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WEALTH FROM THE SEAS

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VALUABLE LIVING RESOURCES FROM OUR SEAS

DR. PAULINE DAYARATNE
Director, Marine Biological Resources Division
National Aquatic Resources Agency

Introduction

Sri Lanka being an Island has access to sea right round through a coast line of 1760 km. Sri Lanka declared its Exclusive Economic Zone (EEZ) in 1976 and the exclusive marine fishery rights was established over 516,000 sq km. This ocean area is a wealth to the nation with different kinds of living organisms ranging in size from microscopic planktons to huge marine mammals like whales. At present the valuable resources harvested from our seas are the fishery resources including fish and many other resources like shell fishes (prawns and lobsters) and mollusc (squid & cuttlefish etc.). Fish is the most important source of animal protein in Sri Lanka. It provides about 60% of the animal protein and about 13% of the total protein in the diet. Annual per capita consumption of fish has increased to about 17 kg in 1987.

Around 2500 MT consisting of highly valued fish products such as prawns, lobsters, cuttlefish, beche-de-mer, shark fins, shark liver oil are exported to countries such as Japan and those of EEC (European Economic Commission) each year.

Fisheries

Sri Lanka has been using the resources from the ocean since time immemorial. However, during the past few decades the fishing industry has undergone significant changes due to the development activities that has taken place particularly in the fisheries sector. Before the 1950's, the fishing in Sri Lanka was a traditional one, with beach seiners (Ma-del) as the main gear (Figure 1). This is a bag like net with long wing like structures attached to long ropes. The total length of the beach seine net sometimes exceeds 4 km. These are operated by flat bottommed log crafts called Madel Parus. In early 1950's there were about 10,000 such units operating right round the island. A large number of fish species are caught by this gear and the area of fishing is limited to the inshore waters within 2-4 km from the shore. Of the species caught by the gear the sardines (Hurulla and Salaya), Indian mackeral (Kumbalawa) Pony fish (Karalla), Anchovies (Halmessa), other small pelagic fish and the young ones of the large fish such as Seer fish (Thora) Queenfish (Kattawa) and Tuna (Balaya, Alagoduwa, Atawalla) were form the dominant groups (Figure 2). At that time, the production by this gear contributed to about 90% of the total marine fish production. The other gear that contributed to the remaining 10% were the hand line, pole and line, gillnets and other stationary gear like stake nets, pound nets etc, operated mainly by the traditional crafts like log rafts (Teppam) and dug outs (Orus and Vallams).

A major change took place in the fishing industry in late 1950's, with the introduction of the mechanisation scheme. With the mechanisation, some of the traditional crafts were equipped with outboard engines and some new crafts with outboard and inboard engines were introduced. With these changes, fishermen could venture into a greater distance from the shore than before and as a result the fishing area as well as the efficiency of gear increased and the production from the marine sector boosted up. With the mechanisation, drift gillnet fishing became more popular and at present more than 90% of the marine production is taken by the gillnets. Gillnet is a wall of netting hanged in the water column and the fish of a particular size (which is determined by the mesh size of the net) get gilled (Figure 3). This is the most common gear now used in Sri Lanka for both small pelagic and large pelagic (Pelagic fish are those found in surface or near surface waters). At present gillnets are operated by traditonal crafts like log raft (Teppam) and dugouts but the major production comes from the introduced crafts namely the 17'-22' FRP (Fibre Reinforced Plastic) and the 3.5 ton class of boats. The other important gear used at present are the long line, trolling line, pole and line, hand line (mainly used for tunas & large pelagics) (Figures 4 & 5) and purse seine (which is a developing fishery to catch mainly the small pelagics) (Figure 6). Beach seine fishing has declined due to the intense use of labour and high investment. In addition to these fishing methods trawling is being practised in certain areas (Mannar, Puttalam, Negombo etc.) targetting mainly prawns. In some areas (Negombo) these trawls are still operated by sail driven dug out (orus) and in Chilaw, Kalpitiya and Puttalam mechanised boats (3.5 t & 11 t boats) are used for trawling (Figure 7).

Among other fishing gear used in Sri Lanka are the bottom set gillnets, trammel nets, etc. which are used mainly for bottom fish like snappers, groupers and lobsters. As in other tropical fisheries, in Sri Lanka too, we have a multi-

