male)	3.5-ton boat	Gillnet	?	?
Beruwala	May 85†					
	Jul 85†	Many brought in daily		Drift gillnets		

Table 8 continued

SITE	DATE(S) VISITED († = unspecified)	CETACEANS LANDED	TYPE OF VESSEL	METHOD OF CAPTURE	DOCKSIDE† VALUE (Rs)	USE†
Beruwala *(cont'd)*	Dec 85†	Many brought in daily		Drift gillnets		
	Feb 86†	1 False killer whale (125-in. female)	32-ft boat	Gillnet	2,000	HF
Wadduwa	Jul 85†					
Hikkaduwa	May 85†					
Galle	May 85†					
	Jul 85†					
	Oct 85†	1 Risso's dolphin	? (from Beruwala)	Gillnet	250	HF
Mirissa	May 85†					
	5-10 Sep 85					
	5 days, mid Oct 85†	1 Rough-toothed dolphin 2 Melon-headed whales 1 Fraser's dolphin	28-ft boat ? ?	Harpooned Harpooned Harpooned	395	HF
	20 Oct 85†	19 dolphins	4 boats	Harpooned		
	Jan 86†	?	Some boats going out for harpooning, but effort reduced from December			
	Mar 86†	3 Bottlenose dolphins on 1 day (all 82-86 in. long)	3.5-ton boat	Harpooned	750-850	HF
Dondra	Jun 85†					
	8, 11, 13 Sep 85	Few	?	Nets only		

Table 8 continued.

SITE	DATE(S) VISITED († = unspecified)	CETACEANS LANDED	TYPE OF VESSEL	METHOD OF CAPTURE	DOCKSIDE[1] VALUE (Rs)	USE[2]
Dondra *(cont'd)*	Oct 85†	Many				
	Jan 86†	Fewer than in Oct				
	Mar 86†	None				
Tangalle	Jun 85†					
	18, 19, 20 Sep 85	Very few		Nets only		
Kalamitiya	Jun 85†					
	16-21 Sep 85	1Risso's dolphin		Gillnet	150	HF
Kottegoda	8-13 Sep 85	Many, regularly		Nets only		
Hambantota	17, 20 Sep 85	Very few		Nets only		
Gandara	17,18 Oct 85	6 Spinner dolphins 2 Risso's dolphin	? ?	Gillnet Gillnet	300 per	
Ammaduwa	17 Sep 85	None				
Kirinda	17, 18 Sep 85	Few; on 17th 1 Bottlenose dolphin		Nets only	225	HF

[1] Exchange rate during 1984-1986 was Rs: 25/ to 27/ per $US1.00.

[2] B = used for bait; HF = sold for human food.

[3] On 4 of the 5 days monitored, more than 3 dolphins were landed; all but one or two of them had been harpooned.

[4] *Fide* S.D. Senanayake.

[5] Identification corrected from Bryde's whale to fin whale, on basis of color photographs of skull and baleen, by J.G. Mead, U.S. National Museum.

On 15 February I found no catch of dolphins by boats arriving in the morning. However, there was both a harpooned and gillnetted catch of dolphins in the afternoon. Some by-catch of dolphins was documented at Negombo during March as well.

Wadduwa

No large vessels operate from this site during the southwest monsoons (July and August). Those which do normally work out of Wadduwa migrate to Beruwala or farther south at this time, and only small boats working close to the coast remain.

Beruwala

There is a heavy by-catch of dolphins in drift gillnets set by vessels working out of Beruwala during the months of July, November and December, at least. Some by-catch occurs in February as well, but by this month the frequency of dolphins being landed appeared to have decreased, at least in 1986 (December 1985 many dolphins were brought in daily; February 1986 only one cetacean, a false killer whale, was brought in on the day of my visit). One night's catch at Beruwala in July (25th) consisted of 18 dolphins.

Hikkaduwa

During my visit in December I learned that no dolphins were being taken at Hikkaduwa because no boats were going out for deep-sea gillnetting at the time. All fishermen at this landing were engaged in what they call "light fishing". This is a method of fishing for small fish which are seasonally abundant. It is accomplished by fixing lights along the net to attract the fish. Light fishing is done only in fairly shallow water. Therefore, cetaceans generally are not taken. The fishermen told me that this type of fishing would continue until about April, after which the normal deep-sea fishery would resume. I conclude that between November and April the fishing industry at Hikkaduwa poses relatively little threat to cetaceans. [S.D. Senanayake (report to NARA, November 1985) also reported that the light-fishing boats at Hikkaduwa and Ambalangoda do not catch many dolphins.]

Galle

I spent little time at Galle and can only state that some catch of dolphins occurs there, at least during some part of the year. Dolphins landed in Galle are often purchased by vendors from Ambalangoda (Figure 12), who keep them frozen until Sunday, when they chop them up and sell them at small internal fairs.

Mirissa

I spent a relatively large amount of time at Mirissa. In October I was there for five consecutive days and found that, as in September, the direct take still exceeded the accidental by-catch of dolphins. Some of the 28- and 32-ft boats went out specifically to harpoon dolphins, embarking during the day and returning at 1600-1800 hrs. The animals brought in on these boats were tied alongside the boat, dropped into the water, and left until the following morning, when they were sold with the morning's fish catch. On four out of the five days I visited Mirissa in October, more than three dolphins were landed. Most had been harpooned.

In January I found that the number of boats going out to harpoon dolphins had decreased since December. On the south coast generally, most boats appeared to be going out for small

Figure 12. Small cetaceans landed at Galle generally are taken away to small villages for immediate sale (left) or are iced and taken by truck (right) to Ambalangoda, where they remain on ice until the Sunday sale. (S. Leatherwood).

fish such as mackerel rather than larger deep-sea species. Those vessels that were gillnetting far offshore were getting few yellowfin tuna and thus few or no dolphins.

Some harpooning effort continued in March, even though the seas were rough.

Gandara

There was no direct harpoon hunt for dolphins at Gandara, but a regular by-catch was evident during the two days I spent there in October. Deep-sea gillnetting had declined by January.

Dondra

During the first half of September there was no harpooning taking place; the only dolphins brought into Dondra at this season were from gillnets. However, by the time of my visit in October, the dolphin harpooning season had begun, as the sea was calm and the weather favorable. The boats going out to hunt dolphins left at mid-day and returned late at night. The catch was sold to vendors at dockside early in the morning. As was true at Mirissa, the harpooned catch of dolphins in October exceeded the netted catch. Each boat that went out for harpooning brought in 5-10 animals. However, every boat did not go out for dolphins every day. Harpooning was done only at times when, for some reason, the boats did not go out for normal fishing or when the fishing was poor.

In December I found that effort at harpooning dolphins had declined at Dondra. I also visited a small landing site at Matara, near the mouth of the Nilwala River, this month. About 15 3.5-ton boats were there. The fishermen told me that they occasionally caught dolphins in their nets and that they occasionally harpooned one or two as well.

In March most of the boats at Dondra were not going out for deep-sea gillnetting but rather were fishing for small fish such as Spanish mackerel. As a result, there was no dolphin by-catch at this season.

Kottegoda

There was a very regular by-catch of dolphins at Kottegoda in September and October. Every day when this landing site was visited, dolphins, mainly spinner and Risso's dolphins, were delivered as a by-catch; however, no harpooning of dolphins appeared to take place here. Due to changes similar to those mentioned for Dondra (above), the by-catch had become negligible at Kottegoda by March.

Tangalle

Few or no dolphins were being taken during September, as little fishing was taking place. Tangalle's resident fishermen generally do not harpoon dolphins, but the many migrating "trawlers" that seasonally work out of this landing do.

Kalamatiya

No vendor for dolphins operates at Kalamatiya, and few dolphins are landed there.

Residents of this area believe transporting a dolphin in a vehicle brings bad luck. Also, it was said by local people that a boy who tried to sell dolphin meat at Hungama (about 3 miles from Kalamatiya landing site) was punished for doing so by the police. The meat was confiscated. There is little consumer demand for cetacean flesh. During a 6-day visit in September, I observed only one dolphin brought in at Kalamatiya. It was a young Risso's dolphin which sold for Rs:150/. It appears that the few dolphins brought in to this landing site are sold cheaply at the landing site and taken away for sale at various small fairs inland. Many fishermen from Kalamatiya apparently dump dolphins entangled in their nets, even when dead, back into the sea rather than bothering to bring them to shore.

Hambantota

There was no harpooning and very little gillnet mortality of cetaceans observed here. The situation appears similar to that in Kalamatiya, judging by what I observed in September. When other members of the crew visited the market 27 May 1985, they found seven spinner dolphins, which were sent to Walasmulla for sale (Leatherwood, unpubl. data, 27 May 1985).

Kirinda

There are no permanently resident fishermen at Kirinda. Migratory fishermen from various parts of the country operate there when the fishing is good and the seas are calm, however, and a substantial by-catch of cetaceans occurs. There was little fishing activity when I visited Kirinda in September, but I was assured that the previous two months had been very productive, with a regular by-catch of dolphins.

Ammaduwa

This small landing site was visited only for one day in September. I was told that only migratory fishermen operate there, and they do so mainly from September to March, using fiberglass boats and traditional craft exclusively. The by-catch of dolphins apparently is very small and irregular.

Distribution and Cost of Cetacean Meat

Marketing methods and prices for cetacean meat differ from landing site to landing site and from one fish market to the next. The reasons for such variation are social, cultural, economic and technical. The information I obtained on the marketing and cost of small cetacean meat is summarized in Tables 9 and 10. Here I present some additional details.

I made frequent enough visits to Mirissa to be able to document seasonal changes in the price of cetacean meat there. In October 1985, although the dockside value per animal varied between Rs:300/ and Rs:680/ according to factors such as the size and species of the animal and the size and nature of the fish catch, dolphin prices generally had declined since the previous month. Apparently this was because of very good fish catches at Mirissa and the fact that large numbers of dolphins were being landed while I was there. For example, on 20 October, soon after I had left Mirissa, 19 dolphins were brought in by four boats (all harpooned). The fishermen found it difficult to sell adult spinners even for Rs:75/ each (S.D. Senanayake, pers. comm.). Evidently, the local market for dolphin meat was saturated at this time.

There is some variability in price between localities. For example, in October 1985 a large spinner dolphin could be sold for about Rs:250/ in Dondra, somewhat less than in Mirissa and Gandara. The price of dolphin is much less at Kottegoda than at Mirissa and Dondra, even though Kottegoda is less than 5 miles away from Dondra Point. There are only two vendors at Kottegoda who buy cetaceans, so there is no competitive bidding. The two vendors, one from Gandara and one from Matara, buy the dolphins cheaply at Kottegoda and sell them, chopped up, at internal fairs. For example, an adult spinner dolphin worth Rs:375/ at Mirissa would sell for only Rs:150/ at Kottegoda. Once taken to the fair inland, it would be sold for about Rs:10/ per kg.

A 318-cm false killer whale landed at Beruwala in February was purchased at dockside by a fish vendor from Colombo for Rs:2,000/. After obtaining the carcass, the vendor chopped it into large chunks, as it was too large to transport whole. The chunks were taken to the St. Johns fish market in Colombo and sold the next day as dugong.

I learned from S.D. Senanayake that a door-to-door fish vendor was selling dolphin flesh as dugong meat in the Colombo suburbs of Kothalawala/Kaduweda on 28 December. This vendor claimed to have bought the dolphin at the Colombo Central Supermarket (St. Johns Market) and said he realized it was not dugong but dolphin. The sale price to consumers - Rs:35/ per kg - was much higher than in most other inland markets which I have visited. This vendor apparently operates regularly in the area but has dolphin flesh only occasionally. Some of his consumers are aware that what he sells as dugong is actually dolphin. Even at the high price, he finds a ready consumer market in this suburban area.

Of three large bottlenose dolphins taken by harpooning and landed at Mirissa in March, one was bought by a vendor for Rs:850/ and sent to a fair at Deniyaye to be sold as dugong, and another was sold at the landing site for Rs:750/. A large (211-cm) bottlenose dolphin taken at Kirinda in September sold for only Rs:250/. It was transported (by bicycle) to Buttala for sale to consumers.

Table 9. Markets and prices of cetaceans in south and southwest Sri Lanka, May 1985-March 1986

Landing Site	Consumer Market		Price in Rs.		Comments
	Coastal	Inland	Whole Animal	Per Kg.	
Chilaw	●		100 - 750	-	Not sold by the kg, but by the heap (Rs. 15-20 per heap) to consumers at fish market.
Negombo	●	●	200 - 1200	6 - 11	Mostly sold in Negombo itself while only a few are taken to internal areas.
Colombo	●	●	-	16 - 35	Price varies with the supply.
Beruwala	●	●	125 - 2000	8 - 20	Markets include Mathugama, Palawatte, Aluthgama, Maggona, Payagala and Katukurunda.
Hikkaduwa		●	100 - 800	10 - 20	
Galle		●	150 - 800	8 - 15	Main market is Ambalangoda.
Mirissa		●	100 - 1500	6 - 15	Variation in price due to supply, size and species.
Dondra		●	150 - 750	5 - 15	3 landing sites, of which Puranawalla the most important. Main market at Urubokka.
Gandara		●	100 - 600	8 - 12	Low whole-animal price due to lack of competitive bidding.
Kottegoda		●	75 - 400	10	Low whole-animal price due to lack of competitive bidding; main markets are fairs at Walasmulla, Deiyandara, Urubokka, Ratumba and Ambalangoda.
Tangalle		●	-	-	No data on prices.
Kalametiya		●	100 - 250	5 - 10	Low prices due to superstition etc. Sold mainly at fairs in Angunakolapalessa, Ambilipitiya, Barawakumbura and Debokkawa.
Hambantota		●	100 - 300	-	No demand and therefore the price is low. Sold at fairs in Urubokka and Walasmulla.
Kirinda		●	100 - 300	5 - 8	Low price due to superstition etc. Market in Buttala.

Table 10. Differences in the price of dolphins in the different areas and according to different species.

PLACE	SPECIES			
	Bottlenose	Spinner	Fraser's	Risso's
Mirissa	●	●	●	●
Length (inches)	109	72	93	94
Whole-animal price (Rupees)	1,495	345	1,095	795
Length (inches)			90	
Whole-animal price (Rupees)			1,075	
Kirinda	●			
Length (inches)	83			
Whole-animal price (Rupees)	225			
Kottegoda		●		
Length (inches)		74		
Whole-animal price (Rupees)		175		
Mylddy	●			
Length (inches)	120			
Whole-animal price (Rupees)	10,000			

Although many informants told me that the demand for dolphin flesh very much depends on the size of the fish catch, there is not necessarily an inverse relationship between the availability of fish and the cost of dolphin meat. For example, at Beruwala the prices for the many dolphins brought in did not decrease when the fish catch was good in December. However, in general the demand for dolphin meat declines at least moderately when the fish catch is good. Fishermen at Gandara told me in October that the price they got for spinner dolphins that day (18th) would have been much higher (than Rs:400/ per animal) if the fish catch had been poor.

The selling of cetacean flesh as dugong is a widespread practice. However, at Chilaw and many other coastal sites, dolphin meat is sold for what it is and consumer demand remains high. It is primarily at inland fairs and markets where the selling of the meat as dugong is commonplace.

Most of the fish brought into Dondra landing site is taken to a market called Wallamadama, just outside Dondra town. Dolphins are also taken there initially. A vendor at Wallamadama buys most of the dolphins brought into Dondra. He transports them to inland areas off Deniyaya such as Urubokka and Middeniya, where they are sold to consumers.

A single vendor buys most of the dolphins brought into Gandara.

At least on the south and west coasts (Negombo, Mirissa, Kottegoda) dolphins with a snout (e.g. *Stenella*, bottlenose, common and Fraser's dolphins) sell for considerably more than those without one (e.g. Risso's dolphin), even if the latter are larger. For example, at Negombo (15 February) a 244-cm bottlenose dolphin sold for Rs:760/ (for bait) on the same day that a 259-cm Risso's dolphin sold for RS:400/ (presumably for human consumption). On 10 September, a 229-cm Fraser's dolphin sold for Rs:1075/ while a 239-cm Risso's dolphin sold to the same vendor for Rs:795/. He said it was because the dolphins without snouts have more blood and thus are messier to handle than those with a snout. This bias may be a generalization derived from the relatively frequent captures of pygmy and dwarf sperm whales, known locally as *lie mulla*, literally meaning "blood dolphin" (Leatherwood 1985).

A 6-m sperm whale killed in a gillnet 1-2 March sold in Negombo for Rs:3000/. In Negombo, the demand for dolphin flesh is high, owing, it seems, to its taste and the fact that it sells at cheaper prices than in the south. As evidence of its popularity, a melon-headed whale completely sold out within 2 hours of its preparation at Pitipana, Negombo, in July 1985,

Figure 13. The meat and other products of a fin whale landed at Negombo were chopped up and sold to many vendors for distribution inland (S. Leatherwood).

when dolphin was being sold there at a standard price of Rs:50/per pound. At the same time, the price in the coastal markets of Payagala and Katukurunda was Rs:8-10/ per pound. A young fin whale, estimated to have been 25 feet long, killed in a gillnet off Negombo was purchased by a vendor for Rs:5000/. It was cut into smaller chunks for distribution (Figure 13). The owner would not part with the skull and baleen plates, which the field crew offered to buy for the NARA Museum, as he had never before seen a whale with baleen.

During interviews in early March 1983, fishermen near Jaffna provided some information on relative economic value of the various species. In Myliddy, due to a high demand and low catch rate, a 3.2-m dolphin was said to fetch a price of up to Rs:10,000/. Interviewers regard this as unlikely given that at the nearby sites of Poliyandy and Pt. Pedro, where dolphin meat also was valued like beef, a 2-m dolphin was said to sell whole for Rs:300-600/ or for Rs:6-25/per lb. (Leatherwood *et al.* 1983). The fishermen at Myliddy likely inflated the price thinking "outsiders" might buy it. A bottlenose dolphin bought at Negombo, 5 March 1985, for Rs:200/was advertised for sale the same day at Peliyangoda for Rs:1,000/. The vendor's expectations were clear when he refused Rs:800/(The Island, 5 March 1985). On 26 May 1985, a fisherman at Galle reported he had received Rs:275/ for 2 adult spinner dolphins. The vendor, who sold the meat at Weligama, reckoned he paid Rs:6-7/ per kg and intended to sell it for Rs:30/ per kg (Leatherwood, unpubl. data, May 1985).

Utilization

Lantz and Gunasekera (1955) noted that dolphin flesh could be prepared fresh (recipes were presented), salted and dried, or pickled and was in any form a popular and inexpensive substitute for fish. At the time of their review, the meat sold in Colombo-Negombo for $.25 per lb.

On the south coast, dolphins are not often eaten by fishermen and their families, except for the liver, which is considered healthy, and sometimes the gonads, which are referred to as eggs. When fishermen in Beruwala were told that the "eggs" were actually part of the male's reproductive system, they showed horror and at least immediately refused to buy or eat them (Leatherwood journal, August 1985). These parts are now distributed inland, where they sell for Rs:16-22/ per kg. They appear to be especially popular among low-income groups.

On one occasion, at Negombo in December 1985, I observed that the chopped-up remains of a dolphin were being sold on the day following that of the carcass's primary sale. This included some bits of meat as well as the blubber, flukes, flippers and head. The vendor who bought the lot for Rs:50/ said he intended to sell it door-to-door, by bicycle, for RS:7/per 500 grams. This isolated observation suggests that dolphins landed at Negombo are utilized fully. Also, in the case of the young fin whale mentioned above, parts of the animal which were not deemed suitable for sale as flesh were chopped up into small 2 in x 2 in. squares and put into salt brine for fermenting to make a kind of dried fish called *jadi*.

The longline fishermen at Beruwala commonly use dolphin as bait, either buying carcasses at the market or taking advantage of their own gillnet by-catch (S.D. Senanayake, report to NARA, December 1985).

Many coastal residents do not eat cetacean flesh themselves, apart from the liver. Fishermen often remove the liver before selling the rest of the carcass. The liver is considered a delicacy, and it is fed particularly to children because of its nutritional value.

The practice of fermenting dolphin flesh and preparing it as "dry fish" has been observed in Chilaw, Negombo and Kalpitiya. Dolphins at Chilaw are sometimes chopped up and sold by the heap or made into "dryfish". At Malabay just outside Negombo, dried dolphin flesh was being sold for Rs:30/ per kg in August 1985 (Leatherwood, unpubl. data).

Case Studies: 15 October 1985 - Rough-toothed Dolphin, 228 cm; Risso's Dolphin, Length Unspecified.

The rough-toothed dolphin was harpooned off a 28-ft. boat and brought to the Mirissa landing in the morning. At the landing site it was bought (whole animal) by a regular buyer of dolphins at Mirissa for Rs:395/. As 15 October was a Tuesday, a weekly fair was operating from 1430 hrs onward at Batemulla, approximately 20 mi from Mirissa and inland. The dolphin was transported to this fair in a van by the vendor who bought it at the landing site. I reached the site of the Batemulla fair at about 1415 hrs and found that, in addition to the rough-toothed dolphin, a Risso's dolphin had been brought by a vendor from Galle. The Risso's dolphin had been brought into the Galle harbor the same morning, having been accidentally entangled in the net of a boat from Beruwala which had come in at Galle due to engine trouble. The vendor from Galle had bought the whole animal for Rs:250/ and spent another Rs:150/ to transport it by trishaw from Galle to this fair. *En route* from the landing sites to the fair, the names of both animals had changed from dolphin to dugong (*mudu uru*). When the fair opened at 1430 hrs, the flesh of both animals was being sold as dugong for Rs:15/ per kg, but as the two vendors were competing with each other they kept lowering the price alternately throughout the afternoon. The price was reduced first to Rs:12/50, then to Rs:10/ and eventually by 1600 hrs to Rs:8/ per kg. By this time both animals were almost sold out as there was a good consumer demand for the meat.

