BAY OF BENGAL PROGRAMME

DEVELOPMENT OF SMALL-SCALE FISHERIES

CURRENT KNOWLEDGE OF FISHERIES RESOURCES IN THE SHELF AREA OF THE BAY OF BENGAL

BOBP/WP/8

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PREFACE

This paper summarises published knowledge of the exploited and exploitable fishery resources in the shelf area of the Bay of Bengal. It also offers some general remarks about the potential for fisheries development in some areas of the region and the need for management measures in other areas; the types of resources studies that need to be carried out; and the availability of information.

The author of the paper is Dr. B. T. Antony Raja, Deputy Commissioner, Fisheries Division, Ministry of Agriculture, Department of Agriculture and Cooperation, New Delhi, India, who served as a consultant to the Bay of Bengal Programme for the Consultation on Stock Assessment for Small-Scale Fisheries held in Chittagong, June 16-21, 1980.

The paper is based on "status papers" submitted to the consultation by member countries, as well as information that emerged during the consultation; additional information from other sources was also utilised. The author and the Bay of Bengal Programme thank the writers of the country status papers and the participants in the consultation for providing most of the material that has gone into the paper.

The purpose of this paper is to indicate, to the extent necessary, which of the various stock assessment estimates for the Bay of Bengal region can be reliably adopted by planners for development and management. The paper does not attempt to evaluate or critically examine the existing information.

The countries covered by the Bay of Bengal Programme are Bangladesh, India, Malaysia, Sri Lanka and Thailand; this paper also takes into account some limited information available for Burma in order to provide a more complete picture of exploited and exploitable fishery resources of the shelf area of the Bay of Bengal. The paper follows a clock-wise geographic sequence, from Sri Lanka to Malaysia.

The paper includes all important information on potential yield revealed by acoustic/trawl surveys, statistical models and biological productivity data; for the sake of comparison and quick appraisal, greater importance has been given to the reported biological productivity of the respective areas.

The paper may serve as a profile of the fishery resources of the Bay of Bengal and also as an introduction to comprehensive surveys of the region.

The views expressed in the paper do not necessarily reflect the opinions of the member governments or of the FAO.

The Bay of Bengal Programme is a regional FAO programme that seeks to develop and demonstrate appropriate technologies in several areas of small-scale fisheries—such as fishing craft, fishing gear, fish handling and utilization, coastal aquaculture. Its goals are to improve the conditions of small-scale fishermen and the supply of fish from the small-scale sector in five countries that border the Bay of Bengal. The Programme is funded by the Swedish International Development Authority (SIDA) and executed by the Food and Agriculture Organization of the United Nations.

CONTENTS

FISHERY RESOURCES OF SRI LANKA

Exploitedresources: The average annual fish production of the past five years is about 128,000 **t,*** two-thirds of which come from the west coast and the balance from the east coast. About 42% of this catch belong to "shore seine varieties" which mainly consist of clupeoids (sardines, anchovies, wolf herring), Indian mackerel, ribbon fish, mullet and the young ones of larger fishes like snappers, croakers, groupers, sharks and skates. The next important group accounting for 26% of the catch belongs to the scombroid group (Spanish mackerels, tuna and tuna-like fishes). Rock fishes form about 12%, sharks and skates 10%, carangids, especially horse mackerel, 7%. The remainder comprises prawns, lobsters and other varieties. About one-third of the present catch is produced by non-mechanised traditional craft; the remainder is shared by small mechanised boats of both traditional and newly introduced types.

It would appear that on the basis of average fish production, the annual harvest is 166.7 **t** per km of coastline, 5.3t per sq km of the exploited area and 2.21 **t** per active fisherman. The catch per non-mechanised vessel, on the basis of current catch, is about 3.6 t and that of mechanised vessels is 11.9 **t,** with a range of 7.5 to 21.0 **t** depending on the type of vessel.

