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THE DEMERSAL
FISHERIES OF SRI LANKA

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THE DEMERSAL
FISHERIES OF SRI LANKA

BOB P/WP/41

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This paper attempts to review the results of all the demersal fishery surveys carried out in Sri Lanka in the past, and to reassess the current status of demersal stocks in the light of the present level of exploitation. This is seen as a first step towards identifying development possibilities, management measures for demersal resources, and areas requiring future investigation.

The investigations for this paper were carried out during 1982 by the small-scale fisheries project of BOBP (Bay of Bengal Programme) in active cooperation with NARA (National Aquatic Resources Agency).

The paper sets out conclusions about the most productive belt for valuable resources, peak seasons, and the level of surplus yield. It suggests that the demersal fishery in the shelf area should be developed as a small-scale fishery, because rapid exploitation may destroy the resource. Development should be on an areawise basis, and capital investment based on surplus yield levels in each area. A combination of fishing methods will be needed to fish the entire exploitable potential in most areas. Besides the bottom trawl, passive methods should be encouraged.

The paper also evaluates the status of Sri Lanka's demersal fishery, on the basis of a field survey at major fish landing sites over a period of two weeks in September 1982, conducted by 12 staff members of NARA; and on the basis of statistics compiled by the Ministry of Fisheries. The paper gives rough estimates of catch and catch rates, species composition and annual demersal production in Sri Lanka.

The BOBP's experimental work on tapping Sri Lanka's demersal resources is reported in other papers. BOBP/WP/6, BOBP/WP/16, and BOBP/WP/40 describe the findings of experiments with bottom longlines. Papers describing experimental work with fish traps and high-opening bottom trawls are under preparation.

The small-scale fisheries project of the Bay of Bengal Programme began in 1979 and covers five countries bordering the Bay of Bengal – Bangladesh, India, Malaysia, Sri Lanka and Thailand. Funded by SIDA (Swedish International Development Authority) and executed by the FAO (Food and Agriculture Organization of the United Nations), the project seeks to develop, demonstrate and promote appropriate technologies and methodologies to improve the conditions of small-scale fisherfolk in member countries.

This document is a working paper and has not been officially cleared by the Government concerned or by the FAO.

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A REVIEW OF THE RESULTS OF DEMERSAL FISH RESOURCES SURVEYS AROUND SRI LANKA

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INTRODUCTION

Till about three decades ago, the demersal fishery of Sri Lanka made very significant contributions to fish production and was probably only exceeded by beach seine and small mesh gillnet fisheries. Bottom handlining was a very popular method for catching big demersal fishes like emperor fishes (Lethrinids) and snappers (Lutjanids). Bottom handlining was carried out with 'vallams' towed by mother ships to the fishing grounds close to the continental slope (Medcof, 1956). Bottomsetgillnets made of natural fibres and bottom longlining were very common in the Jaffna Peninsula and were occasionally practised in Trincomalee and Puttalam (Pearson, 1923). Chaplin (1958) reported that beach seining and handlining were the primary fishing methods in Sri Lanka in the mid-50s. Longlining for large pelagics gained popularity in the late 50s and driftnetting for large pelagics improved markedly after the introduction of synthetic net materials into Sri Lanka around 1963. The traditional distant water trawl fishery on the Wadge Bank had to be suspended in the late 70s. Thus over the last two or three decades, the demersal fishery in Sri Lanka has receded to a position of relatively low significance. Recent fisheries development activities have been geared to readjust the imbalance in the exploitation of available marine resources. The most recent survey of the fish resources around Sri Lanka ("Dr. Fridtjof Nansen" survey, 1978—1980) revealed the availability of sufficient demersal resource potential for increased exploitation. At present, the Bay of Bengal Programme is involved in bottom longline trials around Sri Lanka but the catch rates have not been up to the level expected from the estimated potential though commercial operations of bottom longlining appear to indicate that they are viable economically.

This report is an attempt to review the results of all the demersal fishery surveys carried out in the past and to reassess the status of demersal stocks in the light of the present level of exploitation, as a first step in identifying the development possibilities, management measures for demersal resources and the areas requiring future investigations.

RESULTS OF PAST SURVEYS ON DEMERSAL RESOURCES

A number of surveys on the demersal fishes have been carried out around Sri Lanka since 1920. Major surveys, exploratory fishing and investigations relevant to the subject are summarised in Table 1. Specific investigations on the Wadge Bank trawl fishery are not listed because this ground is no longer available for exploitation by Sri Lanka.

Results of these surveys and the data collected were obtained from the reports submitted (Pearson and Malpas, 1926; Malpas, 1926; Jean, 1957; Berg, 1971; Demidenkov, 1972; Anonymous, 1975; Saetersdal and Bruin, 1978; Blindheim, Bruin and Saetersdal, 1979; Blindheim and Foy, 1980; Hinriksson, 1980).

A number of other reports on the development of fisheries in Sri Lanka have also dealt with demersal fishery resources (Kesteven, 1948; John, 1949; Lantz, 1956; Medcof, 1956; Chaplin, 1958; FAO, 1980).

It will be evident from Table 1 that vessels of various sizes and horse power and gears of various types, sizes and designs have been used in the survey. The majority of them covered the coastal waters generally, up to about 60 m but the surveys by RV 'Hoyomaru' and 'Dr. Fridtjof Nansen' extended up to 130 m and 300 m depth respectively, in certain locations. The RV 'Optimist' covered the deep waters outside the territorial limit of 12 miles from the shore-line. The stratification of the coastal zone was not similar in all cases.

The survey designs, stratification and the types of biological and non-biological information collected varied considerably from survey to survey. In some cases, detailed analysis had not been attempted even though relevant data were available and in other cases sufficient data were either not collected or not analysed.

The number of samplings conducted within a stratum varied considerably between strata and in some cases the number was too small for reliable estimates of catch rates, seasonal variation and catch composition. However, the results of the analysis of the data from each survey served to cross-check the dependability of the findings. The RV 'Lilla' survey (1920—1923) was designed to make tows 7 miles apart, except in untrawlable bottom. This survey had the most intensive sampling programme but was not well designed to bring out seasonal changes. The 'Dr. Fridtjof Nansen' survey covered the west, south and east coasts during three seasons but in three consecutive years.

In re-assessing the status of the demersal resources, emphasis has been placed on stratification of the areas according to bottom conditions, seasonal variation, biological factors, depth and the present level of exploitation.

For a comparative study of the past surveys and to make them complement each other, the available data were re-analysed with a standard stratification of the fishing areas. This was based on the distribution of bottom conditions and the depth, which are two of the physical characteristics that influence the ecology and composition of demersal species in an area. The bottom characteristics, as reported by the survey vessels, were combined to produce the map shown in Fig. 2. The stratification of areas and sub-areas adopted by Pearson and Malpas (1926) was considered to be the most suitable basis for the re-analysis of the data from all the surveys (Fig. 1).

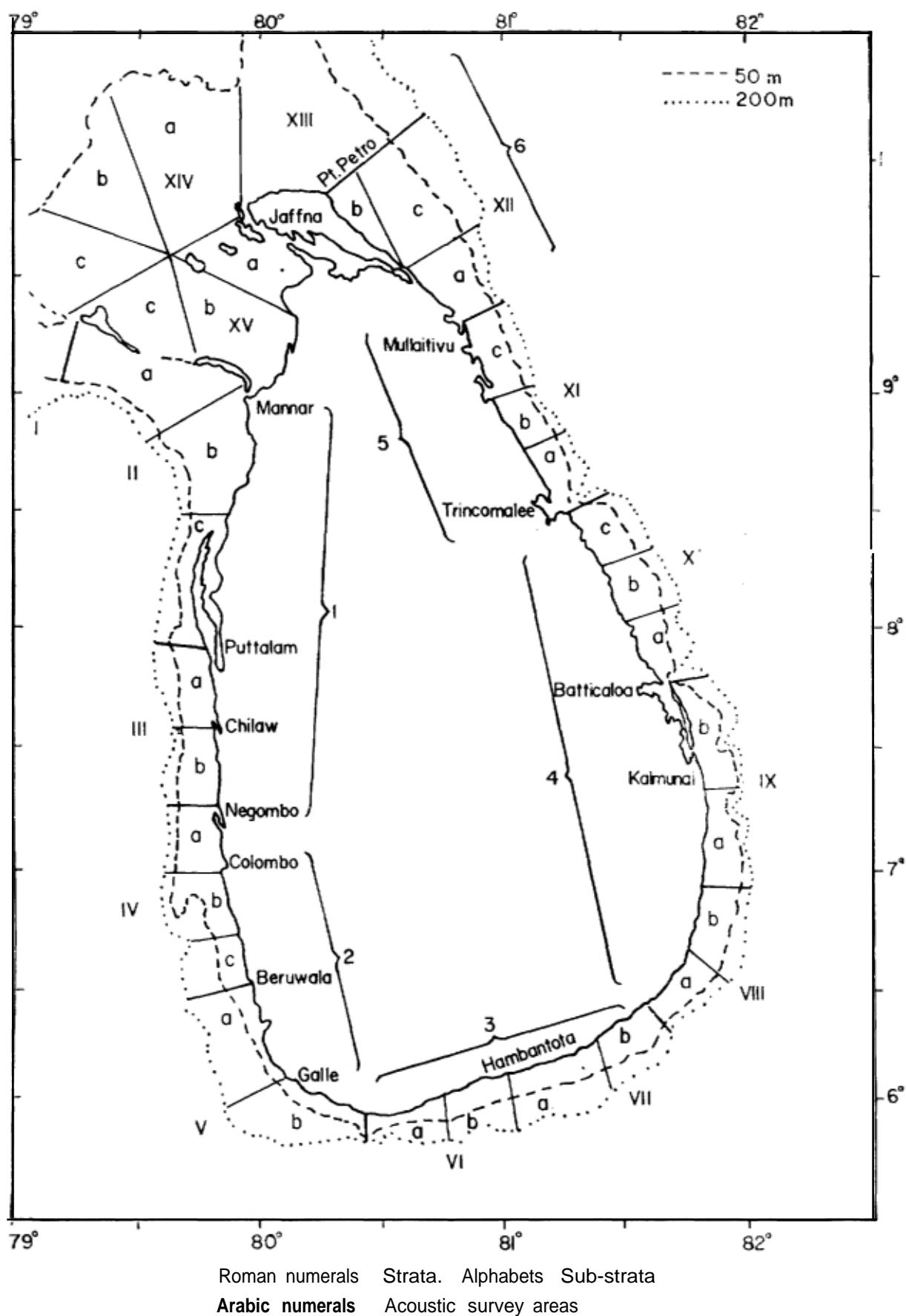


Fig. 1. Stratification of the Continental Shelf Around Sri Lanka.

Bottom condition

The continental shelf around Sri Lanka is generally rocky, particularly between Colombo and Batticaloa. However, sand occurs even in the rocky areas. The northern part, particularly the Palk Strait, is predominantly muddy or muddy sand. Specifically, the bottom conditions in the various strata are as follows (Fig. 2):

- II (a+b) Greyish mud and sand; mainly flat with small rough patches.
 - (c) Flat rocks and coral; evenly flat but uneven towards the edge of the shelf.
- III (a) Flat rocks and corals; rough patches close to edge of the shelf.
 - (b) Coarse white sand with outcrops of rocks and coral; generally hard and uneven closer to the edge of the shelf.
- IV (a) Coarse sand, rocks, corals and shells; flat, even bottom rare outside the 20 m depth.
 - (b) Coarse sand with rocks and corals; mainly uneven and rough bottom.
 - (c) Firm grey sand with scattered outcrops of rocks and corals; very rough towards the deeper end of the shelf, bottom not even.
- V (a+b) Sand, rock, coral and gorgonids; uneven bottom in the mid-shelf area and very rough in the outer-shelf area; even bottom very rare.
- VI (a) Sand with scattered rocky and coral-line patchy; uneven and rough towards eastern end.
 - (b) Sand, rocks and corals; mainly uneven and very rough bottom.
- VII (a) Sandy with rocks; smooth with uneven or rough bottom inshore and outer shelf area.
 - (b) Sand with rocks and corals; predominantly uneven and very rough bottom.
- VIII (a) Firm grey sand in the western half and coarse red and yellow sand in the north-eastern half with very rough rocky patches.
 - (b) Coarse sand; very rough bottom close to the edge of the shelf.
- IX (a Fb) Coarse sand; uneven and rough bottom along the outer belt of the shelf area.
- X (a, b+c) Flat rocks with gorgonids and sponges; intermittent patches of sand, coral and mud; strip of even, flat bottom inshore but major part uneven and rough, particularly the outer shelf.
- XI (a, b+c) Coarse sand with flat rocks, hard mud and sponges; wide parts of the shelf outside 20 m evenly flat.
- XII (a) Mostly firm whitish sand with mud and rocks.
 - (b) Flat rocks and corals; uneven bottom.
 - (c) Flat rocks with coarse sand and shells; generally uneven bottom with large patches of very rough bottom.
- XIII (a) Coarse sand, greyish mud, flat rocks, shells and sponges; generally flat and hard bottom.
- XIV (a) Black ooze with small flat rocks, sand shells and sponges; eastern end fairly flat and hard.
 - (b) Firm black mud, sandy close to Pesalai; fairly even bottom.
 - (c) Soft grey mud, even bottom.
- XV (a) Firm grey mud, sand shells, small flat rocks and sponges; even bottom.
 - (b) Firm grey mud, sand shells, even bottom.
 - (c) Soft grey mud, even bottom.