According to the vendors, this meat sells very fast because it is cheaper than any other kind of meat or fish available. They said it was possible to make a clear profit of about Rs:300/ on each animal at these fairs. The vendors advertise dolphin flesh as cheap and good for the health. They also claim that it gives color to the skin, curls hair, stops hair from graying and retards the aging process generally. On most days of the week there is at least one such small fair operating in some section of this area. For instance, on Wednesday, the day after the fair at Batemulla, there would be another fair operating at Kananke, about 5 miles from Batemulla. Therefore, if these same vendors were to find dolphins at the landing sites the next morning, they would have bought them to take to the fair at Kananke. On the Wednesday of the week after I visited the Batemulla fair, another researcher visited the fair at Kananke. He told me that he found a large bottlenose dolphin from Mirissa and another smaller spinner dolphin being sold there. The price of dolphin flesh at the Kananke fair was much less than at Batemulla - only Rs:6/ per kg.

At the Batemulla fair I interviewed many of the consumers who bought dolphin flesh. Most were Sinhalese Buddhists of a low-income group. Most have large families and an unstable income as they work on large plantations on an impermanent or temporary basis.

They live in small villages within 2-3 miles of Batemulla. The high consumer demand for dolphin flesh here appears mainly due to the need for inexpensive protein. A few consumers said that they buy dolphin flesh not for its nutritional value but purely because they like the taste and enjoy eating it. Some also said that it is very nutritious and good-tasting but they do not give it to small children, fearing that it might make them sick. All the consumers said that they cook the meat like an ordinary beef curry and that once cooked, it is very similar to pork. Most were under the impression that it was dugong flesh, but a few were aware that it was really dolphin being sold as dugong.

Biology and Status of Sri Lanka's Marine Mammals

Studies of Distribution, Movement and Habitat [7]

A series of short cruises was conducted to clarify further the species and relative numbers of cetaceans occurring in Sri Lankan waters and to observe their behavior. Locations of sightings are plotted whenever possible in Figure 14.

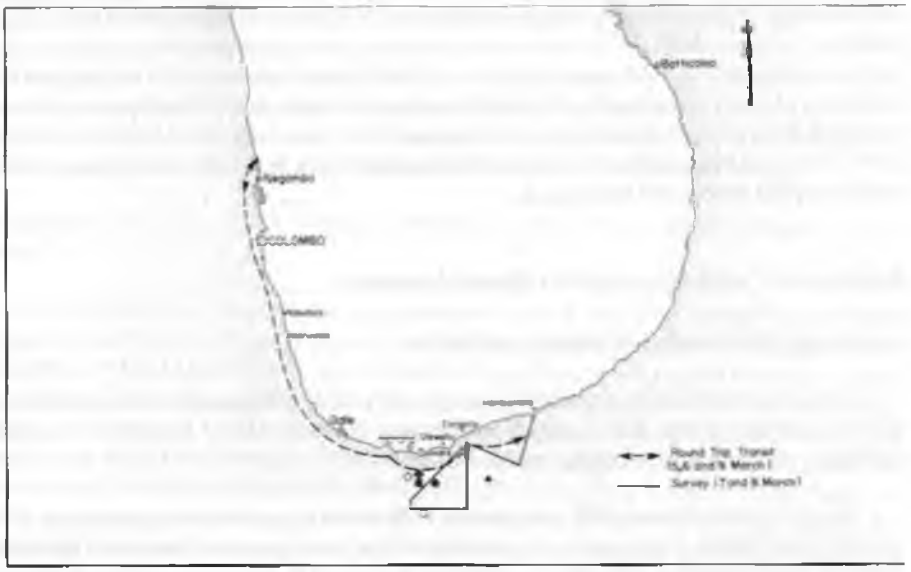
On 12, 13 and 14 March 1985, members of a US-based conservation organization, Oceanic Society Expeditions, participating in a natural-history tour program, searched for cetaceans from the inner harbor at Trincomalee, through Koddiyar Bay, to waters as far as about 6nm off Kevuliya, Foul Point (Daily News, 11 June 1984). They made numerous sightings of cetaceans, including bottlenose and spinner dolphins and blue and Bryde's whales. From

Figure 14. Cruises to determine distribution of cetaceans along Sri Lanka's west, southwest and south coasts and approximate locations of sightings of cetaceans.

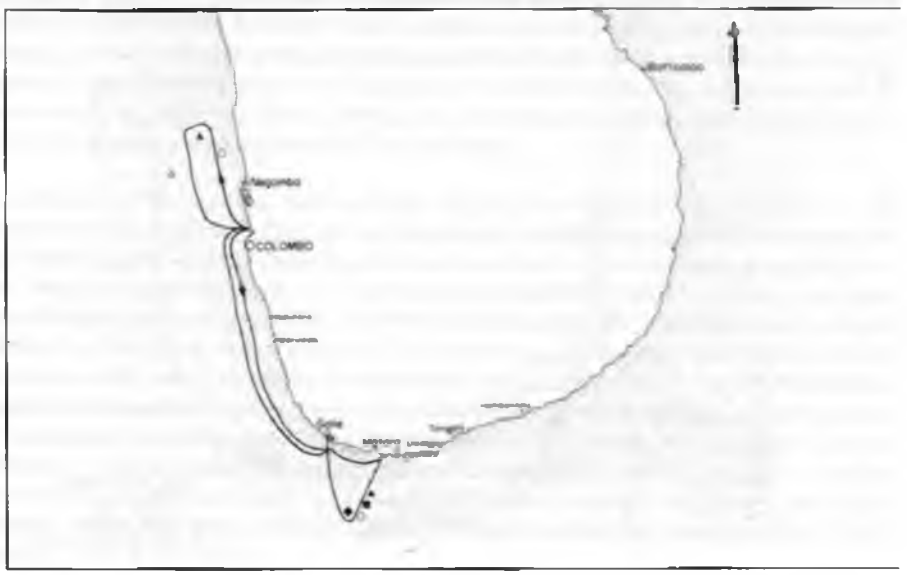
[7] Assembled by the editors from information contained in Anonymous (1986a, b; 1987a, b).

Figure 14 continued.

(b)



(c)



photographs taken during these surveys and in previous years (Leatherwood *et al.* 1984), identifiable individual blue whales were resighted in this same area after 1 day (2 animals), 2 days (1), and 12.5 months (1). One Bryde's whale was seen on two successive days in 1985 (Leatherwood 1985).

From 4 to 9 May 1985, observers aboard the SRV *Heraclitus* made 7 sightings of cetaceans between Colombo and Dondra Head, off the southwest coast. These included blue, Bryde's, and sperm whales and spotted and spinner dolphins. Harpooned dolphins were seen and photographed on the deck of a fishing boat, confirming reports by Alling *et al.* (1982) of the presence of a harpoon fishery for dolphins in that area. Gunaratna *et al.* (1985) speculated that blue whales, seen commonly off northeast Sri Lanka from December through mid-to late May, migrate to the south coast during spring.

During a brief training cruise of the R/V *Samudra Maru*, in September 1985, sperm whales were seen 8-12 miles due west of Colombo.

During November and December 1985 there were frequent survey cruises near Colombo aboard the R/V *Samudra Maru*. Spinner, spotted and bottlenose dolphins were seen about 7 miles off the coast at unspecified localities (S. Senanayake, November and December 1985 reports).

During 16-19 September 1985, while aboard *Northwest Trawler 51* from Mirissa, S. Senanayake observed a large herd of spinner dolphins 58 miles south southwest of Mirissa Harbor. In October, Senanayake travelled aboard *NW 48* (16-19 October) and F/V *Masuda*, a 32-ft. inboard. During the former voyage, he noted spinner dolphins at three locations and on the second, spinner, spotted and bottlenose dolphins. On 5 November, aboard *NW 46* from Galle, he observed a Bryde's whale off Mirissa and spinner, spotted and bottlenose dolphins 15-20 miles southwest of Galle.

During 14-19 December 1985, searches for marine mammals were made from the R/V *Samudra Maru* as it cruised from Colombo-Kirinda-Colombo, mostly along or shoreward of the 200m contour (to 4-6km off shore). Activities aboard consisted of seismic surveys, detailed bathymetric surveys and dredging. Watches were maintained for marine mammals as well. Sightings of blue and Bryde's whales and spinner, bottlenose and Risso's dolphins were made (Figure 14a).

On 7, 8, and 9 March 1986, passengers from the Oceanic Society Expeditions aboard the M/V *Lady Chatterly*, on whale-watching excursions from Tangalle and Kirinda, observed bottlenose, Risso's and spinner dolphins but no great whales (Leatherwood journal, 27 Feb.-15 Mar. 1986). NARA officers Nihal de Abrew and G. Roshan Karunatillake were aboard for these three days as well as for the transits from Negombo to Tangalle and Hambantota to Negombo. Despite continuous watches along cruise tracks about 3-4 miles offshore, they saw only one other group of cetaceans: two spinner dolphins 3 km off Dondra Head (Figure 14b).

During 29-31 March 1986, NARA staff accompanied Roger Payne on a cruise aboard the T/V *Muthukumari*, a Fisheries Ministry training vessel, along the southwest coast. Searches for cetaceans were made visually for 55 minutes and by listening through hydrophones for 5 minutes every hour. Bottlenose and spinner dolphins were seen and sperm whales heard

during the expedition at locations shown in Figure 14c. Immediately following the cruise, staff members returned to Dondra and from 7 to 9 April watched for cetaceans from Dondra Head Lighthouse. They saw a large herd of spinner dolphins and a single unidentified whale 8 April.

Blue whales have stranded (Deraniyagala 1948; Fernando 1912) and been observed alive along Sri Lanka's south and west coasts. In addition to those seen from *Heraclitus* and *Samudra Maru*, a blue whale was seen from shore off Unawatuna 30 December 1985 (Rosemary Sommer, pers. comm., 1985). Bryde's whales, too, have been reported along the west coast, from aerial surveys off the northwest coast in March 1983 (Leatherwood *et al.* 1984), from both *Heraclitus* and the *Samudra Maru* and from a private vessel off Unawatuna 31 December 1984 (Rosemary Sommer, pers. comm., 1985).

Biology of Small Cetaceans[8]

Populations of small and medium-sized odontocetes have proven vulnerable to rapid depletion from over-exploitation (see Mitchell [1975a, b] and Perrin [1988] for some examples). These animals are slow to mature, reproduce infrequently (generally one calf per female every 2 or more years) and in some cases exhibit social behavior (e.g. sex and age segregation, pod cohesiveness) which can complicate the effects of harvesting (see Perrin *et al.* 1984). Marsh (1988) outlined why harvesting of dugongs can involve a high risk of depletion.

Therefore, at the outset of the NARA program there was concern that the unknown but suspected high rates of kill might significantly damage populations of the marine mammal species involved. Landed specimens offered an excellent opportunity to collect basic information on the biology of marine mammals of the region, information which might well prove useful in the long term in detecting effects of sustained fishing. Even if the specimens were not useful for that purpose, however, there was a wealth of knowledge to be obtained from the systematic sampling of the catch, supplemented by examination of fresh stranded specimens.

Accordingly, NARA officers Asoaka Gamage and Chandana Mendes, with help from other project officers, began to collect data and biological specimens from the following ten fish-landing sites: Hambantoda, Tangalle, Dondra, Matara, Galle, Hikkiduwa, Beruwala, Negombo, Chilaw and Kalpitiya. A similar program had been established earlier in Trincomalee by Abigail Alling with W.P. Prematunga, who was collecting information and specimens privately (Figure 15). Prematunga was subsequently recruited to the NARA staff and continued his efforts. In both areas the procedures were basically the same.

The staff arrived at the fish-landing site early and remained late to inventory marine mammal specimens landed. Whenever circumstances permitted, they selected specimens, being careful to take advantage of new species whenever they were found and of previously

[8] This section was prepared by the editors from the reports by Asoaka Gamage, Chandana Mendes and W.P. Prematunga, supplemented by pertinent data in other project reports and in Leatherwood's field journals. It also includes data presented in Prematunga et al. (1985) for the 16 months from January 1984 through April 1985 and Prematunga et al. (1990) for the period April 1985 through November 1986.

unseen size-classes of species seen before. For each specimen, they assigned it a number and photographed it, with the number in the frame, from dorsal, ventral and lateral perspectives; took external measurements, using metal meter sticks, metal measuring tapes and calipers (see Figure 15); noted and sketched scars and lesions on the skin; dissected the specimens and placed stomachs (for food-habit studies), gonads (for reproductive status) and sections of lower jaws containing teeth (for aging studies) in alcohol (the former two) or 5-10 percent formalin. During handling for measurement and/or dissection, they noted lactation, presence of a fetus, presence of visible sperm and presence of endo- and ectoparasites. They also obtained a sample of skulls from the most commonly occurring species for the NARA Museum.

After assisting A. Alling in 1982 and 1983 with work described in various reports (e.g., Alling 1983, 1985 a,b), Prematunga began collecting data on his own. From 1 January 1984 through 30 April 1985, he routinely examined specimens landed and scored them by species and sex; logged weights, either taken directly or estimated as part of the bidding process (price setting prior to sale); and occasionally noted the presence of fetuses. From 1 May 1985 through 31 December 1986, the first 8 months or so as a NMMU employee, he undertook a more ambitious project in which he logged species and sex of all animals known to have been landed; obtained external measurements, following instructions given during training sessions by Leatherwood, and recorded them on standardized data forms basically following Norris (1961); photographed most specimens; noted the presence of fetuses, lactation and visible sperm; noted special circumstances, e.g. when adult females and calves were taken in the same nets; and collected biological materials as described above.

Already, even before the data have been analyzed in any detail, the subproject on systematics and biology has contributed significant new information on species composition off Sri Lanka and on biology of some species in this part of the Indian Ocean. Here are a few examples.

There is little published information on rough-toothed dolphins in the northern Indian Ocean. Marcuzzi and Pilleri (1971) stated, without citing sources, that the species is distributed "in the tropical Indian Ocean." Blythe (1859) reported that two skulls were collected from the northern Nicobar Islands and deposited at the Museum of the Asiatic Society in Calcutta. One of these specimens (No. 1879.11.21.195) apparently was transferred to the British Museum (Natural History) and became the basis of Blandford's (1888:583) statement that the species is found in the Bay of Bengal, a specimen having been collected "near the Nicobar Islands." Additional specimens were collected off India, location unspecified, in 1882 during the voyage of the *Erebus and Terror* (skull at the British Museum [Natural History] specimen No. 345c) (Blandford 1891); in the Indian Ocean, location unspecified, by N. Pike (Museum of Comparative Zoology, Harvard, specimen No. 144); and at Vizagapatam, India, in 1882 (skull 82.1.2.3., British Museum [Natural History]) (Blandford 1891). Hershkovitz (1966) reported that the species occurred in the Aden District and Best (1971) that it was found in the Gulf of Aden. Mohammed Farog Ahmad is reported as having said that strandings have been observed on the Pakistan coast (de Silva 1987). Leatherwood saw a herd in the Bay of Bengal in 1982 (Leatherwood and Clarke 1983a, b; Leatherwood et al. 1984). Whitehead *et al.* (1983) reported a sighting at 06°52'N, 79°28.1'E on 1 November 1983. Keller *et al.* (1984) reported a herd probably of this species seen during aerial surveys off the Seychelles in 1982; and Alling

Figure 15. W. P. Prematunga working with A. Alling (top) and A. Gamage working with a local assistant (bottom) to measure and collect biological samples from spotted dolphins landed at Trincomalee and Galle, respectively (S. Leatherwood, top, and C. Mendes, bottom).

(1985b) found specimens in fish markets in Beruwala (1 on 10 January 1983) and Trincomalee (2 on 8 February 1983), comprising 4 percent of the landed catch she examined.

We are aware of 13 additional specimens examined in Sri Lanka since 1983, when the most recently reported data were collected. On 26 February 1983, Leatherwood and Masaharu Nishiwaki collected a skull of this species at Pitipana, Negombo, and placed it in the NARA/CRIOMM collection (specimen NARA003). There are rough-toothed dolphin skulls in the National Museum, Colombo (specimen no. 3), Perediniya University, Kandy (specimen C), and the University of Sri Lanka, Colombo Campus, Zoology Department Teaching Collection (specimen unnumbered). There were no additional data with any of these specimens (see Appendix 2 A). W.P. Prematunga found a 75kg male and a 75kg female in the main fish market at Trincomalee 22 February 1985; no further data were collected (Prematunga *et al.* 1985). A head, missing the lower jaw, was found at Batemulla weekly market 15 October 1985 (S. Senanayake photographs, Ilangakoon October report). Two specimens were landed at Mirissa 15 October 1985 (Mendes and Gamage, October report) and another (a 210 cm female) 9 March 1986 (Leatherwood journal, March 1986). This last specimen was taken away hurriedly by the vendor before it could be photographed, measured or sampled. Finally, specimens were landed at Trincomalee in May (1) and October (2) 1986 (W.P. Prematunga *in litt.*, 17 June 1987). External measurements of seven of the nine Sri Lankan specimens, including the three collected by Alling in 1983, are presented in Table 11.

There were also few published records from the northern Indian Ocean of several other odontocete species before the NARA/UNEP program began. Data from the program were combined with unpublished information from other workers in the following regional reviews: Risso's dolphin (Kruse *et al.* 1990); pygmy sperm whale and dwarf sperm whale (Chantrapornsyl *et al.* 1990); and pygmy killer whale, killer whale, false killer whale, short-finned pilot whale and melon-headed whale (Leatherwood *et al.* 1990).

The only previous published reports of the occurrence of one other species, Fraser's dolphin, in the Indian Ocean are those of a sighting off the southeast Sri Lankan coast, 06°26'N, 81°53'E (Alling 1985c, 1986), and examination of a 125kg female in the main fish market at Trincomalee 25 January 1984 (Prematunga *et al.* 1985). NMMU field workers documented the landing of four Fraser's dolphins at Mirissa in 1985; three of the four specimens were examined, 90-in and 93-in females 10 September and a 91-in female 14 October. The two larger individuals had been harpooned.

The value of the subproject on dolphin biology is further demonstrated by Prematunga's data from Trincomalee for 1984-1986. Reports on this work were presented in Prematunga *et al.* (1985, 1990), summarized here.

A total of 810 cetacean specimens is known to have been landed at Trincomalee in the three years. There were fewer animals examined in 1986 than in the previous two years, probably reflecting a shorter season and the effects of civil strife in the region on fishing activity and on monitoring of the fish-landing sites. The species and sex composition of the 810 animals landed are shown in Table 12 and Figure 16. With the exception of 1984, more males were taken than females. The total number of animals taken varied by month (Table 12, Figure 17). However, catch rates also varied by month in such a way that takes could not be shown to be directly related to amount of fishing effort. Causes for that variability are not known.

Table 11. Some external measurements (in in.) and weights (in kg) of rough-toothed dolphins taken in Sri Lanka, 1983-1986.

Specimen #	AA S183	AA S6 83	AA S7 83	SS 103 (0283)	CA 0210 85	WPP 050586	WPP 03 10 86	WPP 111086
Date	8 Jan 83	8 Feb 83	8 Feb 83	15 Oct 85	15 Oct 85	5 May 86	3 Oct 86	11 Oct 86
Location	Beruwala	Trincomalee	Trincomalee	Mirissa	Mirissa	Trincomalee	Trincomalee	Trincomalee
Photo code	G(1) 1-9	G(73) 13	#27, 28	Snapshots	P 10, 3-4	5586	-	-
Sex	F	F	F	F	M	M	M	M
Total length	73 in.	50 in.	77 in.	Head only	90 in.	65 in.	87.5 in.	88 in.
Snout (tip of u. jaw) to centre of eye	12	9	12.875	-	15.75	12.5	14.5	15
Snout to melon	-	5.75	6	-	5.5	-	-	-
Snout to corner of mouth	10	9	12.5	-	14.5	11	13	13.25
Snout to ext. auditory meatus	-	12	16.5	-	18.5	14.75	17.75	18.25
Snout to blowhole	-	10.25	15.75	-	15.75	11.5	14	14.75
Snout to flipper	17	15		-	23	18.5	21.5	22
Flipper length, front	8.5	11	15	-	16.5	11.25	16.25	15
Flipper length, back (axilla to tip)	3.5	8	9	-	12	9.25	13	12
Flipper width	-	4	5.75	-	6.5	4.75	6	5.75
Fluke depth	-	Flukes missing	Flukes missing	-	7.75	4.5	6	5.75
Snout to umbilicus	-	29	40.25	-	44	33	42	40.5
Snout to dorsal fin	44	35.5	47.25	-	38.5	-	-	-
Snout to genital slit	47	37.5	54.5	-	57.5	41	53	52
Snout to anus	50	41	58.25	-	65.5	47	62	60.5
Fluke width	16	Flukes missing	Flukes missing	-	22.5	15.5	24	22.5
Tooth count: —L upper		25	24	-	23	25	22	23
—R upper		26	25	-	-	25	22	23
Tooth count: —L lower		26	24	-	23	26	24	24
—R lower		23 (1 slit, no tooth)	24	-	-	25	22	23
Dorsal fin height	5.5	4.75	7.875	-	10.5	6.25	9.5	-
Dorsal fin base	-	7.75	10.625	-	14.5	14	17	15
Weight	~40 kg	15-20 kg	~40 kg	-	-	-	-	-
Girth at axilla	32	25.25	30.875	-	-	-	-	-
Girth max (dist. from tip of u. jaw)	-	25.75 (-)	32.5 (34.5)	-	-	-	-	-
Girth at anus	-	13.25*	2.875*					

*caught in same net

Table 12. Small cetaceans examined at the main fish market, Trincomalee, 1984-1986. Abbreviations indicate: Spinner dolphin (S.l.); Spotted dolphin (S.a.); Risso's dolphin (G.g.); Striped dolphin (S.c.); Bottlenose dolphin (T.t); False killer whale (P.c.); Pilot whale (G.m.); Dwarf sperm whale (K.s.); Pygmy sperm whale (K.b.); Rough-toothed dolphin (S.b.); Fraser's dolphin (L.h.); Unidentified dolphin (U.d.); Unidentified mesoplodont (U.m.) and Pygmy killer whale (F.a.).