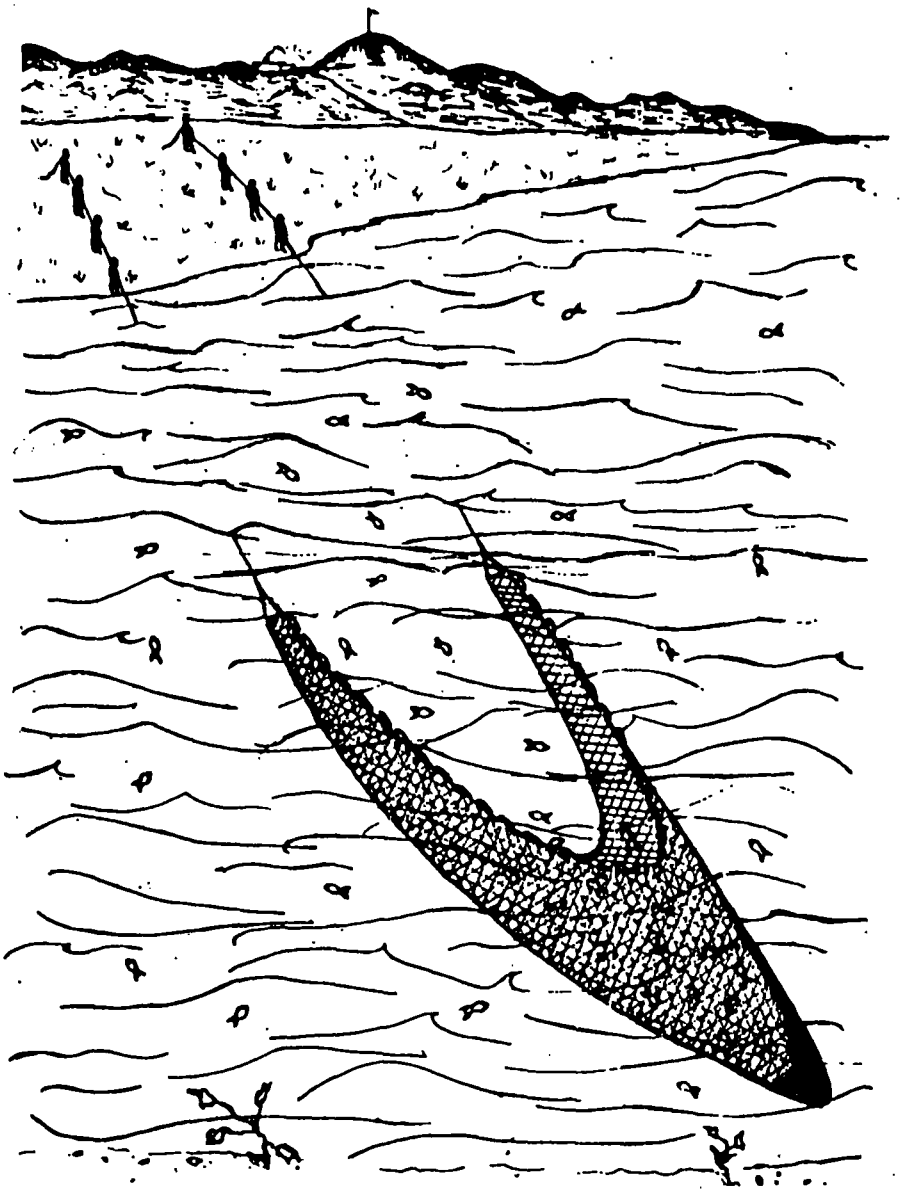


Figure 1: Beach seine operation - A traditional fishing method

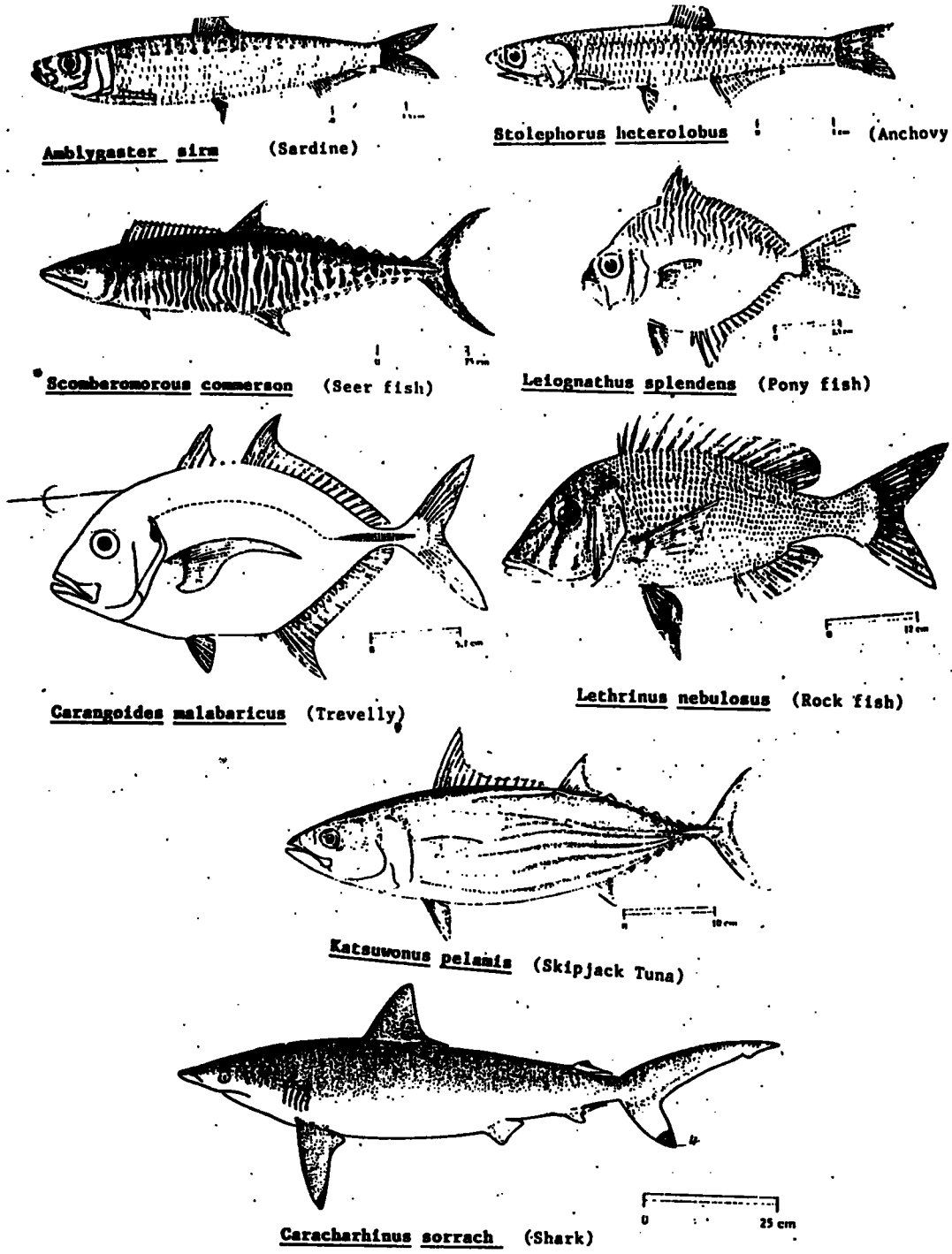
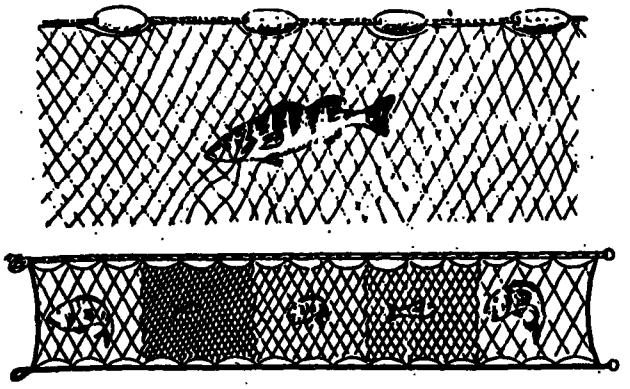
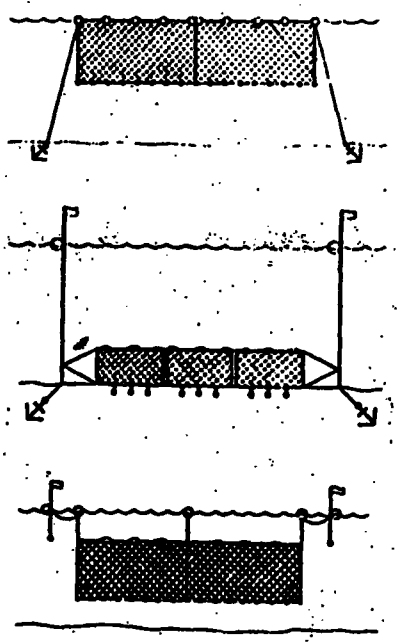


Figure 2: Some commercially important marine resources from our seas.



The mesh size of a gillnet determines the size of the fish caught.



Gillnets can be used at the surface, midwater or on the bottom, either anchored or free floating, depending on the target fish.

Figure 3: . Gill nets - The most common fishing gear used in Sri Lanka.

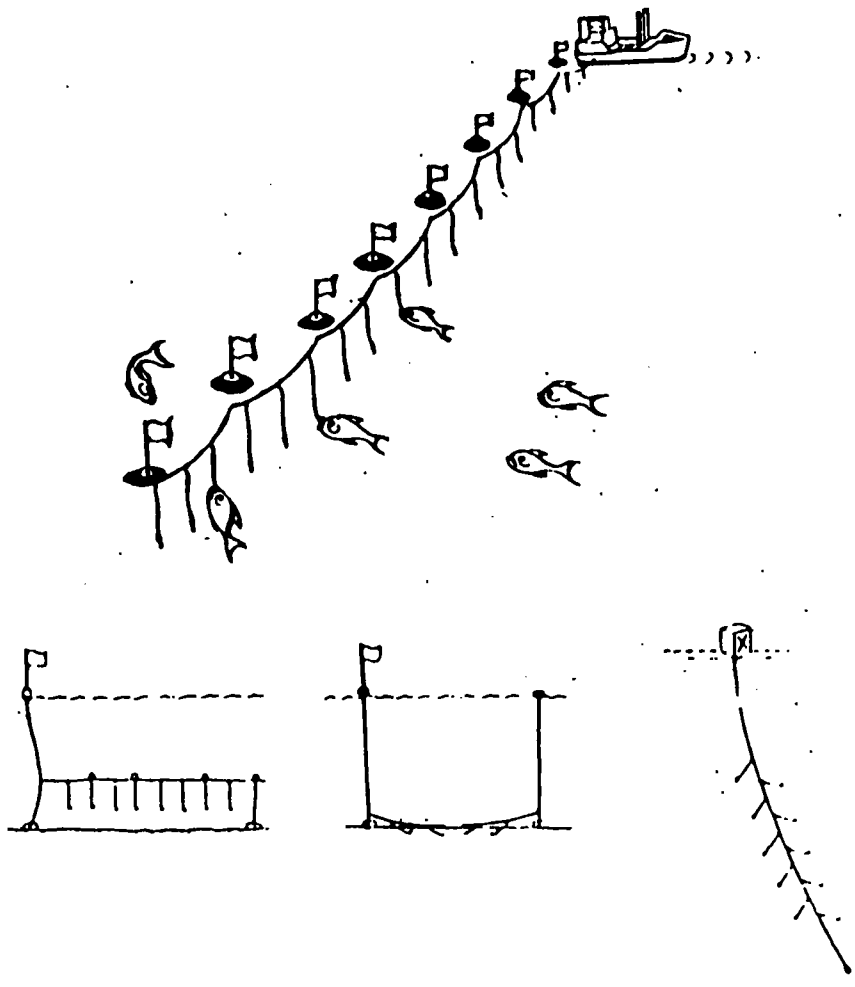


Figure 4: Longlines Used mainly for large pelagics in Sri Lanka.

Longlines of baited hooks can be deployed at the surface, midwater, at the bottom or vertically in the water column.

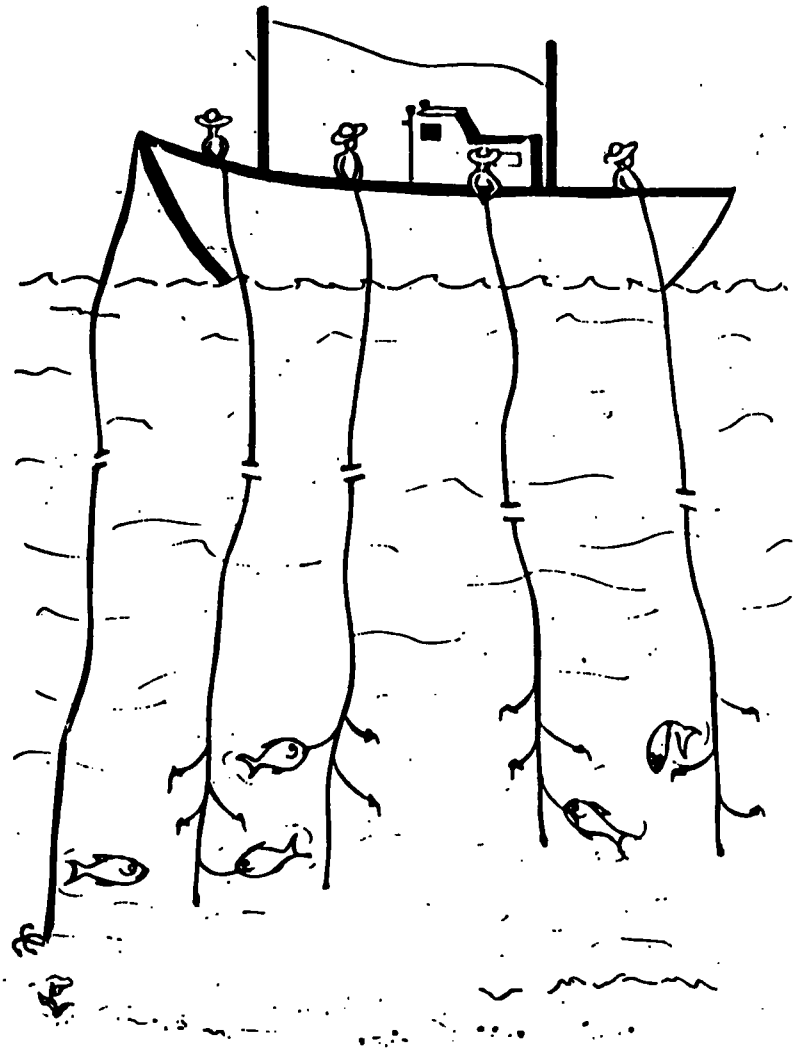


Figure 5: Handlines - A common gear to catch bottom fish. miltiple baited hooks on a line cna increase the catch.