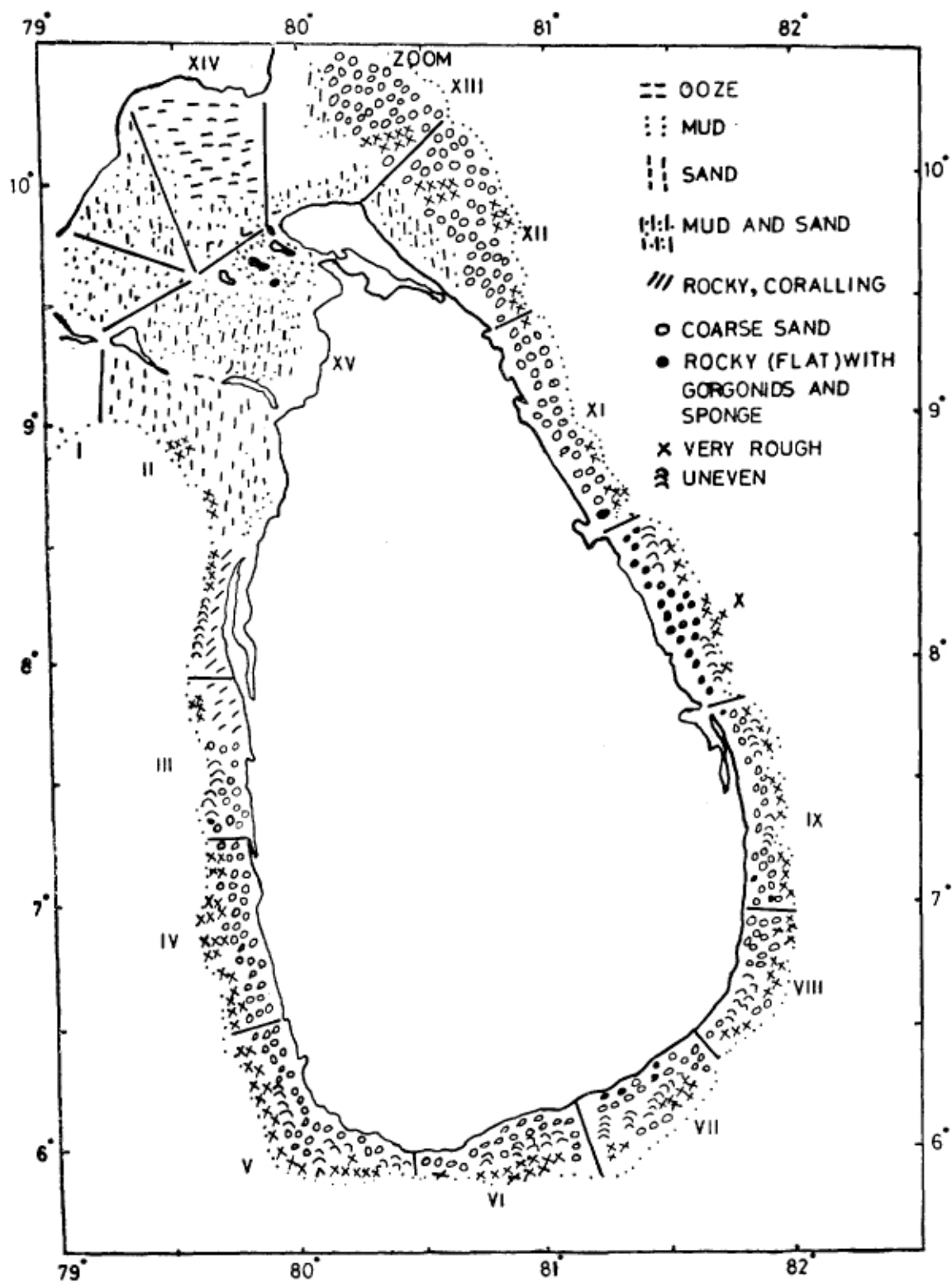


Fig. 2. Bottom Sediments and Condition (Based on Pearson Er Malpas, 1926)

From Puttalam to Colombo (Strata III and IV), the shelf has an extensive trawlable bottom but the south-west part has rough and uneven bottom. The Hambantota area has a limited trawlable bottom. There are smooth bottom grounds only in the inshore area south of Trincomalee but north of it the bottom is very suitable for trawling.

The slope begins very abruptly in most areas except in the Palk Bay, Gulf of Mannar and the Pedro Bank areas. The shelf widens gradually south of Puttalam and narrows on the east coast.

Demersal Species Composition

About 55 families represented by some 215 species of demersal fishes were identified by Pearson and Malpas (1926). Subsequent demersal surveys did not list the species in such detail but all the surveys recorded about eight groups as the most common and predominant ones — Lethrinidae (Emperor fishes), Lutjanidae (Snappers), Carangidae (Jacks and Trevallies), Serranidae (Groupers), Pomadasyidae (Grunts/Sweetlips), Leiognathidae (Ponyfishes), Acanthuridae (Surgeon fishes), and some Cartilaginous types (Carcharhinidae—requiem sharks, Mylibatidae – eaglerays, Rhinobatidae – guitarfishes and Dasyatidae – stingrays). On an average, each of these groups contributed more than 10% to the catch composition in one or more strata.

The number of species entering the trawl catches in each stratum varied between 12 and 97 and it was observed that there is a correlation between the number of species recorded and the number of hauls made or the quantity of fish caught, in each stratum. This characteristic projects the distributional pattern in each stratum. It is likely that all the demersal species occurring within a stratum are not evenly distributed and that niches with high fish densities have greater numbers of species than the rest of the ground. This is supported by the various types of niches formed by different combinations of bottom sediments, bottom condition and depth within each stratum.

The main demersal species, in the common groups mentioned above, are as follows:

Lethrinidae	—	<i>Lethrinus nebulosus</i> , <i>L. miniatus</i>
Lutjanidae	—	<i>Lutjanus malabaricus</i> , <i>L. rivulatus</i> , <i>L. lineolatus</i> , <i>L. argentimaculatus</i> , <i>Pristipomoides typus</i> , <i>Aprion virescens</i> .
Carangidae	—	<i>Caranx ignobilis</i> , <i>C. sexfasciatus</i> , <i>Carangoides malabaricus</i> , <i>Gnathanodon speciosus</i> , <i>Decapterus russelli</i> , <i>Selar crumenophthalmus</i> .
Serranidae	—	<i>Ephinephelus undulosus</i> , <i>E. areolatus</i> , <i>E. tauvina</i> , <i>Cepheopholis</i> spp.
Pomadasyidae	—	<i>Plectorhynchus pictus</i>
Leiognathidae	—	<i>Leiognathus</i> spp. <i>Secutor</i> spp.
Acanthuridae	—	<i>Acanthurus strigosus</i>
Carcharhinidae	—	<i>Carcharias</i> spp. <i>Hemigaleus balfouri</i>
Mylibatidae	—	<i>Aetomyleus nicholfi</i>
Rhinobatidae	—	<i>Rhinobatis granulatus</i> , <i>Rhynchobatus djiddensis</i>
Dasyatidae	—	<i>Gymnura poicoura</i>

During the 'Lilla' survey (1920—23) Lutjanids were generally more predominant than Lethrinids whereas the latter were predominant during the 'Dr. Fridtjof Nansen' survey (1978—80). During the 'Lilla' cruises *L. miniatus* was the predominant Lethrinid species but *L. nebulosus* was predominant during the 'Dr. Fridtjof Nansen' cruises. At the same time, the 'Lilla' catches of Lutjanids were predominantly *L. malabaricus* followed closely by *L. rivulatus* and *L. lineolatus* but 'Dr. Fridtjof Nansen' catches were primarily *L. malabaricus*. The long interval between the two surveys (approximately 60 years), differences in the characteristics of the gear, craft and survey design and possible changes in relative abundances of these two predominant groups could account for these differences.

Analysis of the composition of the trawl catches made by 'Dr. Fridtjof Nansen' showed that Lethrinids were the most frequently occurring predominant group on the west coast, followed by Carangids, skates and Leiognathids. In the south, Lethrinids were displaced by Serranids and followed by Lutjanids and Lethrinids. On the east coast, Lutjanids were predominant in

many of the strata followed by Carangids, Pomadasyids, Lethrinids and Serranids. The northern part of the island was not surveyed by 'Dr. Fridtjof Nansen' but 'Lilla' operations showed that Leiognathids were the predominant group in the trawlable grounds. It has been reported that Lethrinids are the most predominant group on the Wadge Bank (Sivalingam, 1969) while Lutjanids surpassed the Lethrinids on the Pedro Bank (Berg, 1971).

Sparidae (seabreams) were very poorly represented all around the island and Sciaenidae, (jewfishes) occurred in significant quantities only in stratum V. Chaetodontidae and Acanthuridae constituted a higher proportion in the 'Lilla' survey than in the 'Dr. Fridtjof Nansen' survey. Seasonal changes in species compositions were observed and this will be discussed later, in relation to the seasonal variation in catch rates.

The 'Lilla' survey results exhibited significant contributions by certain minor groups which were not evident from the results of the 'Dr. Fridtjof Nansen' survey. According to the 'Lilla' survey results, Balistidae (Trigger fishes/File fishes) formed 34% of the catch from the Wadge Bank and about 7% in strata VIII and IX; Nemipteridae (Threadfin breems) 55.2% in stratum XII; Priacanthidae (Bulls eyes) 16.4% in stratum VII; Lacteridae (False trevally) 7.4% in stratum IV; Ostraciontidae (Boxfishes) and Tetraodontidae (Pufferfishes) 7% each in stratum VIII. In fact Balistidae may periodically occur in large concentration close to the edge of the shelf. About 2.5 tonnes of Balistidae were caught during two tows made during a demonstration cruise by the RV 'Bien Dong' (Vietnamese research vessel), off the West coast, in 1975 (personal observation).

In the strata around the northern part of the island (XIII, XIV & XV), the catch composition was significantly different from the rest of the areas as seen from the report of Hinriksson (1957). This is due to the type of bottom, the shallowness of the waters and their geographic characteristics. Ponyfishes are the most predominant group in the Palk Bay (strata XIV and XV) and some parts of the north-east coast (XI). The stratum directly north of the peninsula (XIII) showed a predominance of ponyfishes, sharks, skates.

On the continental slope (200—350 m) off the north-east and north-west coasts, exploration by RV 'Optimist' and RV 'Dr. Fridtjof Nansen' revealed the occurrence of deep sea species such as *Chlorophthalmus b/scornis*, *C. agassizi*, *Cubiceps* sp. and Myctophids, in abundance. Deep sea lobsters (*Puerulus sewelli*) and shrimps, *Aristeus semidentatus* and *Heterocarpus gibbosus* were also abundant in these depths.

The bottom trawl gear is possibly the best sampling equipment for demersals and considering the small mesh size of the cod-end in the trawls used during the 'Lilla' and 'Dr. Fridtjof Nansen' surveys, the sampling should be a reasonably good representation of the demersal species composition in the areas surveyed. Bottom longline, handline, vertical longline, shark longline and traps are selective in terms of species and even size. This is evident from the results of the 'Hoyomaru', 'Dr. Fridtjof Nansen' 'Canadian', 'North Star' and BOBP trials (Table II).

During vertical longlining trials on the east and north-east coasts, Lutjanids alone contributed more than 75% of the catch and the trials on the north-west coast showed that serranids alone contributed over 80% (Table II). The species composition in the bottom longlining catches by 'Dr. Fridtjof Nansen', indicated that Lutjanids, Lethrinids and Serranids together accounted for nearly 75% of the total catch (Table II). In shark longline fishing trials conducted by RV 'North Star', sharks formed 88% of the total catch; the trap fishing trials conducted by the BOBP were for a limited period of time and also limited to areas close to Colombo, Trincomalee and Hambantota. The results indicated that more than 50% of the catches were Lethrinids (Emperor fishes); and Serranids (Groupers), though very low, were the second most common variety. Lutjanids (Snappers), Carangids (Jacks and Trevallies), and Pomadasyids (Grunts) were poorly represented and Balistidae (File fishes) contributed more than the last two varieties (Table II).

Catch rates

It will be evident from Table I that the sizes of crafts, horse-power of the engines, and characteristics of the bottom trawl used for the various surveys were different. This does not permit direct comparison of the results from these surveys. However, an analysis was attempted

- (a) to check the consistency in the relative changes in the catch rates for various strata and seasonal variation pattern;
- (b) to observe any change in the status of the demersal stocks over the years covered by the surveys; and
- (c) to obtain indicative catch rate figures for different classes of vessels and different fishing methods.

As none of the surveys was complete in all aspects, re-analysis of the available data from all the surveys makes them complementary to one another for obtaining better results.

The results of the analysis are presented in Table III. For those surveys in which the number of samplings in each substratum was small, the catch rates were determined for the stratum.

During the RV 'Lilla' cruises (1920—23), the bottom trawl catch rates varied between 0 and 400 lbs/hr. in most of the strata, excluding those in the south and south-east where it varied between 0 and 200 lbs/hr. The catch rates from bottom trawling trials by RV 'Canadian' (1955—56) ranged from 0 to 150 lbs/hr. in practically all the strata. During the RV 'Dr. Fridtjof Nansen' operations (1978—80), the bottom trawl catch rates varied between 0 and 2000 kg/hr particularly in the north-east, in depths less than 100 m and between 2 and 6500 kg/hr. in the 100—300 m depth range. The mean catch rates in different fishing areas are shown in Fig. 3.

The differences in the catch rates between surveys are attributed to the differences in the classes of vessels and the gears used. The hook and line methods used were effective only on selected components of the demersal stocks and hence the catch rates in these cases tend to be lower than those of bottom trawl catches, irrespective of the size of the craft used. The fish caught with shrimp trawl nets tend to show higher catch rates mainly because these shrimp grounds are specific and the density of very small varieties is relatively high.