Exploitable resources: The review made by Silva (1965) indicates three different estimates of harvestable resources, ranging from 267,000 **t** to 850,000 t. These estimates are mainly based on certain assumptions of yield per unit area ; the differences in the estimates arise from differences in assumptions as well as differences in the areas taken for computation (which range from about one-third of the shelf area to a little more than the shelf area). Tiews (1966) indicated a potential yield of 60,000 t from demersal resources, whereas Jones and Banerji (1973) placed the demersal resources at 52,000t and assumed a yield of 90,000t from pelagic resources. There are also other works from Sri Lanka which relate to estimates of certain chosen areas and species (Mendis, 1965; Durairatnam, 1966; Sideek, 1977). In the offshore and deep sea areas, Sivasubramaniam (1977) estimated a potential yield of 29,000t from pelagic resources, mainly from tunas and tuna-like fishes, and partly from sharks, Spanish mackerels, Indian mackerels, flying fish and squids.

The recent acoustic survey conducted by *R/V Dr. Fridtjof Nansen* during August/September 1978 (Saetersdal and de Bruin, 1978) made a provisional estimate of 520,000 **t** as the standing stock of an area of about 13,235 km^2. Assumptions based on density values obtained in the surveyed areas of the northwest coast indicated that there may be a standing biomass of 210,000 t in the remaining shelf area of 11,137 km^2. thus estimating a total biomass of 730,000 t. Of this standing stock, the survey report came to a provisional conclusion that the annual sustainable yield would be 250,000 t, consisting of 80,000 **t** of demersal/semi-demersal fishes and 170,000 t of pelagic resources.

The following table compares the above estimated potential with the level of the present harvest.

Region	Shelf area (km^2)	Biomass ('000t)	Potential yield ('000 t)	Potential yield/km^2 (t)	Current yield ('000 **t)**	Current yield/km^2 **(t)**
Northwest ..	11137	210	80	7	63	6
Southwest ..	3497	220	72	21	30	9
East	9738	300	98	10	54	6
Sri Lanka	24372	730	250	10	147	6

* Throughout this report, unless otherwise stated, the discussion on India refers to the east coast of India; on Malaysia to the west coast of peninsular Malaysia; and on Thailand to the west coast of Thailand, Also, tonnes is abbreviated as t throughout this report.

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The above table would indicate that the northwest coast is the most intensively exploited area; there is still some scope for increasing the yield. In the other areas, production could be stepped up considerably. The production per unit area seems to be the highest in the southwest, but this inference should be drawn with some caution, because the survey for the northwest region was only partial and did not cover the reportedly rich areas of Palk Bay and Palk Straits as also the shallow region of the northwest coast where high abundance has been reported from fishing experiments. There is yet another point to be considered in this context. The northwest coast including the Gulf of Mannar and Palk Bay should, in fact, be richer than what was indicated in the above survey, if results obtained on organic productivity in the Gulf of Mannar/ Palk Bay region (Nair *etal.,* 1973) are any guide. The organic productivity was found to range from 2 to 5 g^c/m^2/day in the Gulf of Mannar within 50 m depth and 0.3 g^c/m^2/day to 6.0 g^c/m^2/day in the Palk Bay up to 10 m depth. If we consider an average of even 1.0 g^c/m^2/day, the tertiary production of the area would be about 305,000t and the harvestable potential at least about double the values indicated in the table above. Since the survey was limited to a very short period which excluded the shallower regions, the survey report has correctly concluded that its estimate may well prove to be on the conservative side.

Taking into account the values of tertiary production in the two 5° squares, 5°-10°N and 75°-85°E given by Cushing (1971), the annual standing tertiary production in the shelf waters of Sri Lanka would be 194,000 t and 110,000 t for the west and east coasts respectively, as indicated below:

Region		Shelf area (km^2)	Tertiary production per 5° sq (x 10^6 t)	Tertiary production per km^2 (t)	Tertiary production in the shelf area (t)
West coast	..	14,634	4.050	13.3	194,362
East coast	..	9,738	3.452	11.3	110,039
Total	..	24,372	—	12.5	304,401

The basic figures of tertiary production taken for the above computation are an average of both shelf and oceanic waters. The rate of biological productivity is higher near the coastal waters; considering this fact and also the trophic levels of the exploited fishes, the potential yield would be certainly more than half of the tertiary production figure given above. The standing biomass from the acoustic survey is about 2.5 times the tertiary production estimated above. It will be shown later in this paper that in some areas, the actual yield or potential yield equals or exceeds the computed tertiary production.