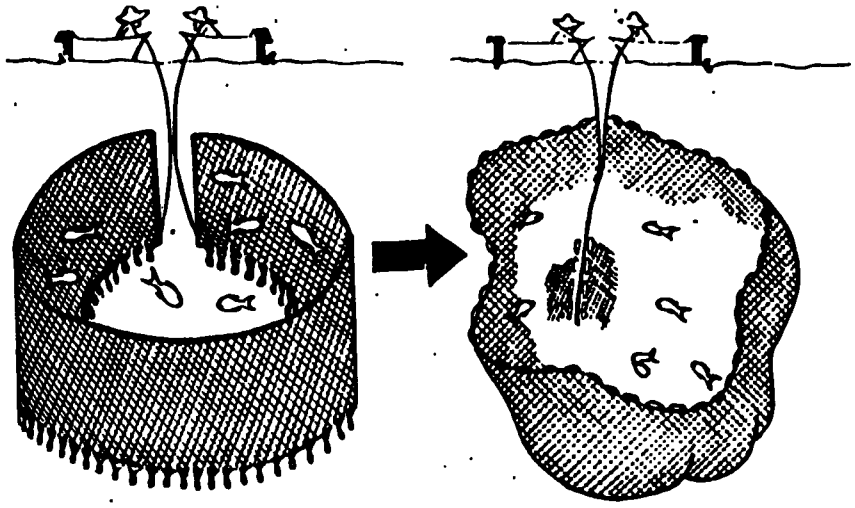


Figure 6: Purse seining - A recently developed fishing method targetting small pelagics.

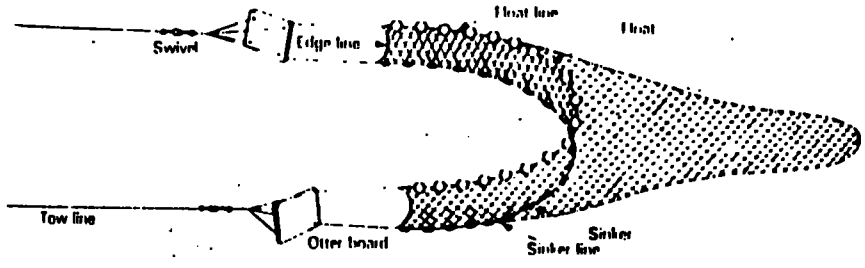


Figure 7: Trawl net with otter boards: targetting mainly Prawns.

species, multigear fisheries. That is in one particular gear more than one species are caught and that more than one gear is used to exploit the same species. Table 1 gives the type of craft and gear used in Sri Lanka with the recent statistics.

Table 1 : Type of Craft and Gear used in Sri Lanka

Craft	Gear	Number (1984)
1. Traditional crafts (Mechanised or non mechanised) Dugout canoes, Teppams, Ma-del Paru.	Drift Gill nets Pole & Line Troll Line Hand Line Beach-seine Purse-seine	14,387 (NM) 3757 (M)
2. 5-6.5 m Fibre glass boats	Drift Gill nets Long line Troll line Hand line Purse-seine	 6882
3. 9 m boats (3.5 ton) (Wooden & Fibre glass hulls)	Drift Gill net Long line Troll line Hand line Pole & Line Purse-seine	 2829
4. 11 m boats (NW-AbuDhabi boats)	Drift Gill Net Long line	 80
		27,935

Other Gear - Cast net
Trammel net
Bottom set gill net
Traps

NM = Nonmechanised
M = Mechanised

Resources

Resources in our seas could be categorised into three major groups depending on the distance from the shore where they are found or the depth of the water column. They are

1. Coastal Resources (resources within the continental shelf region)
2. Offshore resources (resources in the offshore area from the edge of the continental shelf to a distance of about 100 miles from the shore)
3. Deep sea resources (resources in the deep sea >200 M)

Coastal Resources

More than 95% of the marine production comes from the coastal waters and the commercially important groups are :

1. *Small pelagics*

These are the small inshore varieties. Over 30 species belonging to 8 families are utilised. Primarily harvested ones are the sardines *(Sardinella* spp.), anchovies *(Stolephorus* spp.), mackeral *(Rastrelliger kanagurta)* Indian scad *(Decapterus* spp.), Pony fish *(Leiognathes* spp.), small carangids, flying fish *(Exocetidae),* half beaks *(Hemiramhidae)* and barracudas *(Sphyraena* spp.). With the increasing fishing pressure in the coastal area there is a general belief that Sri Lanka has now reached the maximum level of exploitation of the coastal resources. However, some coastal resources still remain underutilised. Among these are the cephalopod resources (squid and cuttlefish), half beaks (Hemiramphidae) and the sardines in the southern region.

2. *Demersals*

These are the species inhabiting the sea bottom or the waters near the bottom. About 215 demersal species belonging to 55 families have been identified around Sri Lanka. About 10 groups are predominant and commercially important. Of the most important ones are the emperor fish (Lethrinidae), snapers (Lutijanidae), Jacks Trevallies (Carangidae), groupers (Seranidae), grunts sweetlips - (Pomadasidae) and sea catfish (Ariidae). Trawling is the most important gear in catching the demersals followed by handline and bottom set gillnets. The northern part of Sri Lanka between 8^0 and 10^0 contribute to about 80% of the total demersal production. The most productive depth range is 20-60 m for valuable demersals.

3. *Prawns*

About 10 species of shrimps have been recorded among Sri Lanka commercial catches and five species make significant contribution. They are

White Prawn *(Penaeus indicus & P. merguensis)*

Green tiger *(P. Semisulcatus),*

Brown tiger *(P. monodon)*

and Small prawns *(Metapeneus dobsoni)*

Trawling and bottom set gillnets are the most common gear used for catching prawns.

4. *Lobsters*

Six species of lobster *(Panilurus* spp.) are fished wherever reefs and rocky areas exist around the country. Trammel nets and bottom set gill nets are used to catch them. Due to the heavy demand from the tourist hotels and export market this resource has been intensively exploited. Their production has shown a decline from 2,560 t in 1977 to 608 t in 1986.

5. *Cephalopods - (squid & cuttlefish)*

In Sri Lanka, there is no major fishery for these varieties at present and the main contribution comes as incidental or bycatch of purse seine, beach seine, trawl fishery etc. Seasonally small artisanal crafts conduct night fishing in areas like Trincomalee, Dondra and Galle for squid with gas lamps and scoop nets. Following commercially valuable species have been identified.

Cuttle fish - *Sepia pharoanis*

„ - Sepia aculeata

Squid - *Doryteuthis singhalensis*

Squid - *Loligo duvauceli*

Squid - *Notatodorus sloani*

6. *Large Pelagics*

The large pelagics found in the coastal waters on the west, south and east coasts of Sri Lanka are primarily the skipjack *(Katsuwonus pelamis),* yellowfin tuna *(Tunnus albacares),* kawakawa *(Euthynnus affinis),* frigate tuna *(Auxix* spp.), king mackeral *(Scomberomorous* spp.), billfish *(Isthiophoridae and xiphidae)* and pelagic sharks *(carchardae and sphyrinidae).* Most of these species are highly migratory and are distributed in the offshore waters but show seasonal migrations towards the coastal area.

Offshore resources

These are the resources found in the offshore area - area beyond the continental shelf margin. In Sri Lanka these resources are harvested by a fleet of about seventy, 11 ton boats and about seven hundred 3.5 ton boats which are modified for multiday fishing. These boats remain in sea for about 6-7 days and sometimes reach as far as 150 miles from the shore.