Within a substratum or stratum, the catch rates were highly variable for the same season. This indicates patchiness or uneven density distribution of the demersals. Relatively high mean catch rates were realised in strata TI, III, IV, XII, XIII, XIV and XV which are in the northern part. The catches from XIII, XIV and XV included a large proportion of varieties smaller in size and of poor commercial value such as ponyfishes and skates. The catch rates and species composition indicate that there are very few varieties of large abundance or in other words, there are numerous varieties with very low abundance, which is the general trend in tropical waters.

Catch rates of relatively important and abundant varieties were also estimated from the mean total catch rates and species composition obtained from the 'Dr. Fridtjof Nansen' trawl survey. Lethrinids showed highest concentration in area IV; Lutjanids in area II; Serranids in area VI; Pomadysids in areas III and XI; Carangids in areas IV and X; Leiognathids in areas II, VII and XV and sharks and skates in areas VIII and XIII.

The shallow strata in the north (II, XIV & XV) could not be surveyed by the large vessel, RV 'Dr. Fridtjof Nansen'. For these strata, data from the surveys conducted by RV 'Lilla' (Pearson and Malpas, 1926), RV 'Hurulla', RV 'Lagga' (Hinriksson, 1980), RV 'Canadian', RV 'Myliddy' (Berg, 1971) and the Indo-Norwegian Project vessels (Rao, 1973), were used to project catch rates for a vessel of the RV 'Dr. Fridtjof Nansen' class. Applying the ratio of the catch rates realised by RV 'Lilla' and RV 'Dr. Fridtjof Nansen' in other strata covered by both vessels, to the catch rates obtained by RV 'Lilla' in the northern strata, the expected catch rates for RV 'Fridtjof Nansen' were estimated to be in the region of 800 kg/hr. Berg (1971) also estimated a catch rate of 800 kg/hr. in the Palk Bay (XV).

Catch rates in relation to fishing depths

It is generally known that size and density distribution of demersal species varies with increasing depth.

Pearson and Malpas (1926) compared the catch rates in different depth ranges prevailing on the Wadge and Pedro Banks, and showed that catch rates of valuable fish increased up to about 45 fathoms beyond which they declined. The low quality smallfish declined steadily from the

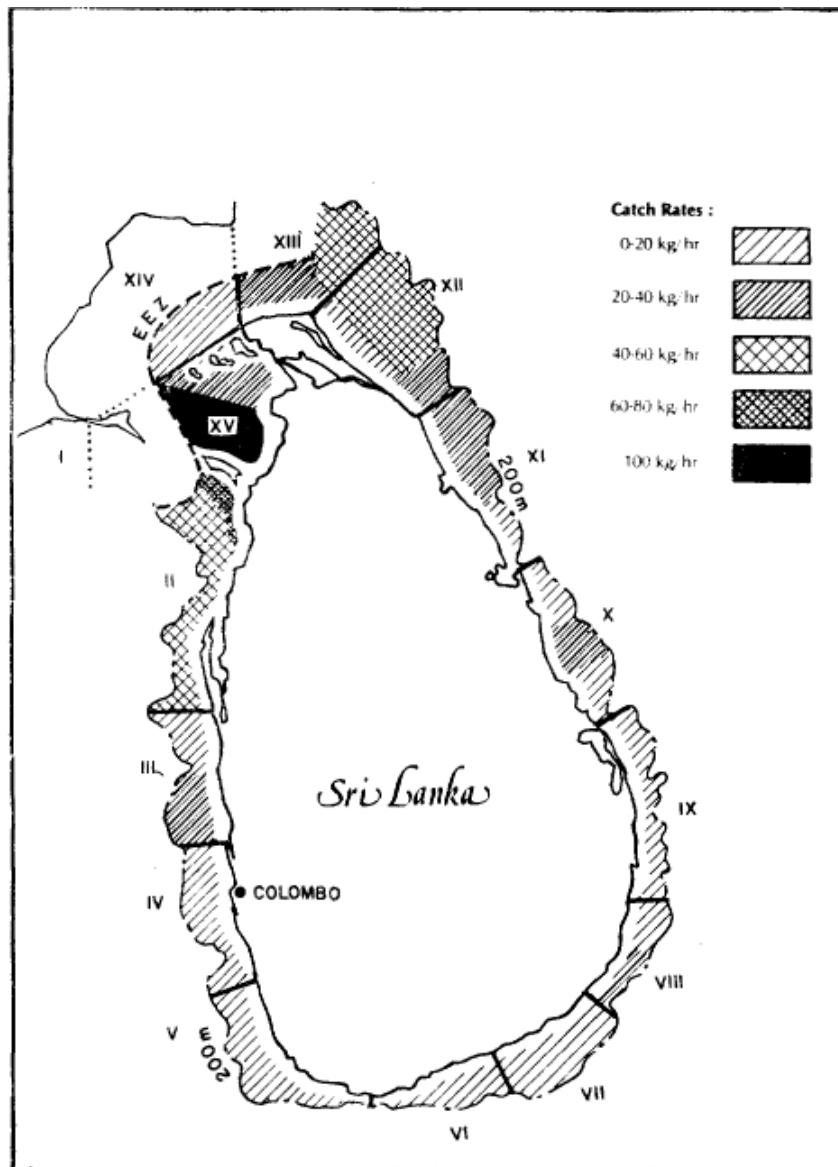


Fig. 3. Mean Catch Rates of Demersal Fish in Various Fishing Areas (II to XV) for 50' to 60' Trawlers of Approximately 100 H.P.

shallow to the deeper waters in the Pedro Bank. In the case of the Wadge Bank, the low quality fish showed an increase from 10—20 fathom depth to 20—45 fathom.

Area	Depth range	Gr. 1 fish	Gr. 2 fish	Total
Wadge Bank	< 10 fm	Operation Nil		
	10— 20 fm	143.3 lbs/hr.	11.4 lbs/hr.	154.7 lbs/hr.
	20— 45 fm	200.4 lbs/hr.	34.6 lbs/hr.	235.0 lbs/hr.
Pedro Bank	< 10 fm	11.8 lbs/hr.	58.9 lbs/hr.	70.7 lbs/hr.
	10— 20 fm	118.7 lbs/hr.	23.0 lbs/hr.	141.7 lbs/hr.
	20— 45 fm	115.9 lbs/hr.	13.3 lbs/hr.	129.2 lbs/hr.
	46—1 00 fm	39.8 lbs/hr.	2.0 lbs/hr.	41.8 lbs/hr.

Sivalingam (1969) reported that the 20—30 m depth range on the Wadge Bank showed the highest density of *Lethrinus nebulosus* and that the mean length of this species increased with depth, from 35 cm in 15—20 fathoms depth to 47.7 cm in 40—50 fathoms depth.

Inside bays, the 15 cm size group of this species was also reported to be caught in abundance by fishermen. Sivalingam also reported that the highest densities for some big demersal species on the Wadge Bank, were in the following depth ranges:

Groupers	30—40fm
Grunts/Sweetlips	20—30 fm
Snappers —	
<i>L. dodecanthus</i>	40—50 fm
<i>L. malabaricus</i>	20—30 fm
<i>Pristipomoides</i> sp.	40—50 fm

Berg (1971) reported the following trends, based on his trials in May/June 1967:

Area	<10 fm	10—20 fm	>20 fm
Mullaitivu	38 kg/hr.	33 kg/hr.	80 kg/hr.
Trincomalee	15kg/hr.	180 kg/hr.	9kg/hr.
Batticaloa	74 kg/hr.	4 kg/hr.	
Pt. Pedro	4 kg/hr.	19 kg/hr.	

On the basis of the results of the survey with RV 'Optimist', Demidenko (1972) stated that there was an inshore complex made up of Lethrinids, Lutjanids, Pomadasyids, Carangids, Serranids, Balistids, Sparids, Leiognathids, Mullids and Sphyraenids and an Oceanic complex (beyond 200 m depth) mainly of Tringilidae, Nemipteridae, Priacanthidae, *Chlorophthalmus* sp. and Stromateidae.

Analysis of the RV 'Hoyamaru' trials with vertical longline (Table IV), indicated relatively better catch rates for groupers in depths up to 80 m; snappers showed higher catch rates in depths over 80 m. Groupers appeared to be fairly evenly and sparsely distributed in depth ranges upto 50 m but catches of snappers were poor in less than 80 m, both on the north-east and north-west coasts (Table V). The mean weight of individual fish also appeared to follow the pattern of the catch rate (Table IV).

A similar analysis of the data from 'Lilla' cruises suggests an increasing trend in the catch rates from 20 to 70 m on the south-west, south and east coasts (Table V).

An analysis of the 'Dr. Fridtjof Nansen' trawling results indicated more frequent occurrence of high catch rates in the 10–20 m depth range in some strata, mainly during January and February. Operations beyond the 100 m depth range produced very high catch rates of deep sea fishes, shrimps and lobster which are not commonly found in depths less than 100 m. It was also noted that the most predominant species in the different depth ranges of each stratum was not the same. In order to reduce the effect of changes in the species composition on the catch rates in different depths the depth-wise variation in the catch rates of individual varieties was analysed for three of the important groups. A decline in the density of Lethrinids in depths beyond 30 m, a less significant decline in the relatively lower density of Lutjanids in the depths beyond 40 m and a rather scattered distribution of Serranids with evenly low density, were indicated.

Seasonal variations in catch rates

Seasonal samplings in each stratum were very few or almost absent during the surveys, hence seasonal variations in the catch rates are not clearly evident. However, the results of the analysis carried out with available data are presented in Tables VI & VII. The large variation in the catch rates within a season for any stratum, appears to have reduced the significant differences between seasonal mean catch rate values. The differences in the number of samples, depth ranges sampled and the patchiness in the distribution of fish, within strata, appear to have contributed to the large variance.

From these tables, it appears that relatively better catch rates were realised between March and June in the north-west (11±111) August and November in the west (IV), January and June in the south-west (V) and south (VI–VIII) coasts, August and December in the south-east (IX), January–June in the east (X, XI) and between July and December in the north-east (XII) and north coasts (XIII, XIV, XV). Blindheim and Foyn (1980), on the basis of seasonal changes in the biomass estimated through an acoustic survey, conjectured that there is a northerly distribution on the west coast around the south-west monsoon. This could not be confirmed from the changes in the catch rates and species composition. During the 'Dr. Fridtjof Nansen' survey, the seasonal variation pattern in the bottom longline catch rates was also similar to that of the trawl catch rates.

Size composition

Length frequency distributions were analysed for a few major species with the data available from the 'Lilla' survey (1920–23) and the 'Dr. Fridtjof Nansen' survey (1978–80). Significant differences in the peak modal size ranges were not evident probably indicating very little changes in the structure of the population between these surveys, even though some changes in the percentage species composition were noticed.

The length frequency distribution for *Lethrinus nebulosus*, by strata and season, showed the occurrence of significant recruitment in the north-west coast, probably during January–February. Generally a larger size of this species was observed during May–June and the modal size of 60 cm was observed in strata VI to X during that season. The samples of other species were very much smaller in size and their length frequency distributions were not well defined. However, their general size ranges are presented here (Table VIII) with the intention of using this information in a later section of this report.

BIOMASS AND POTENTIAL YIELD

On the basis of the acoustic survey of the fish resources around Sri Lanka, Blindheim and Foyn (1980) estimated biomass values for demersal varieties for three seasonal coverages. The classification of integrator readings and echograms into pelagics and demersals was subjective and in some cases the interpretations were doubtful because it was not possible to identify the echo-recordings by actual fishing operations. Further, the acoustic survey method was not effective for the first 0.5 m layer from the bottom which is very significant for demersal species and the

survey was also limited to waters deeper than 10 m. Variations in the swimming layer of some demersals and other behavioural characteristics also influenced the acoustic estimation of abundance. On the whole, these factors are expected to have caused an under-estimation of the demersal fish biomass. However, in the absence of any historical data on catch and effort on demersal fish around Sri Lanka, the biomass estimates resulting from 'Dr Fridtjof Nansen' survey were used for determining the potential yield.

The biomass estimates are available for three seasonal coverages but stratified into six large areas around the island, excluding the northern part. Data are not available for allocating biomass into the stratification adopted in this report but the strata corresponding to the stratification applied during the acoustic survey are indicated in the relevant tables. The seasonal differences in the demersal fish biomass in each stratum are considered to be not very large for the acoustic method of estimation and hence the mean of the three seasonal biomass values, for each area, was used for estimating potential yields from the respective areas (Table IX).

The biomass values for the first coverage were based on the discussions in the survey report as they were not tabled in the reports. Further, the north-west coast was only partially surveyed during the first coverage and hence the biomass could be estimated for the whole stratum but the results of the partial survey had been used to project the probable level of demersal biomass in that area and also for the Palk Bay and Palk Strait areas (Blindheim, de Bruin & Saetersdal, 1979).

(i) Gulland's first approximation method

Saetersdal and Bruin (1978), Blindheim *et al.* (1979) and Blindheim and Foyn (1980) applied Gulland's first approximation of $Y_{max} = 0.5 MB_0$, for estimating the maximum potential yield (Y_{max}) from a virgin biomass (B_0) and used a value of 0.4 as the natural mortality rate (M). As the demersal stocks around Sri Lanka are being exploited, application of the modification of the first approximation was considered, i.e. $Y_{max} = 0.5 (C + MB)$ where C is the annual production of demersals in tonnes and B is the mean annual biomass of the exploited stocks.