1 9 8 4

Month	S.l.			S.a.			G.g.			S.c.			T.t.			P.c.			G.m.			K.s.			K.b.			S.b.			L.h.			U.d.			U.m.			F.a.			Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
JAN	6	2	10	3	3	6	0	2	2	0	0	0	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	13	8	23
FEB	4	1	10	1	1	2	1	3	4	1	1	2	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	20
MAR	5	4	9	5	0	5	3	7	13	2	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	13	31
APR	13	12	26	0	3	3	4	4	8	3	5	8	1	0	1	0	1	1	0	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	27	50
MAY	3	3	6	5	6	11	0	1	1	0	0	0	0	1	1	0	2	2	2	4	6	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	17	28
JUN	9	13	22	3	3	6	6	5	11	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	22	40
JUL	3	3	6	0	0	0	1	3	4	1	0	2	1	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	8	15
AUG	3	5	8	0	0	0	3	2	5	0	0	0	0	1	1	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	9	16
SEP	5	6	11	2	1	3	0	1	1	0	0	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	8	17
OCT	15	12	27	5	7	12	0	1	1	0	1	1	2	1	3	0	0	0	0	0	0	0	1	1	2	3	5	0	0	0	0	0	0	0	0	0	2	3	5	0	0	0	26	29	55
NOV	1	3	4	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	4	4	8
DEC	3	3	6	1	0	1	0	0	0	1	1	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	11
TOTAL	70	67	145	27	25	49	18	29	50	8	11	20	8	5	14	3	4	7	2	4	6	3	3	6	2	3	5	0	0	0	0	1	1	1	0	1	3	3	6	0	0	0	146	164	310

Table 12 continued

1985

Month	S.l.			S.a.			G.g.			S.c.			T.t.			P.c.			G.m.			K.s.			K.b.			S.b.			L.h.			U.d.			U.m.			F.a.			Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
JAN	0	1	1	0	1	1	2	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	5
FEB	4	5	9	2	6	8	2	5	7	2	2	4	4	1	5	0	0	1	1	2	3	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	16	22	38
MAR	4	8	12	4	2	6	4	1	5	0	0	0	1	2	3	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	15	28
APR	6	4	10	2	4	6	0	0	0	2	2	4	1	1	2	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	11	23
MAY	0	2	2	1	2	3	0	2	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	5	6	11
JUN	5	1	6	0	2	2	1	1	2	3	0	3	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	11	5	16
JUL	26	7	33	3	2	5	10	9	19	0	2	2	0	3	3	0	0	0	0	0	0	3	3	6	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	44	27	71
AUG	13	4	17	6	1	7	6	4	10	6	6	12	2	4	6	0	0	0	0	0	0	3	2	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2	36	24	60
SEP	2	4	6	0	0	0	0	0	0	2	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	4	8	13
OCT	15	10	25	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	17	10	28
NOV	2	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
DEC	11	6	17	0	0	0	1	5	6	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	13	13	26
TOTAL	88	52	140	19	20	40	26	27	53	18	17	35	9	11	20	0	1	2	1	2	3	8	7	15	1	1	2	1	1	2	0	0	0	0	0	2	0	1	1	5	3	8	476	143	323

Table 12 continued

1 9 8 6

Month	S.I.			S.a.			G.g.			S.c.			T.t.			P.c.			G.m.			K.s.			K.b.			S.b.			L.h.			U.d.			U.m.			F.a.			Total		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
JAN	1	0	1	0	1	1	0	1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	6
FEB	0	0	0	1	0	1	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3
MAR	4	8	11	0	1	1	3	0	3	1	0	1	0	2	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4	11	12	24
APR	17	8	26	5	9	15	5	5	10	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	22	53
MAY	11	2	13	11	8	19	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	23	11	34
JUN	1	0	1	4	2	6	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	8
JUL	0	2	2	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4
AUG	7	5	12	2	0	2	1	0	1	0	0	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	7	18
SEP	2	1	3	1	1	2	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	6	2	8
OCT	5	5	10	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	1	0	1	9	6	15
NOV	1	2	3	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4
DEC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	49	31	82	14	22	47	10	6	16	7	2	10	5	5	10	1	1	2	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	4	3	7	103	70	177
GRAND TOTAL	207	150	367	70	67	136	54	62	116	33	30	65	22	21	44	4	8	11	3	6	9	11	10	21	3	4	7	4	1	5	0	1	1	1	0	3	3	4	7	9	6	15	424	368	810

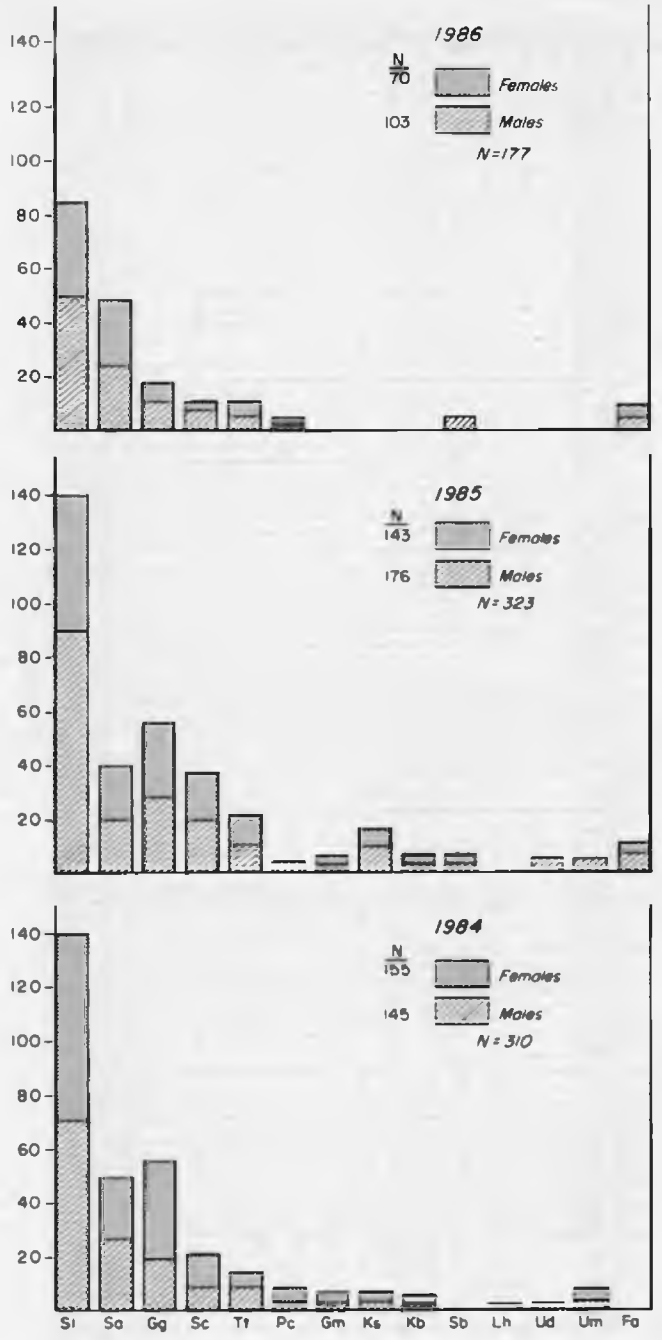


Figure 16. Species and sex composition of small cetaceans landed at Trincomalee, 1984-1986.

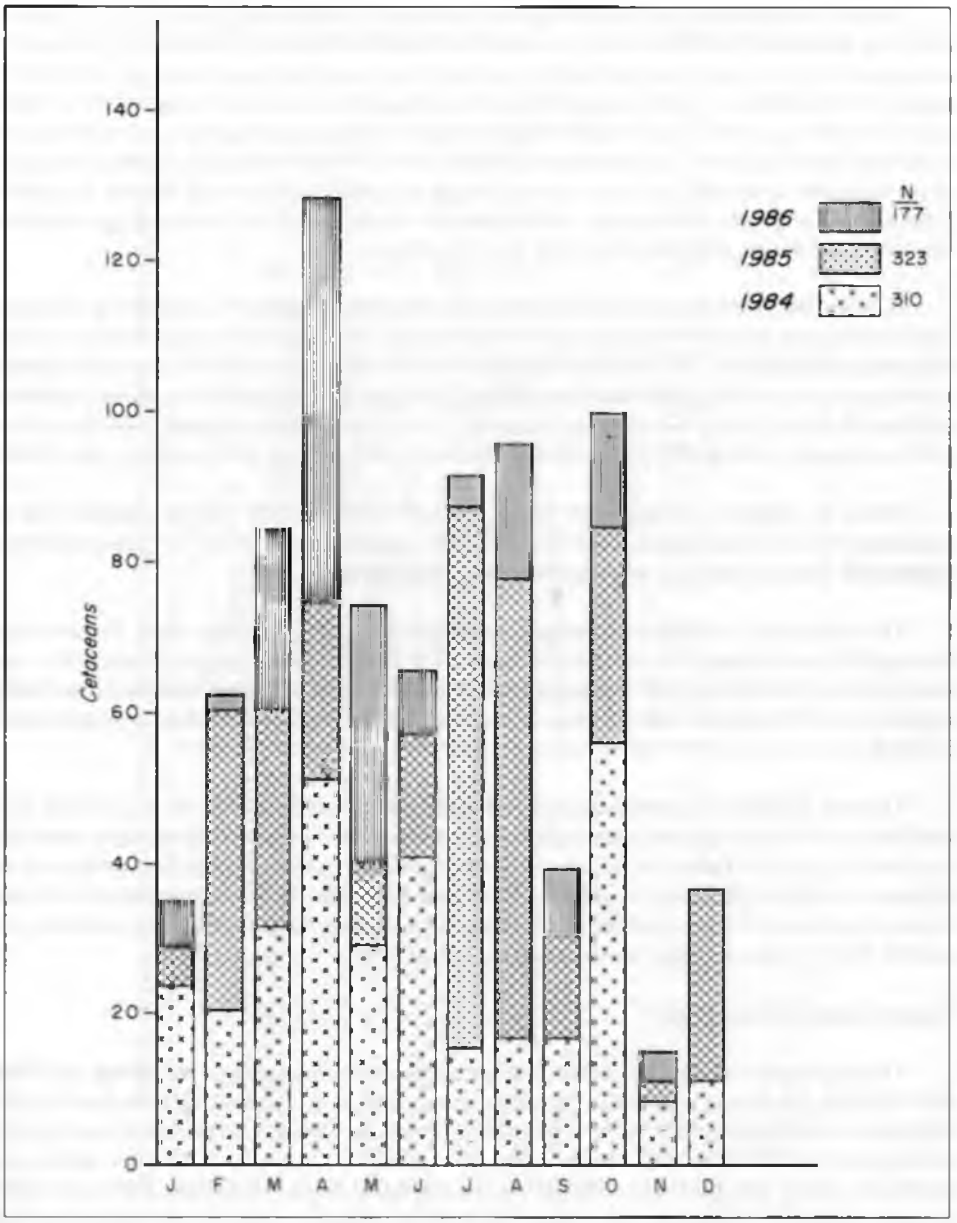


Figure 17. Seasonal distribution of observed landings of small cetaceans at Trincomalee, 1984, 1985, 1986 and total.

There was clear seasonality in the takes of some species. Seasonality in landings of species not often taken may well have been an artifact of small sample sizes. However, seasonality in takes of the commonly landed species (spinner, spotted, Risso's and striped dolphins) is more likely meaningful. It may suggest shifts in fishing areas or cetacean migrations into and out of the fishing areas. One possible explanation of seasonal changes in catch rates is that certain oceanic dolphins associate with yellowfin tuna, *Thunnus albacares*, a principal target of the fisheries. It would not be surprising if high takes of dolphins were closely correlated with periods of good tuna catches. Unfortunately, detailed data on fish landings were not available, and it was not possible to test this hypothesis.

Four species were taken far more frequently than others (Figure 16). Spinner, spotted and Risso's dolphins were taken most often in most years, although more striped than spotted dolphins were taken in 1985. As there is no quantitative information on abundance or relative abundance of any of these species on the fishing grounds, it is not possible to assess the effects of takes. However, these were the four cetacean species most commonly seen during surveys off Trincomalee during 1982-1985 (Alling 1986; Leatherwood *et al.* 1984; Leatherwood 1985).

Work on dolphin biology was deemphasized in November 1985 to permit staff to concentrate on other activities, notably searches for cetaceans along the west and southwest coasts and "benign research on large cetaceans" (Anonymous 1987b).

The extensive collection of materials assembled by Prematunga from Trincomalee through 1986 was transferred to NARA, Colombo (W. P. Prematunga *in litt.*, 17 June 1987). All specimens (Appendix B 2) are now stored at NARA, Colombo, but they remained essentially unanalyzed at the time of this writing. Measurements of some specimens are summarized in Table 13.

To date, attempts to work on this collection using locally available equipment and facilities have simply proven unsuccessful. The wealth of biological specimens available supports appeals for further research on the biology of Sri Lanka's marine mammals and on measures to reduce mortality in gillnets. Proposals for collaborative research received from outside institutions with appropriate equipment, expertise and importation permits will receive serious consideration by the Chairman of NARA.

Current Status of Dugongs[9]

The importance to dugongs of the shallow seagrass beds in the Gulf of Mannar and Palk Bay between Sri Lanka and India has long been recognized. Several authors have called attention to the vulnerability of the dugongs in this region, due initially to direct hunting and netting for meat (Phillips 1927; Norris 1960), later (1950s-1960s) also to incidental catching in turtle and shark nets (Jonklaas 1960, 1961; Deraniyagala 1965a; Van Reyk 1967) and more recently to habitat degradation caused by intensive trawling for prawns, the widespread use of powered vessels and fishing with dynamite (Bertram and Bertram 1970a,b; Silas and Bastian Fernando 1985). The meat of dugongs continues to be valued highly in both southeast

[9] This section was prepared by the editors from published sources, unpublished data compiled by Leatherwood from various sources and data contained in the NARA reports to UNEP (Anonymous 1986a,b; 1987a, b).

Table 13. Sizes (in cm) of some small cetaceans landed at Trincomalee, Sri Lanka, 1985-1986 (Source: W.P. Prematunga, NARA).

Species	SEX	1985				1986				TOTAL			
		N	Range	$\bar{X}$	SD	N	Range	$\bar{X}$	SD	N	Range	$\bar{X}$	SD
Spinner dolphin S.l.	M F	72 30	89.1 - 182.1 95.5 - 183.4	149.7 142.5	28.38 27.34	43 25	112.1 - 199.9 93 - 191	152.6 152.9	26.5 27.7	115 55	89.1 - 199.9 93 - 191	150.8 147.2	27.6 27.8
Spotted dolphin S.a.	M F	6 8	87.9 - 213.9 82.8 - 163	158.3 109.33	54.9 24.2	23 20	96.8 - 197.4 98.1 - 203.8	154.4 136.5	32.5 32.73	29 28	87.9 - 213.9 82.8 - 203.8	155.2 128.8	37.1 32.6
Striped dolphin S.c.	M F	11 12	99.3 - 210.1 99.3 - 211.4	141.8 136.4	40.8 39.0	4 4	140.1 - 208.9 122.3 - 170.6	171 146.8	31.7 20.3	15 16	99.3 - 210.1 99.3 - 211.4	149.6 139.0	39.8 34.9
Bottlenose dolphin T.t.	M F	3 8	131.2 - 262.3 129.9 - 264.9	212.2 187.5	70.8 57.9	6 3	127.4 - 242 159.2 - 264.9	176.4 217.8	45.7 53.8	9 11	127.4 - 262.3 129.9 - 264.9	188.3 195.8	53.7 55.9
Risso's dolphin G.g.	M F	19 18	149 - 270.0 86.6 - 292.9	205.2 175.7	34.9 44.9	9 4	166.8 - 224.1 168.1 - 184.7	190.9 179.9	19.9 7.9	28 22	149 - 270 86.6 - 292.9	200.6 176.4	31.2 40.6
Rough-toothed dolphin S.b.	M F					2	165.6 - 222.9	-	-	2	165.6 - 222.9	-	-
False killer whale P.c.	M F					1 1	-	150.3 206.3					
Pygmy killer whale F.a.	M F	3 6	117.2 - 170.6 95.3 - 222.6	143.9 181.2	26.7 53.1	4 3	95.5 - 206.3 132.4 - 192.4	151.2 160.9	45.3 30.0	7 9	95.5 - 206.3 95.3 - 222.6	148.1 174.4	35.8 45.7
Pygmy sperm whale K.b.	M F	1 1	-	143.9 216.5	-								
Dwarf sperm whale K.s.	M F	6 5	109.5 - 157.9 122.3 - 211.4	137.1 175.3	20.8 34.0								

India and Sri Lanka, so any animals taken, whether deliberately or incidentally, are likely to be used for human food.

Little new information about the dugong's status in Sri Lanka has come to light since the ban on their direct capture came into force in 1970 (Bertram and Bertram 1970 a,b). The purpose of this section is to record data obtained since 1970. There has been no systematic or sustained effort to study either the live dugong population or the dugong fishery in Sri Lanka since the Bertrams' visit in 1970, so this report is necessarily incomplete in many respects. Leatherwood made 8 visits to Sri Lanka during the years 1982-1986 for periods totaling about 4 1/2 months. Although most of his work centered on investigation of the cetacean fishery, every opportunity was taken to inquire about dugongs. He also organized and conducted a brief aerial survey covering a portion of known dugong habitat off northwest Sri Lanka and an overland expedition, with Peter Lagendyk of the World Wildlife Fund Netherlands, Michael and Regina Santerre of NARA and Martha Smythe of the S/RV *Tulip* crew, to examine specimens and interview fishermen at fish-landing sites in Trincomalee, Mulativu, Jaffna, Puttalam and Mannar and associated smaller villages during March 1983 (Leatherwood *et al.* 1983). Leatherwood's Sri Lanka collaborators assisted in his research and continued to collect information during his absence through 1986. We are especially indebted to Ameen Afzal, Rohan Gunaratna, W.P. Mahendra and P.B. Karunaratne for providing useful information on dugongs.

Dugong Names in Sri Lanka

The Sinhala name for the dugong is *mudu uru*. The Tamil names are *kandal pandi* (Anonymous 1970), *orgil* and *avuliya*, the last referring to the fact that the animal "feeds with mammary glands".

Dugong Distribution in Sri Lanka

Recently-published range maps (Husar 1978; Nishiwaki *et al.* 1979; Jones 1981; Nishiwaki and Marsh 1985) show large hiatuses in the dugong's historic and current distribution in the Bay of Bengal and Arabian Sea, such that the Indo-Sri Lankan population is probably isolated. However, it must be borne in mind that there has been little scientific investigation of potential dugong habitats along intervening stretches of coast. There is no published morphological or biochemical evidence of differences between stocks of dugongs.

Although they have not been collated in any systematic way previously, there appear to be enough bits of information scattered in the literature to demonstrate that dugongs formerly occurred at least sporadically along most of the Sri Lankan coastline where suitable habitat exists (or existed). Arab and Greek seamen had watched dugongs in the seas off Mannar in ancient times (Tennant 1859; Rasanayagam and Mudaliyar 1926). Megasthenes recorded the existence of a creature "with the aspects of a woman" in the ocean near Taprobane. Tennant (1859:557) further reported that a male and a female were captured at Mannar in 1560 and carried to Goa, where they were dissected by Demas Bosquez, and that a specimen killed at Mannar examined by him at Colombo and then sent to the Museum of Natural History in Belfast in 1847 was 7 ft. long. All sources seem to agree that dugongs are (and were historically) especially common along the north and northwest coasts. The area from the

Jaffna Peninsula south to Kalpitiya and including Puttalam Lagoon has been regarded as the principal center of abundance (Figure 18) (Tennant 1859; Nevill 1885; Millett 1914; Phillips 1927). Husar (1978) claimed that dugongs had been extirpated from the southwest coast, on the authority of Deraniyagala (1965a; also see 1965b), who stated:

> "The dugong... once inhabited most bays, estuaries and lagoons and its tushes [tusks?] were often available, while its flesh was on sale regularly. Today it is restricted to Dutch and Portugal bays, the sea around the islands to the north west of Ceylon, and possibly to one or two lagoons on the east coast that are not visited by fishermen."

In 1970 Bertram and Bertram believed that most of Sri Lanka's remaining dugongs were in the northwest, between Jaffna and Puttalam, and that they were "virtually absent" from the south coast.

There is some literature to support Deraniyagala's statement concerning the regular presence of dugongs along the east coast. During the early twentieth century they were frequently caught in the shallow lagoons near Trincomalee (Millett 1914:85). In 1887 dugongs reputedly were present year-round off Batticaloa toward Vendeloos Bay. They were caught occasionally in the outlet of Batticaloa Lake, and "strays" were taken near Dondra and Aratura (Nevill 1885). Jones (1981: figure 1) shows them as occurring along the east coast south of Batticaloa (see Figure 2).

A dugong was taken in 1883 at Matara, where dugongs were "almost unknown" (Haly 1884).

Discussions with local people provided us with some rudimentary information on the dugong's recent status around Sri Lanka (Table 14).