The resources exploited at present are primarily the large pelagic like tunas, billfishes, pelagic sharks and oceanic species of flying fish. Due to their highly migratory nature most of these fish stocks are shared by more than one nation. Not only the coastal states of the Indian ocean but other industrial fishing nations like France and Spain are engaged in fishing for these resources particularly in the western Indian Ocean. As the fishing in international waters outside the Exclusive Economic Zone (EEZ) too has an impact on these common resources, many coastal countries have shown concern over this and have made requests to FAO, to form a new body for tuna management in the Indian Ocean.

Deep Sea Resources

The only fishery that exists for the deep sea resources is the bottom set longline fishery for gulper sharks (*Centrolophorus* spp.) which is exploited for liver oil. This fishery is carried out in a depth of 200-300 m. Many other deep sea resources have been indentified by previous resource surveys. Of these the important resources are the deep sea lobsters (*Peulurus* spp.) and shrimps (*Aristeus* spp. and Heterocarpus spp.). Occurrence of deep sea cuttlefish and squids also have been indicated. However, all these varieties have no established market anywhere and hence the economic viability of exploiting these resources remains doubtful.

Present Production and Future Plans

The total marine production in Sri Lanka in 1989 was 157, 411 tonnes. Of these around 60,000 t were small pelagics, 30,000 t large pelagics, 20,000 t demersal, 4700 t prawns and 660 t, lobsters. The national development fisheries plan have determined the following production targets.

Year	1991	1992	1993	1994
Coastal	153,570	159,794	166,102	172,746
Offshore	27,500	29,000	30,500	32,000
Deep sea	9,000	12,000	15,000	18,000
Total	190,070	200,794	211,602	222,746

It is hoped to achieve the targets by increasing the harvest from the unutillised or underutilised resources in the coastal area and by increasing the production from the offshore and deepsea areas by introducing more boats for offshore fishing. Due to the high capital costs and the technologically advanced vessels, equipment and skills required in the deep sea sector, the government has identified this sector as more suited for foreign collaboration.

Management of the Resources

The living resources in the sea are not unlimited. There is a maximum level at which one could exploit a resource on a sustainable basis. This is called the maximum sustainable yield or MSY. Many resource surveys carried out around waters of Sri Lanka have estimated the MSY levels of different stocks. To exploit the resources at the MSY level the existing fisheries is well monitored by a sampling programme conducted by the NARA scientists. Management of fisheries is done mainly by regulation of fishing effort (no. of boats engaged in a particular fishery), mesh size and the fishing areas. The stock assessment studies carried out by the fishery biologist are of immense use to understand the present level of exploitation of the resources. To increase the production from out seas the underutilised and unutilised resources have to be harvested and the optimally utilised resources have to be well managed.

A well managed fishery would keep generations fed with fish as a source of animal protein.

CRAB RESOURCE OF SRI LANKA

S.C. JAYAMANNE
National Aquatic Resources Agency

Introduction

Sri Lanka being an island, has a coastal line of 1760 km dotted with estuaries and lagoons. The coastal areas of Sri Lanka are rich in fish, crustacean and molluscan fauna. Crabs, lobsters and prawns are popular and economically important crustaceans which contribute to the wealth of the sea. A great proportion of economically important crustaceans are marine or partially marine depending on the sea for the existence of their young.

Along with the rapid expansion of the prawn industry in the west coast over the last decade crabs have generated a remarkable position as a foreign exchange earner despite the ever existing high demand for crabs in the local market. Crabs in fact, has a great market acceptancy in the west as well as in the east. It is now exported to many countries, Japan, Singapore, Malaysia, South Korea, Maldives, United Kingdom and Australia although not in bulk.

The purpose of this article is to highlight some important aspects ot the crab resource in Sri Lanka, particularly in the Negombo lagoon which is the most popular place for crabs in the country. Unfortunately there had been very few studies in the past on crabs of Sri Lanka (almost none besides observations of some authors and few unpublished reports) and the only comprehensive study made so far on this resource was the study conducted by the present author on the biology and economics of the mud crab, *Scylla serrata* in the Negombo lagoon during 1985 - 1989 (this study was financed by NARESA). This study has revealed a vast amount of information on the crab resource covering biological aspects; such as taxonomy, growth, food, and reproduction etc. and economic aspects; such as population dynamics, fishery, and status of the resource etc.

Crabs are a diverse group of crustaceans inhabiting both marine and fresh water environments. Predominantly they are marine or brackish water and often both. There are 54 species of crabs found in brackish water and marine habitats of Sri Lanka. They belong to families Calappidae, Leucosidae, Portunidae and Grapsidae. Portunid crabs are the most important group of crabs as they comprise the edible ones which are promising candidates for aquaculture.

Crabs of Economic Importance

In Sri Lanka there are three species of edible crabs popular among all communities in the country. They are in the order of preference *Scylla serrata* (Forskal), *Portunus pelagicus* and *Portunus sanguinolentus*. The most important of all crabs is *Scylla serrata* and to some extent Portunus pelagicus. They are marine and brackish depending on the sea for part of their life cycle and lagoon for the rest.

Scylla serrata is commonly known as the "Kalapu kakuluwa" (mangrove crab) or 'Ala man kakuluwa' and is of great demand, in local and export markets. It is a large crab which can grow up to about 25 cm in carapace length and 1.5 kg in weight.

Portunus pelagicus is mostly found in the sea and comes to the market as sea catches, but is also caught in the lagoon. *Portunus pelagicus* also grows to a fairly large size of about 10 - 15 cm in carapace length, and attains a weight of about 500 - 750 g.

Crabs Habitat

The crabs are generally distributed in the sea and lagoons/estuaries of Sri Lanka. Females spawn in the offshore area and the larval stages live and grow in the sea. They enter the lagoon at a much larger larval stage known as megalopa which is a benthic form about 4.5 mm long. The megalopa usually inhabits the shallow area of the lagoon and feeds on zooplankton and detritus. They are also cannibalistic preying on newly molted megalopa larvae. The megalopa molts finally into a small crab.

The small crabs measure about 2 - 7 cm in carapace length and inhabit sea grass beds and mangrove roots. They usually hide in sheltered areas in intertidal and subtidal paths of the lagoon.

Sub adult of *Scylla serrata* (7-13 cm carapace width) move more freely and inhabit small creeks and open areas of the lagoon. They are predominantly benthic but they also move up and down in deeper areas and even in intertidal

areas. The bigger crabs (above 13 cm) occupy deeper subtidal areas and move into intertidal areas for feeding but not to the extent that sub adults moves. Large crabs occupy a prominent position in the macro fauna of the deeper benthic zone.

Portunus pelagicus is in the sea for most part of the year, and comes to the lagoon during some months of the year. They are generally found in areas of high salinity (near mouth of the lagoon). Not much research has been done on this species in Sri Lanka.

Distribution

Scylla serrata is found in almost all the lagoons/estuaries in Sri Lanka. They are abundant in lagoons and estuaries of the west, north, and east coasts. The presence of *Scylla serrata* in the lagoons and estuaries of the south coast has also been reported. Crabs are mostly fished in Jaffna, Kokkilai, Nayaru, Batticaloa, trincomalee, Puttalam, Chilaw, and Negombo lagoons.

Methods of Exploitation

Baited traps are the most popularly used gear for capturing crabs in most of the lagoons in the country. This is a low cost device, designed specially for fishing crabs and is the only gear that is specifically operated for crabbing.

The fishermen of Negombo, Chilaw, Puttalam, Batticaloa, Jaffna, Nayaru and Kokilai use baited traps as the main gear against crabs but those in Trincomalee lagoon use only gill nets. In the other lagoons mentioned too the crabs are caught by Drift gill nets but as by-catches of prawn landings. In Negombo, the fishermen also operate brush-piles which too land a certain proportion of crabs along with prawns.

Seasons of Fishing

Crabs are caught throughout the year in most of the lagoons. In the lagoons of the west coast of Sri Lanka November/December is the peak period. Catches are usually low during June, July and August. The above seasonality is not known for other lagoons in the country.

Production of Crabs

Average production of crabs in Sri Lanka per annum is around 1200 metric tons. This includes both *N. pelagicus* and *Scylla serrata*. Production of crabs in the Negombo lagoon during 1985 - 1989 varied between 35 - 45 metric tons per annum. The amount exported from Sri Lanka per annum varied from 939 metric tons in 1985 to 375 metric tons in 1989. The average foreign exchange earning during this period was approximately Rs. 34.2 million (range Rs. 26.9 - 37.7 million).

Present Status of the Fishery

The crab fishery is showing a fast decline in the Negombo lagoon as a result of heavy exploitation in the absence of any form of management. The high price offered for the commodity has attracted fishermen and they are all out to land as much crabs as possible irrespective of the size, age or sex. The mesh size of the nets used are small that they catch crabs of very small size threatening the balance of the resource. The current situation is that about 80% of the total landings comprise of immature crabs, which are yet to contribute to their own generation. Selling immature crabs for local consumers is now a common feature in the Negombo market. The catch per unit effort is showing a declining trend from 1985 onwards. This indeed is a result of over fishing which is threatening the existence of the resource.