On the basis of the annual production of demersal species for 1982, as was roughly estimated by Maldeniya (the second part of this report), the approximate levels of production from the various strata are given below:

Stratum	Acoustic survey area code	1982 Production (tonnes)	Stratum	Acoustic survey area code	1982 Production (tonnes)
II+III	1	4807.4	XI	5	3112.8
IV+V	2	2910.0	XII	6	227.3
VI+VII	3	1108.3	XIII,XIV	7	25333.0
VIII, IX+X	4	2598.1			
Total					40096.9

Her study indicated that besides shrimp trawling in the north-west (strata II+III) and north (strata XIII—XV) which produced demersal varieties as by-catch, handline and large mesh bottom set gillnets are the primary demersal fishing methods around the island. Considering the selectivity of these gears and the areas in which they are applied, it is evident that the latter two methods exploit primarily the larger demersal species such as emperor fishes, snappers, groupers, trevallies, grunts and also sharks and skates; while the shrimp trawling operations produce primarily the smaller demersal species such as ponyfishes. Sporadic catches of demersals are also being made by very few larger trawlers and even by beach seine but their contributions to the demersal fish production are not likely to be significant.

In view of the fact that trawls with relatively small meshed cod-end are not very selective, the catches include almost all varieties in the surveyed areas. Larger varieties being the primary

object of the existing demersal fishery, the fishing mortality rates (F) of such stocks were estimated by using the production figures for the various groups of strata (excluding shrimp trawl by-catches) and the corresponding biomass values for the larger demersal varieties, derived by applying the percentage compositions of species to the biomass values (Table X). An 'F' value of 0.12 was obtained for the whole area, excluding the Palk Strait and Palk Bay areas around the north. As the structure of the demersal stock(s) is not known, 'F' estimated independently for the six areas surveyed, ranged from 0.01—0.42.

Considering the large number of demersal species with large differences in their life-span, natural mortality rates corresponding to the various species groups were applied to the estimated biomass values for the species groups. As natural mortality rates for the relevant species around Sri Lanka are not available, the following ranges based on the results from other tropical waters (Vidal, 1981) were used.

Category	Species groups	Range of M
1	Lethrinids, Lutjanids, Serranids, Large Carangids, Elasmobranchs, Sciaenids	0.2—0.4
2	Sparidae, Pomadasysidae	0.4—0.8
3	Leiognathidae	0.5—1.0
4	Balistidae, Acanthuridae, Scaridae, Aridae, Psetodidae	0.5—0.8
5	Carangidae (small), Stromateidae, Chirocentridae	0.4—1.0
6	Other demersals	0.2—0.8

The biomass of each category and in each stratum was derived by applying the percentage species composition of the trawl catches made during the acoustic survey, to the total demersal fish biomass estimated for that stratum. The production estimates of these categories were similarly estimated using the estimated composition of the catches by various fishing methods used in that stratum.

The total maximum potential yield values and sub-totals for the larger demersals are the sum total of the estimates for individual categories. Surplus yield values are the maximum potential yields minus the estimated production of the corresponding grOLips, in each stratum.

The values of maximum potential yield thus estimated are presented in Table X. Because of numerous uncertainties and approximations entering this estimation, it is recommended that the lower limit of the estimated maximum potential yield values be used in any consideration of the demersal resources for further exploitation. A cautious estimate of the maximum potential from all demersal fish resources of the surveyed area is in the region of 45,000 tonnes/annum and that for valuable large varieties will be in the region of 25,000 tonnes/annum, excluding the Palk Bay and Palk Strait areas.

Blindheim and Foyn (1980) suggested a biomass of 170,000 tonnes for the unsurveyed northern part including the north-west survey area 1. Considering the biomass estimated for the north-west area 1, during the second and third coverage, the biomass in the Palk Bay and Palk Strait area may be about 100,000 tonnes. In the light of the percentage species composition derived by Berg (1971), Pearson and Malpas (1926) and Hinriksson (1980), larger varieties will not be more than 15% of the biomass and on this assumption, the maximum potential yield of demersals in the Palk Bay and Palk Strait area would be about 30,000 tonnes/annum, with about 4,500 tonnes/annum of valuable large sized varieties.

The mean catch rate in the acoustic survey area V or stratum XI (Trincomalee – Mullaitivu) is much higher (227.5 kg/hr) than in area 4 directly south of Trincomalee (164.1 kg/hr.) and is very close to that of the Pedro Bank (240.3 kg/hr.) which is directly north of Mullaitivu. However, acoustically estimated biomass for area 5 is very small because of the very small extent of its area, caused by narrowing of the continental shelf. A high density within a small area tends

to get rapidly depleted by the higher intensity of fishing. The shallow waters from Pt. Pedro to Mannar (strata XIII, XIV Et XV) is the only stretch in which the demersal species are the primarily exploited resources. This is reflected in the production pattern. This stretch contributes over 60% of the demersal species produced around Sri Lanka and about 25% of the total demersal fish production appears to come from the shrimp trawl fishery within that stretch, mainly as by-catch.

(ii) Swept area method

As the acoustic estimation of the demersal biomass was considered to be subjective, an attempt was made to estimate the mean biomass by the swept area method. Mean catch rates from the bottom trawl samplings during the 'Dr. Fridtjof Nansen' survey and an area of 0.0107 km^2 /one hour tow (based on Blindheim *et al.*, 1980 for Pedro Bank area) were applied to the estimated area surveyed. The estimated values of biomass for different areas are given in Table XI. A mean total biomass of 148,258 tonnes was obtained when no escapement was assumed, which is about one-half of the estimate of 299,000 tonnes from the acoustic survey. The plots of estimates by the two methods for each stratum and each coverage showed reasonably good correlation ($r=0.8044$) but the biomass estimates by the swept area method were generally lower than the corresponding acoustic estimates. The deviations were very significant in respect of all three coverages of the acoustic survey area 2 (strata IV+V). The number of stations trawled during each coverage was extremely small (average 1/250 km^2) and excluded large extent of untrawlable rough or rocky bottom. However, if an Efficiency Coefficient of 0.5, which is generally used, is applied then the mean biomass estimated by this method would be almost equal to that derived from the acoustic survey.

(iii) Method using the "intrinsic rate of increase" of the population

Pauly (1980) describes the use of the equation $P_{\infty} = 2.3 W^{-0.26} B_{\infty}$ where P_{∞} is the potential yield, W is the mean weight (in grams) of the adult animal and B_{∞} is the virgin biomass of the stock. This method avoids the use of natural mortality rates which are unknown for the demersal species around Sri Lanka, and is considered a suitable method for double checking the estimates from the other two methods. The mean weights for the adults of all the demersal species are difficult to determine. The bottom longline gear used during the trials tends to capture the larger size range of the big varieties of fish belonging to categories 1 and 2. The mean weight of these categories were estimated from the mean weight of the fish caught during the bottom longlining trials and mean weights recorded during the RV 'Dr. Fridtjof Nansen' survey (1978—1980). A weighted mean of 4650 g obtained for categories 1 and 2, was applied to the biomass estimated for the same categories (Table X) and the potential yield value obtained was 45125 tonnes/annum. This is almost the same as the upper limit of the potential yield estimated by Gulland's method for the areas excluding Palk Bay and the Gulf of Mannar.

DISCUSSION

Although a number of demersal fish surveys have been conducted in the past, many of them have been repetitious and not complementary. As a result, there are wide gaps in the information and data collected. Any further investigations must be carefully planned and designed to fill these gaps in the knowledge of the demersal fish resources around Sri Lanka.

The acoustic method of surveying for demersal fish has many limitations at present, particularly in the separation of demersals from the pelagics and in ensuring the inclusion of fish very close to the bottom. The target strengths of various tropical demersal species are unknown and conversion factors are generally based on results from theoretical projections. A well-designed trawl survey tends to yield good results for abundance and biological studies.

Compilation of statistics on catch and effort in the existing demersal fishery will be of immense value in determining yield levels and in monitoring the annual changes in the status of demersal stocks.

The assessment of the demersal fish production based on the field surveys and interviews with fishermen is a very crude estimation because of the very short period of study and the high degree of variability of the demersal fishery as a primary and secondary method in the various areas even during the same season. However, stratification by crafts, methods, area and season adopted provides some confidence in the distribution pattern of the fishing effort on demersal varieties and the crude estimate of the production level is considered to be reasonable for the purpose for which it was determined. Discrepancy between the estimates made by Maldeniya (Second part of this report) and those presented in the annual report of the Ministry of Fisheries has been observed but any discussion on this must be put off until a more comprehensive study of the demersal fishery is made.

No major differences have been observed in the catch compositions and seasonal variations based on the past surveys and the bottom longline trials carried out by the BOBP (Fonseka, 1985). The seasonal coverages are incomplete in most cases and hence the peak months cannot be narrowed down to more specific periods.

Generally, higher catch rates with bottom longline seem to be in greater depths (>30 m) than in the case of the trawl catch rates (Fonseka, 1985). Perhaps this is influenced by the selectivity of bottom longline, particularly due to the size of hooks, and the catch rates are better in the depth ranges where the vulnerable size range of the fish are more prevalent. On the other hand the trawl catches, particularly with small mesh cod-end, will reflect the density pattern irrespective of size, and high catch rates in lesser depth would indicate a higher density of mixed size ranges.

Assuming that the estimated maximum potential yield of larger demersals is realistic, the average yield of such varieties on the continental shelf would be only about 1 tonne/km² which is not a high value. Further, only an unknown fraction of this will be of the size range vulnerable to a gear such as the bottom longline and even that component does not appear to be evenly distributed. Hence the catch rates obtained with the bottom longline gear tend to be very low. As these stocks are presently not overfished, the bottom longline catch rates of the 1950s and 1980s are not significantly different. The RV 'Dr. Fridtjof Nansen' obtained relatively higher catch rates with the bottom longline gear, in areas around the south of Sri Lanka (strata VI & VII) and the Gulf of Mannar (Table III). In other areas the catch rates with this vessel were not significantly higher than the values realised during the RV 'North Star' operations during 1954—1957 and the BOBP trials during 1980—82. Non-significant higher values could be attributed to the fact that RV 'Dr. Fridtjof Nansen' was equipped with scientific fish finders to locate demersal fish concentrations and used only 200 hooks per set on identified locations.

When the number of hooks is increased, the length of the mainline also increases and some of the hooks are likely to fall on the bottom which is outside the patches of fish concentration. This can contribute to a decline in the catch rate. The ideal number of hooks cannot be determined unless the exact location of fish concentration and the extent of the patch are known. However, for economic viability an optimum number of hooks has to be used to reach the compensatory point between catch rate and catch.

The closeness of the biomass estimated by the acoustic method and that estimated by the swept area method, with efficiency coefficient adjustment, gives reasonable confidence in the mean biomass estimate for demersal fish. The potential yield estimation from the biomass values obtained by employing Gulland's and Pauly's approaches are subjected to the crude parameters, namely, natural mortality rates in one method and the mean weights of adult fish on the other. The method involving the mean weight of the adult fish is valid for virgin biomass values but the demersal stocks around Sri Lanka certainly do not constitute a virgin biomass. A value of $M=0.4$ tends to give a very high yield value for tropical demersals (FAO, 1981). Hence the lower limit of maximum potential yield by Gulland's method, i.e. 45,000 tonnes from the continental shelf excluding the shallow part within 10 m depth, the Palk Bay and Palk Strait is considered to be a modest estimate for a cautious approach to the development of the demersal fishery around Sri Lanka, until the validity of these estimates can be confirmed or a more reliable estimate becomes available. In the absence of any guidance factors on the potential yield from

the unsurveyed area inside the 10 m isobath around the island, excluding the north, only about 10% increase in the potential yield may be safely attributed to this portion of the continental shelf.

CONCLUSIONS

1. Although a number of demersal resources surveys have been conducted in the past, the results have not been able to fill the gaps in the knowledge of the resources.
2. The depth range of 20—60 m appears to be the most productive belt for valuable demersal species.
3. Peak seasons for demersals seem to fall mainly within the first half of the year for most areas except those in the north-east and north. Further studies are necessary to indicate the seasons more specifically.
4. There is room for doubling the present yield from the demersal resources. The maximum potential yield from the continental shelf area, excluding the very shallow part inside the 10 m depth, the Palk Bay and Palk Strait, is in the region of 45,000 tonnes/annum. However, the maximum potential yield of valuable demersal varieties is about 25,000 tonnes/annum. About 10% of the maximum potential yield values may be added for the area less than 10 m depth. Based on the conjectured biomass of 100,000 tonnes and the percentage species composition in the Palk Bay, Palk Strait and Pt. Pedro areas, the maximum potential yield from this part is considered to be 30,000 tonnes/annum of all demersal varieties and only about 3,500 tonnes/annum of large demersal varieties.
5. Considering the present level of demersal species production from all areas, the total surplus yield may be considered as 36,000 tonnes/annum for all types of demersal fish and 13,000 tonnes/annum for valuable large varieties.
6. Development of demersal fishery on the shelf should be areawise and capital investment in this sector should be based on the surplus yield levels for each area (Table X). Based on the surplus yield levels, it is recommended that demersal fishery on the shelf area should be developed as a small-scale fishery. Rapid exploitation may lead to destruction of the resources and also the existing fishery.
7. There are good prospects for the development and expansion of the demersal fishery in areas II to X (Mannar-Trincomalee). Innovations in the existing demersal fishery may be sufficient in areas XII to XV (Mullaitivu—Mannar). The surplus yield level in area XI (Trincomalee-Mullaitivu) does not encourage any further development of the demersal fishery as a primary method in this area. There appears to be no scope for expansion of the fisheries for large sized species in the Palk Bay and Palk Strait areas XIII to XV.
8. In view of the bottom conditions, exploitation of demersal resources on the shelf around Sri Lanka cannot be achieved solely with the bottom trawl. Other passive methods also have to be encouraged, particularly for the exploitation of demersals on very rough or untrawlable bottom. Combinations of methods will, therefore, be necessary to fish the entire exploitable potential in most areas. On the north-west and north coasts, trawling supplemented by bottom set gillnetting; in the south and south-east coasts, hook and line method supplemented by bottom set gillnetting; and a combination of all these methods in all other areas, may help achieve a reasonable coverage of the fishing grounds and a production level close to the maximum potential yield.
9. Considering the existing demand, the primary interest is in the exploitation of larger varieties such as emperor fishes, snappers, jacks and trevallies and the secondary interest in sharks, skates and groupers. Large quantities of the smaller varieties, which form the by-catch of the shrimp trawl fishery and setnet fishery, have a very poor demand and hence are not likely to be the primary objective of the demersal fishery in any area unless better utilization is guaranteed. If

increased exploitation of small demersal varieties is to be encouraged immediate steps are called for to improve the utilization of these varieties and also to increase the demand for such varieties, particularly in areas XIII—XV (Palk Strait and Palk Bay). Such steps are also required for larger demersals, in view of the prevailing differences in the prices of the large demersals and large pelagic varieties.