Seasonal Movements

In at least one area of Australia (Shark Bay) dugongs migrate seasonally in response to changing water temperatures and foraging opportunities (Anderson 1986). Jones (1980, 1983) has stated his impression that in the Palk Bay-Gulf of Mannar region dugongs move seasonally in response to the effects on seagrasses of storm systems associated with monsoons. Such movements, according to Jones, could involve passage across Palk Bay where the sea is uniformly shallow; in the deeper Gulf of Mannar dugongs would likely follow the edge of the shallow (50m) shelf, the coast or the reef system forming Adam's Bridge. Fishermen interviewed in Mannar in March 1983 felt that dugongs sometimes moved to the deep sea and that this accounted for the fact that they were present in the Mannar area only seasonally (Leatherwood journal, February-March 1983). This belief was communicated to N.W. Mohammed Mohideen of NARA, who reported from his experience in the Mannar area that much of the population of dugongs migrated, perhaps as far as India, between October and January, as few dugongs are seen off Sri Lanka during these months (personal communication, May 1984). Knowledge of the nature and timing of dugong movements in the Sri Lankan region remains in a primitive state.

Figure 18. Sri Lanka, showing places cited in the dugong account.

Table 14. Recent (post-1960) information on dugongs from various parts of Sri Lanka, arranged roughly south to north.

Location	Comments (Source in italics)
Dikwella	2 taken in fishing nets, early 1970s; 1 released alive. *W.P. Mahendra, NARA, 1 Feb 1986*
Galle	1 washed shore, 1960s. *W.P. Mahendra, NARA, 1 Feb 1986*
Weligama	Sometimes present Oct-Dec in seagrass beds southeast of large bay at Galle. *Leatherwood, unpublished, 25 May 1985*
Kudawella	2 taken in net 2-5 miles from shore, Jun 1962; one a lactating female. *W.P. Mahendra, report to NARA, Jan 1986; A. Ameen, report to NARA, Jan 1986*
Karainagar	Absent from this area. *Leatherwood, unpublished*
Kurinjampitiya	Last seen mid 1970s. *Leatherwood, unpublished*
Athtal	Last seen late 1970s. *Leatherwood, unpublished*
Palliawatta	2 brought ashore about 1981, one 2500 lbs, one 3000 lbs. *W. Christy Fernando*
Islands of : Thuchuchimunai, Iluppanduwa,Mukkalui, Vellae, Palliyawatta, Battalangunduwa and Punchigunduwa; Kalpitiya area; near Karadivu, Palugahaturai and Pukkulama	Seen occasionally, mid 1980s. *DFEO reports, Ministry of Fisheries*
South end of Wilpattu National Sanctuary	1 taken about end 1984 or early 1985. *R. Gunaratna, personal communication*
Mannar	Female and calf taken in gillnet about Dec 1982. *Leatherwood, unpublished*
St. Anthony's	2 or 3 taken in Jan 1983. *Leatherwood, unpublished*
South Bar	A 3ft calf seen at sea in Apr 1983. *N.M. Mohammed Mohideen, NARA, 15 March 1984*
Silvaturai	A female taken in Feb 1986 was slaughtered and placed on sale at Kandakuliya in Feb/Mar as "dried fish". *Leatherwood journal, March 1986.*
Jaffna area	1 taken in fishing net, 1 Jun 1985, held 2 days in turtle pen, then butchered for food. *P.B. Kuranaratne (fide N. Obeysekera)*
Myliddy	Very rare, not seen since 1979 or 1980. *Leatherwood et al. (1983)*
Poliyandi	As recently as 1983, were still seeing dugongs "occasionally" and taking one every 5 or 6 months accidentally in gillnets. *Leatherwood et al. (1983)*

Some data, in addition to those published by Norris (1960), are available on the monthly catches in north and northwest Sri Lanka. In Table 15 and Figure 19 we have combined these data with those of Norris.

Estimation of Catches

The exploitation of dugongs in Sri Lanka dates to ancient times. Archaeological excavations in 1982 at Manthota (Mantai), an ancient seaport in the Mannar district, revealed fragments of dugong bones, including cut and broken skulls, in strata estimated to represent approx. 3,000 years B.P. (Cyran Deraniyagala, personal communication to Rohan Gunaratna). Associated finds (mostly mesolithic stone tools) and the nature of the fragmentation of the bones suggest that dugongs were killed and butchered during this time.

In the 1880s, 40-50 dugongs were caught at Mannar in a season (Haly 1884). Apart from anecdotal accounts indicating that dugongs continued to be hunted and netted regularly (e.g. Millett 1914), we are aware of no meaningful estimate of the annual catch until the 1950s.

In the years 1955-1960, dugong meat was routinely served at a Catholic festival at Maduru Road (Moru) between 2 July and 15 August. The animals were caught near Mannar and Jaffna, transported to Moru in wet sacks and kept alive until butchering (P.B. Karunaratne, pers. comm., 6 June 1983). As recently as 1983, dugong meat figured in an annual October festival at the Catholic church at Silavaturai (Leatherwood journal, March 1983). No details were available.

Approximately 100-150 dugongs were estimated as taken per year in Mannar district during 1957-1959 (Bertram and Bertram 1970a,b), based on the catch data presented by Norris (1960). In early 1970 the Bertrams estimated, based on interviews with fishermen, local officials and others at 70 coastal sites, that no more than 100-150 dugongs were taken annually throughout Sri Lanka. Most of this catch was made "inadvertently in nets set for fish." Jones (1981) stated that catches were decreasing during the second half of the 1970s from the 100-150 level of 1970, but he gave no details explaining the reasons for this trend. In his 1983 paper Jones referred to the continuing strong demand for and high price of dugong meat in Jaffna and Mannar, and he noted the virtual absence of enforcement of the ban on its sale in Sri Lanka. Jones (1980: 236) claimed that Sri Lankan fishermen still took "special interest in catching any [dugongs] they could find." This situation continued through at least March 1985 (Leatherwood unpubl. data).

Josephs (1986) wrote that dugongs were "an ancient delicacy not often seen in recent decades." Already by 1970 (and perhaps well before then) some cetacean meat was being marketed as dugong (Bertram and Bertram 1970a,b), although it was unclear whether this was done out of ignorance or as a deliberate attempt at disguise. Today, cetacean meat is often, but not always, marketed as dugong meat in at least Beruwala (Ilangakoon, 17 March 1986 report), Galle (Ilangakoon, 31 October 1985 report) and Colombo (Ilangakoon, 7 February 1986 report). At Chilaw cetacean meat is sold for what it is, not, as in the southern fishing areas, as dugong (Ilangakoon, 7 February 1986 report). Evidently the vendor can expect a much higher price for dugong than for cetacean meat. For example, a door-to-door salesman was selling "dugong" meat in the Colombo suburbs of Kothalawala/Kaduwela in December 1985

Table 15. Monthly catches of dugongs for the years 1953, 1957-59. Data from Norris (1960) and unpublished from Ceylon administrative report (1953 data).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Vankalai	8	27	51	45	5	3	25	-	-	-	3	1
Iluppaikadavai	-	-	-	-	-	3	18	3	1	-	-	-
Vidattaltivu	1	-	1	1	-	1	1	1	-	-	-	-
Marichukaddi	3	8	2	1	2	-	6	3	-	4	3	2
Karaitivu	-	1	-	-	-	2	2	-	1	-	-	2
Pesalai	-	-	1	-	-	-	1	-	1	5	-	-
Achchankulam	-	-	-	-	1	2	6	6	3	-	-	2
Arippu	-	-	-	-	2	2	-	2	-	-	2	-
Iranaitivu	-	1	-	-	3	8	9	7	8	6	-	1
Kondachohukuda	-	-	-	-	-	7	-	6	3	-	4	-
Silvathurai	-	1	-	-	-	4	-	-	-	-	4	-
Vellankulam	25 between April and September											
Talaimannar	-	1	2	3	-	-	4	3	1	-	-	-
Mundampiddi/Munampiddy	-	-	-	-	-	-	-	1	-	-	1	-
Puttalam	-	-	-	-	-	-	-	-	2	-	-	-
Illupaladai	-	-	-	-	-	-	-	-	-	-	1	-
Mandativu	-	-	1	-	1	-	-	-	-	-	-	1
Karaigoor	-	-	2	-	1	-	-	-	-	-	-	1
Kankalai	-	4	-	-	-	-	-	-	-	-	-	-
Kovilmunai	-	1	-	-	-	-	-	-	-	-	-	-
Serakuli	-	-	-	-	2	-	-	-	-	-	-	-
Illupanduwa	-	-	-	-	-	-	-	-	-	5	-	-
TOTALS	12	44	60	50	17	32	72	32	20	20	18	10

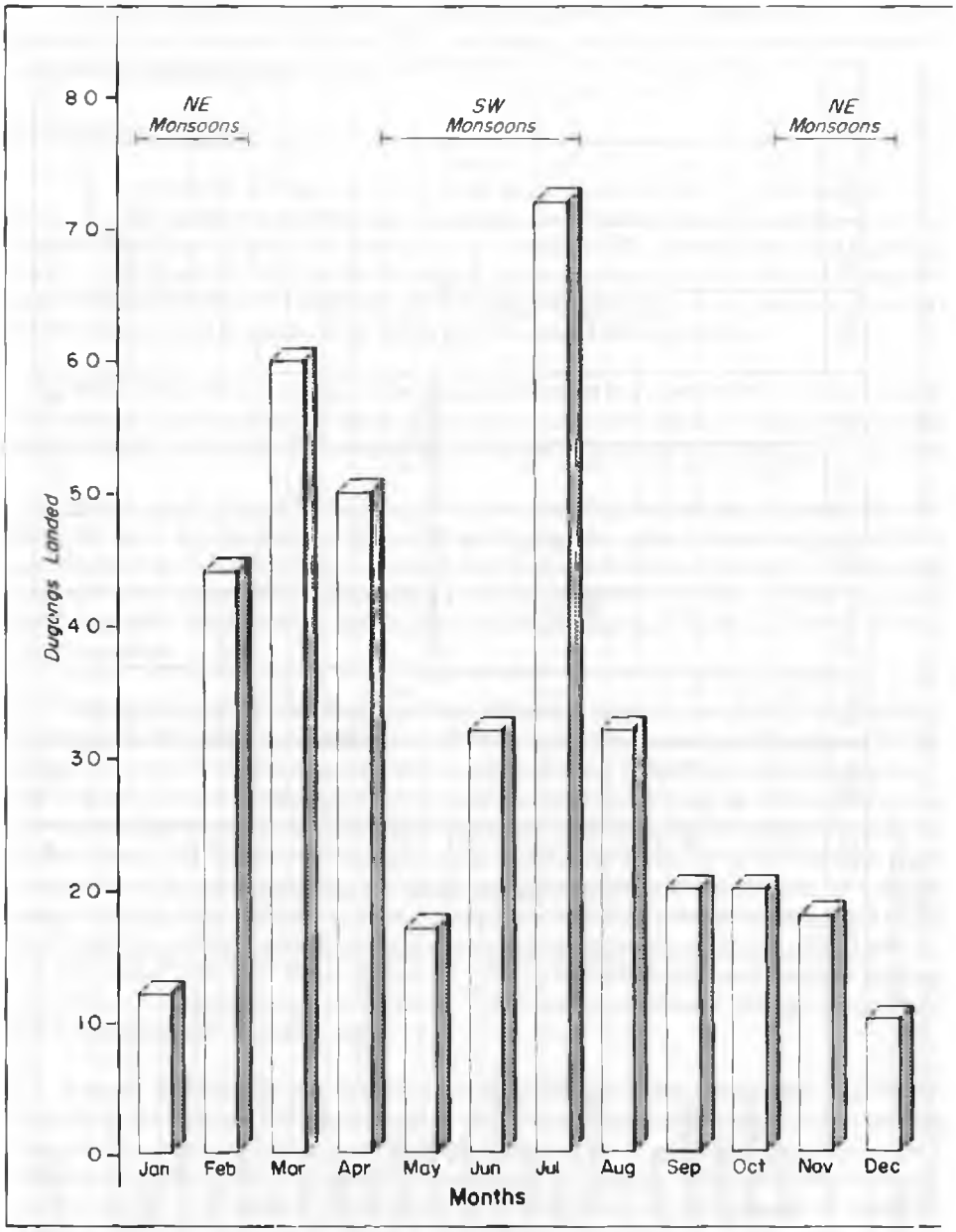


Figure 19. Monthly trends in the catches of dugongs (see Table 15).

for 35 rupees per kg, which is much higher than the 16-20 rupees per kg price of meat acknowledged to be from cetaceans (Ilangakoon, 7 February 1986 report). The salesmen peddling cetacean meat as dugong meat do so knowingly. Oddly, although some of those who purchase the meat are under the impression that it really is from a dugong, some are aware of the fraud but buy it anyway (Ilangakoon, 31 October 1985 and 7 February 1986 reports). The apparently widespread practice of selling cetacean meat as dugong meat signals a need for great care in evaluating dugong catch information from Sri Lanka.

Leatherwood was assured during interviews with people at Talaimannar and Mannar, 3 March 1983 (M.S. Perera and S. Ramani, personal communications), that dugongs were still taken there at a rate of about one per month. A mother and calf had been caught about a month before his visit. They reported that at least some of the meat was packed in ice and sent to Colombo. In November 1985, W.P. Mahendra found dugong meat for sale in a small market on the north side of Colombo town (pers. comm., 2 Feb 1986). A female dugong was taken near Silavaturai and brought to Kandukiliya for sale in February 1986. Its dried meat was still available for sale in early March (Ravi Borasinghe, personal communication to Ameen Afzal).

At a Sinhalese migratory fishing camp in Mannar, Leatherwood learned on 3 March 1983 that dugongs were still taken by harpoon, net and dynamite. One had been taken by net the week before; three, including a calf of about 60 pounds, in the month prior. The fishermen try to capture dugongs whenever they encounter them, even though they are aware that doing so is illegal and that the law is enforced to some extent. Most of the meat is shipped on ice to Colombo. The dockside value of dugong meat in 1983 was 10 rupees per pound, and it was sold at the market in Negombo for 25 rupees per pound. Fishermen in Jaffna, Mannar and Puttalam told Leatherwood they often kept the flippers and other less desirable parts but sold the rest as it was too valuable to keep (Leatherwood *et al.* 1983). There were said to be many fishing camps on the island in Puttalam Lagoon where dugongs and dolphins were taken regularly. However, one informant at Dikwella (*fide* W.P. Mahendra) claimed that dugongs no longer inhabited Puttalam Lagoon, speculating that they had been killed off or driven away by the practice of dynamiting fish. The same person stated that dugong meat had been available in a shop near his home in approximately November 1985 (*fide* W.P. Mahendra). Joseph de Livero, owner of the trawlers operating in the Puttalam area, reiterated the point that dugongs, found formerly in some abundance near Kondakuliya, were now absent from that area (Leatherwood journal, 1 Aug. 1985).

Gunaratna (1985) determined that some catching of dugongs continued into the mid 1980s in northwest Sri Lanka (Table 14.). On average, he estimated that one animal was taken every two months. However, the area to which this estimate applied was not specified; nor was the manner of taking (e.g. directly by harpoon or deliberate netting, accidentally in gillnets etc.).

Museum Specimens

The earliest Sri Lankan dugong specimen we are aware of in any institution is a 7-ft. individual collected at Mannar and sent to the Museum of Natural History in Belfast in 1847 (Tennant 1859). Wiley (1905:38-40) reported that "the aquatic mammals are represented by an excellent set of dugongs, male, female, young and a skeleton. The female specimen exhibited is 10 ft. long; it was captured at Kayta near Jaffna."

An effort was made to document and curate dugong specimens in Sri Lanka museums. The basic information is given in Appendix B1. Other materials known to have been collected, including some cited in literature, seem to have been lost, probably due to bungled transfers or curatorial mishandling. Apparently, also, extensive notes on the species were burned when the National Museum was officially turned over to the University, as no one showed any interest (P.B. Karunanatne pers. comm., 3 June 1985).

Current Population Size

It is widely acknowledged that the dugong population off southern India and northern Sri Lanka is much diminished from levels of the late nineteenth and early twentieth centuries. Most of this reduction is attributed to exploitation. However, Jones (1980) implicated the cyclone of December 1954 as a factor contributing to the dugong's decline in Palk Bay. The catastrophic impact of major storms on dugongs is well documented (Marsh 1989), and periodic mass mortality from natural causes may take on special significance when the dugong population has already been fragmented and reduced by over-exploitation.

H. Jayewardene of NARA stated in 1985 that the dugong population centered in Sri Lankan portions of the northern Gulf of Mannar, Portugal Bay and Palk Bay contained less than 100 individuals. However, the basis for this estimate was not given.

In two days of aerial and vessel searches in 1981 covering portions of Palk Bay, the Gulf of Mannar and Puttalam Lagoon, only two dugongs were observed: one southwest of Mannar and one north of Kudiremalai Point (Chandina de Alwis, personal communication to H. Jayewardene, 24 May 1985). Extensive shipboard searches in April 1982 in the Strait of Malacca, Andaman Sea and Bay of Bengal, including some shallow coastal areas of suitable dugong habitat, resulted in no dugong sightings (Leatherwood *et al.* 1983, 1984).

An aerial survey on 4 March 1983 (supported by the World Wildlife Fund Netherlands) covered much of what was qualitatively judged to be prime dugong habitat in Palk Bay and south along the northwest coast of Sri Lanka to Chilaw, including Puttalam Lagoon (Leatherwood *et al.* 1983; 1984: fig. 3, bottom). It is unlikely that the negative results of this survey (zero sightings of dugongs) could be explained by chance factors alone. The sea state was calm and the water clear and shallow, with abundant seagrasses. Numerous sightings were made in this area of dolphins and Bryde's whales, demonstrating the adequacy of sighting conditions for spotting sea mammals generally. The bright sand bottom and clear waters made turtles, sharks and rays clearly visible. In similar conditions off northern Australia where some thousands of dugongs are known to occur, dugongs and their sediment plumes are detected with relative ease (Anderson 1982, 1986), although the animals may remain submerged longer, and thus be more difficult to detect, in deep water (10m+) than in shallow water (Marsh and Saalfeld 1988). Leatherwood *et al.* (1984) concluded from the March 1983 survey that few if any dugongs were present in the species' prime areas of past occurrence in Sri Lankan waters.

The Need for a Dugong Sanctuary

The need for dugong sanctuaries in India and Sri Lanka has been recognized for many years (Jonklaas 1961; Jones 1980). However, in spite of repeated recommendations toward

such an end, no concrete measures have been taken in either country. A proposal for preserving dugongs in the Gulf of Mannar and Palk Bay areas was made by NARA, in association with the Department of Wild Life Conservation, to the Symposium on Marine Mammals of the Indian Ocean held in Colombo 22-25 February 1983 (see Appendix A). It was proposed that live dugongs be captured and placed in "large pen like enclosures to be constructed in suitable coastal locations." The most promising site was considered the mouth of Puttalam Lagoon adjacent to Kalpitiya on the west coast. The report of the dugong subcommittee of the symposium recommended that research, public education and improved enforcement of protection laws accompany efforts to set aside major area as reserves. It expressed the hope that adequate measures could be taken to prevent the dugong's extirpation in the Indo-Sri Lankan region without resort to a live-capture and captive-maintenance program but acknowledged that such a program might prove necessary.

Sri Lanka's Centre for Research on Indian Ocean Marine Mammals further proposed in 1985 that an area centered at the mouth of Puttalam Lagoon and encompassing coastal waters bordering Wilpattu National Sanctuary on the east, latitude 8°N on the north and longitude 79°05'E on the west, be declared a dugong reserve. As a marine extension of an established park, this proposed reserve was viewed as the best way of implementing some effective protection of wild dugongs quickly.

To our knowledge, no concrete action has been taken towards effecting any of the recommendations or proposals described above.

The usual long list of desiderata that accompanies every proposal for a wildlife sanctuary has been drawn up: detailed studies of habitat characteristics; investigations of the animals' home ranges, seasonal movements, population structure, energy requirements etc.; planning for development of an infrastructure of research and education facilities; evaluation of the likely socioeconomic impacts of the sanctuary; policing of human activities within the sanctuary; and of course the need for outside financial and technical help in getting the project off the ground. Any initiative presupposes a certain degree of political stability in the region and at least a modicum of grass-roots tolerance, if not outright support.

In a country torn by civil unrest, as Sri Lanka has been for the past five years, with some areas, particularly those bordering prime dugong habitat, facing chronic problems of poverty, malnutrition and human population growth, dugong conservation inevitably languishes rather far down on the government's agenda. This is not to say there is a lack of support for conservation principles in educated circles. Many Sri Lankans are deeply concerned about the way their island nation's natural heritage is being squandered. Unfortunately, it seems unlikely that the dugong in this region can survive in the long term without some kind of dedicated outside interest and commitment.

Annotated Checklist of Sri Lanka's Marine Mammals[10]

The NARA/UNEP project outline originally included a subtask on systematics and biology. Museum specimens were inventoried and many available skulls measured and photographed (see Appendix B1). Data were collected for a variety of specimens taken in fisheries

[10]Prepared by the editors.

around the country (see Appendix B2). Those data have not been properly examined but remain archived within the country. We urge that programs be established to study these materials, preferably with Sri Lankan graduate students working under Sri Lankan graduate advisors but with outside experts serving on their committees.

Three recent publications provide extensive information on cetaceans occurring in Sri Lankan waters. Following the recommendations of the Zeist and Colombo workshops, Leatherwood (1986) prepared a catalogue of information available (sightings, strandings, fisheries by-catches and specimens) on cetaceans of the Indian Ocean Sanctuary. Alling (1986) published records of sightings made from the S/RV *Tulip* in Sri Lankan waters, especially around Trincomalee. Taking into account the material in Leatherwood (1986) and Alling (1986), de Silva (1987) published a compilation of cetacean records from the north Indian Ocean. The "checklist" presented here briefly summarizes the information in de Silva (1987) and makes appropriate additions, clarifications and corrections based on new (or freshly interpreted old) data. Except in cases where a particular reference is relevant to the discussion at hand, we have not repeated the sources documented and cited by de Silva.