Future Perspectives

Crab resource is an asset to the country which can be brought to the status of a major foreign exchange earner by efficient management. As in Australia it is essential to impose legal barriers prohibiting the use of nets with small mesh size that can capture immature crabs. More often legal barriers do not serve any purpose if the people concerned are not properly sensitised on the issue. If crab fishery fails it is the fishermen who will be immediately and directly affected. Therefore, education through extension services and mass media can do a great service to safeguard this invaluable resource. Crab culture is another area which warrant feasibility studies.

CORALS AND THEIR VALUES

U. WEERAKKODY
Department of Geography
University of Ruhuna

Corals are environmental ornaments when they develop into colonies, reefs or ledges. A coral is a lime-secreting marine polyp, mainly living in colonies in inter-tropical seas. Since corals can only grow in clear, well oxygenated water, with plentiful supplies of microscopic life as food, they are restricted to undisturbed marine environment. They cannot live in fresh, brackish or running water. The temperature of water should be above 20^0C (68^0F), therefore, growth of corals is widespread in tropical seas between the latitudes of 30^0N and 30^0S. They grow, however, in the coastal water at a depth not exceeding 45-55m (20-30 fathoms).

Corals grow into elongated or circular-shaped colonies upon submarine basements. Consequent growth of corals one upon another forms a reef. A reef is composed of coral limestone, the accumulated skeletons of coral polyp colonies. The three main types of reefs are (a) fringing reef, (b) barrier reef and (c) atoll. Fringing reef is defined as an uneven platform of coral, fringing and attached to the coast, with a shallow narrow lagoon between it and the mainland, or with no lagoon at all, and with its seaward edge sloping steeply into deep water (Figure 1). Barrier reef is a coral reef parallel to the coast but separated by a lagoon of considerable depth and width. Atoll can be explained as a circular elliptic or horse-shoe shaped reef enclosing a lagoon. The first two types of coral reefs are abundant around the island of Sri Lanka. The well-developed coral reefs can be observed along the SW coast which stretches from Colombo to Tangalle. Scattered coral reefs are found along the Kalkuda and several other coastal tracts of NE Sri Lanka (Figure 2).

Origin of Coral Reefs of Sri Lanka

Even though the living coral reefs are abundant in submarine areas, some dead reefs can be observed along the coastal hinterland of the SW coast. These corals are buried by a 2-6 m thick soil layer in the Akurala-Midigama coastal tract. Field observations carried out by the author unravel that the buried corals are of two types: 1) accumulated debris washed off onto former shore zones by storm surge: and 2) reefs developed into successive levels when the sea level of Sri Lanka rose upto +5 m during the period between 4000 and 6000 years before the present (Weerakkody, 1988). When the present coastal land areas were submerged by the high sea level throughout a long period of time, the coral reefs began to grow along the SW coast. They emerged afterward due to the subsequent fall of sea level. The oldest coral reefs of Sri Lanka are from the SW coast and their age is marked as around 6000 years before the present. The Hikkaduwa living reef exhibits successive levels of growth from east to west. The author argues that the successive levels indicate a marine regression which occurred 4000 years before the present (Weerakkody, 1990).

Uses and Exploitation of Coral Reefs

The coral reefs of Sri Lanka, as elswehere in the world are attractive ecosystems which are utilized for promoting tourism, fishing, scientific education, etc. of a nation. Unfortunately, they are used in Sri Lanka under destructive economic practices. The corals commonly known as limestone (hunugala) are used as raw material for fertiliser and ceremic industry and as a construction material. Sources of lime in Sri Lanka are threefold; a) the Miocene limestone mined from the northwest area and Jaffna peninsula, b) the crystalline limestone derived from quarries of the Central Highlands, and c) corals mined and collected from SW and NE Sri Lanka (for details, see Cooray, 1984). About 50% of the total production of limestone comes from corals mined in the southwestern part of the island. Coral mining activities of this part can be divided into three categories, namely:

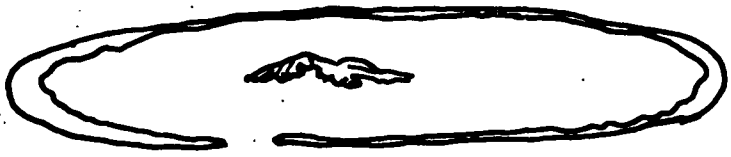
1) gathering corals by breaching living reefs situated along the present onshore area,

2) collecting debris washed off onto the shore,

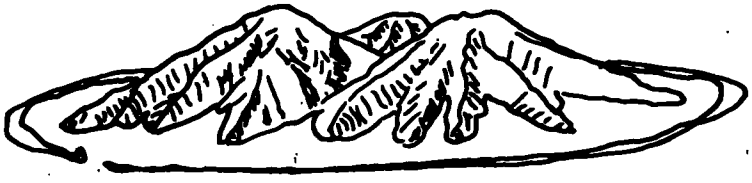
3) mining buried coral reefs which are preserved in the coastal hinterland.

The corals produced by the breaching of living reefs is a major environmental problem of Sri lanka. This malpractice causes several disturbunces and geomorphological imbalances of the coast. Destruction of living reefs degrades marine habitats which are characterized by breeding grounds of fish and many other marine organisms. On the other hand, reefs act as shields against the sea waves beating towards the beach. Therefore, they protect the coast against high impact of wave energy. Breaching of reefs enhances coastal erosion.

FRINGIN REEF



ATOLL



BARRIER REEF

Figure 1: Three categories of coral reefs. See for details, Lobeck (1967)

The mining activities concentrated upon buried coral reefs along the hinterland create some environmental problems such as land pollution, soil degradation, health hazards, etc. Mined holes are not filled again by man or nature. Therefore, they remain as stagnant bodies of brackish water and help in breeding activities of mosquitoes. Several deaths caused by drowning in these water bodies have been reported during the past decades. Other damage to the environment induced by mining activities is the loading of subsoil onto the topsoil. The subsoil spread upon the surface of the ground cannot be used for agriculture because the subsoil lack humus and nutrients which are utilized by plants. However, more than 25,000 people earn their living from mining activities. They produce some 9000-11,000 tones of corals annually.

The quantity of corals produced by the above mentioned three categories of coral miners is shown in Table 1.

Table 1: Annual Production of Corals along the Coastal Zone

Type of activity	Amount in tons	Percentage
Mining buried coral reefs	10,400	57.58
Collecting debris on the shore	5377	29.78
Breaching living reefs	2282	12.62

Source: Economic Review

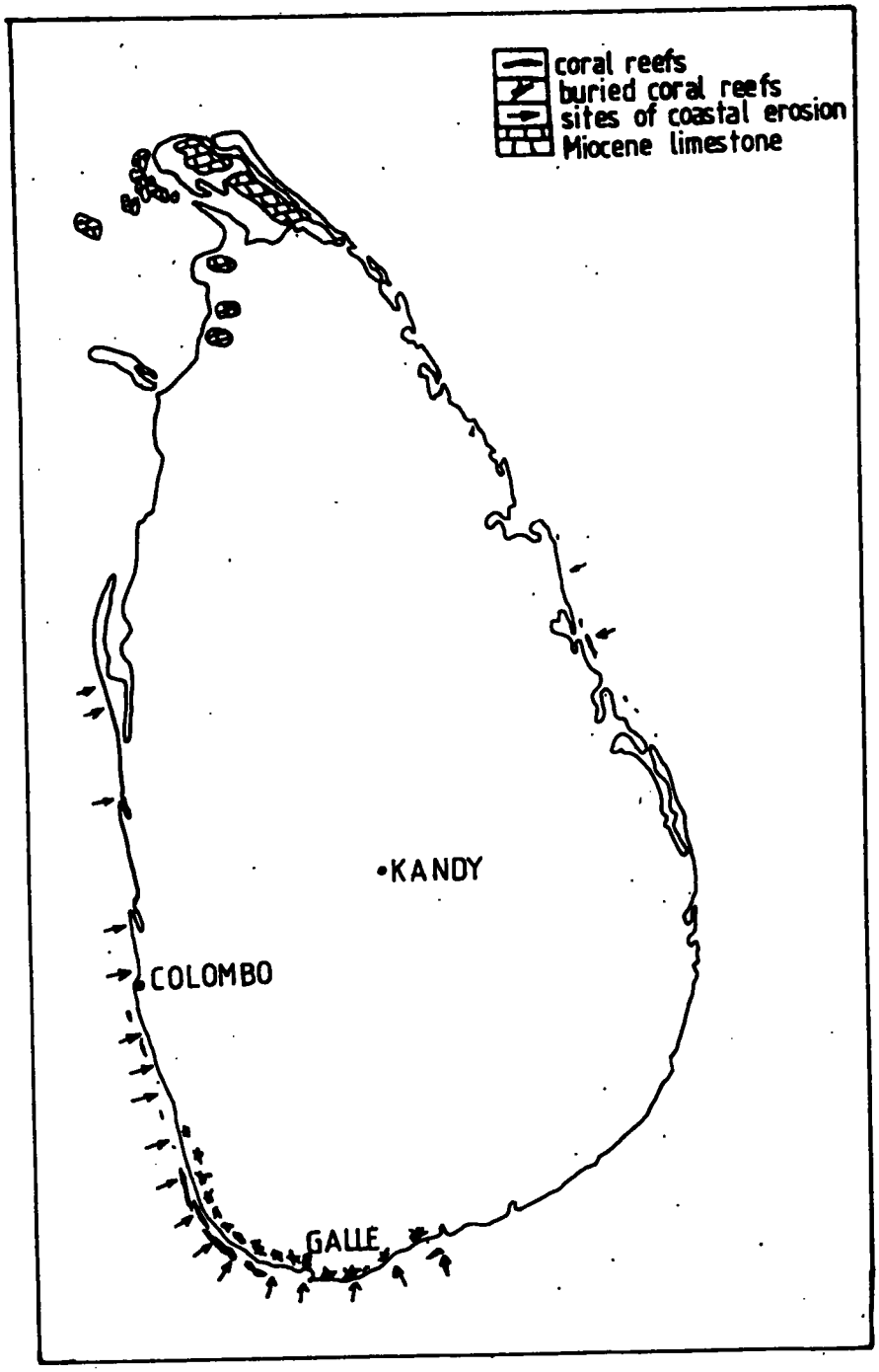


Figure 2: Distribution of coral reefs and Miocene limestone of Sri Lanka. Note the sites of coastal erosion along the SW coast.