10. The density and distribution pattern of the large demersals are such that they are not likely to give better results with the bottom longline than those realised during the BOBP trials. However, careful searching with suitable fish finding equipment may give slightly better returns in a few areas.

Steady supply of bait/fish at a price comparatively cheaper than the food fish and a good guaranteed price scheme for the demersal fish catches are likely to significantly improve the economic viability and interest in this fishing method in many areas. If hook and line methods are to be encouraged, a bait supply scheme has to be established to ensure steady supply at reasonable cost.

11. There is a significant seasonal migration of crafts and fishermen from the west, south and north coasts to the east and south-east coasts, mainly during the lean season for pelagics. Encouragement of demersal fishing in their own areas during the lean season and the establishment of a similar system on the east and south-east coasts, will contribute to an increase in overall production of both pelagic and demersal varieties around the country.

12. There is an urgent need to evaluate the status of the demersal fishery in Sri Lanka and such an activity should be an essential part of the activities of the National Aquatic Resources Agency. The assessment carried out over a very short period was very crude and not accurate enough. Systematic observations around the country will be the simplest and cheapest way to assess the changes in the status of the demersal stocks and also to check the validity of the estimates presented.

REFERENCES

1. Anonymous 1975 Report of Exploratory Fishing in the Coastal Waters of Sri Lanka. *Japan Marine Fishery Resource Research Centre, Tokyo, Japan*: 1—49 (Mimeograph).
2. Berg, S. E. 1971 Investigation on the bottom conditions and possibility for prawn and fish trawling in the north and east coast of Ceylon. *Bull. Fish. Res. Stn. Ceylon*, 22 (1 & 2): 53—88.
3. Blindheim, J., G. H. P. de Bruin and G. Saetersdal 1979 *A survey of the coastal fish resources of Sri Lanka, Report No. II*, April—June 1979, Institute of Marine Research, Bergen: 63pp
4. Blindheim, J. and L. Foyn 1980 *Ibid.*, Report No. III, January—February 1980. Institute of Marine Research, Bergen: 78 pp.
5. Chaplin, C. E. 1958 *Report of the Director of Canadian Fisheries Project, Colombo Plan* (Manuscript).
6. Demidenkov, U. 1972 *Results of the Fishery Investigation by RV 'Optimist', 10 March—13 December 1971* (Manuscript).
7. FAO 1980 *Report of the consultation on stock assessment for small scale fisheries in the Bay of Bengal. Chittagong, Bangladesh, June 16—21, 1980*. Vol. I & II, BOBP/REP/10.1 and 10.2: 25pp&141 pp.
8. FAD 1981 *Review of the fishery resources*. IOFC Committee for Development and Management of Fisheries in the Bay of Bengal. IOFC: DM/BB/81/5: 9 pp.

9. Fonseka, M. 1985 Some biological observations from bottom longlining trials around Sri Lanka in BOBP/WP/40, in *Promotion of bottom set longlining in Sri Lanka, Bay of Bengal Programme, Development of Small-Scale Fisheries in the Bay of Bengal, Madras.* BOBP/WP/40.
10. Henriksson, T. G. 1980 *Survey of demersal fish resources off the north, north-west and north-east coasts of Sri Lanka.* FAO publ. FD :DP/SRL/72/051.: 51 pp.
11. Jean, Y. 1957 *Summary of operations of 'Canadian' and 'North Star' April 1954—March 1957, Colombo Plan* (Manuscript).
12. John, C. C. 1949 *Some suggestions for developing the sea-fisheries of Ceylon.* (Manuscript)
13. Kesteven, G. L. 1948 *Report on the fisheries in India, Pakistan and Ceylon* (Manuscript).
14. Lantz, A. W. 1956 *Report of the Director of the Canadian Fisheries Project, Colombo Plan, Canada—Ceylon, 1953—1956* (Manuscript).
15. Malpas, A. H. 1926 The marine biological survey of the littoral waters of Ceylon. *Bull. Ceylon Fisheries*, **2**: 13—165.
16. Manikam, P. P., V. A. Fernando and B. W. Perera 1981 *Report of the committee to examine the economic viability of the activities of the Cey-Nor Development Foundation Ltd., Sri Lanka.* Sp. Publ.—NQRAD: 58 pp.
17. Medcof, J. C. 1956 *Fisheries Survey* (Manuscript): 37 pp.
18. Pajot, G. and K. I. Weerasooriya 1980 Fishing trials with bottom longlines in Sri Lanka. *Bay of Bengal Programme, Development of Small-Scale Fisheries*, BOBP/WP/6: 15 pp.
19. Pauly, D. 1980 A selection of simple methods for assessment of tropical fish stocks. *FAO Fish. Circ.* (729): 54 pp.
20. Pearson, J. and A. H. Malpas 1926 A preliminary report on the possibilities of commercial trawling in the seas around Ceylon, *Bull. Ceylon Fisheries*, **2**: 1—12.
21. Rao, K. V. 1973 Distribution pattern of the major exploited marine fishery resources of India. *Proceedings of Symposium on Living Resources of the Seas around India*, Spl. Publ. Central Marine Fisheries Research Institute, Cochin, **11**: 18—101.
22. Seatersdal, G. S. and G. H. P. de Bruin (eds) 1978 *A survey of the coastal fish resources of Sri Lanka, August—September 1978—Institute of Marine Research, Bergen:* 1—45.
23. Sivalingam, S. 1969 Wadge Bank Trawl Fishery Studies Part I—V. *Bull. Fish. Res. Stn. Ceylon*, **19** (1 & 2): 13—26; **20** (1 & 2): 27—64.
24. Vidal, J. H. 1981 Yield estimated for fisheries resources in the Sultanate of Oman. FI: DP/RAB/71/278/16 (FAO): 80 pp.

Table I

List of past surveys

Vessel	Period	Type of investigation and particulars of gear	Areas surveyed (Experts)
1. RV Lilla, 126', 249 Gr.T, 500 h.p.	1920—23	Bottom trawl surveys; headrope 70', foot rope 100', mesh 5" tapering to 1" cod end.	Around Sri Lanka including Wadge and Pedro Banks (Pearson & Malpas).
2. RV Canadian 45', 80 h.p.	1955—56	Bottom trawl survey; 40' headrope, 50' footrope—Yankee 35, 3 3/4" mesh cod end.	Inshore waters around Sri Lanka (Capt. R Pyne).
3. RV North Star, 45', 80 h.p.	1954—57	Handlining, bottom longlining (tarred cotton); 35 hks/50 fm; No. 6 shark longline No. 9 hooks.	Inshore waters around Sri Lanka (Capt. Barry)
4. RV Canadian, 45', 80 h.p.	1963—67	Prawn trawl; headrope 30', 35 mm cod end.	North and east coasts.
5. RV Myliddy, 33 m, 240 h.p.	1967	Granton trawl; high-opening trawl 80 mm cod end; prawn trawl; headrope 100' 40 mm cod end.	North and east coasts. (Dr. Berg)
6. RV Optimist	1971	Bottom trawling in deep waters.	Around Sri Lanka, outside territorial waters (Dr. Demidenko)
7. RV Hoyomaru, 496 tons, 1000 h.p.	1975	Vertical longline; 8 hooks/line,	North-west and north-east of Sri Lanka (Mes Tanino. Haskimoto & Tanaka).
8. RV Hurulla, 11 m, 96 h.p.; RV Lagga, 8.4 m, 22 h.p.	1975—78	Bottom fish trawl; 32—36 mm cod end.	Palk Bay & Gulf of Mannar (TG Henriksson)
9. RV Dr. Fridtjof Nansen	1978—80	Bottom trawl and acoustic survey; headrope 96', foot rope 63'; 20, 30, 40 mm cod end; bottom longline; monofilament, 200 hooks, No. 8.	Around Sri Lanka.

Table II

Percentage species compositions from the bottom longline, shark longline and trap fishing trials

Area	Season	No. of Operations	Emperor	Snapper	Grouper	Jacks & Trevallys	Grunts	Sharks & Skates	File Fishes	Others
II to XII	1978—80	53 bottom longline operations 'Dr. Fridtjof Nansen'	41.7	29.4	8.5	9.2	2.4	7.3	0	1.5
II—V+ XII	Feb. '56— Feb. '57	'NorthStar'sharklonglineoperation Av. 70 hooks x 35 operations	—3.7—		5.9	0	0	90.4	0	0
III, VII+XI	8/82— 10/82	Av. 10 Trapsx40 operations— 38' Fishing Craft – BOBP trials	55.1	9.9	17.7	0.7	2.6	0	7.4	6.5
II	Jan—Feb. 1974	Vertical longline operations—RV 'Hoyomaru' 29 x 136 hooks	6.3	3.5	85.4	2.9	0	0	0	1.9
IX±X	—do—	—do— 25x 136 hooks	0.8	77.7	12.3	1.5				7.7

Comparison of catch rates obtained for different areas during different surveys

RV 'North Star'	RV 'Canadian'	RV 'North Star'	RV 'Myliddy'	RV 'Hoyomaru'	RV 'Hurulla'	RV 'North Star'	'Dr. Fridtjof Nansen'	'Dr. Fridtjof Nansen'	BOBP trials
45' 80 hp Handlining	Shrimp trawl, 35 mm codend	Bottom longline, 35 hooks/50 fm 1000 hooks/set	35 m 240 hp, Granton trawl 80 mm codend, Shrimp trawl, 110', 40 mm codend	496 Gr.T, vertical longline, 8 hooks x 17 lines	11 m 96 hp. RV 'Lagga' 8.4 m 22 hp, Bottom trawl 32-36 mm codend	Shark longline 70-100 hook	150' 1500 hp, Bottom trawl 20, 30, 40 mm codend	Bottom longline	Bottom longline
1954-1957 kg/line/hr	(Nov.) (April) 1963-1967 kg/hr	1954-1957 kg/100 hks	1967 May/June kg/hr	1975 kg/100 hooks	Nov. 1975- Jan. 1978 kg/hr	Feb. 1956- Feb. 1957 kg/100 hooks	Aug. 1978- Feb. 1980 kg/hr	Aug. 1978- Feb. 1980 kg/100 hooks	1) Nov-Dec. '80 2) Dec '81-Mar '82 3) May '82-Aug '82 4) Nov '82-May '83 kg/100 hooks
				(a) 11.6			420	33	5 ¹
				(b) 3.8					
	(c) 386			(c) 14.1					
0.2	172	2.2				84.8	266	0.5	
0.6	73	4.1							
		4.6						7.5	7.4 ^a
		5.3					345		5.1 ^a
		12.1							
		12.3				187.0	167	15.6	
						637.0			
							146	30.5	
							352	35.7	
							246	12.5	
	60		60	23.4 9.7			93	12.0	
		17.3							
		12.7		6.4					
		8.7		132.2*			215	9.7	5.5 ^a
		5.4	140		123.0				11.4 ^a
4.5							227	11.4	
5.1	115.6	7.4	250 100 (Fish trawl) (Shrimp trawl)		71.0				
	181.0	9.7		5.3		175.0	240	5.0	
	49	5.6		*84.5					
0.3	130	3.3	400	21.1					
8.9	138	6.3			64				
9.9	472.8	2.6 1.5	1200 820 (Fish trawl) (Shrimp trawl)		191				
			365				240		

Vessel		RV 'Lilla'	RV 'Canadian'
Gear		126' 500 hp Bottom trawl, Headrope 70', Footrope 100', 5" tapering to 1" codend	45' 80 hp, Bottom trawl, Yankee - 35' 3 3/4" codend
Season & Unit of Catch rate		1920-1923 kg/hr	(June) (Oct.) 1955-1956 kg/hr
Area	Area Code		
Gulf of Mannar Pamban (a) Silavathurai (b) Kalpitiya (c)	II		
Puttalam-Chilaw (a)	III	12.5	6.2
Chilaw-Negombo (b)		40.2	5.0
Negombo-Colombo (a)		11.6	5.3
Colombo-Kalutara (b)		33.9	25.6
Kalutara-Bentata (c)	IV	4.9	
Bentota-Galle (a)	V	20.5	
Galle-Matara (b)		12.5	
Matara-Tangalle (a)		9.4	
Tangalle-Hambantota (b)	VI	12.9	
Hambantota-Yala (a)		20.1	
Yala-Amaduwa (b)	VII	4.4	
Amaduwa-Kumana (a)		31.2	
Kumana-Komari (b)	VIII	3.6	
Komari-Kallar (a)		0.9	
Kallar-Batticaloa (b)	IX	13.4	
Batticaloa-Velaichchenai (a)	X	15.6	4.7
Velaichchenai-Panichankera (b)		29.9	6.6
Panichankera-Trincomalee (c)		4.4	7.5
Trincomalee-Pudawakatuwa (a)		4.9	2.2
Pudawakatuwa-Pulmodai (b)	XI	27.6	27.9
Pulmodai-Mullaitivu (c)		22.3	13.3
Mullaitivu-Thalayaddi (a)	XII	19.6	11.5
Thalayaddy-Pt. Pedro (b+c)		6.2/62.0(b) (c)	
Pt. Pedro-Jaffna	XIII	37.5	5.8
Island	XIV	16.1 (a) 7.1 (b) 12.9 (c)	
Jaffna-Mannar	XV	35.7 (a) 203.5 (b) 106.2 (c)	6.8 2.3
Pedro Banks		62.0	

Table IV

Catch rates (kg/100 hooks) at various depths, based on the results of vertical longlining operations by RV 'Hoyornaru'.
Catch number/100 hooks is in parenthesis. Mean weights of the fish are given below catch rates.