Sperm Whale (Figure 20 a,b)

Present during much of the year in Sri Lankan waters, especially along and seaward of the 1000m depth contour. Sightings off south coast in May (Gunaratna *et al.* 1985); off Colombo in November (this document). Specimen, 20ft, Negombo, taken in gillnet, 1-2 March 1986 (Ameen Afzal report to NARA, March 1986); calf, Negombo, taken in gillnet 40km offshore, 8 April 1986 (W.P. Mahendra).

Figure 20. W. P. Mahendra, of the NMMU, examines a sperm whale stranded at [illegible], May 1986 (a); an entangled young sperm whale landed at Negombo, 8 April 1986 (b); pygmy sperm whales, an 8ft female (background) and a 56.5-in. male (foreground), taken in a gillnet, along with yellowfin tuna, and landed at Trincomalee, July 1985 (c); and a dwarf sperm whale landed at Negombo, 15 November 1982 (d). [S. Senanayake (a,b), W.P. Prematunga (c) and M. Santerre (d)].

Figure 20 continued.

(b)

(c)

(d)

Pygmy Sperm Whale (Figure 20 c)

Present off northeast Sri Lanka at least July, August and October, and off west and southwest Sri Lanka in March, July and August as evidenced by landings of by-catches at Trincomalee 1982-1985 and Waddna and Negombo 1960-1985. All 15 records from Sri Lanka through August 1985 summarized in Chantrapornsyl *et al.* (1990). Subsequent record 9 September 1985, a 70-in. female at Kottegoda (A. Gamage and C. Mendes, September report to NARA).

Dwarf Sperm Whale (Figure 20 d)

Present off northeast Sri Lanka all months except October-January, off west and south Sri Lanka March, April, July, September, October and November, as evidenced by landings of by-catches at Trincomalee 1983-1985 and Negombo, Moratuwa, Beruwala, Galle and Kottegoda 1915-1985. All 32 records summarized in Chantrapornsyl *et al.* (1990). There are subsequent records of a 65.5-inch male at Beruwala 20 October 1985 (A. Gamage and C. Mendes, October report), and a specimen of unreported size and sex 26 May 1986 at Negombo (R. Perera report to NARA).

Southern Bottlenose Whale

De Silva (1987:508) listed the whale that stranded alive in Colombo harbor, 24 June 1939, as *Ziphius cavirostris*, citing, without comment, Deraniyagala (1945; 1965b [a reference not included in his bibliography]) as his source. Deraniyagala (1945) did in fact refer this specimen to *Z. cavirostris*. However, subsequently he (Deraniyagala 1960) "corrected" his own "error" and reassigned the specimen to *Hyperoodon planifrons*. Mead (1989:335) described Deraniyagala's (1960) identification as "clearly erroneous," although Heyning (1989) curiously failed to note (in both his text and his range map) the presence of *Z. cavirostris* in the northern Indian Ocean.

Alling (1986:392) "tentatively identified" *H. planifrons* off the east coast of Sri Lanka on two occasions, both in April. One of these sightings involved a group of 40 animals. Although her description of the whales' appearance and behavior fits the southern bottlenose whale, the lack of photographic or other tangible documentation makes it impossible to conclude with certainty that southern bottlenose whales occur in waters off Sri Lanka. As noted by Mead (1989:335), confirmed records from northwest Australia and Brazil demonstrate that *H. planifrons* enters warm temperate waters and make plausible the identification of some beaked whales in the tropical Pacific (K.C. Balcomb, pers. comm.; Leatherwood *et al.* 1982; IWC 1989a) as southern bottlenose whales. We consider as open the question of whether this species is a normal part of the cetacean fauna in the northern Indian Ocean; we will not be surprised if definite evidence that it is becomes available.

Cuvier's Beaked Whale (Figure 21 a)

Present during much of the year in Sri Lankan waters (records for January, March, April, June, July, August). See discussion under Southern Bottlenose Whale above. A single specimen was taken in a gillnet off Negombo in May 1986 (S. Senanayake *in litt.*, 7 June 1986).

(a)

(b)

(c)

Figure 21. A young Cuvier's beaked whale (identified by J.G. Mead from photographs by A. Alling) harpooned off Trincomalee and landed at the main fish market, 15 March1983 (a); an unidentified beaked whale landed at Beruwala, April 1986 (b); and Professor P. E. P. Deraniyagala collecting a specimen of a ginkgo-toothed beaked whale, 1964 [A. Alling (a), C. Mendes (b) and courtesy of National Museum (c)].

Ginkgo-toothed Beaked Whale (Figure 21 c)

The single record of a January stranding near Colombo remains the only confirmed evidence of this genus in Sri Lanka.

Other Beaked Whales, Ziphiidae (Figure 21 b)

Several ziphiids were observed at fish-landing sites or markets but not positively identified to species by NARA staff. While most or all of these may have been of one of the three species listed above, several other ziphiid species are known from elsewhere in the Indian Ocean, and their appearance in Sri Lankan waters would be unsurprising. Records: Trincomalee, 15 March 1983, 265-cm female (Alling 1983 *in litt.*, 7 June 1986); Trincomalee, 18 December 1985, 133-in. female (WPP812) taken in gillnet (W.P. Prematunga *in litt.*, 17 June 1987); Negombo, 29 April 1986, ca 15-ft., V-shaped pair of throat grooves, prominent notch between flukes, no erupted teeth but "a razor like blade which resembles teeth" (L. Perera report to NARA, 6 May 1986).

Rough-toothed Dolphin (Figure 22 h)

Not listed for Sri Lanka by de Silva (1987). New records include specimens at Beruwala (Alling 1985b) and Trincomalee (Alling 1985b; Prematunga *et al.* 1985) plus 13 other specimens from the northeast, southwest and west coasts (see Biology of Small Cetaceans for details).

Indo-Pacific Humpbacked Dolphin

The skull from Arippu, Mannar, and the adult male taken in a seine net near Egoda Uyana, Western Province, April 1934 (Colombo Mus. Spec. No. 93), remain the only specimens. Deraniyagala (1945: plate XVI) provided an excellent illustration of the latter specimen which was cast and is now displayed at the Ratnapura Museum (see Appendix B1). Leatherwood *et al.* (1984) reported a sighting from aircraft of what were probably humpbacked dolphins in Dutch Bay, Puttalam Lagoon, 5 March 1983. A coastal species probably very rare in Sri Lankan waters.

Bottlenose Dolphin (Figure 22 e)

Widely distributed and resident in Sri Lankan coastal waters. Numerous new records (see Appendix B2).

Common Dolphin (Figure 23)

Only one species is currently recognized in this genus. The validity of the species *D. tropicalis*, cited for Sri Lanka by de Silva on the basis of a specimen in the Colombo Museum (locality unspecified), is problematical. Although the common dolphin certainly occurs off Sri Lanka and may be at least seasonally abundant in some areas, we question the identification made by Lantz and Gunasekera (1955), the basis for de Silva's statement that it is abundant off Negombo and Trincomalee during the fishing season. Alling's (1986) observations (as well as the catch records - see Appendix B2) suggest that spinner, spotted and striped

dolphins are much more frequently encountered than common dolphins in both areas. Lantz and Gunasekera mentioned only common and bottlenose dolphins as being implicated in the fisheries interactions which they describe. Their failure to comment on other species suggests that their identification procedures were inadequate. New records: Trincomalee, taken in gillnet, 7 March 1987 (W.P. Prematunga *in litt.*, 17 June 1987).

Fraser's Dolphin (Figure 22 i)

Although not included among the species previously known from Sri Lanka according to de Silva's list, Fraser's dolphins were seen off Trincomalee in February 1983 (Alling 1986) and are taken at least occasionally off the northeast (1 specimen in January, Prematunga *et al.* 1985) and southeast coasts. New records include: 10 September 1985, Mirissa, 3 adult females, at least 2 of them harpooned (C. Mendes and A. Gamage, report to NARA, September 1985).

Spotted Dolphin (Figure 22 c) and Spinner Dolphin (Figure 22 a,b)

These species clearly are abundant, and probably resident, in Sri Lankan waters. The numerous records from Sri Lanka are summarized by Gilpatrick *et al.* (1987). Additional records are presented in Appendix B2.

Striped Dolphin (Figure 22 d)

Present during much of the year in Sri Lankan waters, mainly in depths of 1000m or more (see Alling 1986). The numerous records from Sri Lanka are summarized by Wilson *et al.* (1987). Additional records are presented in Appendix B2.

Risso's Dolphin (Figure 22 f,g)

Common in Sri Lankan waters during much of the year, possibly year-round. New records are summarized in Kruse *et al.* (1990).

Melon-headed Whale (Figure 24 c)

De Silva had only a skull from Palk Strait in the Calcutta Museum as evidence for this species off Sri Lanka. New records are discussed by Leatherwood *et al.* (1990).

Short-finned Pilot Whale

Although probably fairly common along the shelf edge and possibly resident, de Silva had only a fossil vertebra from near Colombo as evidence for the species off Sri Lanka. Alling (1986) described three sightings off the northeast coast. New records are discussed by Leatherwood *et al.* (1990).

Pygmy Killer Whale (Figure 24 b)

Present in small numbers at least off northeast and southwest coasts. New records are summarized by Leatherwood *et al.* (1990).

(a)

(b)

(c)

(d)

Figure 22. *Most of the dolphin species reported for Sri Lanka: spinner dolphins at 7°34'N, 79°21'E, 7 March 1982 (a) and at Negombo, 15 September 1985 (b); a spotted dolphin at Beruwala, 8 August 1985 (c); a striped dolphin at Beruwala, 4 June 1985 (d); a bottlenose dolphin (e) and Risso's dolphin (f,g) at Beruwala, 8 August 1985; a rough-toothed dolphin (h) and a Fraser's dolphin (i) at Mirissa, 15 and 14 October 1985, respectively. [A. Alling courtesy WWF (a), S. Senanayake (b,d), S. Leatherwood (c,e,f,g), C. Mendes (h) and A. Gamage (i)].*

Figure 22 continued.

(e)

(f)

(g)

Figure 22 continued.

(h)

(i)

Figure 23. *The skull of a common dolphin, referred to by de Silva (1987) as* Delphinus tropicalis, *at the National Museum, Colombo.*

Figure 24. Gillnet-caught adult and calf false killer whales landed at Trincomalee, 10 April 1986 (a); a young pygmy killer whale landed at Beruwala, 6 August 1985 (b); and the head of a melon-headed whale landed at Pitipana, Negombo, 4 July 1985 (c). The smaller "blackfish" are known as makara mulla, *or dragon dolphin. [W.P. Prematunga (a), W.P. Mahendra (b) and C. Mendes (c)].*

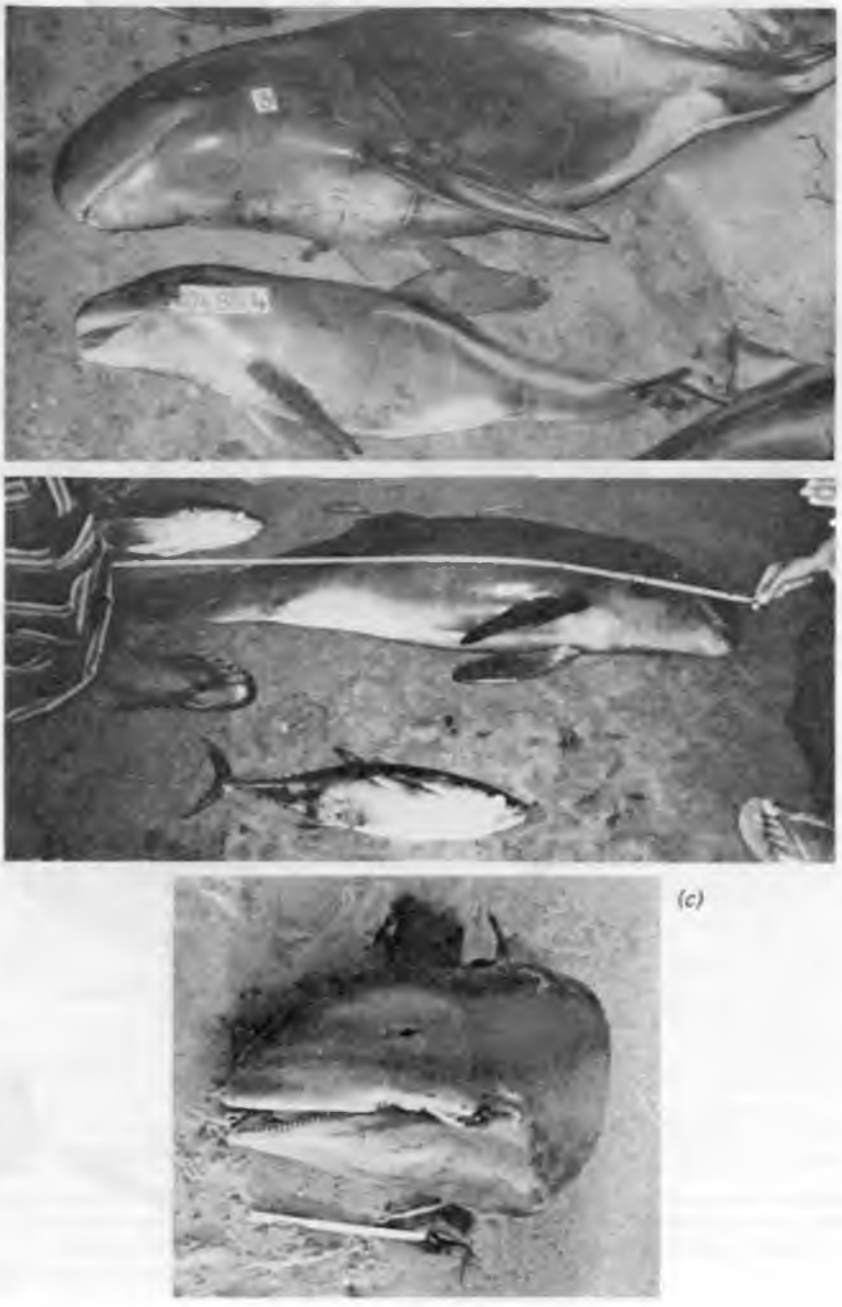


Figure 25. Three views of an 111-in. female killer whale landed at Negombo, 8 April 1986. (A. Ilangakoon).

Figure 26. *Photographs of a finless porpoise labelled simply "from Sri Lanka". Judging from its length, this appears to be the 670mm specimen noted by de Silva (1987) to have been collected 20 March 1970 on Wadge Bank, and now in alcohol at the Museum of Comparative Zoology, Harvard University. (Courtesy of National Museum, Colombo).*

False Killer Whale (Figure 24 a)

Widely distributed during much of the year in Sri Lankan waters. New records are summarized by Leatherwood *et al.* (1990).

Killer Whale (Figure 25)

May be rare in Sri Lankan waters. De Silva noted only two records, both from 19th-century sources and pertaining to the west coast. New records: entangled specimen in the market at Kirinda, 1982, and a 7-8m specimen at Kottegoda, 14 July 1983, entangled in a net (L. Joseph pers. comm. to Leatherwood); a 111-inch female, taken in a gillnet about 40 km southwest of Negombo and landed at Negombo, 8 April 1986 (Ilangakoon April report to NARA). Fishermen off the south coast report seeing killer whales 25 miles offshore on occasion (S. Senanayake, 15 June 1985 report to NARA).

Finless Porpoise (Figure 26)

Probably very rare in Sri Lankan waters. The specimen from Wadge Bank, March 1970, mentioned by de Silva is the only record.

Blue Whale (Figure 27 a)

In spite of the possibility that some stranding records in the literature are of misidentified fin whales, the blue whale is known to be one of the more common mysticetes in Sri Lankan waters. The temporal spread of sightings and strandings suggests that there may be a resident population off the northeast coast (Gordon and Alling 1987). Two subspecies are widely recognized, *B. musculus musculus* and *B. musculus brevicauda*, the latter generally called the

(a)

***Figure 27**. Some of the baleen whales known from Sri Lankan waters: blue whale off Trincomalee, 14 March 1984 (a); baleen from a young fin whale (estimated by the fisherman to have been about 20-22ft. long) killed in a 4.5-in. mesh gillnet and landed at Pitipana, Negombo, 4 August 1985 (b, c); and a Bryde's whale off Foul Point, Kevuliya, 12 March 1984 (d). [S. Leatherwood (a-c) and P.A. Folkens (d)].*

Figure 27 continued.

(b)

(c)

(d)

pygmy blue whale (Ichihara 1966). The identity of the Sri Lankan animals, possibly *brevicauda*, has not been established.

Fin Whale (Figure 27 b,c)

There are relatively few records of fin whales from Sri Lankan waters, particularly in comparison to blue whales. The strandings listed by de Silva are for February (1), June (2) and August (3) and from only the west and north coasts. New record: a 25-ft. animal taken in a gillnet off Negombo, 4 August 1985 (Leatherwood journal, August 1985).

Bryde's Whale (Figure 27 d)

A tropical species present in coastal and offshore waters, probably year-round. Observed by NARA staff during cruises off west and southwest coasts.

Minke Whale

Present, in low density, during much of the year. New record: single sighting inside Clappenberg Bay, 3 March 1983 (Leatherwood *et al.* 1984).

Humpback Whale

Records from Sri Lanka with dates are for January and February, the austral summer; so, all members of this population may not make an annual summer feeding migration to the Antarctic (Whitehead 1985; Reeves *et al.* 1990). Humpback songs have been recorded in the Gulf of Mannar in February (Whitehead 1985).

Dugong (Figure 28)

Numerous records and specimens from Sri Lanka, primarily the Gulf of Mannar and Palk Bay regions. Indo-Sri Lankan stock in immediate jeopardy of extirpation.

Figure 28. A dugong specimen at the National Museum, Colombo. Even though the Indo-Sri Lankan stock is in immediate danger of extirpation, it is poorly represented in institutional collections. (courtesy National Museum).

Information Network

The coordinator of the information network was responsible for soliciting from the public information on sightings and strandings of marine mammals and for assisting members of other subprojects in soliciting and assembling details on fishing-related mortalities and marketing of cetaceans (and dugongs) by site. This was accomplished by distributing forms to would-be participants, discussing the importance and approach of the programs with them, and serving as a clearinghouse for all queries and reports received. This last task included communicating routinely with at least the most active participants in the network to improve their observations and reporting and to sustain their interest and enthusiasm. The information network was not established as an end in itself but rather to provide information useful to other elements of the research program and to provide contacts for the public-awareness efforts.

Basic information packets, including data forms, were prepared in English, some also in Sinhala and Tamil.

The sighting form was prepared by the NMMU from forms used in the eastern North Pacific (Leatherwood *et al.* 1982), modified with help of the Director (Marine) of the Ministry of Fisheries. The form requested date, time, position, information on weather and sea state, species seen, number of individuals, markings used to make the identification and name and address of the observer(s). It also provided a space for sketching the features the observer considered important in the identification.

Sighting forms were distributed to naval personnel, lighthouse keepers and staff, aviators, employees of beach-front hotels, the Ministry of Fisheries, which through the DFEOs distributed them to fishermen in all 14 fishing regions, fish merchants, scientists, members of conservation organizations (especially coastal residents of the Wildlife and Nature Protection Society and the Life Savers Association of Sri Lanka, which dispatched them to members for distribution in all 12 of the coastal areas they serve) and interested lay-persons.

Sighting reports were scarce. One likely reason is that fishermen, the people most likely to be in a position to observe cetaceans (there is little recreational boating in Sri Lanka), were often reluctant to reveal facts which might lead to restrictions on their net or harpoon fisheries for these animals. Forms that were returned often contained vague or confusing descriptions, making identifications difficult or impossible. Further, fishermen along the south and southwest coasts did not generally seem to understand the importance of logging species of animals. Instead, they offered general, generic statements about seeing dolphins or whales in certain areas over long periods of time.

In Sri Lanka, as elsewhere, strandings can be an important source of information and specimens. Records of strandings in early documents of the Colombo Museum, for example, provided the first evidence of the occurrence of blue and fin whales off Sri Lanka (Haly 1887:10). Even earlier documents provided evidence of whaling activity off shore. For example, Tennant (1859) reported that whales were "... captured within sight of Colombo and more than once carcasses, after having been flinched by the whalers, have floated ashore near the lighthouse...." During the NARA/UNEP program several stranding events were re-

ported by the public. However, there was a general shortage of stranding records returned under the program, probably reflecting (a) the inaccessibility of much of the coast, (b) the generally poor communication systems in some areas, (c) the rapidity with which carcasses deteriorate in the tropical climate and (d) the ignorance of many coastal residents about the identity of marine mammals and the importance of reporting them.

To enhance their usefulness, stranding forms were prepared at two levels of detail. The first, for persons unfamiliar with marine mammals, requested a minimum of detail. The second, for participants with more knowledge about marine mammals, requested more detailed data, following standard procedures for measuring and recording data [Norris (1961) for cetaceans and Paul K. Anderson (1986 unpublished) for dugongs].

The fishing information forms requested a variety of information on boat types, owners and operators, fishing effort by time and area, and catches and market values of marine mammals and target species. These forms were placed primarily with DFEOs, owners and senior captains of selected vessels, and a few fishermen who agreed to serve as volunteer observers. Their distribution was somewhat more restricted than other forms, and both placement and follow-up were coordinated with the NARA officers studying mortality of marine mammals in fisheries.

The earliest tangible evidence that the then-fledgling information network was working was on 9 June 1985 when an informant in Galle, with the encouragement of others on the waterfront, sought out a NMMU field crew working at another fish-landing site and directed them to a false killer whale, a species he had not seen before; the crew otherwise would have missed this specimen in their work in the general area.

In general, it must be concluded that the information network served little scientific purpose, although the sense of participation given to some Sri Lankans may well have justified the effort.