Corals should be baked in a kiln to produce quicklime. Accordingly, baking of corals is a part and parcel of the industrial process. More than 300 kilns are situated in the area between Ambalangoda and Matara. Since a load of coral is baked for several days, thick smoke can be observed throughout the year specially along the Galle-Ambalangoda road.

The price of a lorry of quicklime at Midigama is about Rs.3000/= while at Akurala it increases upto Rs.3500/= to 4000/=. However, most kiln owners complain that their profit is marginal due to the interference of middlemen. Labourers and other workers complain that they are underpaid and exploited. They receive daily wages depending on their sex and experience. Table 2 shows the daily average wages at Akurala mine fields.

Table 2 : Daily Wages of Labourers at Akurala Mine Fields

Type of labourer	Average wage in Rs.
Skilled labourer	112.50
Unskilled labourer	
Male	70.00
Female	50.00
Child	32.00
Water pump operater	117.00

The average income of a mine owner depends on the content of corals in his mine. However, no one can assure how much can be produced by a mine. The risk is so great in the Midigama area since every land subject to mining does not essentially contain corals. Information given by mine owners unravel that their profits do not exceed Rs.10,000/=. However, the profit depends on the size of mine and other factors such as condition of drainage, thickness of the upper layer of soil, quality and quantity of corals contained in the mine, etc. It is difficult to get information on the real incomes of mine and the kiln owners.

The low wages and low profits suggest that the mining of corals is not a profitable economic activity. Comparision between low income and low profit, and environmental damages induced by mining suggests that this malpractice should be stopped and the work force engaged in it should be re-employed in other profitable sectors of the economy.

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VIDA 13-2-17

TOWARDS SUSTAINABLE UTILIZATION OF PENAEID PRAWN RESOURCES IN SRI LANKAN WATERS

S.J.C. JAYAWICKREMA
National Aquatic Resources Agency

The Penaeid prawns (Phylum - Arthropoda, Class- Crustacea, Family - Penaeidae) are very important as a commercial fishery resource in the world. Penaeid prawns are widely distributed in the Indian Ocean and surrounding areas. These are the most valuable of the crustaceans in waters around Sri Lanka, India, Malaysia, the Gulf and many other regions. In Sri Lanka this fishery is very important as it is a very good foreign exchange earner. Among marine products exported from the country, frozen prawns is a major item. Valuewise the earnings from prawn exports are around 70% of the total foreign exchange earned from marine products which amounts to about Rs. 303 million (Anon. 1985).

The world total fish production has been recorded as 84,945, 300 MT out of which 2,548,200 MT has been recorded from the Western Indian Ocean region to which Sri Lanka belongs. The total production of Sri Lanka has been recorded as 175,409 MT (FAO 1985).

To the world fish production the Crustaceans contribute 3.8% and to the total production of the Western Indian Ocean region the Crustaceans contribute 1.78%.

According to the Ministry of Fisheries (Anon.1985) the coastal marine prawn production is around 4,000 MT which contributes 3% by weight to the total marine landings of Sri Lanka. Although the contribution to the total production of fish around Sri Lanka is low, valuewise prawn resources are very inmportant to the economy of the country. This group is also very important because of their abundance and relatively large population sizes.

Most of the penaeid prawns are marine, but show migratory behaviour. They spawn in deeper areas of the sea and eggs and larvae are found in surface and sub - surface waters (Subramanyam, 1965). According to Manisseri and Manimaran (1981), they spend the juvenile stages in estuaries and again move out to sea at the sub adult stage.

According to de Bruin, 1970, the salinity, sub - strata and depths play important roles in segregating species of penaeid prawns in estuaries and in the sea. His study of the distribution of penaeid prawns in estuaries and seas around Sri Lanka shows that some species are found in both estuaries and the sea while others are purely marine. To the former category belong *Penaeus indicus, P. semisulcatus, P. latisulcarus, P. monodon, P. merguiensis, Metapenaeus dobsoni, M. tolensis, M. mannarensis, Trachypeneus salaco, T. sedili, T. curvirostis, Atypopenaeus stenodactylus, Parapeneopsis maxillipedo, P. uncta, P. tenella, P. coromandelica* and *Parapenaous longipes*. *Metapenaeus elegans* and *M. burkenroadi* were found only in estuaries.

P. indicus and *P. monodon* were found in estuaries right round the island, but *P. semisulcatus, P. latisulcatus, Metapenaeus burkenroadi, M. monoceros, M. affinis, M. ensis, Parapeneopsis comuta* and *P. nana* were found restricted to the high salinity lagoons of the northern and eastern regions and more saline mouths of estuaries of low salinity lagoons of the south - west and southern regions. *Metapenaeus elegans* and *M. dobsoni* were either absent or scarce in the north and east, but abundant in the south - west and southern regions.

In the sea most species avoid hard - bottom such as coral, granite and sand stone. *Penaeus semisulcatus* was found to be abundant on soft green mud sharing with *Penaeus merguiensis, Metapenaeus monoceros, M. affinis* and *M. ensis, P. indicus* was reported to be abundant on very soft sand and also on a bottom of mud and sand.

Although *Metapenaeus dobsoni* and *Parapeneopsis coromandelica* were found in mud and sand their distribution was also found to be affected by depth since they were not found on patches of mud and sand beyond 7 fathoms. *Trachypeneus salaco, Metapenaeopsis stridulans, M. tolensis, Atypeneus stenodactylus* were restricted to depths varying from 10 - 13 fathoms.

In the Indo Pacific region 33 species of penaeid prawns have been recorded from Pakistan, India and Sri Lanka. Out of these, 31 species have been recorded by de Bruin (1965) in Sri Lankan waters. Siddeek (1978) recorded a new species the *Parapene-opsis stylifera* (Milne Edwards) which raised the total upto 32.

The main prawn landing centres of the West coast of Sri Lanka are Negombo and Chilaw. The total annual production from these areas exceed 600 MT per annum,

contributing to more than 15% of the total annual production of shrimps around the island. At Kalpitiya which is the major landing site in the North - Western coast an annual production of 75 MT per annum has been recorded. These prawns are caught from the Portugal Bay trawling ground. Palk Bay shrimp trawling ground also contributes a considerable amount.

In these areas many commercially important species of panaeid prawns have been recorded. The species of the genus *Penaeus* which command the highest prices in the local market as well as in foreign countries are *P. indicus, P. monodon, P. merguiensis* and *P. semisulcatus*. These are categorised as large prawns having a length range of 12 - 20 cm. Out of these species *P. indicus* catches constitute about 60% of the total annual shrimp catch from Negombo and Chilaw areas (Jayawickrema & Jayakody, 1991). At Kalpitiya *P. semisulcatus* contributes about 92% of the annual catch (Jayawickrema & Suraweera, 1989). In the Palk Bay too *P. semisulcatus* is the major constituent (Siddeek, 1986).

The catches also comprise smaller prawns of the length range 10 -15 cm, such as *Parapeneopsis stylifera, P. comuta, P. coromandelica* and *Metapenaeus dobsoni*. These are in great demand in the local market.

Because of the commercial importance of penaeid prawns a lot of work on various aspects of their biology, taxonomy, population dynamics and stock assessment studies have been carried out in Sri Lanka as well as in other areas of the Indo-Pacific region.

De Bruin (1965) has made taxonomic studies of Penaeid prawns and their distribution in Sri Lankan waters. De Bruin 1970, 1971 has also described the distribution and relative abundance of Penaeid prawns in the estuaries and seas around the island.