Area	20-30 m	30-40 m	40-50 m	50-60 m	60-70 m	70-80 m	80-90 m	90-100 m	100-110 m	110-120 m	>130 m
January	6.2(5) 1.2		0.3(1.0) 0.3								
Ha		0	11.7	(21.3) 0.5							
IIb	3.9(95) 0.4	4.3(7.0) 0.6	5.9(1 6.6) 0.3		5.1 (7.0) 0.7	2.2(5.0) 0.4					
IIc		11.7(22) 0.5	12.6(30) 0.4	29.3(70) 0.42		2.5(5.0) 0.6					
February IX				8.7(12.5) 0.7	8.8(10) 0.82		45.2 (26.5) 1.7				
IXb				0	9.7(14.5) 0.7						
Xb					9.7(1 4.5) 0.7						
Xc									(108.5) (117.0) 0.93	179.4 (2.32) 0.8	
XIa							3.7(7.0) 0.5				
XIb							0				
XIIa							2.0(3.0) 0.66	8.5 (19.0) 0.45			
XJlc								85.9 (60.4) 1.4	83.3 (44.0) 1.9		
XIII						21.1 (21.0) 1.0					

Table V**Catch rates in different depth ranges from Lilla' cruises (lbs/hr)**

Depth range	Stratum							
	IVa	Va	VII a	Xla	Xlb	Xlc	XIIc	XIII
20—30 m	19.7	—	2.0	8.0	9.0	20.2	134.2	64.9
30—40 m	25.3	—	13.2	—	—	—	92.0	102.0
40—50 m	—	—	—	15.5	34.4	54.0	120.5	—
50—60 m	—	—	—	—	—	—	115.0	75.0
60—70 m	—	74.3	65.1	—	—	—	—	264.0
70—80 m	—	30.0	60.3	—	—	—	—	63.0

Table VI**Seasonal differences in catch rates of predominant groups
observed in the Dr. Fridtjof Nansen' survey results (kg/hr)**

Area	Season					
	January—February '80		April—June '79		August—September '78	
II	139	Lethrinids Leiognathids	655	Lethrinids Leiognathids Lutjanids		
III	174	Lethrinids	338	Lethrinids Pomadasyids		
IV	211	Lethrinids Lutjanids	97	Skates Lutjanids	888	Lethrinids Carangids
V	128	Carangids Serranids	315	Carangids	60	Skates
VI	88	Serranids	384	Serranids	52	Serranids
VII	584	Lethrinids	236	Leiognathids		
VIII	104	Skates+Sharks	500	Lutjanids Leiognathids Acantharus	71	Lutjanids Serranids
IX	46	Lutjanids Pomadasyids	125	Lutjanids Pomadasyids	161	Pomadasyids Lutjanids
X	265	Lutjanids Acantharus	186	Carangids Lethrinids	229	Carangids Lutjanids
XI	240	Carangids	253	Pomadasyids Serranids	117	Serranids Lutjanids
XII	155	Lethrinids Lutjanids Carangids	279	Lethrinids Serranids Lutjanids	1032	Leiognathids

Table VII

Seasonal variations in catch rates during some of the surveys

(kg/hr or kg/100 hooks, unless otherwise stated)

Area		Jan.	Feb.	Mar.	April	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.
1963—65 'Canadian' Prawn Trawl	II	60 lb			218							133	51 lbJhr.
	III				278 lb	427					310		
	XI									148			
	XII	430	605			140	201	88	290	180	234		
	XIV	430	605	329						630			
	XIII										130		
1979—80													
'Ceynor' Boats		1636	1261	1754	591 kg/day	295	—	2199	1913	—	—	2058	2000 kg/day
Bottom Trawl catches		Year round 80—95% marketable fish 0.3—3.5% shrimp and 8—40% ponyfishes											
'North Star'													
B. Longline catch	III	5.2 lb	3.5	13.3								10.1 lb	
	IV	7.1 lb									2.3	12.5	12.4 lb
	V	23 lb	22.4	24.3									
	X				20.7	33.5	28.5	18.2	9.0	22.2	27.4		
	XI				12.1	14.5	14.5	23.3	18.0	21.9	16.2		
	XII							14.5					
	XIII								34.9				
	XV									2.1			

Table VII (Continued)

Area		Jan.	Feb.	Mar.	April	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.
[24]	'Lilla'												
	Bottom Trawl				457	28 lb							
	III												46lb
	IV												48 d
	V												24lb
	VI												50lb
	VII												39 lb
	VIII												12lb
	IX												
	X									6.5			
	XI									42lb			
	XII									105 lb			
	XIII									68			
	XIV									28			
	XV									ilOlb			

Table VIII

(a) Size ranges of some demersal species in the
trawl catches of Dr. Fridtjof Nansen' (*In cm*)

(b) Size ranges of demersal species in the
vertical longline catches of 'Hoyomaru' (*In cm*)

Species	Area	Size range	Modal size		Area	Range	Mode
<i>Epinephelus undulus</i>	III	35—70	50—55	<i>E. areolatus</i>	NW	23—37	30—32
	II	25—70	60—65		NE	20—41	38
<i>Lutjanus</i>	II	40—70	45—50	Red coral cod	NW	15—39	30
<i>arçjentimamaculatus</i>	III	20—60	25—30		NE	29—45	40
<i>L. sanguineus</i>	II	35—75	50—55	White snapper (species unknown)	NE	20—67	44—45 60—61
<i>Pristipomoides typhus</i>	III	20—60	45—50	Large eyed bream	NE	29—51	42

Table IX
Estimated biomass values for demersal varieties, during the three seasonal
acoustic coverages by 'Dr. Fridtjof Nansen'

Stratum	Acoustic survey area code	Area within 100 fm depth nm ² /km ²	Biomass (tonnes)			Mean value
			Aug.—Sep. 1978	April—May 1979	Jan.—Feb. 1980	
II+III	1	1500/5130		100,000	35,000	67,500
IV+V	2	1350/4617	140,000	130,000	105,000	125,000
VI }-VII	3	940/3215	50,000	30,000	55,000	45,000
VIII, IX	4	1300/4446	40,000	40,000	30,000	36,600
XI	5	560/1915	10,000	20,000	10,000	13,300
XII	6	1020/3488	10,000	10,000	15,000	11,600
Pedro Bank upto 10°15" N						
XIII, XIV+XV	7	131 5/4500				
	Palk Strait					
	Palk Bay		170,000			
II+III	1	1500/5130.				
Total				330,000	250,000	299,000

Projected estimate for acoustic survey areas 1 and 7 based on first coverage of area 1 (Saetersdal and de Bruin, 1978).

(?) – Partially surveyed during the first coverage.

Table X

Mean biomass estimates for various categories of fishes entering the trawl catches

Stratum	Area code	Mean total biomass	Mean biomass (tonnes)		Annual maximum potential yield (tonnes)	Mean biomass (tonnes)					Annual total maximum potential yield (tonnes)	Surplus yield (all demersals)	Surplus yield (large demersals)
			Category 1	Category 2		Category 3	Category 4	Category 5	Category 6	Category 7			
11+111	1	67500	32740	6210	6924— 11440	5535	943	6142	15728	202	12673— 29622	7866	2100
IV+V	2	125000	72520	2432	9127— 16866	0	256	29056	20608	128	17064— 39740	14285	6300
VI+VII	3	45000	23040	3645	3347— 6380	2745	3015	1845	10665	45	6222— 14147	5500	2700
VIII, IX+X	4	36600	17018	4063	2608— 5123	1134	1793	8088	4028	476	5360— 12063	2762	1400
XI	5	13300	5427	2022	2503— 3450	173	532	1636	3490	13	3356— 5967	240	0
XII	6	11600	6020	1183	978— 1817	719	1032	336	2297	11	1713— 3676	1400	690
XIII, XIV+XV	7	100000	—15000—		3429— 4929	—60000—	10000	15000			29815— 56815	4200	0
Total					29916— 50005						76203— 162030	36253	13190

Table XI

Estimated biomass value for demersal varieties applying the swept area method on the trawl catches of Dr. Fridtjof Nanson'

Stratum	Acoustic survey area	Mean catch rate (kg/hr.)	Area (nm ²)	Catch/nm ² (kg)	Biomass (tonnes)
1±11	1	329.5	1500	30,794.3	46185
IV+V	2	253.6	1350	23,700.9	31995
VI+VII	3	175.2	940	16,373.8	15387
VIII, IX+X	4	164.1	1300	15,336.4	19929
XI	5	227.5	560	21,216.6	11905
XII	6	240.3	1020	22,457.9	22909
Total					148310

Average swept area/haul=0.0107 nm² (Blindheim and de Bruin, 1978)

STATUS OF DEMERSAL FISHERY IN SRI LANKA

by

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INTRODUCTION

A proper assessment of the resources available and the methods of exploitation is very necessary for the successful implementation of a plan for the development of the fishing industry. These assessments have to be based on the scientific collection and processing of data. Although the Ministry of Fisheries compiles various forms of statistics regarding the industry, it is not possible to draw definitive conclusions from these data regarding the status of the available resources and the viability of commercial exploitation because of inadequacies in sampling, coverage, personnel, supervision, reporting, etc. However, a well designed survey to collect data and to compute of detailed statistics on fish catches on a continuing basis will provide an adequate and reliable base for a proper assessment of the potential of the fish resources around the country. An attempt has been made here to evaluate, in a rather rough manner, the status of demersal fishery in Sri Lanka. In carrying out this study information from two main sources was considered.

- Information collected through a field survey conducted at all major fish landing sites around the island simultaneously over a period of two weeks from 14 to 28 September, 1982, including interviews with fishermen, by 12 staff members from NARA and BOBP.
- The demersal fish production in various parts of the island estimated on the basis of the statistics compiled by the Ministry of Fisheries.

It is to be admitted that the field survey was of a very short duration. The extrapolated data, therefore, lead to what should be regarded only as rough estimates.

CENSUS OF CRAFT AND FISHING METHODS

The survey covered all the major fish landing sites in the country and catch compositions and average landings were determined in relation to each type of fishing gear and craft used. All thirteen District Fishery Extension Officers' (DFEO) divisions were covered in the collection of data and categorized area-wise as follows:

- | | | | |
|---------------|----|----|---------------------------------------|
| 1. North-west | .. | .. | Mannar, Puttalam and Chilaw |
| 2. West | .. | .. | Negombo, Colombo, Mutwal |
| 3. South-west | .. | .. | Kalutara, Beruwela |
| 4. South | .. | .. | Galle, Matara |
| 5. South-east | .. | .. | Tangalle, Pathanagala |
| 6. East | .. | .. | Batticaloa, Kalmunai |
| 7. North-east | .. | .. | Trincomalee, Mullaitivu |
| 8. North | .. | .. | Jaffna, Point Pedro and Kankasanturai |

Information on the number of fishing crafts used in demersal fishery at each centre was collected by direct observation and through information collected by DFEOs. The information on catches,

catch compositions, seasonal changes, etc., was gathered mainly through interviews with fishermen and partly by observations. The summarized data are given in Tables I and II. A study of these tables brings out the following features:

- The handline method appears to be the most widely used technique all around the island. This is because most of the local fishermen use handlining as an ancillary method with other types of gear. The usage of non-mechanized traditional crafts closely follows the pattern of the usage of handlining around the country. This may be due to the large number of local fishermen who engage in small-scale fishing. The number of boat days for handlining is comparatively higher than those for all other methods put together, except in the north.
 - Among the other two types of fishing employed all around the country, bottom set gillnetting appears to be popular in the north, north-east and north-west areas, whereas bottom set longlining appears to be popular in the north-west and north followed by south.
- Trawling for demersal fish is limited mostly to the north and north-west coasts, since suitable shrimp trawling grounds are limited to these areas only; some trawling is conducted in the west also. Bottom set traps are in use to a very limited extent. As with trawling, this method is practically restricted to the north and north-west coasts. These are mostly operated by small-scale fishermen.
- There are relatively more non-mechanized traditional crafts in the north-east and south. There are more 3½ tonners and 18 footers in the north-west; the 3½ tonners are also more numerous in the north and west.
 - Of the various types of mechanized crafts in use, the E-26 type (3½ tonner) is very common in all areas except the north-west and north where 18' FRP boats and mechanized traditional crafts are predominant. FRP boats are rarely used in the west and east coasts, where non-mechanized traditional crafts and E-26 type boats are common. Bottom set gillnets and bottom longlines are widely used by mechanized crafts whereas handlines are commonly used by non-mechanized traditional crafts.