Public Awareness Campaign

NARA set out to raise the awareness of Sri Lankans about marine mammals and the problems of conservation these animals face in the world generally and in Sri Lanka particularly. Some educational activities were conducted on an *ad hoc* basis during 1985 and early 1986, as indicated below. A steering committee, consisting of the following members, was established in March 1986 to direct an accelerated campaign from that point onward: Ranjan Fernando, President of the Wildlife and Nature Protection Society (WNPS), Chairman; Hiran Jayewardene, Chairman of NARA; Anton Atapattu, Director, Ministry of Fisheries; Renton de Alwis, Ceylon Tourist Board; M. M. Premaratne, Ministry of Education; S.W.K. Kotegama, Sri Lankan March for Conservation; a representative of the Young Zoologists Association, and Palitha Gunewardene, head of the NMMU Public Awareness Section. Also active from the formal inception of the program were consultant Roger Payne, visiting CSI representatives Kate O'Connell, Karen Steuer and Phillip Clapham, and NARA officers Rohan Gunaratna and Nihal de Abrew.

The philosophy of the public awareness campaign in Sri Lanka was best expressed in a communique from the steering committee to would-be participants from the media in a workshop held 26 March 1986 at the Sri Lanka Foundation Institute:

> "We...have begun a campaign to conserve our natural heritage of the rich and diverse marine mammal life, the whales and dugongs that surround us....Sri Lanka is taking a leading role in the conservation of marine mammals of the region...through participation in international organizations....At the same time, the country has balanced these international interests with the needs of the local economy and our own ecology. Unfortunately, many Sri Lankans are unaware of these facts, and inadvertently contribute to the demise and possible extinction of local species of whales, dolphins and dugongs. The most effective way of dealing with this crisis is through educating the people about the issues at stake, and creating an awareness of the need to conserve these mammals." (R. Fernando and R. Gunaratna *in litt.*, 14 March 1986).

Among the most tangible products reported for the Public Awareness Campaign were:

Before and after establishment of the formal steering committee, release of numerous articles to the press and conducting interviews for radio and television. [A NARA presentation in January 1986 was interpreted by fishermen as indicating that a new law had been passed making the killing of dolphins and sale of their meat illegal (S. Senanayake report to NARA, January 1986)].

Initiation of MERMA News, a newsletter on marine mammal activities of NARA's NMMU, published with help from CSI and WNPS.

Preparation, in cooperation with CSI, of the Sri Lankan section of a proposal to UNEP for public awareness pilot projects in Sri Lanka, Iceland and Brazil. While CSI provided some educational materials to Sri Lanka (slides, videos and a brochure), the proposal remains unfunded and the overall project unimplemented.

Joint sponsorship with CSI on 18 May of "Whales Forever Day", which included a nationwide television showing of a film on marine mammals preceded by a summary of NARA's program and a general appeal for public support.

Presentation of a display: "Harpooning of Dolphins in the Trawler Fishery", Natural Resources Engineering and Science Authority of Sri Lanka, University of Colombo, 26-29 September 1985.

Hosting of the workshop for over 40 journalists, 26 March 1986, at which participants were addressed by Roger Payne, on "Whales in the Sri Lankan Context", and NARA senior research assistant Anouk Ilangakoon, on "The Socio-Economic Aspects of the Dolphin By-Catch".

Anticipating the development of a tourist industry off Trincomalee, production and distribution of a color brochure entitled "Whales of Trincomalee Canyon - the Greatest Show on Earth" showing members of the Oceanic Society Expeditions watching sperm and blue whales from the *R/V Sudaya*.

The increasing awareness in Sri Lanka about the involvement of dolphins in fisheries can be traced to publicity surrounding the *Tulip* expeditions, (Alling *et al.* 1982, 1983, 1984; Whitehead *et al.* 1983), accelerated as a result of the NARA/UNEP program. For example, interest was sufficiently high that on 5 March 1985 a journalist traced "The tragic fate of the humble dolphin." In a piece of investigative reporting reminiscent of Anouk Ilangakoon's method of collecting data, Naranda Nissanka followed a freshly killed dolphin (from the photographs apparently a bottlenose) from the village market at Peliyagoda to its vendor. He had bought it from fishermen in Negombo and refused an offer for Rs: 800/, holding for his price of Rs: 1,000/.

There were no programs or criteria for evaluating the effectiveness of the public awareness campaign.

POSTSCRIPT

There is little doubt that awareness about cetaceans by the average Sri Lankan, at least in the fishing villages most often visited by the NMMU representatives and in the major population centers of Kandy and Colombo, increased significantly during 1983-1986. (The personal interest of former president J.R. Jayewardene, who went to sea several times to see whales and dolphins, ensured that news releases, at least during 1983-1986, received favorable coverage.) Beginning with publicity surrounding the Tulip *expedition, increasing through radio, television and newspaper interviews and other news releases surrounding the 1983 meeting and intensifying in periodic news flashes and special programs during the period of the NARA/UNEP program, few citizens in the larger population centers were left unexposed to some important facts: (1) Sri Lanka can boast of having, within its territorial waters, one of the most diverse cetacean faunas in the world, (2) small cetaceans are involved increasingly in fisheries in Sri Lanka, dying when they become entangled in gillnets or are harpooned for use as fish bait or human food, (3) the government is concerned about the status and future of Sri Lanka's marine mammals and aware of the vital role fishermen and consumers must play if over-exploitation of marine mammals is to be avoided, (4) activities other than fishing probably are affecting marine mammals and their ecosystems and (5) unless citizens cooperate voluntarily in conserving marine mammals, current laws will have to be enforced more strictly and perhaps new, even more stringent laws will need to be enacted.*

It remains to be seen whether the heightened public awareness of marine mammals in Sri Lanka will be effective in countering certain grim realities. Without a major commitment to enforcement, accompanied by the development of means of detecting and punishing violations, fishing laws are ineffectual. The Sri Lankan government's long-standing commitment to increased fishing output and the genuine need for greater protein harvests to keep pace with the rapidly growing human population make it unlikely that the fishing industry's taking of dolphins will be curtailed forcibly. Also, a long period of civil strife has drawn attention away from conservation. Many of the shortcomings of the NARA/UNEP program on marine mammals are easy to understand in this context. Hopefully, once the nation returns to stability, Sri Lanka will resume its efforts to promote kinder treatment of the whales, dolphins and dugongs so that future generations can enjoy their presence off Sri Lanka's shores.

There is a growing concern in Sri Lanka that populations of marine animals, including "resident" marine mammals, off the northeast coast are suffering from the effects of developments inland. The flow of nutrients into Trincomalee Canyon, the dominant submarine feature of the area, appears to be

primarily from runoff of the Mahaweli River. Thus, the food chain of the area, from nutrients-microplankton-macroplankton and eventually to the great whales and odontocetes, is affected at least as much by the land (nutrient-rich runoff) as by the sea (upwelling and indrift). Continued interruption of the flow of the Mahaweli, including further damming and unnaturally-timed seasonal releases of water, and inland practices which add pollutants and reduce or prevent the free accumulation and natural flow of nutrients, are reducing coastal production (Ravil Senanayake, The Island, *2 December 1983). Thus, in addition to the threat of direct killing by humans in directed and undirected fisheries, marine mammals here as elsewhere face the specter of increasing pollution and environmental degradation. The future survival of the marine environment in Sri Lanka, and thus the quality of the Sri Lankan people's future, tied as they are to the sea, depends on vigilance and innovative actions.*

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APPENDICES

Appendix A
Symposium on Marine Mammals of the Indian Ocean[11]
Colombo, Sri Lanka
22-25 February 1983
Recommendations, Participants and List of Documents[12]

Recommendations

1. General
   It is recommended that all Indian Ocean States take appropriate action to promote greater awareness of, and interest in, marine mammals in general, and those of the region in particular.

[11] The conference was organized on behalf of NARA by Tissa Amaratunga. The meeting report was prepared by the meeting chairman, Sidney Holt, assisted by a committee of the participants. The final version was edited by Nalanika Obeysekera. That unpublished report is on file with NARA.

[12] Presented as they exist in the unpublished report of the workshop.

2. Management

2.1 All Indian Ocean States are called upon to take, within the scope of their national jurisdiction, specific measures for the conservation of marine mammals of the region, on the basis of up-to-date scientific data.

2.2 The Republic of the Seychelles is congratulated on the initiatives it has taken within and outside the framework of the International Convention for the Regulation of Whaling (1946) to protect marine mammals. All states, and in particular the Indian Ocean States, are urged to extend their support and encouragement to such initiatives.

2.3 The International Whaling Commission (IWC) is congratulated on its increased membership, the strengthening of its Secretariat, the increase in its research programme on whales, and in particular for its decision to aim at the cessation of commercial whaling activities by 1986 by establishing zero catch limits for the 1986 coastal and the 1985/86 pelagic seasons, subject to review by 1990.

2.4 All States and, in particular the Indian Ocean States, are urged to comply strictly with the decision of IWC.

2.5 It is recommended that all States consider becoming parties to the International Convention for the Regulation of Whaling.

2.6 The need is recognized for inter-governmental arrangements of global scope, possibly implemented through regional organizations with comprehensive powers, aimed at ensuring the conservation and non-consumptive development[13] of all species of marine mammals.

2.7 It is recommended that, pending the establishment of inter-governmental arrangements of the type referred to in Recommendation 2.6, or the exercise of an appropriate protective role by IWC, the Indian Ocean States enter into regional arrangements for the conservation and non-consumptive development of marine mammals.

2.8 It should be recognized that rational and scientific management of marine mammals of the Indian Ocean requires that no arbitrary and artificial limit be set in determining the boundaries of that ocean, and in particular the southern boundary.

2.9 The proposal of the Minister of Fisheries of Sri Lanka to establish in Sri Lanka as early as possible, a Regional Centre for the Study of Marine Mammals, particularly of the Indian Ocean, is warmly welcomed and endorsed.

2.10 A provisional programme of appropriate national and international projects of research relating to the conservation and non-consumptive development of such mammals be implemented through the Centre, is provided for further consideration by participants and others concerned.

2.11 Bilateral and multilateral donor agencies, and other interested entities, are called upon to provide financial and other support for projects related to the conservation and non-consumptive development of marine mammals, in particular, for projects to be carried out by the Regional Centre referred to in Recommendation 2.9.

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[13] By "non-consumptive development" is meant the observation, investigation, study and breeding of marine mammals and other benign activities associated with them. These may include regulated and limited live-capture (sometimes referred to as "low-consumptive use"), but does not include any activity involving the habitual killing of marine mammals for their physical products or their subjection to any type of cruel treatment or harassment whether or not such treatment has, as its objective, the advancement of scientific knowledge.

2.12 There is an urgent need for study of the conservation and non-consumptive development of marine mammals.

2.13 A comprehensive study should be made of the economic consequences, both to presently whaling and non-whaling nations, of the pause in commercial whaling referred to in recommendation 2.3. The IWC is invited either to undertake such a study itself, in collaboration with such other inter-governmental organizations as may wish to be associated with it or, if not, to make available such relevant information in its possession for use by others.

2.14 The attention of States is invited to the urgent need for immediate measures for the conservation of the dugong (*Dugong dugon*). The range of this threatened species is shrinking and it is depleted throughout its range. The population occurring in Palk Bay and the Gulf of Mannar may be on the verge of extinction. States are urged to extend appropriate expert and other assistance to ensure the survival of the dugong and the maintenance of at least its present range.

3. Scientific and Technical

Some of the following recommendations are closely related to certain proposals contained in the Report of the Zeist Workshop which was made available to participants in the symposium. For ease of reference, extracts of the relevant workshop proposals are given in Appendix VII.

3.1 Strandings of marine mammals

It was agreed that much information about cetaceans can come from strandings of dead and dying animals but that it is essential that scientists be informed quickly so that they can reach the location in time to identify the animals and collect biological specimens for study. If live strandings are reported quickly it may be possible to respond in time to get the animals back into the sea alive; techniques for doing this successfully are being used elsewhere.

It is recommended that steps be taken in each country:

(a) to ensure that the populace is informed and alerted and that a communications network involving local officials and a central clearing house is created.

(b) to provide special training of scientists/technicians in identification and specimen collection and preparation for storage, and the collection of on-the-spot observations of measurements and other relevant observations.

(c) to establish recovery teams able to act on short notice with already-assembled materials, equipment and means to transport them, as well as a budget to deploy them.

(d) to establish a central point for compiling and holding information, including data on the location of specimens and samples.

(e) to make available information keys and field manuals suitable for use by field staff. Also simple aids to identification for use by fishermen, local authorities and members of the public.

Suggestions for the types of observations needed in this connection, and also in connection with Recommendations 3.2 and 3.3 are given in Appendix XIII. 15

(f) to arrange that those lay persons who draw attention to strandings or in other ways provide information or assist in this activity, be apprised of the results, thus ensuring their continued interest in contributing.

3.2 Sightings of marine mammals from shore or ships of opportunity

It is recommended that where it is practicable to encourage and organize such observations, this should be done. The requirements for success include the items (a) to (f) set out in Recommendation 3.1 above.

3.3 Accidental and incidental catches of marine mammals in fishing nets

It seems that such catches are increasing greatly as a result of changes in fisheries especially the introduction of synthetic netting which is not easily visible in use, and is indestructible both when in use and when torn adrift or abandoned. It is recommended:

(a) that these catches be monitored so that at least the numbers, species composition, seasonality and sizes are known, and the possible effects on the population can be evaluated. Such evaluation is extremely difficult, since it requires knowledge of population size and dynamics which is hard to acquire and may take a long time. It is therefore prudent to assume that all such catching may be harmful, and advisable to seek ways of modifying fishing gear to reduce or eliminate accidental catch. International exchange of experience will be useful, but local experimentation will be necessary.

(b) that every opportunity be taken to make use of accidental catches to yield biological information. The requirements for success are essentially the same as those set out in (a) to (f) of Recommendation 3.1. In addition there is need to make arrangements where possible to sample the landings of accidentally caught animals throughout the year, on a continuing basis (to determine trends) and at a number of representative locations.

(c) that the co-operation of fishermen in providing information and in reporting accidental take be secured by informing them of the reason why such catches are harmful.

3.4 Mutual aid among specialists and laboratories

(a) Countries in which marine mammals studies are just beginning need specialised scientific literature: taxonomic treatises, manuals, reprints. *It is recommended* that everyone in a position to do so help them acquire these essential tools. Each such country might designate a central point for literature archive (Repository Library). Exchange must work both ways: important information is contained in local bulletins which do not get distributed widely outside the country or even locally. If reprints from these were sent to major libraries abroad they would stimulate much assistance in return, including expert advice and literature exchange.

(b) The number of experts in the world who can reliably identify cetaceans, in life or dead, is very few. Therefore the exchange of scientists is essential. It is recommended that funds be sought to enable them to visit countries and provide on-the-spot training, for example at sea and at localities where fish and incidental catches of marine mammals are landed.

(c) It is recommended that a comprehensive bibliography of publications about marine mammals of the Indian Ocean be prepared including reference to key publications of broader scope.

3.5 Protected areas

Within the Indian Ocean Sanctuary for Whales, it may be necessary to establish a number of smaller protected zones of refuges (e.g. by seaward extension of terres-

trial protected areas) in which cetaceans are protected from accidental catch, from pollution that may be harmful and from other destruction of habitat. It is recommended that a review be made to identify such places and begin the process of establishing appropriate refuges which would most likely fall wholly or substantially under the jurisdiction of one or more coastal states (see also recommendation 3.16). In some cases domestic legislation would be sufficient while in other cases bilateral or even multilateral agreements between governments of adjacent states may be needed.

3.6 Damage to marine mammal habitat

Many kinds of activity in the ocean or on land which affect the adjacent sea may be harmful to marine mammals, especially on the Continental Shelf and in Exclusive Economic Zones. These include offshore drilling and exploitation, explosions underwater and on the seabed, concentrated movement of large ships, construction on shore that causes runoff of soil and silt, outflow of pollutants from intensive agriculture, urban agglomerations and industry. *It is recommended* that in each country a review be made of localities and activities that are currently causing potential problems or where such problems may be imminent. It is further recommended that steps be taken as far as possible to remove, contain or lessen any identified threats and to include in programmes of scientific and technical investigation, provisions to that end.

3.7 Indian Ocean Sanctuary for Whales

The symposium welcomes the establishment of the Sanctuary. It has already shown its value in creating awareness of marine mammals in the region that was not there before and in attracting funds for research. It is, however, in its present form unsatisfactory in three respects.

(a) It is unclear exactly what species of cetaceans are covered by the IWC decision. The IWC is urged to clarify this matter soon, so that conservation of cetaceans that may not be covered with respect to regulatory action by IWC can be provided for by other international means, either through new global agreement or through regional actions (see Recommendation 2.6).

(b) The boundaries are not entirely satisfactory. It is recommended that consideration be given to including within the sanctuary, the river systems and estuaries of coastal states bordering the Sanctuary. Secondly, it is further recommended that the present southern boundary at 55°S, being ecologically unreasonable, be removed and the southern boundary be established as the edge of the Antarctic Continent or fast ice. This would be justified because the sanctuary should cover the entire life-cycle ranges, that is, the feeding and breeding zones, of the main species. By this change the sanctuary would include the Indian Ocean Sector of the entire area for which the IWC sets catch limits and other regulations under Article V of the 1946 Convention. (See also Recommendation 2.8). It is recommended that some consideration be given to modify the eastern boundary, perhaps to take in more of the area defined as the Indian Ocean as stated in the Introduction.

(c) The development of a management regime and research activity in the sanctuary would be facilitated if all the coastal states were to join the IWC and it is recommended that this be encouraged. (See also Recommendation 2.5).

3.8 Marine mammal legislation

In many countries existing legislation is far out of date. Now that the Law of the Sea Convention is completed it would be timely for new national legislation to be drawn up in such countries, pertaining to activities (by nationals and foreigners) in their EEZs. This pertains also to trade in animals and/or products from them in accordance with modern ideas concerning the needs for conservation of marine mammals and their habitats. *Such actions are recommended.*

3.9 Benign research and non-consumptive use

No Indian Ocean states are now regularly catching whales, although there are occasional accidental catches. Further, the deliberate killing of other marine mammals is still permitted in very few of these states. It is desirable that where practicable other values of these animals be realized for the benefit mainly of the local populations. In some places organization of regulated "whale watching" by visitors to the locality can be highly profitable. It seems that the coasts of Sri Lanka offer such areas. It is recommended that the possibilities be evaluated and assistance by the responsible government authority where appropriate be encouraged. In doing so, attention should be given to the need to ensure that whale watching is conducted such that it is not itself harmful to the whales.

The non-existence of exploitation for commodities gives both the need and the opportunity for useful benign (non-lethal) research which has already clearly proven its value elsewhere, and also, recently, locally (off Oman, Sri Lanka). It is recommended that benign research be strongly encouraged. In particular the work by 'Tulip' has very quickly yielded scientifically significant and potentially economically interesting results. This type of work must be continued for several more years, and it is also important that it be publicised so that public awareness can lead to further financial and logistic support.

3.10 Indus River dolphin (Susu) *Platanista gangetica minor*

The river dolphins are included in the list of species of cetaceans known to exist in the Indian Ocean Whale Sanctuary and are listed in the report of the Zeist Workshop. The participants in the symposium took cognisance of the critical situation of the Susu in the Indus River and expressed their deep concern about this. They called upon the governments and people of countries concerned to do all in their power to ensure the survival of this unique and scientifically valuable species.

3.11 Live capture of cetaceans

Small cetaceans are being captured alive at several localities within the Indian Ocean. It is recommended that standards for capture, transport and captive maintenance be widely adopted. Such standards have been worked out and are in force in some other areas and could readily be adapted to Indian Ocean conditions.

3.12 Public Awareness

(a) In general there is little public knowledge in many places within the region, even of the existence of the marine mammals and certainly not of the threats to them or to their values. It is recommended that this be corrected, by vigorous national campaigns and by international/regional cooperation. Posters, visuals (films, slides, videos), auditory aids and lectures are all useful. It is particularly important to use such materials and conduct such a campaign in the schools.

(b) The idea of a cruise by the 45m research vessel 'Plancius' in the region, visiting

coastal localities in many countries to help create awareness and to educate is a good one and should be encouraged. Such activities should also incorporate research as far as possible and include taking selected local people to sea and instructing them. The proponents of this scheme are commended and encouraged to complete the plan for it and implement it as soon as practicable.

3.13 Indian Ocean Data Centre

An Indian Ocean data information exchange and reference centre, particularly for the central and northeast region, should be established. Sri Lanka would be a good location for this and it is recommended that a centre be established in Sri Lanka. In this connection, the possibility of using the Indian Ocean Data Centre of the proposed Committee for Exploration of the Indian Ocean should be examined.

3.14 Marine Mammal Newsletter

It is recommended that a regional marine mammal newsletter be compiled and distributed regularly. It should contain information about strandings, sightings, experiments, progress reports on research activities and conservation activities, accounts of relevant meetings and the like.

3.15 Marine Mammal Research Centre(s)

Consideration should be given to the creation of a regional or sub-regional marine mammal research centre or centres (See also Recommendation 2.9).

3.16 Recommendations pertaining especially to the dugong (See also recommendation 2.14)

(a) It is recommended that research be undertaken promptly to determine the distribution, current numbers, habitat preference and migration routes of dugongs. The results of such studies are required to make choices among alternative protection measures.

(b) Research should be conducted into all aspects of the fisheries in which dugongs are now being taken. The results of such studies can support and focus education and law enforcement efforts.

List of Papers Presented at the Symposium[14]

Document #

32 Alling, A. A preliminary report of marine mammal fisheries in Djibouti, Oman and Sri Lanka.

31 Boonprakob, U., S. Chantrapornsyl and O. Bhatia. Occurrence of dugong (*Dugong dugon*) in coastal waters of Phuket Island and the attempt to keep dugongs in captivity.

31 de Silva, P.H.D.H. Taxonomy of Cetacea of the Indian Ocean.