According to de Bruin (1970), the capture methods of penaeid prawns also vary from area to area. Trawling in the estuarine waters is found to be impracticable on account of the presence of submerged logs and stakes. However, local fishermen fish for penaeid prawns round the island using simple types of gear. In estuaries on the south - west coast between Panadura and Galle the common method of capture is the Kraal or Ja-kotu. Later on, this method of capture has spread to Puttalam and Jaffna. In Negombo and Chilaw estuaries, prawns are captured at night by stake seines set against the direction of the current. The commonest method of capture in other parts of Sri Lanka (estuaries and lagoons) is the cast net.

In the sea, prawns are mainly caught by trawling. In Negombo trawling is carried out by sail driven, out-rigger canoes whereas in Chilaw, trawl net is operated by sail driven canoes and operated by mechanised FRP boats.

In Kalpitiya too prawn trawling is carried out by mechanised 3.5 ton and 11 ton boats. In Palk Bay three types of gear have been employed to carry out prawn fishery; trawling conducted by 3,5 ton mechanised boats, the gill net and trammel net fishery carried out by FRP boats and non-mechanised log crafts (Siddeek, 1986).

Population dynamics and stock assessment studies are very important in the management of any living resource. Any commercially important living resource can be exploited within a limit. This is called sustainable utilization which is the use of the resource by the present generation and protecting this to be utilized by the future generation.

Regarding the shrimp resources around Sri Lanka many workers have carried out studies on proper utilization. Siddeek (1986) has carried out biological impact studies on shrimp trawling in the Palk Bay area. The results have indicated that there is no immediate threat from the trawlers to the shrimp resources in this area, but rather a beneficial effect because of the introduction of larger mesh sizes in the cod-end of the trawl net.

The Protugal Bay trawling ground off Kalpitiya is also a very rich prawn ground. In this area Suraweera and Jayawickrema, (1989) carried out a biomass estimation of *Penaeus semisulcatus*. The mean stock biomass of this area has been estimated as 4 MT. The maximum sustainable yield (MSY) which is the yield that can be exploited maximally without affecting the standing stock has been calculated as 42 MT. The results indicate that the *P. semisulcatus* stocks in this trawling ground is over-exploited and it is necessary to regulate the number of boats operating in this area.

Siddeek and Jayakody (undated) have estimated the standing stock biomass of many species of prawns in the Chilaw sea such as *Penaeus indicus, P. semiculcatus, P. monodon, Metapenaeus dobsoni* and *Parapeneopsis stylifera* to be 3,133 kg, 1,095 kg, 313 kg, 2,509 kg and 1,764 kg respectively. More than one hundred 3.5 ton mechanised crafts operate here. According to Jayawickrema and Jayakody (1991) the yield per recruit studies on *P. indicus* which is the most commercially important prawn species caught in this area indicate that the present yield can be increased by 14% to get the optimum yield. But according to yield per recruit analysis, increasing the minimum mesh size and increasing the fishing effort should be carried out concurrently to get the optimum yield.

The Negombo area is well known for prawns caught in the sea as well as in the Negombo estuary. For assessment of the prawn stock in the sea around Negombo a direct relationship between the fishing effort and the associated catch was employed (Jayakody and Jayawickrema, 1987) to find out the maximum sustainable yield (MSY). The

1982 in Negombo have been oriented towards a declining trend which is a sign of overfishing.

In areas southwards from Colombo ie, Kalutara, Beruwala, Galle and further southwards there is no intensive fishery going on except for a few sail driven canoes and fiber glass boats employed in trammel netting.

Overfishing is the main threat to the prawn population around Sri Lanka. Overfishing is a process which develops slowly and steadily over a period of several years. Although the fishing effort does not show a significant increase over the period, repeated fishing in the same area can have a harmful effect on the prawn population.

Overfishing can occur in two different ways. Growth overfishing can be due to the massive removal of new recruits which is indicated by the appearance of very small prawns in the catches. In addition to this, repeated fishing of spawners can lead to a depletion of the stock which is termed recruitment overfishing. As most of the prawns spend a part of their life cycle in the lagoons and estuaries (Manisseri and Manimaran, 1981) factors like, heavy fishing of sub-adult stage in the lagoon, change in the physico-chemical factors of these areas, depletion of mangroves etc. can also cause depletion of shrimp stocks.

In order to manage the prawn fishery at a sustainable level, regulations on the number of boats operating and the minimum mesh size of the nets can be employed. The regulation of the number of boats operating is a complex problem which involves many socio-economic factors.

In the case of shrimp trawling it is difficult to impose mesh regulations too. This is a multispecies fishery where shrimps of a broad size range are caught by the gear. Smaller sized shrimps are aslo commercially important because these are preferred by locals. The larger ones are important as foreign exhange earners. Therefore, the calculation of a single optimum mesh size for trawlers should be determined as an average weighted according to weight and the economic value of each species.

Now we can understand how the prawn stocks around Sri Lanka are affected by improper fishing practices. It is our duty to exploit all biological resources sustainably keeping in mind that these should be conserved for our future generations.

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SEA TURTLES OF SRI LANKAN WATERS

DR. R.H. WICKRAMASINGHHE,
Institute for Tropical Environmental Studies
41, Flower Road
Colombo 7

Turtles are the most ancient surviving reptiles, their origin antedating the extinct dinosaurs and the still living Tuataras of New Zealand.

The Testudinate reptiles (i.e. turtles, tortoises and terrapins) were well established by about 185 to 200 million years ago in the Triassic period of the geologiclal record. They had acquired their present day form and aquatic modifications by the Cretaceous (90 million years ago) and the marine turtles of this period resembled today's species while being contemporary with the dinosaurs.

The marine turtles of today consist of seven species -

1. *Dermochelys coriacea* (Leathery, Leatherback or Trunkback turtle or Luthe);
2. *Chelonia mydas* (Green turtle);
3. *Chelonia depressa* (Flatback turtle);
4. *Caretta caretta* (Loggerhead turtle);
5. *Eretmochelys imbricata* (Hawksbill turtle);
6. *Lepidochelys kempi* (kemp's or Atlantic Ridley);
7. *Lepidochelys olivacea* (Pacific Ridley, Olive Ridley or Olive loggerhead).

Of these seven species, the nesting range of the Kemp's Ridley is restricted to the east coast of America from Massachusetts to Mexico. The nesting ranges of other six species include beaches in one or more countries bordering the Indian Ocean. These six species are, for instance, known to nest in Australia. The Leatherback turtle, Green turtle, Pacific Ridley, Loggerhead and Hawksbill are known to nest in Sri Lanka while the Flatback may visit our waters occasionally.

Nesting records of these turtles in Sri Lanka are mainly from the west and south of the island. This preponderance of records from the west and south is attributable to the high density of human habitation along this coast and the accessibility to wild life observers from Colombo. However, turtles (male and female) frequent a much greater extent of the coastal waters of the island including those of the north. Mating takes place in the sea close to the nesting site.

Turtles come ashore to lay their eggs. In the case of the turtles of the Indian Ocean this usually takes place at night and at high tide. Stormy weather does not appear to hinder egg-laying and may, in fact, help the survival of the eggs by disturbing the sand to the extent that predators would not observe evidence of nesting. This may also be related to the occurrence of a "mass nesting" or "arribada" of about one hundred Olive Ridleys which took place in December 1978 in Sri Lanka just before a cyclone. While mass nestings (of turtles of one species on one beach on one or at most a very few days) are known to take place in other countries, such as India, Mexico and French Guiana, this is not the case in Sri Lanka, as a rule.

Nesting takes place on the beach above the surf line and oviposition (egg-laying) takes place into a 16 inch deep egg chamber dug out by the female turtle at the end of a 15 inch deep hollow termed the "body pit". The average clutch size varies from 50 to over 200 eggs depending on the species and the average weight of each egg from 40 gm. to over 78 gm. The longest incubation period is that of the green turtle and is 6 to 12 weeks with an average of 8 weeks. The period of incubation is inversely dependent on the temperature. For the green turtle, incubation at 27^0C results in hatching in 80 days, while at 30^0C it takes 55 days and at 32^0C 48 days.

Another interesting observation is that the sex ratio of hatchlings of certain species is dependent on the temperature of incubation of the eggs. This dependency of sex on the temperature at which the egg is incubated is, of course, quite different from the situation found in animals, such as mammals, where sex is determined by the chromosomal make-up.

The hatching success may average around 85% in the wild and, while the hatchlings may take several days to work their way up to just below the surface, the final emergence is delayed until nightfall or a shower of rain. On emergence the hatchlings make their way as fast as possible to the ocean in order to escape from birds and other predators, such as certain species of crabs. Light cues appear to be a principal factor in guiding newborn hatc-

hlings to the ocean, although other factors may, also, have an influence.

Even once they reach the sea, hatchlings are still exposed to predators in the form of shark and other fish and birds, such as gulls and terns. In view of the numerous hazards encountered by hatchlings it has been estimated that every one to four adults represent the survivors of a thousand hatchlings.

Little or nothing is known of where hatchlings spend their first year (the "lost year") after leaving their nesting beach in Sri Lanka. During this time most are carnivorous and need to frequent localities where sufficient food is available relatively close to the surface. After leaving their nesting beach, hatchlings are next seen after they have reached 10 to 50 lbs. weight and are, possibly, one year of age.