Thus, the above review of information would indicate a harvestable yield of 250-300,000 t for the shelf region of Sri Lanka. This figure appears to be a reasonable target to aim at for immediate fishery development.

FISHERY RESOURCES OF INDIA

Exploitedresources: The average catch on the east coast of India for the last five years, 1975-79, is about 386,000 t comprising 192,000 t of pelagic fishes, 154,000 t of demersal fishes, 38,000 t of crustaceans and 2,000 t of molluscs. The total production showed a declining trend from 1975 to 1977; and recovered somewhat during 1977-79. The decline is largely due to reduced catches from the coast of Andhra Pradesh which was hit by a series of cyclones, affecting the major fisheries of sardines, ribbon fishes, leiognathids and prawns. The traditional non-mechanised sector contributes about two-thirds of the total catch and the small and medium mechanised sectors the remainder. The largest component of the catch is taken from the Tamil Nadu coast, followed by Andhra Pradesh, Orissa and West Bengal. In other words, the quantum of exploited catch of this region decreases from south to north.

The pelagic and demersal stocks contribute almost equally to the total exploited resources. In the multi-species fishery, the important resources are sardines, anchovies, *H//sa,* ribbon fishes, carangids, Indian mackerel and Spanish mackerel among the pelagic group; and elasmobranchs, cat fishes, croakers, leiognathids, perches, pomfrets, prawns and crabs in the demersal group.

The continental shelf is generally narrow extending on an average to about 45 km from the shore— except in the Palk Bay/Palk Strait regions in the south, and off northern Orissa and West Bengal in the north where the shelf region is quite extended. Almost the entire fish production comes from within a distance of about 35 km namely, up to a depth of 75 m. There are patches of high, medium and low annual production in the area. Generally, the regions 8°-12°Nand 17°-21°Nwitness the highest production and the intervening area, mixed patches of medium and low production (Silas *et at.,* 1976). This appears to conform roughly to the tertiary production picture obtained from Cushing (1971). The intense fishing season is January-March in the lower east coast (Tamil Nadu and Andhra Pradesh) and October-December in the upper east coast.

Of the total marine fishermen population of 0.6 million, about 25% are active fishermen. There aresome 4,000 mechanised boats, most of which engage in trawling, and 70,000 non-mechanised boats; the most common among the latter are log-ralts, dug-out canoes and plank-built boats, The most common gear employed by these boats are gill nets, drag nets, boat seines, bag nets **and** hooks and lines.

The average annual yield from the exploited resources is 128.2 t per km of coastline, 4.4 t per km^2 of the exploited area, 2.54 t per active fisherman, 32 t per mechanised boat and 3.7 t per non-mechanised craft. Around the Andaman group of islands in the Bay of Bengal, the catches have been steadily increasing, the latest figure (1978) being 1579t. About 1,000t come from the pelagic stocks, chief of which are the sardines, anchovies, carangids, mullets, Indian mackerel and Spanish mackerel. The demersal varieties contribute the balance; the major constituents are elasmobranchs, perches and leiognathids. There is also a minor seasonal fishery for the gastropods, *Turbo* and *Trochus.* Catches taken off the Orissa-West Bengal coast by Thai vessels under charter to Indian companies but landed in the Andamans amounted to 5500 t in 1978. There are about 1000 fishermen—predominantly migrants from the mainland—who operate very close to the coast. There are some 500 craft, mainly dug-out canoes, which employ cast nets, gill nets, shore seines, hooks and lines and anchor and trawl nets. The total area exploited may be around 1200 sq km.

Exploitable resources: Studies by Jones and Banerji (1973), Nair *et a!.* (1973) and Antony Raja (1974) indicate that the annual exploitable potential for the east coast would be in the order of 600-926,000 t. While Jones and Banerji (1973) apportioned their estimate of 815,000 t as 672,000t of pelagic resources and 143,000t of demersal resources, Antony Raja (1974) considered his estimate of 926,000 t to be shared equally between the two.