25 Gambell, R. Establishment of the Indian Ocean Sanctuary for whales.

33 Gordon, J. A summary of field work attempted so far.

17 Heinsohn, G. B. Aspects of the biology of two species of Indo-Pacific dolphins, *Sousa chinensis* and *Orcaella brevirostris*, in Northwestern Australian waters. (Abstract).

[14] Each document bore the following abbreviations followed by an identifying number: NARA/SMMIO/SP#, for National Aquatic Resources Agency/Symposium on Marine Mammals of the Indian Ocean/Scientific Paper. Citations should include that information followed by the indication "(unpublished)".

20a Heinsohn, G. B. Conservation of the dugong. (Abstract).

26 Hiby, A. R. Suggested techniques for censusing large whales using sighting surveys.

30 Holt, S. J. A note on the establishment of the Indian Ocean Sanctuary.

2 James, P. S. B. R. On the stranding of whales along the Indian coast with special reference to recent incursions of sperm whales into the coastal waters of India.

21 Jones, S.The present status of the dugong in the Indo-Sri Lanka waters - a plea for cooperative action.

3 Joseph, L., S. M. Siddeek and D. S. Jayakody. Cetaceans landed by fishermen in Negombo, Sri Lanka.

22 Kataoka, T., S. Asano, T. Morlim, S. Ishihara and S. Kutamura. On the keeping of dugong (*Dugong dugon*) in Toba Aquarium.

4 Kuthalingam, M. D. K. and K. Vankataramanujam. A review of the stranding and occurrence of marine mammals along the Indian coasts and their conservation.

10 Lal Mohan, R. S. Observations of an edentate dolphin from Calcut, India.

11 Lal Mohan, R. S. Taxonomic position of the dolphin, *Delphinus longirostris* Cuvier.

5 Leatherwood, S. and J. Clarke. Cetaceans in the Strait of Malacca, Andaman Sea and Bay of Bengal, April 1982 - with a preliminary review of marine mammal records from those regions.

7 Manikfan, M. A. Capture of the smaller cetaceans for food in the Laccadive Islands.

23 Marsh, H. Dugong life history, implications for the management of Australian populations.

20 Marsh, H. and G. Heinsohn. Conserving the dugong. Australia's responsibility.

12 Nishiwaki, M. Marine mammal species considered to be in the Indian Ocean.

24 Nishiwaki, M., Ta'san and S. Hendrokusomo. Growth of the captive dugong (*Dugong dugon*).

14 Santerre, M. T. and R. M. Santerre. The occurrence and distribution of marine mammals in Sri Lanka.

— Secretary General, Law of the Sea Office, United Nations, New York. Preliminary study on the legal aspects of the conservation and management of marine mammals. (This document was unnumbered.)

30 Singarajah, K. V. Behavioural observations and estimates of relative abundance of minke whales based at Costinha land station - Brazil.

15 Thomas, P. A. Casual landings of porpoises and dolphins from the inshore areas off Goa during the period 1973 to 1979.

19 Whitehead, H. Humpback songs from the North Indian Ocean,

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Appendix B
Marine Mammal Specimens in Sri Lanka

1. Accessioned Specimens in Sri Lankan Institutions

During various visits to Sri Lanka, 1982 through 1986, Leatherwood visited many of the institutions which maintain marine mammal collections and worked with staff of the institutions to inventory these materials. In 1985 and 1986, with the help of NMMU staff Nalanika Obeysekera, Sujiva Senanayake, Anouk Ilangakoon and Rohan Gunaratna, he photographed and measured many of those specimens. During the NARA/UNEP Project he took advantage of the visits to train NARA officers listed above and Asoaka Gamage, W.P. Mahendra and Chandana Mendes on how to identify species, collect and preserve specimens, and measure skulls. Original data sheets and photographic negatives from all museum work in Sri Lanka are currently on file at Oceans Unlimited, San Diego, California, but are scheduled for transfer to the U.S. National Museum, Smithsonian Institution, Washington, D. C., in 1990. Duplicate copies of lists and measurements were deposited at the Sri Lankan National Museum in Colombo. The basic inventory, included in Leatherwood (1986), is summarized in Table B1.

It should be noted that many specimens and records, including some referred to in published accounts, are no longer available, having been lost during various reorganizations and transfers. Regrettably, many of the registers were burned when control of the National Museum was transferred to the University (P.B. Karunaratne, pers. comm. 3 June 1985).

2. Specimens Collected during the NARA/UNEP Program, 1985-1986

The biological specimens and related data collected during the NARA/UNEP program all are housed at NARA, Colombo. As of 9 January 1986, all soft tissues were in replenished storage media (formalin or alcohol), and all hard tissues were safely boxed and in good condition (A. Gamage, *in litt.*, 9 January 1986). Duplicate copies of data forms and many of the photographic slides, negatives, prints and proof sheets also are filed at Oceans Unlimited, San Diego, California. We present here, in Table B2, a summary of specimens obtained by members of the National Marine Mammal Unit through December 1985. We are aware that there are additional materials at the Unit. However, we did not have an inventory; so, they are not included on this list.

It is our hope that this listing will permit interested students and professional researchers to identify and make use of this extensive collection of valuable materials, some from poorly-known species. To our minds, it would be a pity if this valuable collection were to be lost, significantly damaged or inadequately used in the coming years.

Table B1. Marine mammal specimens in Sri Lankan institutions.

Species	Specimen	COLLECTED			Nature of materials/Comments
		Date	Location	By[1]	
I. COLOMBO MUSEUM					
Physeter catodon	-	?.09.1889	Talaimannar	-	skull without mandibles, 5.21m long, on display
Balaenoptera musculus	-	?.09.1894	Ambalangoda	-	skeleton, on display, with some baleen
Pseudorca crassidens	-	30.09.1939	Godawaya	-	skull
Pseudorca crassidens	-	30.09.1939	Godavaya	-	skull
Physeter catodon	88	-	-	-	fetus
Ziphius cavirostris[1]	88A	24.06.1939	Colombo Harbour	-	skull with mandibles
Ziphius cavirostris[1]	88B	-	-	-	skull, lower jaw, teeth
Ziphius cavirostris[1]	88C	01.07.1963	Hikkaduwa	-	skull
Ziphius cavirostris[1]	88D	?.06.1967	Madihe, Matera	-	skull
Kogia simus[1]	89	-	-	-	-
Kogia breviceps	89	30.11.1915	Moratuwa	-	skull
Pseudorca crassidens[1]	90A	?.12.1890	Moratuwa	-	-
Pseudorca crassidens[1]	90B	1891	-	-	"in reserve collection"—skeleton on display
Pseudorca crassidens	90C-H	-	-	-	lost during evacuation (Minister for Cultural Records *in litt.*, 11.10.60)
					skull sent to National Museum, Kandy, apparently lost (S. Leatherwood, unpubl.)
Tursiops truncatus	92	?.03.1924	Pearl Bank	-	mounted skeleton apparently lost
Tursiops truncatus[1]	92A	1930	-	-	skull, no mandibles
Tursiops truncatus[1]	92B	1930	-	-	skull, no mandibles
Tursiops truncatus[1]	92C	?.12.1916	Puttalam	W.E. Wait	-
Dugong dugon	-	11.10.1952	-	-	skull from Colombo Nat. Museum (lost) (S. Leatherwood unpubl.)
Stenella longirostris[1]	92D	23.01.1954	-	-	received from Department of Fisheries
Stenella longirostris[1]	92E	23.01.1954	-	-	received from Department of Fisheries
Delphinus delphis[1]	92-1	-	-	-	incomplete skull without mandibles

Table B1 *(continued)*

Species	Specimen	COLLECTED			Nature of materials/Comments
		Date	Location	By*	
Delphinus delphis[1]	92-2	-	-	-	incomplete skull without mandibles
Stenella (attenuata?)	92-3	-	-	-	incomplete skull without mandibles
Delphinus delphis[1]	92-4	-	-	-	incomplete skull without mandibles
Sousa chinensis[1]	93	03.04.1934	-	-	from Department of Fisheries to Ratnapura 28.01.5
Dugong dugon	94C	10.08.1961	Pannai, Jaffna	-	-
Dugong dugon[1]	94D	22.08.1961	Jaffna	-	male fetus, in formalin
Tursiops truncatus[1]	001	-	-	-	-
Tursiops truncatus[1]	002	-	-	-	-
Steno bredanensis[1]	008	-	-	-	-
Stenella coeruleoalba[1]	a	-	-	-	incomplete skulls, all without mandibles
Stenella attenuata[1]	b	-	-	-	incomplete skulls, all without mandibles
Stenella attenuata[1]	c	-	-	-	incomplete skulls, all without mandibles
Mesoplodon ginkgodens[1]	3WZS	26.01.1963	Ratmalana	-	skull, cast, misc. skeletal parts and pieces in formalin
Balaenoptera acutorostrata	2W	1962	Jaffna	-	scapulae, transferred from Jaffna
Globicephala macrorhynchus[1]	-	-	Pitipana	-	skull
Pseudorca crassidens	-	-	-	-	skeleton
Globicephala macrorhynchus	-	-	Colombo	-	vertebrae
Pseudorca crassidens[1]	-	-	-	-	plaster cast, on display
Dugong dugon[1]	-	-	-	-	female 2.7m, stuffed skin, on display
Dugong dugon[1]	-	-	-	-	female calf 1.1m, stuffed skin, on display
Balaenoptera (physalus?)	-	-	-	-	baleen plates, on display
II. PERADENIYA UNIVERSITY					
Tursiops truncatus	1[2]	1968	Mannar	C. Santiapillai	Head, in formalin
Steno bredanensis	A[2]	-	-	-	skull without mandibles or teeth
Stenella (longirostris?)	B[2]	-	-	-	skull without mandibles or teeth

Table B1 *(continued)*

Species	Specimen	COLLECTED			Nature of materials/Comments
		Date	Location	By[4]	
Stenella longirostris?	C[2]	-	-	-	skull, left ramus
Tursiops truncatus	D[2]	-	-	-	skull without mandibles
Peponocephala electra	E[2]	-	-	-	(specimen not seen)
Dugong dugon	A-1[2]	1968-70	-	C. Bertram	skull with mandibles
Dugong dugon	B-1[2]	-	-	H. Crusz	skull with mandibles
Dugong dugon	C-1[2]	-	Wilpattu	Univ. Staff	skull with mandibles
Dugong dugon	A-2[2]	1973-74	-	-	fetus in formalin, 23.75in)
Dugong dugon	B-2[2]	1973-74	-	-	fetus in formalin, 12.5 in.) collected together
Dugong dugon	C-2[2]	1973-74	-	-	fetus in formalin, 23.0 in.)
Dugong dugon	-	3.06.1952	Gulf of Mannar	-	Whole animal received; Crusz and Fernando(1964), S. Leatherwood (unpubl.) (not seen or listed in the bibliography).
III. UNIVERSITY OF SRI LANKA (Colombo Campus)					
Pseudorca crassidens	01[3]	-	-	-	skull with mandibles
Tursiops truncatus	02[3]	-	-	-	skull with mandibles
Tursiops truncatus	03[3]	-	-	-	skull with mandibles
Stenella sp	04[3]	-	-	-	skull without mandibles
Dugong dugon	05[3]	-	-	-	skull with mandibles
Dugong dugon	06[3]	-	-	-	skull with mandibles
Dugong dugon	-	8.05.1964	-	-	Incomplete skeleton from Colombo Museum (lost)
IV. JAFFNA MUSEUM[5]					
Balaenoptera acutorostrata	62.203.6	1962	Jaffna	-	skeleton
Dugong dugon	-	30.10.1954	-		2 tusks (lost), Gunaratna (1985)

Table B1 *(continued)*

Species	Specimen	COLLECTED			Nature of materials/Comments
		Date	Location	By*	
Dugong dugon	-	21.10.1960	Pannai		fetus; Gunaratna (1985)
Dugong dugon	61-196-6	24.03.1961	Pannai		fetus; (to DNM) Gunaratna (1985)
Dugong dugon	61-197-6	24.03.1961	Pannai		fetus; (to DNM) Gunaratna (1985)
Dugong dugon	61-198-6	1.05.1961	Pannai		fetus; (to DNM) Gunaratna (1985)
Dugong dugon	-	12.08.1961	-		fetus; (to DNM) Gunaratna (1985)
Dugong dugon	-	29.01.1962	Pannai		fetus; Gunaratna (1985)
Dugong dugon	-	21.02.1962	Pannai		fetus; Gunaratna (1985)
Dugong dugon	-	11.03.1962	Pannai		fetus; Gunaratna (1985)
V.RATNAPURA MUSEUM					
Sousa chinensis	93	03.04.1934	-	-	stuffed specimen, from Colombo Museum28.01.195
Physeter catodon	-	-	-	-	skull without mandibles
Mesoplodon ginkgodens	-	-	-	-	cast of the specimen 3W25, Colombo Museum
Ziphius cavirostris	-	-	-	-	cast of head; unnumbered specimen from Colombo Museum

Table B1 *(continued)*

Species	Specimen	COLLECTED			Nature of materials/Comments
		Date	Location	By[4]	
VI. NARA/CRIOMM					
C = Colombo T = Trincomalee					
Megaptera novaeangliae	-	? 03.1981	Chilaw	-	complete skeleton, on display
Tursiops truncatus	001C	26.02.1983	Pitipana	SL/MN	skull without mandibles
Tursiops truncatus	002C	26.02.1983	Pitipana	SL/MN	skull without mandibles
Steno bredanensis	003C	26.02.1983	Pitipana	SL/MN	skull without mandibles
Globicephala macrorhynchus	009C	26.02.1983	Pitipana	SL/MN	skull without mandibles
Physeter catodon	010C	26.02.1983	Pitipana	SL/MN	partial cranium
Kogia simus	011C	26.02.1983	Pitipana	SL/MN	skull without mandibles
Stenella longirostris	012T[1]	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Grampus griseus	016T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Grampus griseus	017T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Grampus griseus	018T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Grampus griseus	019T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Tursiops truncatus	020T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Tursiops truncatus	021T	16.03.1984	Trincomalee	SL/MN	skull without mandibles
Stenella attenuata	a-cc	06.08.1985	Beruwala	SL	head, being prepared
Stenella attenuata	b-cc	06.08.1985	Beruwala	SL	head, being prepared
Stenella attenuata	c-cc	06.08.1985	Beruwala	SL	head, being prepared
Kogia breviceps	022T	15.03.1984	Back Bay	SL	skull without mandibles
Kogia simus	023T	16.03.1984	Trincomalee	SL	skull without mandibles
Kogia simus	024T	16.03.1984	Trincomalee	SL	skull without mandibles
Grampus griseus	CA020885	08.06.1985	Beruwala	AG,CM	skull of adult male

Footnotes

1. Identifications confirmed by Masaharu Nishiwaki, 5 May 1983
2. All specimens unnumbered at the time of examination, 28 May 1985. Numbers assigned by Lionel Pereira, technician in charge of the collection, with permission of Hilary Cruz, Chairman, Department of Zoology.
3. All specimens unnumbered at the time of examination, 1 June 1985. Numbers assigned by B. Hubert, technician in charge of collection, under direction of S. Leatherwood and A. Gamage.
4. SL=Stephen Leatherwood; MN-Masaharu Nishiwaki; AG=Asoka Gamage; CM=Chandana Mendes.
5. We were unable to visit Jaffna Museum.
6. On 15 and 16 March 1984, Leatherwood collected 24 spinners from Trincomalee (main market and Back Bay). Specimens missing during inventory on 17 August 1985 are not listed here.

Table B2. Specimens collected during the NARA/UNEP program, 1985-1986.

KEY:

Column	Column Header	Description
1	SP	Species Code
2	DATE	MMDDYY (ie. 020285)
3	LO	Location (letter code see below)
4	SPEC#	Speciman number
5	S	Sex (f=female, m=male, x=unknown)
6	Le	Length (in inches)
7	S	Stomach (y=collected, x=not collected)
8	T	Teeth (y=present, x=not present)
9	R	Reproductive material (y=present, x=not present)
10	P	Postcranial material (y=present, x=not present)
11	S	Skull (y=present)
*	*	Photo only (information from photo)

Location	
ba	Batemulla
be	Beruwala
do	Dondra
ga	Galle
go	Gondara
ha	Hambantota
hi	Hikkaduwa
ka	Kandakuliya
ki	Kirinda
ko	Kottegoda
mi	Mirissa
ne	Negombo
ta	Tangalle
tr	Trincomalee

Table B2 continued

Feresa attenuata

Sp	Date	Lo	Spec#	S	Le	S	T	R	P	S
fa	102585	ko	ca521085	f	70.0	x	y	x	x	x
fa	101485	tr	js109385	m	46.0	y	y	y	x	x
fa	082085	tr	pp3185	f	81.0	y	y	y	x	x
fa	080985	tr	js109485	f	81.5	y	y	y	x	x
fa	080885	ga	ac080885	m	85.0	y	y	x	x	y
fa	080785	tr	js109585	f	86.5	y	y	y	x	x
fa	080785	tr	js109685	f	87.4	y	y	y	x	x
fa	080785	tr	js113485	f	37.4	y	y	y	x	x
fa	080685	be	ca010885	f	48.5	x	x	x	x	x
fa	072785	tr	wpp1485	m	56.5	x	x	x	x	x
fa	071385	tr	js104585	m	67.0	y	y	y	x	x
fa	062985	tr	wpp0885	f	53.0	y	y	y	x	x
fa	040383	tr	aa522383	f	82.5	y	x	x	x	x
fa	040383	tr	aa52483	m	47.4	x	x	x	x	x
fa	020883	tr	js109885	x	xx.x	y	x	x	x	y

Grampus griseus

gg	xxxxxx	xx	js111785	x	xxxxphoto only					
gg	xxxxxx	ga	13	x	xxxxphoto only					
gg	xxxxxx	xx	wpp2485	x	xx.x	x	x	x	x	x
gg	122585	tr	wp312	m	64.5	x	x	x	x	x
gg	122585	tr	wp412	f	83.0	y	y	y	x	x
gg	122285	tr	wp612	f	86.0	y	y	y	x	x
gg	121785	tr	wp712	f	74.0	y	y	y	x	x
gg	121785	tr	wp1012	f	72.0	x	x	x	x	x
gg	121285	tr	wp112	f	104.	y	y	y	x	x
gg	101785	mi	ca161085	m	55.5	x	x	x	x	x
gg	101685	ko	ca091085	m	67.5	x	x	x	x	x
gg	101585	ba	ai1031	x	xxxxphoto only					
gg	092085	ko	ca093985	m	60.0	x	x	x	x	x
gg	091385	ko	ca350985	m	52.0	x	x	x	x	x
gg	091085	mi	ca230885	f	94.0	y	x	x	x	x
gg	082185	tr	wpp3485	f	75.0	y	y	y	x	x
gg	081585	tr	wpp2585	m	74.0	y	y	y	x	x
gg	081585	tr	wpp2405	m	65.0	y	y	y	x	x
gg	080985	tr	js108885	f	87.5	y	y	y	x	x
gg	080885	tr	js108985	m	70.5	y	x	y	x	x
gg	080685	be	ca020885	m	115.	y	x	x	x	x
gg	080685	tr	js109085	m	76.0	y	y	y	x	x
gg	072785	tr	js108285	m	64.0	x	x	x	x	x
gg	072585	tr	js109185	f	58.5	x	x	x	x	x
gg	072485	tr	js107885	m	34.0	y	y	y	x	x
gg	072485	tr	js107985	f	106.	y	y	y	x	x
gg	072485	be	ac120785	m	96.0	x	y	x	x	x
gg	072385	tr	js107785	m	76.5	y	y	y	x	x
gg	072185	tr	js107185	f	92.0	y	y	y	x	x
gg	072185	tr	js106785	f	63.0	x	x	x	x	x
gg	072085	tr	js106385	f	82.0	y	y	y	x	x
gg	072085	tr	js106685	f	66.0	y	y	y	x	x
gg	071585	tr	js105485	f	104.	y	y	y	x	x
gg	071485	tr	js104685	m	76.5	y	y	y	x	x
gg	071285	tr	js104085	m	44.0	y	y	y	x	x
gg	071285	tr	js103985	m	70.4	y	y	y	x	x
gg	071185	tr	wpp1985	m	115.	y	y	y	x	x
gg	071085	tr	wpp1785	f	67.5	y	x	y	x	x
gg	071085	tr	js103385	m	66.0	y	x	y	x	x
gg	071085	tr	wpp1685	f	82.0	y	y	y	x	x
gg	071085	tr	js103185	f	80.0	y	x	y	x	x
gg	070885	tr	wpp1685	m	74.0	y	x	y	x	x
gg	070785	tr	js102385	m	64.5	y	x	y	x	x
gg	070685	tr	js102185	f	73.0	y	x	y	x	x
gg	070585	tr	js101885	m	43.0	y	y	y	x	x
gg	070285	tr	wpp0985	m	84.5	y	y	y	x	x
gg	062785	tr	wpp0685	m	79.0	y	x	y	x	x
gg	062285	tr	wpp0385	f	75.0	y	x	y	x	x
gg	060485	be	ssa1010685	f	10 3"	x	x	x	x	x
gg	060485	be	1507851	x	xxxxphoto only					
gg	012585	xx	wp25185	x	xxxx	x	x	x	x	x

Kogia breviceps

kb	072085	tr	js109985	f	85.0	y	y	y	x	x
kb	070785	tr	js102485	m	56.5	y	y	y	x	x
kb	070285	ne	aib29	x	xxxxphoto only					