Voyaging

Turtles are known to perform extensive sea voyages. Numerous tagging experiments have recorded voyages of over 1000 miles. One loggerhead was found to have travelled some 1650 miles in 91 days.

Some of these voyages are undertaken by turtles in order to travel from feeding grounds to nesting beaches. It is now known that turtles return to lay their eggs on the same beach as that on which they themselves originated. It is very unlikely that male and female turtles travel long distances to reach a particular beach relying on chance to bring them to the right place at the same time.

Various hypotheses have been proposed to account for how turtles navigate across the oceans. Some of these hypotheses draw on those proposed for direction - finding by other animals such as bees, migratory birds, and salmon. The direction-finding mechanism would need to operate together with a memory on which extensive data is imprinted. The hypotheses proposed for navigation by turtles include 1) odour and taste gradients, 2) echo sounding of the sea floor, 3) sensing of current flows, 4) sensing of magnetic variations, 5) sensing of the Coriolis force, 6) inertial guidance system and 7) celestial navigation and compass sense. Agreement has not been reached as to whether any one or several of these mechanisms or yet others assist turtles to navigate.

Influence of Man

That the mechanisms and habits which have evolved surrounding the breeding of turtles are highly successful is borne out by the fact that marine turtles have survived for over a hundred million years. It is amazing that *Archelon*, a marine turtle with an eleven foot carapace and which was present over ninety million years ago, closely resembled present day forms.

The advent of man and, more importantly, his activities in recent times have drastically changed this picture. Estimates of the international survival status of the various species of marine turtle are replete with classifications such as "heavily depleted", "limited geographic distribution", "actively threatened with extinction", "rare" and "critically endangered".

Many are the pressures from man on the survival of turtles. Eggs, turtle flesh and calipee (for soup) are taken for consumption, while the Hawksbill is killed for tortoiseshell (although its flesh is, sometimes, poisonous). Pollution of nesting beaches, such as by oil spills, can affect egg-laying (n.b. the Green turtle nests in South Yemen and its numbers may be reduced by the massive oil releases, which occurred during the recent Gulf War). Pollution of seas by junk such as polythene bags can, also, endanger turtles which swallow these in mistake for their normal prey of jelly fish.

Nesting beaches may, also, be utilised for housing construction, hotels, highways, industry etc. In addition to reducing the area available for nesting, and increasing the likelihood of egg predation by man, the lighting of coastal highways etc. may disorientate nesting turtles and hatchlings.

Another threat to turtles is that posed by fishermen's nets. In Sri Lanka fishermen generally fish coastal waters using gill nets at night. These may be nets of 200 to 800 metres used within 15 to 20 km. of the shore or those of 0.8 to 1.5 km. used within 30 to 45 km. The turtles, which are generally night swimming and night nesting in Sri Lanka, become (accidentally) entangled in these nets and are usually slaughtered.

Inadequate studies have been made on depradations of turtles in Sri Lanka. Estimates have suggested that 200 to 500 adult turtles may be slaughtered (both at nesting beaches and from gill nets) and 20,000 eggs plundered per year. This estimate would not include turtles and eggs lost due to natural causes, predators (other than man), pollution etc.

Turtle Conservation

Turtles and their eggs are protected by law in Sri Lanka. This legislation is adequately designed but is, unfortunately, inadequately implemented (as is the case in many countries where such legislation has been enacted).

A conservation effort has in recent years been developed to collect turtle eggs from nesting beaches, transfer them

emergence. Such an effort was first proposed by members of the Wildlife and Nature Protection Society in 1962 and the first hatchery commenced operations in 1970. Turtle conservation activities are also carried out by certain tourist hotels on the coast, in addition to the work of the Department of Wildlife conservation. Several turtle conservation activities have received financial support from the Victor Hasselblad Wildlife Trust (Sri Lanka).

Transferring turtle eggs to a hatchery provides protection during incubation from humans and other predators, such as wild pigs, jackals, dogs, mongooses, monitor lizards and, occasionally, even leopards. During their journey across the beach to the sea, protection is often needed from predators, such as crows, gulls, terns, herons and sea eagles. A turtle hatchery is an enclosed area in which eggs brought from the nesting beaches are re-buried. The egg nests may be discovered on the beach by the operators of the hatchery but the bulk of the eggs are purchased from residents of the area.

The percentage hatching rate in the wild is around 85%, but that in hatcheries is usually about 67% or less, probably due to the disturbance of the egg contents during handling. On emergence the young turtles are placed in a tank of sea water for a few hours until they are released to the ocean. The release involves placing the hatchlings on the beach and letting them make their own way across the sand to the water. This is believed to enable some characteristics of the beach to be imprinted on the hatchling's memory and enable it to recognise the beach when it returns as an adult for breeding purposes.

While these conservation efforts are commendable, it is estimated that the number of hatchlings released so far probably does not approach replacing the adults slaughtered and eggs plundered in the same period. This is particularly so in view of the estimate that only 1 to 4 hatchlings per thousand survive to adulthood. One obstacle to expanding the programmes has been inadequate finances, particularly for purchases of turtle eggs. However, some finances are being generated by charging an admission fee from visitors to the hatcheries. (The admission fee also carries the possibility of the visitor releasing hatchlings to the ocean and, thus, in a small way participating in the activity of the conservation project). These projects need to be expanded and the existing legislation implemented more effectively if a precipitous decline in turtle numbers is to be avoided.

Global Warming

Other factors do, of course, also place stresses on turtle populations. One factor, as mentioned above, is the pollution by flimsy polythene which may choke an adult turtle, while other pollutants may for instance affect prey populations on which turtles feed.

Another factor which may eventually affect turtle populations is the postulated "global warming", which may result as a consequence of the increase of atmospheric carbon dioxide concentrations. While this rise will be very gradual, it has been suggested that due to the eventual melting of the polar ice caps and expansion of the ocean waters, large tracts of low-lying land could go under water. Should this happen it is highly likely that many traditonal nesting beaches of marine turtles will also go under water, thus adding another obstacle to the continued survival of turtles.

Finally, it must, also, be noted that global warming may increase the temperature at which hatching occurs. This, as has been noted above, may alter the male to female ratio of the hatchlings, thus placing further constraints on their breeding.

It is now time that the littoral states of the Indian Ocean devised and implemented a programme for the conservation of marine turtles in the region. If not, we, the inhabitants of the Indian Ocean region, may be responsible for acts of extinction which did not occur over 100 million years.

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SCIENCE TIT BITS

T. SABARATNAM
Daily News, Lake House
Colombo 1

This column is a compilation of some of the recent research findings - national and international.

Back to Home Child Births

Hospital surveys in Sri Lanka show that only one in 100 children are born in home. This is due to the belief that having a baby in hospital is safer.

A recent conference on child birth in New York has concluded that it is safer for women to have their babies at home. Reason: experts say the high-tech equipment used in hospitals damage one in seven babies.

They cited figures from Holland in their support. In Holland where a third of all babies are born at home - in the simple, old fashioned way - the death rate among babies and mothers is the lowest in the world.

A caution: induced births are generally bad for babies.

Oil Fires may Bring more Rain to Sri Lanka

Two studies now show that smoke from burning oil wells in the Gulf may bring more rain in monsoon countries and the earlier fear that the monsoon will be weakened is not correct.

The first study is by the London Meteorological Office. It concluded that "there will be a slight enhancement of the Asian summer monsoon due to increased precipitation caused by smoke particles."

The second is by the Max Plank Institute in Hamburg, Germany. It says in the report published in a British science journal: "There is no indication of a weakening of the Indian summer monsoon as has frequently been speculated. There is even a region of enhanced rainfall over India during the onset phase of the monsoon in early June in response to the anamolous heating over Tibet. The enhanced rainfall region shifts further north during the following two months".

These studies have been proved correct. The South West monsoon which broke in Sri Lanka during the last week of May was accompanied with furious winds and intense rain. The massive waves the winds blew on to the coast had caused heavy sea erosion.

Liquid Nitrogen Drops do the Trick

A British firm now puts a droplet of liquid nitrogen into the packs of food stuff to keep them in good condition for a longer time. The liquid nitrogen vapourises the moment it is dropped, increasing its volume 700 fold. The nitrogen gas rapidly displaces the air inside the packs. Thus the pack is freed of the polluting micro-organisms. This method prevents roasted cofee powder, roasted pea nuts and potato crisps going rancid, peanut butter changing colour due to oxidation and milk products losing colour and flavour due to oxidation.

Butter Fruit to Combat Malnutrition

Indian researchers are now pushing for the popularisation of the growing of butter fruit trees (Avocado) as a means of combating malnutrition. Butter fruit, now a rich man's delicacy, is harmful to fat saturated rich people, researchers say. It is better suited for the poor as its fat content ranges from 20 to 25 percent. It grows well in the hill country and its cultivation should be popularised.

Science's Three Cs

Science thrives on controversies, confrontations and conflicts of opinion, not personal but related to the subject.