ANALYSIS OF FISHERY DATA

Although attempts were made to estimate for each month the average catch per boat, the number of fishing days and the catch per boat per fishing day, due to limitations of the field survey and the available fishery statistical information, it was thought that the study should be limited to the estimated data for the whole year instead of for each month. Thus the total average catch per boat for the year 1982, for each type of fishing method, was calculated and the catch rate was obtained by dividing this figure by the estimated total number of fishing days in the year. The estimated figures are given in Tables IIIa to IIIe for each district and for each type of fishing gear. The data was analysed only on the basis of gear and not according to the class of boats. The catch rate i.e., catch per boat per fishing day, does not take into account the efficiency of different types of boats employed for the same type of fishing. Thus, the data presented are only a rough guide to the general pattern of catches from different methods and their relative importance in different coastal districts.

FISHING SEASON

Bottom set gillnet: The gillnet fishing is conducted throughout the year in the northern half of the island, in the coastal belt covered by Mannar, Chilaw, Negombo, Trincomalee and Jaffna. In the other areas, except in Batticaloa on the east, the fishing is generally from October to April. At Batticaloa alone, the fishery is during the other half of the year from April to September.

Bottom set longline: This fishery extends throughout the year at Jaffna, Mannar and Puttalam, representing the north and north-west areas, Negombo (west) and Galle (south).

Excepting Batticaloa and Mullaitivu, where the fishery extends from February/March to October, the fishing is conducted in the other areas, during October to April. This is more or less the same pattern as for bottom set gillnet operations.

Handline fishing: In Puttalam and Chilaw (north-west), Jaffna (north), Trincomalee (north-west), Negombo (west), Kalutara (south-west) and Kalmunai (east), handline fishing is carried out throughout the year. As in the case of bottom longline fishing, the fishing is suspended in Batticaloa and Mullaitivu during the November to January—February period while in the other areas it is suspended during May to October.

Trap fishing: This type of fishing is restricted only to three districts in the north, north-east and north-west parts, i.e., Jaffna, Trincomalee and Mannar, and is conducted all through the year.

Trawling: This is also conducted only in a few districts in the northern, north-western and western parts, almost throughout the year. But intense activity is seen only at Mannar.

In general it can be stated that the fishing activity is more or less all round the year in the northern half of the island, while at Batticaloa and Mullaitivu, the fishing is limited to April-September which is the south-west monsoon period; in the other districts, fishing is conducted during the other half of the year, October to April, which falls within the north-east monsoon period.

It is not known why bottom set longlining operations are not conducted off Trincomalee, Mutwal and Chilaw districts, whereas they are conducted in the adjacent districts. A similar question arises in respect of bottom set gillnetting in the case of Mullaitivu and Mutwal and in respect of handlining off Mutwal.

CATCH AND CATCH RATES

Bottom set gillnet (Table Iila): The largest annual catch per boat (26 tonne) and the highest catch rate (107 kg) are obtained at Jaffna, closely followed by Chilaw (22 tonne; 100kg). Colombo has also recorded a fairly high catch rate (96 kg) but the fishing activity is restricted to one half of the year, unlike the former two districts where fishing is throughout the year. Other districts which have registered good catches are Mannar, Negombo and Kalmunai but the catch rate is around 50 kg per fishing day. On the other hand, at Galle and Batticaloa, the annual catch per boat was low but the catch rate was higher, around 80 kg.

Bottom set longline (Table IIlb): Pathanagala on the south-east coast has recorded the highest catch (24 tonne) and catch rate (162 kg) and has overshadowed all other districts. The next best is Jaffna with an annual catch of 20 tonne and a catch rate of 83 kg. Good catches are obtained at Negombo, Kalmunai and Galle with catch rates of 50—60 kg. At Colombo and Batticaloa, the annual catches are lower, but the catch rate is higher, 65—75 kg. The records of other areas show poor returns.

Handline (Table IIlc): Being an ancillary fishing method and carried out mostly by the non-mechanized traditional boats and 18 footer mechanized boats, the total annual returns and catch rate per boat are rather low, the former ranging from 500 to 4500 kg and the latter from 2 to 4 kg. The best catch rate is registered at Galle (24 kg) followed by Kalutara (19 kg). The average catch rate is 17 kg at Mannar, Chilaw, Batticaloa and Kalmunai. The poorest returns are from Pathanagala (7 kg) and Jaffna (2 kg).

Trap fishing (Table IIId) : Indications of some prospects are seen at Trincomalee and Jaffna, although the catch rate is as low as 11 kg.

Trawling (Table IIle): By far, the best annual catch and catch rate for all types of demersal fishing are recorded at Mannar with a total annual catch of about 80 tonnes and an average catch rate of 292 kg per boat. During June to December, the catch rate is as high as 500 kg and during the other months it is about 90 kg. At Jaffna, Chilaw and Mutwal, the catch rate

is very low at 21–23 kg. At these places fishing is carried out by the 3½ tonners and perhaps the prawn component sustains the operations. The non-mechanized traditional crafts employing trawl nets at Negombo show a catch rate of 7 kg only.

ANNUAL DEMERSAL FISH PRODUCTION

The catch distribution of demersal fish production in 1982 is given in Table IV by area, district, gear and type of craft. The salient features emerging from these figures of demersal fish production are:

- Trawling accounts for the largest share (31%) of the total catch of about 40100 tonne; bottom set gillnets and handlines share equally 51% of the catch; bottom longlines come next in importance with 16%; trap fishing accounts for an insignificant 2%.
- In area-wise production, the north-west region tops with 38%, closely followed by north with 35%. In fact, the northern part of Sri Lanka, between 8°N and 10°N, so dominates that 81% of total production comes from this region.
- The 3½ tonne boats contribute nearly 60% of the total catch while the non-mechanized traditional boats and 18 footers account for 19% and 18% of the catch, respectively. One half of the contribution made by the 3½ tonners is credited to trawling, and the next largest share (29%) is from gillnetting.
- Among the top two districts, Jaffna (13900 t) and Mannar (11400 t) the latter's importance is almost exclusively due to the returns from trawling, whereas Jaffna's yield comes from diversified fishing, namely, bottom set gillnetting, bottom longlining, trawling and trap fishing in that order of importance. The returns from handlining account for the importance of Trincomalee, Chilaw and Kalmunai. Bottom longlining is the most important type of demersal fishing in Galle, supported by handlining, both largely from non-mechanized traditional crafts.

The total demersal fish production for the years 1973 to 1982 is given in Table V. The source of data, except for 1982, is the statistics prepared by the Ministry of Fisheries.

From these figures it is seen that but for an all-time low of 30,000 tonne in 1975 and a record catch of 48,000 tonne in 1981, the annual production has tended to hover around the average figure of 38,000 tonne. In the year of lowest production, the districts affected were Negombo, Puttalam, Jaffna, Trincomalee, Batticaloa and Kalmunai. Heavy catches in Jaffna and improved landings in Mannar and Puttalam contributed to the record catch in 1981.

Jaffna has always topped the district-wise production with an average of 12000 tonne. Negombo, which in 1973 shared the top place with Jaffna, has been witnessing a drastic fall in production over the years. Although there has been some recovery in 1980 and 1981, the decline has again manifested in 1982. Mannar has recently emerged as the second most important district, although practically all through the earlier years Trincomalee occupied this position.

A general declining trend is also noticed in Colombo, Kalutara, Matara and Mullaitivu. It is not known whether the changing trend is due to shifting of the bases of operation of the crafts, or due to differences in the methodology of data collection and estimation or due to some other cause.

SPECIES COMPOSITION

The varieties caught are mainly groupers, snappers, emperors, brems (collectively called 'Rock fishes'), carangids, shark, and skates. However, the individual contributions of different varieties were not available in respect of most of the DFEO divisions. Therefore, an analysis could not be attempted. However, the demersal fish production figures given by the Ministry of Fisheries for 1981 (Table VI) would provide some idea of the contribution of various groups. The 'rock fishes' form about 36% while the others, i.e., sharks, skates and carangids, account individually for about 20% each.

Table I

Estimated average number of crafts operating the specified gear per month and the estimated average number of boat days per annum

(Estimation of the number of boat days is based on the average number of crafts and number of fishing days; NC=Number of crafts; BD=Number of boat days)

Gear Area	Bottom set gillnet		Bottom set longline		Handline		Fish trap		Trawling	
	NC	BD	NC	BD	NC	BD	NC	BD	NC	BD
North-west	33	16387	133	47616	357	204556	50	15000	156	43309
West	13	4380	17	5416	201	47015	—	—	52	29220
South-west	40	3462	16	1533	57	7585	—	—	—	—
South	48	3168	56	18117	202	52498	—	—	—	—
South-east	5	800	19	5450	90	27188	—	—	—	—
East	9	2235	16	4587	297	120708	—	—	—	—
North-east	107	23004	7	1334	442	173172	23	5796	—	—
North	268	64960	149	34962	445	114704	268	77152	308	91395

Table II

**Average number of crafts under each class
(periodic sample average) in each of the areas**

Area	Craft			
	3½ tonners	18 footers	Mechanized traditional	Non-mechanized traditional
North-West	453	982	192	194
West	324	7		220
South-West	34	29	—	90
South	186	43	62	431
South-East	97	13	13	72
East	55	24	—	260
North-East	25	252	20	677
North	439	139	611	201
Total	1613	1489	898	2145

Table Iila

Bottom set gillnet — Estimated average catch per boat (kg)

Area	District	Fishing season	Annual catch	Number of fishing days	Catch per fishing day
North-West	Mannar	January—December	12040	248	49
	Puttalam	October—April	1050	35	30
	Chilaw	January—December	21600	216	100
West	Negombo	January—December	11520	216	53
	Mutwal	—	—	—	—
	Colombo	November—April	11470	120	96
South-West	Kalutara	November—April	4490	86	52
South	Galle	November—April	5480	66	83
	Matara	—	—	—	—
South-East	Tangalle	October—May	8000	160	50
	Pathanagalla	—	—	—	—
East	Batticaloa	April—September	3300	41	80
	Kalmunai	September—May	10800	216	50
North-East	Trincomalee	January—December	8400	216	39
	Mullaitivu	—	—	—	—
North	Jaffna	January—December	25790	242	107

Table IIIb

Bottom set longline—estimated average catch per boat (kg)

Area	District	Fishing season	Annual catch	Number of fishing days	Catch per fishing day
North-West	Mannar	January—December	6480	216	30
	Puttalam	January—December	1910	141	14
	Chilaw	—	—	—	—
West	Negombo	January—December	12360	228	54
	Mutwal	—	—	—	—
	Colombo	November—March	7500	100	75
South-West	Kalutara	November—April	5640	93	61
South	Galle	January—December	10540	185	57
	Matara	October—April	2800	140	20
South—East	Tangalle	October—April	3340	140	24
	Pathanagala	November—April	24300	150	162
East	Batticaloa	March—October	4880	75	65
	Kalmunai	September—May	12200	216	56
North-East	Trincomalee	—	—	—	—
	Mullaitivu	February—October	1600	179	9
North	Jaffna	January—December	19510	234	83

Table IIIc
Handline fishing—estimated average catch per boat (kg)

Area	District	Fishing season	Annual catch	Number of fishing days	Catch per fishing day
North-West	Manna	October—April	2320	133	17
	Puttalam	January—December	3470	240	14
	Chilaw	January—December	3390	200	17
West	Negombo	January—December	1580	144	11
	Mutwal				
	Colombo	November—April	1390	90	15
South-West	Kalutara	January—December	2490	133	19
South	Galle	November—April	1850	78	24
	Matara	October—June	2110	182	12
South-East	Tangalle	October—June	1980	151	12
	Pathanagala	November—April	1000	150	7
East	Batticaloa	March—October	2460	146	17
	Kalmunai	January—December	4530	261	17
North-East	Trincomalee	January—December	2880	212	14
	Mullaitivu	February—October	2160	180	12
North	Jaffna	January—December	500	258	2

Table hid
Trap fishing—estimated average catch per boat (kg)

Area	District	Fishing Season	Annual Catch	Number of fishing days	Catch per fishing day
North-West	Mannar	January—December	150	300	0.5
North-East	Trincomalee	January—December	2760	252	11.0
North	Jaffna	January—December	3110	288	10.8

Table IIIe
Trawling—estimated average catch per boat (kg)

Area	District	Fishing Season	Annual Catch	Number of fishing days	Catch per fishing day
North-West	Mannar	January—December	80490	276	292
	Chilaw	July—May	5890	276	21
West	Negombo	July—May	1890	276	7
	Mutwal	January—December	6000	288	21
North	Jaffna	January—December	6750	297	23

Table IV

36-A

Catch distribution (in tonne) on the basis of areas, districts, crafts and type of fishing gear — 1982