Kogia simus

ks	xxxxxx	xx	js111685	x	xxxxphoto only					
ks	xxxxxx	xx	js111585	x	xxxxphoto only					
ks	102085	be	ca251985	m	65.5	y	y	x	x	x
ks	090985	ko	ca200985	f	70.0	x	x	x	x	x
ks	080985	tr	js110085	m	60.0	y	y	y	x	x
ks	082485	tr	wpp4085	m	62.0	y	y	y	x	x
ks	080985	tr	js110185	f	65.0	y	y	y	x	x
ks	072385	tr	js107585	f	83.0	x	x	x	x	x
ks	071285	tr	js104185	m	43.0	y	y	y	x	x
ks	070885	tr	js102685	m	55.0	y	x	y	x	x
ks	070885	tr	wpp1585	f	72.5	y	y	y	x	x
ks	070785	tr	js102285	f	48.0	y	y	y	x	x
ks	070585	tr	js101985	f	76.0	y	y	y	x	x
ks	070585	ga	ca050785	m	72.0	x	x	x	x	x
ks	072485	tr	wpp1285	m	58.5	y	y	y	x	x
ks	070385	ne	ca010785	x	xxxx	x	x	x	x	x
ks	070385	ne	ca020785	x	xxxx	x	x	x	x	x
ks	062985	tr	wpp0785	m	44.5	y	y	y	x	x

Lagenodelphis hosei

lh	101485	mi	ca011085	f	91.0	y	x	x	x	x
lh	091085	mi	ca220985	f	93.0	x	x	x	x	x
lh	091085	mi	ca210985	f	90.0	x	x	x	x	x

Mesoplodon SD.

me	121885	tr	wp812	f	133.	y	x	y	x	x

Pseudorca crassidens

pc	102385	mi	ca421085	m	96.0	y	x	x	x	x
pc	070985	ga	cm000685	x	xxxx	x	x	x	x	y

Stenella attenuata

sa	xxxxxx	ga	js112185	x	xxxxphoto only					
sa	xxxxxx	tr	wpp00185	x	xxxxphoto only					
sa	xxxxxx	mi	ss6085	m	xxxxphoto only					

Table B2 continued

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sa 102585 mi ca531085 m 64.0 x x x x x
sa 102485 mi ca481085 f 70.0 y x x x x
sa 102485 mi ca471085 m 68.0 y x y x x
sa 102185 mi ca311085 m 66.0 y x y x x
sa 102185 ko ca401085 m 77.0 x x x x x
sa 102185 mi ca301085 m 80.0 y x x x x
sa 082685 tr wpp4485  m 82.5 y y y x x
sa 082385 tr xxpp3585 m 84.0 y y y x x
sa 080885 ga ac090885 f 49.0 x x x x x
sa 080685 tr jsl10285 m 34.5 y x y x x
sa 080685 tr jsl10385 m 77.0 y y y x x
sa 072585 be ca180785 f 65.0 x x x x x
sa 072585 be ca170785 f 78.0 x x x x x
sa 071885 tr jsl05985 m 44.0 y y y x x
sa 071885 tr jsl05885 f 45.0 y x y x x
sa 071585 tr jsl05385 f 64.0 x y x x x
sa 071585 tr jslo5285 f 32.5 y x y x x
sa 071485 tr jslo4785 f 40.5 y x y x x
sa 071385 tr jsl04485 f 43.4 y y y x x
sa 071185 tr jsl10585 m 51.0 x y y x x
sa 062885 tr jsl01185 f 35.0 y y y x x
sa 061785 tr jsl10485 f 42.5 x x x x x
sa 060985 mi ac060985 f 63.0 y x y x x
sa 060985 mi ca080985 m 81.0 y x y x x
sa 060985 mi ca100985 m 88.0 y x y x x
sa 060985 mi ca090985 f 71.0 y x y x x
sa 060985 mi ca070985 f 66.0 x x x x x
sa 052985 tr wpp185   f 40.5 x x x x x
sa 052585 ga ag185    m 61.5 x y x y x
sa 040985 mi ca010985 f 80.0 x x x x x
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Steno bredanensis

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st xxxxxx mi ss5885   f xxxxphoto only
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Stenella coeruleoalba

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sc xxxxxx mi ss5585   m xxxxphoto only
sc xxxxxx mi ss4785   f xxxxphoto only
sc xxxxxx xx 169851   x xxxxphoto only
sc xxxxxx xx 169852   x xxxxphoto only
sc xxxxxx xx 169853   x xxxxphoto only
sc xxxxxx xx 169854   x xxxxphoto only
sc xxxxxx xx 17985    x xxxxphoto only
sc 121885 tr wp912    f 77.0 x y x x x
sc 120785 tr wp2312   m 81.0 y y y y x
sc 102285 ko 00000041 f 52.0 x x x x x
sc 091785 tr wp609    m 44.5 y y y x x
sc 091685 tr wp809    m 47.0 y y y x x
sc 091685 tr wp709    f 48.5 y y y x x
sc 091685 tr wp909    f 44.0 y y y x x
sc 091685 tr wp1009   m 51.0 y y y x x
sc 091685 tr wp1109   f 53.0 y y y x x
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sc 091185 ko ac290985 m 39.0 x x x x x
sc 091185 do ac280985 m 44.5 x x x x x
sc 091185 ko ca300985 x 47.0 x x x x x
sc 090985 mi ca180985 f 43.0 x x x x x
sc 090985 mi ca190985 m 40.5 x x x x x
sc 090985 mi ca180985 f 43.0 x x x x x
sc 090885 mi ac100885 f 42.0 x x x x x
sc 090785 mi ca130985 m 49.5 x x x x x
sc 090685 mi ca060985 f 63.0 y x y x x
sc 082785 tr wpp4685  f 73.0 y y y x x
sc 082685 tr wpp4385  m 48.0 y y y x x
sc 082585 tr jsl10785 f 39.0 y x y x x
sc 082185 tr wpp3385  f 50.5 y y y x x
sc 081885 tr wpp2985  m 82.5 y y y x x
sc 081085 tr jsl13285 m 68.5 x x x x x
sc 080985 tr jsl10885 m 46.0 x x x x x
sc 080985 tr jsl10685 f 42.0 x x x x x
sc 080985 tr jsl10985 f 42.0 x x x x x
sc 080985 tr jsl11085 f 49.5 x x x x x
sc 080785 tr jsl11185 m xxxx y y y x x
sc 072485 be ac130785 f 36.5 x x x x x
sc 071785 tr jsl05685 f 83.0 y y y x x
sc 070585 ga ca050785 m 42.0 x x x x x
sc 070485 tr jsl01484 f 41.0 y y y x x
sc 062685 tr jsl00985 m 39.0 x x x x x
sc 062285 tr jsl00685 m 39.0 y y y x x
sc 062085 do ca05085  f 47.0 y y y x x
sc 062085 tr wpp0285  m 66.0 y y y x x
sc 061885 hi ca040685 f 66.0 y x y x x
sc 061785 be cm020685 m 45.0 x x x x x
sc 061885 be cm030685 m 45.0 x x x x x
sc 061785 be cm010685 m 43.0 y y x x x
sc 060485 be al020685 m 35.5 x x x x x
sc 050785 be ac040785 m 75.0 x x x x x
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Stenella longirostris

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sb 101585 mi ca021085 m 90.0 y x y y y
sy xxxxxx do ss6485   f xxxxphoto only
sl xxxxxx be ca080785 m xxxxphoto only
sl xxxxxx be ca070785 f xxxxphoto only
sl xxxxxx ga jsl11885 x xxxxphoto only
sl xxxxxx xx ca22     x xxxxphoto only
sl xxxxxx xx ca21     x xxxxphoto only
sl xxxxxx xx 1707853  x xxxxphoto only
sl xxxxxx xx 1707852  x xxxxphoto only
sl xxxxxx xx 1607851  x xxxxphoto only
sl xxxxxx mi 28A      x xxxxphoto only
sl xxxxxx mi ss4985   x xxxxphoto only
sl xxxxxx mi ss4885   f xxxxphoto only
sl xxxxxx ka ss4685   x xxxxphoto only
sl xxxxxx ka ss4585   x xxxxphoto only
sl xxxxxx mi ss9785   x xxxxphoto only
sl xxxxxx mi ss9685   x xxxxphoto only
sl xxxxxx xx 229851   x xxxxphoto only
sl xxxxxx xx 229852   x xxxxphoto only
sl xxxxxx xx 0610851  x xxxxphoto only
sl xxxxxx xx 0610852  x xxxxphoto only
sl xxxxxx xx 051085   x xxxxphoto only
sl xxxxxx xx 2985     x xxxxphoto only
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Table B2 continued

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sl xxxxxx xx wpp5385  x xxxxphoto only
sl xxxxxx xx wpp5285  x xxxxphotc only
sl xxxxxx xx wpp5185  x xxxxphotc only
sl xxxxxx xx wpp5085  x xxxxphotc only
sl xxxxxx xx wpp4985  x xxxxphoto only
sl xxxxxx tr 1810851  m 66.0 y y y x x
sl xxxxxx ko ca270985 m 66.0 x x x x x
sl xxxxxx ko ca270985 m 66.0 x x x x x
sl xxxxxx tr wpp5485  f 59.0 y y y x x
sl 122585 tr wp212    m 38.0 y y y x x
sl 122385 tr wp512    f 38.5 y y y x x
sl 121585 tr wp1112   f 49.0 x x x x x
sl 121585 tr wp1312   m 71.4 x x x x x
sl 121585 tr wp12112  m 71.4 y y y x x
sl 121585 tr wp1412   f 49.0 x x x x x
sl 121285 tr wp1512   m 68.5 x x x x x
sl 121185 tr wp1612   m 66.5 x x x x x
sl 121085 tr wp1812   m 68.0 x x x x x
sl 121085 tr wp1912   m 67.0 y x x x x
sl 121085 tr wp1712   f 63.0 x x x x x
sl 120885 tr wp2012   m 39.4 x x x x x
sl 120885 tr wp2212   m 66.5 y y y x x
sl 120385 tr wp2412   m 67.0 x x x x x
sl 120385 tr wp2512   m 68.0 y y y x x
sl 120385 tr wp2612   f 63.0 x x x x x
sl 111285 xx jsl13785 m 64.0 x x x x x
sl 111285 tr wp11     m 63.5 x y x x x
sl 111285 tr wp211    m 64.0 y y x x x
sl 110985 do ac320985 f 69.0 x x x x x
sl 110985 ko ac310985 f 50.0 x x x x x
sl 102685 do ca541085 m 70.0 x x x x x
sl 102685 ?? ac551085 m 76.0 x x x x x
sl 102585 mi ca511085 f 73.0 x x x x x
sl 102385 tr 231085   m 38.0 x x x x x
sl 102285 do ss9585   m xxxxphoto only
sl 102285 mi ca381085 f 67.0 x x x x x
sl 102285 mi ca371085 m 68.0 x x x x x
sl 102285 mi ca321085 m 66.0 x x x x x
sl 102285 tr 2210851  f 56.5 x x x x x
sl 102285 xx 22108503 f 51.0 x x x x x
sl 102285 tr 2210852  f 58.0 x x x x x
sl 102285 tr jsl13685 f 67.0 x x x x x
sl 102185 mi ca321085 f 71.0 y x y x x
sl 102185 mi ca321085 m 66.0 x x x x x
sl 102185 mi ca331085 f 71.0 y y y x x
sl 102185 mi ca341085 m 72.0 x x y x x
sl 102185 mi ca351085 f 69.0 y x x x x
sl 102185 mi ca361085 f 69.5 x x y x x
sl 102085 be ca231085 f 65.5 y x y x x
sl 102085 be ca241085 f 75.0 y x y x x
sl 102085 be ca221085 m 59.0 y x x x x
sl 102185 be ca221085 m 59.0 y x x x x
sl 101885 go ca191085 m 69.5 x x x x x
sl 101885 go ca181085 m 70.0 x x x x x
sl 101885 go ca201085 m 72.8 x x x x x
sl 101885 go ca211085 m 74.0 x x x x x
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sl 101885 tr 1810[illegible] m 64.0 y y y x x
sl 101885 tr jsl13585 f 60.0 x x x x x
sl 101785 mi ca101085 m 65.0 x x x x x
sl 101785 ko ca171085 f 74.0 x x x x x
sl 101785 mi ca121085 m 69.5 x x x x x
sl 101785 mi ca151085 m 75.0 x x x x x
sl 101785 mi ca111085 m 64.5 y x y x x
sl 101685 mi ca081085 m 72.0 x x x x x
sl 101685 mi ca071085 f 72.5 y x y x y
sl 101685 mi ca061085 m 66.0 y x y x x
sl 101685 tr 161086   m 38.0 y y y x x
sl 101685 tr wpp5685  m 70.0 y y y x x
sl 101585 tr jsl13885 m 35.0 y y y x x
sl 101585 mi ca051085 f 69.0 y x y x x
sl 101485 mi ca131085 m ref. ca111085
sl 101385 tr 131085   m 59.5 x x x x x
sl 100985 tr wpp5585  f 68.0 y y y x x
sl 100785 tr wpp5385  m 62.0 y y y x x
sl 100685 tr wpp5285  f 69.0 y y y x x
sl 100685 tr 06108502 m 67.0 y y y x x
sl 100685 tr 06108502 m 70.5 y y y x x
sl 100585 tr jsl13385 m 71.0 y y y x x
sl 092285 tr wp409    f xxxx y y y x x
sl 092285 tr wp309    f 69.0 y y y x x
sl 092285 tr wp209    f 61.0 y y y x x
sl 092285 tr wp109    m 70.0 y y y x x
sl 091785 tr wp509    f 70.5 y y y x x
sl 091385 ko ac360985 m 62.0 x x x x x
sl 091385 ko ac370985 m 74.0 x x x x x
sl 091185 do ac330985 m 72.5 x x x x x
sl 091185 do ac340985 m 64?? x x x x x
sl 091185 ko ac310985 f 50.0 x x x x x
sl 091185 do ac320985 f 69.0 x x x x x
sl 091085 ko ai94     x xxxxphoto only
sl 091085 ko ca240985 m 72.0 x x x x x
sl 091085 ko ca250985 m 74.0 y x y x x
sl 091085 ko ca260985 m 65?? x x x x x
sl 090885 mi ca150985 f 66.0 x x y x x
sl 090885 ko ca160985 m 64.0 x x x x x
sl 090885 ko ca170985 m 71.0 x x x x x
sl 090885 tr wp2112   f 49.5 y y y x x
sl 090685 mi ca110985 f 66.0 y x y x x
sl 090685 mi ca120985 f 65.0 x x x x x
sl 090485 mi ca050985 f 68.0 y x y x x
sl 090485 mi ca020985 m 70.0 x x x x x
sl 090485 mi ca030985 m 67.0 x x x x x
sl 090485 mi ca040985 f 73.0 y x y x x
sl 090285 tr wp1309   m 68.0 y y y x x
sl 082885 tr wp108II  m 68.0 y y y x x
sl 082585 tr wpp4185  m 56.5 y y y x x
sl 082385 tr wpp3885  m 62.0 y y y x x
sl 082385 tr wpp3685  m 62.5 y y y x x
sl 082385 tr wpp3785  m 58.5 y y y x x
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Table B2 continued

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sl 082085 tr wpp3285  f 68.0 y y y x x
sl 081985 tr wpp3085  m 53.5 y y y x x
sl 081885 tr wpp2885  f 72.0 y y y x x
sl 081785 tr wpp2785  m 45.5 y y y x x
sl 081685 tr jsl111285 m 65.0 y y y x x
sl 081585 tr wpp2685  m 52.5 y y y x x
sl 081585 tr wpp2385  m 68.0 y y y x x
sl 081585 tr wpp2285  m 69.0 y y y x x
sl 081585 tr wpp2185  m 69.0 y y y x x
sl 081485 ne ac120885 m 62.5 x x x x x
sl 080885 tr jsl11385 f 40.0 y y y x x
sl 080785 tr jsl11485 f 54.0 y y y x x
sl 080785 do jsl12085 x xxxxphoto only
sl 080785 be jsl11985 x xxxxphoto only
sl 072985 tr jsl08685 m 43.0 x x x x x
sl 072985 tr jslo8585 m 67.0 x x x x x
sl 072785 tr jsl08385 m 46.0 y y y x x
sl 072685 tr jsl11585 f 62.5 x x x x x
sl 072585 be ca210785 m 71.0 y x y x x
sl 072585 be ac220785 m 59.0 x x y x x
sl 072585 be ca150785 m 79.0 y x y x x
sl 072585 tr jsl08185 m 61.0 y y y x x
sl 072585 be ca160785 m 56.5 x x x x x
sl 072585 be ca230785 m xxxx x x y x x
sl 072485 tr jsl08085 m 60.5 y y y x x
sl 072385 tr jsl07685 m 51.0 y y y x x
sl 072285 tr jsl07485 m 39.5 y y y x x
sl 072285 tr jsl07385 m 40.5 y y y x x
sl 072285 tr jsl07285 m 68.0 y y y x x
sl 072185 tr jsl06885 m 53.4 y y y x x
sl 072185 tr jslo6985 m 49.0 y y y x x
sl 072185 tr jsl07085 m 67.5 y y y x x
sl 072085 tr jsl06585 f 42.5 y y y x x
sl 072085 tr jsl06485 m 66.5 y y y x x
sl 071985 tr jsl06285 m 62.0 y y y x x
sl 071985 tr jsl06185 f 37.5 y y y x x
sl 071885 tr jsl06085 m 67.0 y y y x x
sl 071785 tr jsl05785 m 38.4 y y y x x
sl 071785 tr jsl05585 f 41.4 y y y x x
sl 071685 tr jsl05185 f 53.5 y y y x x
sl 071585 tr jsl08785 f 62.5 y y y x x
sl 071585 tr jsl04985 m 66.5 y y y x x
sl 071585 tr jsl05085 m 69.5 y y y x x
sl 071585 tr jsl04885 m 66.0 y y y x x
sl 071385 tr jsl04385 m 48.0 y y y x x
sl 071385 tr jsl04285 f 59.0 y y y x x
sl 071185 tr jsl03885 m 40.5 y y y x x
sl 071085 tr jsl03485 m 54.0 y y y x x
sl 071085 tr jsl03585 m 51.5 y y y x x
sl 070985 tr jsl02985 m 59.5 y y y x x
sl 070985 tr jsl03085 f 53.0 y y y x x
sl 070885 be ac060885 f 74.0 x x x x x
sl 070885 be ca070885 m 56.5 x x x x x
sl 070885 tr jsl02785 m 52.2 y y y x x
sl 070685 tr jsl02085 m 42.0 y y y x x
sl 070585 ga ca060785 f 48.0 y x y x x
sl 070485 tr wpp1385  m 64.5 y y y x x
sl 070385 tr wpp1185  m 71.5 y y y x x
sl 070285 tr wpp1085  m 68.5 y y y x x
sl 062985 tr jsl01285 m 46.5 y y y x x
sl 062785 tr jsl01085 m 70.0 y y y x x
sl 062485 tr jsl00885 m 43.5 y y y x x
sl 062385 tr jsl00785 m 59.0 y y y x x
sl 062185 tr jsl00485 f 42.5 y y y x x
sl 061285 tr jsl00285 m 45.5 x x x x x
sl 060885 be ca030885 m 58.0 x x x x x
sl 052985 tr jsl00185 f 40.5 x x x x x
sl 052785 ha rg0485   f 69.5 x x x x x
sl 052785 ha rg0385   f 73.4 x x x x x
sl 052785 ha rg0185   m 69.0 x x x x x
sl 052785 ba rg0285   f 68.5 x x x x x
sl 052685 mi cm0185   f 44.0 x x x x x
sl 052685 ml ag0285   m 47.5 x x x x x
sl 050885 ta rg010585 m xxxx x x x x x
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Tursiops truncatus

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tr xxxxxx xx 28685    x xxxxphoto only
tr 102485 mi ca491085 f 88.5 y y y x x
tr 102485 mi ca501085 f 88.0 x y x x x
tr 102385 mi ca461085 m 117. y x y x x
tr 102385 mi ca451085 m 88.5 y x y x x
tr 102385 mi ca441085 f 100.5y x x x x
tr 102285 do ca391085 f 106. x x x x x
tr 102085 be ca261085 f 105. x y x x x
tr 102085 be ca271085 f 58.0 x x x x x
tr 091785 ki ac380985 f 83.0 y y y x x
tr 090785 mi ca140985 m 109. y x y x x
tr 082785 tr wpp4585  f 52.5 y y y x x
tr 082785 tr wpp4785  f 101.5y y y x x
tr 082485 tr wpp4285  f 104. y y y x x
tr 082485 tr pp3985   m 103. y y y x x
tr 081485 ne ac110885 f 85.5 x x x x x
tr 081485 ne ca130885 f 48.0 x x x x x
tr 081485 ne ca140885 m 51.0 x x x x x
tr 080985 tr jsl13085 m 51.5 x x x x x
tr 080985 tr jsl13185 f 93.0 x x x x x
tr 080685 be ca040885 m 67.0 x x x x x
tr 080685 be ac050885 f 97.0 y y y x x
tr 072585 be ca140785 m 85.0 y x x x x
tr 072585 be ca072085 f 95.0 y y y x x
tr 072585 tr jsl12985 f 60.5 y y y x x
tr 072485 tr jsl12885 f 53.5 y y y x x
tr 071685 tr jsl12785 f 73.0 y y y x x
tr 070985 tr jsl12685 f 51.0 y y y x x
tr 061985 tr jsl12585 m 95.5 y y y x x
tu xxxxxx xx ca200785 x xxxxphoto only
tu xxxxxx xx 1607852  x xxxxphoto only
tu 080785 ne jsl12385 x xxxxphoto only
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This appendix includes some specimens collected before the start of the NARA/UNEP project by W. P. Prematunga, A. Alling and S. Leatherwood. It does not include some specimens examined late in 1985 or early in 1986. Though the latter are referred to in the monthly reports, no details are provided.

Gillnetting is the fishing method of choice in Sri Lanka, and its use is growing. Unless care is taken to moderate the growth of the fisheries and their impacts on marine resources, including mammals, the future could be difficult for these young aspiring fishermen from Mirissa and for their counterparts elsewhere in the country. *(Photo S. Leatherwood)*