MT — Mechanized traditional

NMT — Non-mechanized traditional

Fishing Gear	Bottom-set gill net					Bottom-set longline					Handline					Trap Fishing			Trawling			
Craft	3½ tonners	18 footers	MT	NMT	Total	3½ tonners	18 footers	MT	NMT	Total	3½ tonners	18 footers	MT	NMT	Total	MT	NMT	Total	3½ tonners	NMT	Total	Grand Total
Area/District																						
North-West																						
Mannar	170	409	120	—	699	—	130	21	39	190	—	613	—	14	627	—	8	8	9892	—	9892	11416
Puttalam	—	—	26	—	26	495	—	—	72	567	8	291	—	164	463	—	—	—	—	—	—	1056
Chilaw	—	85	—	—	86	—	—	—	—	—	1	1938	289	104	2332	—	—	—	296	—	296	2714
Total	170	495	146	—	811	495	130	21	111	757	9	2842	289	282	3422	—	8	8	10148	—	10148	15186
West																						
Negombo	173	—	—	—	173	272	—	—	—	272	368	—	—	40	408	—	—	—	—	183	183	1036
Mutwal	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	120	—	120	120
Colombo	21	88	—	—	109	30	—	—	—	30	11	—	—	127	138	—	—	—	—	—	—	277
Total	194	88	—	—	282	302	—	—	—	302	379	—	—	167	546	—	—	—	120	183	303	1433
South-West																						
Kalutara	60	31	—	9	100	52	43	—	—	95	29	32	—	118	179	—	—	—	—	—	—	374
Total	60	31	—	9	100	52	43	—	—	95	29	32	—	118	179	—	—	—	—	—	—	374
South																						
Galle	198	22	43	—	263	392	—	219	504	1115	45	34	49	633	761	—	—	—	—	—	—	2139
Matara	—	—	—	—	—	28	—	—	—	28	125	32	—	82	239	—	—	—	—	—	—	267
Total	198	22	43	—	263	420	—	219	504	1143	170	66	49	715	1000	—	—	—	—	—	—	2406
South-East																						
Tangalle	40	—	—	—	40	66	—	—	—	66	148	14	14	85	261	—	—	—	—	—	—	367
Pathangala	—	—	—	—	—	360	60	23	—	443	25	4	2	1	32	—	—	—	—	—	—	475
Total	40	—	—	—	40	426	60	23	—	509	173	18	16	86	293	—	—	—	—	—	—	842
East																						
Batticaloa	74	19	—	—	93	7	11	—	—	18	61	—	—	518	579	—	—	—	—	—	—	690
Kalmunai	—	54	—	—	54	168	760	—	—	244	—	—	—	1610	1610	—	—	—	—	—	—	1908
Total	74	73	—	—	147	175	87	—	—	262	61	—	—	2128	2189	—	—	—	—	—	—	2598
North-East																						
Trincomalee	7	547	55	305	914	—	—	—	—	—	30	228	76	1801	2135	—	63	63	—	—	—	3112
Mullaivituvu	—	—	—	—	—	—	11	—	—	11	—	216	—	—	216	—	—	—	—	—	—	227
Total	7	547	55	305	914	—	11	—	—	11	30	444	76	1801	2351	—	63	63	—	—	—	3339
North																						
Jaffna	6223	609	368	409	7609	1614	1506	14	7	3141	—	1	151	70	222	246	588	834	2111	—	2111	13917
Total	6223	609	368	409	7609	1614	1506	14	7	3141	—	1	151	70	222	246	588	834	2111	—	2111	13917
Grand Total	6966	1665	612	723	10166	3484	1837	277	622	6221	851	3403	581	5367	10202	246	659	905	12419	183	12602	40095

Table V

Total demersal fish production (1973 to 1982) (Tonne)

			1982	1981	1980	1979	1978	1977	1976	1975	1974	1973
Mannar	..	..	11416	5861	3913	3421	3038	3076	4657	3676	3062	3332
Puttalam	..	..	1056	4434	1974	717	2588	3465	2395	2484	3262	2082
Chilaw	..	..	2714	1169	—	—	—	—	—	—	—	—
Negombo	..	..	1036	3441	3665	1840	2560	1636	4090	4643	6722	10861
Colombo	..	..	277	716	1058	691	1095	1351	1033	661	610	398
Kalutara	..	..	374	999	1073	1495	1665	1228	1365	721	1744	936
Galle	..	..	2139	1300	1418	1945	1379	2220	2013	844	619	555
Matara	..	..	267	1259	1929	1639	2098	2122	2244	1478	889	1004
Tangalle	..	..	367	938	993	—	—	—	—	—	—	—
Hambantota	..	..	—	—	—	1001	670	1143	2069	961	1373	1097
Batticaloa	..	..	690	893	2060	755	1609	1460	1028	960	794	3637
Kalmunai	..	..	1908	1220	1310	1793	1091	1628	1634	726	764	704
Trincomalee	..	..	3112	6308	6630	6079	5601	4521	4093	2157	3514	3277
Mullaitivu	..	..	227	1148	1749	3487	1279	1800	1731	998	1594	416
Jaffna	..	..	13917	18359	11368	14172	13226	9421	7236	9893	11997	10784
Total	..		40095*	48045	39140	39035	37999	35071	34593	30202	36945	39083

* Includes the catch at Mutwal (120 t) and Pathanagala (475 t).

Table VI
Group-wise demersal fish production in 1981 (Tonne)

Districts	Sharks	Skates	Rock fishes	Carangids	Total
Mannar	1137	2716	1303	705	5861
Puttalam	620	1381	1496	937	4434
Chilaw	42	228	781	118	1169
Negombo	2106	556	481	298	3441
Colombo	2	1	263	450	716
Kalutara	140	95	490	274	999
Galle	63	20	672	545	1300
Matara	264	48	594	353	1259
Tangalle	232	262	356	88	938
Batticaloa	404	129	294	66	893
Kalmunai	377	174	379	290	1220
Trincomalee	1182	754	2563	1809	6308
Mullaitivu	168	10	857	113	1148
Jaffna	2902	4624	6717	4116	18359
Total	9639	10998	17246	10162	48045

Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings out six types of publications:

RePorts (BOBP/REP/. . .) describe and analyze completed activities such as seminars, annual meetings of IIOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

Working PaPers (BOBP/WP/. . .) are progress reports that discuss the findings of ongoing BOBP work.

Miscellaneous Papers (BOBP1'MIS/. . .) concern work not originated by BOBP staff or consultants — but which is relevant to the Programme's objectives.

Newsletters (*Bay of Bengal News*), issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

Information Documents (BOBP/INF/. . .) are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Manuals and Guides (BOBP/MAG/. . .) are instructional documents for specific audiences.

A list of publications follows.

Reposh (BOBPJREPL....)

1. Report of the First Meeting of the Advisory Committee. Colombo, Sri Lanka, 28-29 October 1976. (Published as Appendix 1 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
2. Report of the Second Meeting of the Advisory Committee. Madras, India, 29-30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, 1-10 November 1978. Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)
4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.
5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3-8 September 1979. Madras, India, April 1980.
6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8-12 October 1979. Madras, India, June 1980.
7. Report of the Fourth Meeting of the Advisory Committee. Phuket, Thailand, 27-30 November 1979. Madras, India, February 1980.
8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.
9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India, 3-14 December 1979. Madras, India, September 1980.
- 10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 1: Proceedings. Madras, India, September 1980.
- 10.2 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16-21 June 1980. Volume 2: Papers. Madras, India, October 1980.
11. Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4-7 November 1980. Madras, India, January 1981.
12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh. Hyderabad, India, 11-26 November 1980. Madras, India, September 1981
13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, 1-5 December 1981. Madras, India, February 1982.
14. Report of the First Phase of the "Aquaculture Demonstration for Small-Scale Fisheries Development Project" in Phang Nga Province, Thailand. Madras, India, March 1982.
15. Report of the Consultation-cum-Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27-November 6, 1981. Madras, India, May 1982.
16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983. Madras, India, March 1983.
17. Report of Investigations to improve the Kattumaram of India's East Coast. Madras, India, July 1984.
18. Motorization of Country Craft, Bangladesh. Madras, India, July 1984.
19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16-19, 1984. Madras, India, May 1984.
20. Coastal Aquaculture Project for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.
21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Edeltraud Drewes. Madras, India, September 1985.
22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25-26, 1985. Madras, India, May 1985.

1. Investment Reduction and Increase in Service Life of Kattumaram Logs.
R. Balan. Madras, India, February 1980.
2. Inventory of Kattumarams and their Fishing Gear in Andhra Pradesh and Tamil Nadu.
T. R. Menon. Madras, India, October 1980.
3. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Sri Lanka.
G. Pajot. Madras, India, June 1980.
4. Inboard Motorisation of Small G.R.P. Boats in Sri Lanka. Madras, India, September 1980.
5. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Bangladesh.
G. Fajot. Madras, India, September 1980.
6. Fishing Trials with Bottom-Set Longlines in Sri Lanka.
G. Fajot, K. T. Weerasooriya. Madras, India, September 1980.
7. Technical Trials of Beahcraft Prototypes in India.
O. Gulbrandsen, G. P. Gowing, R. Ravikumar. Madras, India, October 1980.
8. Current Knowledge of Fisheries Resources in the Shelf Area of the Bay of Bengal.
B. T. Antony Raja. Madras, India, September 1980.
9. Boatbuilding Materials for Small-Scale Fisheries in India. Madras, India, October 1980.
10. Fishing Trials with High-Opening Bottom Trawls in Tamil Nadu, India.
C. Pajot, John Crockett. Madras, India, October 1980.
11. The Possibilities for Technical Cooperation between Developing Countries (TCDC) in Fisheries.
E. H. Nichols. Madras, India, August 1981.
12. Trials in Bangladesh of Large-Mesh Driftnets of Light Construction.
C. Pajot, T. K. Das. Madras, India, October 1981.
13. Trials of Two-Boat Bottom Trawling in Bangladesh. C. Pajot, J. Crockett. Madras, India, October 1981.
14. Three Fishing Villages in Tamil Nadu. Edeltraud Drewes. Madras, India, February 1982.
15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982.
16. Further Trials with Bottom Longlines in Sri Lanka. Madras, India, July 1982.
17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh. Soleh Samsi, Sihar Siregar and Martono of the Directorate General of Fisheries, Jakarta, Indonesia. Madras, India, August 1982.
18. Review of Brackishwater Aquaculture Development in Tamil Nadu. Kasemsant Chalayondeja and Anant Saraya of the Department of Fisheries, Thailand. Madras, India, September 1982.
19. Coastal Village Development in Four Fishing Communities of Adirampattinam, Tamil Nadu, India.
F. W. Blase. Madras, India, December 1982.
20. Further Trials of Mechanized Trawling for Food Fish in Tamil Nadu.
C. Pajot, J. Crockett, S. Pandurangan, P. V. Ramamoorthy. Madras, India, December 1982.
21. Improved Deck Machinery and Layout for Small Coastal Trawlers. C. Pajot, J. Crockett, S. Pandurangan and P. V. Ramamoorthy. Madras, India, June 1983.
22. The Impact of Management Training on the Performance of Marketing Officers in State Fisheries Corporations.
U. Tietze. Madras, India, June 1983.
23. Review of Experiences with and Present Knowledge about Fish Aggregating Devices.
M. Bergstrom. Madras, India, November 1983.
24. Traditional Marine Fishing Craft and Gear of Orissa. P. Mohapatra. (Under preparation)
25. Fishing Craft Development in Kerala: Evaluation Report. O. Gulbrandsen. Madras, India, June 1984.
26. Commercial Evaluation of IND-13 Beachcraft at Uppada, India. R. Ravikumar. Madras, India, June 1984.
27. Reducing Fuel Costs of Fishing Boats in Sri Lanka. (In preparation)
28. Fishing Trials with Small-Mesh Driftnets in Bangladesh.
G. Pajot and T. K. Das. Madras, India, March 1984.
29. Artisanal Marine Fisheries of Orissa: a Techno-Demographic Study. M. H. Kalavathy and U. Tietze
Madras, India, December 1984.
30. Mackerels in the Malacca Straits. Colombo, Sri Lanka, February 1985.
31. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. Colombo, Sri Lanka, February 1985.
32. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu: A Study of Techno-economic and Social Feasibility. Rathindra Nath Roy, Madras, India, January 1985.
33. Factors that Influence the Role and Status of Fisherwomen. Karuna Anbarasan.
Madras, India, April 1985.
34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashem, Madras, India, August 1985.
35. Pen Culture of Shrimp in Backwaters of Killai, Tamil Nadu. M. Karim and S. Victor Chandra Bose.
Madras, India, May 1985.
36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam. Colombo, Sri Lanka, October 1985.
37. A Review of the Biology and Fisheries of *Hilsa ilis/sa* in the Upper Bay of Bengal. B. T. Ansony Raja
Colombo, Sri Lanka, October 1985.
38. Credit for Fisherfolk: The Adirampattinam Experience. R. S. Anbarasan and Ossie Fernandez.
[In preparation]

39. The Organization of Fish Marketing in Madras Fishing Harbour. M. H. Kalavathy. Madras, India, September 1985.
40. Promotion of Bottom Set Longlining in Sri Lanka. K. T. Wecrasooriya, S S C Pieris, M. Fonseka. Madras, India, August 1985.
41. The Demersal Fisheries of Sri Lanka. K. Sivasubramanian and R. Maldeniya. Madras, India, December 1985.

Manuals and Guides (BOBP/MAG/....)

1. Towards Shared Learning: Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual. Madras, India, June 1985.
2. Towards Shared Learning: Non-formal Adult Education for Marine Fisherfolk. Animators' Guide. Madras, India, June 1985.

Miscellaneous Papers (BOBP/MIS/..)

1. Fishermen's Cooperatives in Kerala: A Critique. John Kurien. Madras, India, October 1980.
2. Consultation on Social Feasibility of Coastal Aquaculture. Madras, India, 26 November—I December 1984. Madras, India, November 1985.

Newsletters (Bgy of Bengal News):

20 issues quarterly from January 1981 to December 1985.

Information Documents (BOBP/IjVFf..)

1. Women and Rural Development in the Bay of Bengal Region: Information Sources. Madras, India, February 1982.
2. Fish Aggregation Devices: Information Sources. Madras, India, February 1982.
3. Marine Small-Scale Fisheries of India: A General Description. Madras, India, March 1983.
4. Marine Small-Scale Fisheries of Andhra Pradesh: A General Description. Madras, India, June 1983.
5. Marine Small-Scale Fisheries of Tamil Nadu: A General Description. Madras, India, December 1983.
6. Marine Small-Scale Fisheries of Sri Lanka: A General Description. Madras, India, November 1984.
7. Marine Small-Scale Fisheries of Orissa: A General Description. Madras, India, December 1984.
8. Marine Small-Scale Fisheries of Bangladesh: A General Description. Madras, India, September 1985.