Banerji (1973) made an assessment of the probable magnitude of maximum yield from the exploited stocks of all important pelagic fisheries, utilising the catch and effort data for 1958-67 and employing the parabolic form of Schaefer's yield equation. From the records presented by him for various pelagic stocks, it is seen that the maximum yield from the inshore waters of the east coast would be about 124,000 t. The current average yield of five years for these stocks has exceeded this estimate by about 30%. Except *Chirocentrus, Stolephorus* and carangids, the present harvest of all other species or groups of species has exceeded the respective estimated maximum yield.

With regard to demersal resources, Joseph *etal.* (1976) utilised the exploratory survey data for the period 1958-74 to estimate the potential yield by employing the swept area method. They calculated a standing stock of about 343,000 t and a potential yield of about 206,000 t for an area up to 40 fathoms depth. Since these authors have not taken into account the "escapement factor", generally assumed as 50%, the standing stock estimated by them should be equivalent to the potential yield – if the natural mortality is taken as 1.0. This would mean a potential yield of 3.8 t per sq km as compared to a figure of 3.1 t obtained from the data furnished by Mitra (1973) for a portion of this region.

Krishnamurthi (1976) has also used the swept area method on the exploratory survey data for the period 1961-70 and has estimated a standing stock of 419,000 t. For comparison with the former estimate, if the mortality is assumed as 1.0, the potential yield would be 209,000 t for a little over half of the area of the east coast (Andhra Pradesh-Orissa). This indicates a potential yield of 5.0 t per km. From an analysis of the data provided by Joseph *et a!.* (1976), it is seen that, for roughly the same region, the estimated standing stock, after correction, amounts to 372,000 t and the potential yield to 186,000 t, which is rather close to the estimate of Krishnamurthi (1976). However, one feature that is not clear while comparing these two studies is that, although the basic data are supposed to be the same, the swept area considered is different; it is 0.0765 km^2 in the study of Krishnamurthy (1976) but it is only about one-half of this, namely, 0.0391 km^2, in the report of Joseph *et al,* (1976). In both the studies, the swept area does not appear to have been correctly evaluated; the respective estimates would, therefore, require revision.

The Wadge Bank area is ascribable partly to the west coast and partly to the east coast of India. For the Wadge Bank and part of Pedro Bank now under the Indian EEZ, the potential yields from demersal resources can be computed as 8400 t and 450 t based on the report of Mendis (1965). Shomura (in Gulland, 1971) has suggested 7,000t as the potential yield of demersal resources on the basis of various reports relating to Wadge Bank. On the other hand, it has been reported that the surveys of the Pelagic Fisheries Project have indicated a standing demersal stock of 73,000t in this area (George *etal.,* 1977). The tertiary production of Wadge Bank can be computed as 13.2 t per km^2 from the values given by Cushing (1971); this would mean a tertiary production of about 180,000 t per annum in this area of 13,500 km2.

George *etal.* (1977) have made estimates of potential yield from the east coast of India employing two methods – one based on the reported organic productivity and the trophic levels the different fishes belong to, and the other based on the possible rate of fish production per sq km. According to the first method, they obtained a potential yield of 655,000t for the entire shelf, apportioned as 577,000 t from the inshore waters up to 50 m depth and 78,000 tin the offshore region, 50-250 m depth. By the second method, they assumed 12 t and 20 t as potential yield per sq km within 50 m depth in the lower east coast and upper east coast respectively, and one half of the above respective rates in the offshore region up to 200 m depth.

On this basis, they calculated a total yield of 1,409,000 t with a share of 1,018,000 t and 391,000 t from the respective depth areas mentioned above.

An attempt is made herein to calculate the potential yield for the east coast of India on the basis of values of tertiary production given by Cushing (1971). The following tabular statement indicates the method of estimation.

Computation of Tertiary Production for the East Coast of India

Northeast monsoon period

Latitude (°N)	Shelf area (km^2)[1]	TERTIARY PRODUCTION For 5°sq(x 10^6t)[2]	For km^2(t)[3]	For the shelf (t)
8-10	24,915	1.563	5.1498	128,307
11 -14	13,485	1.505	5.0098	67,557
15- 19	32,065	0.815	2.7701	88,823
20-21	41,315	1.780	6.1144	252,616
Subtotal	111,780	—	4.8068	537,303

Southwest monsoon period

Latitude (°N)	Shelf area (km^2)[1]	For 5°sq(x 10^6t)[2]	For km^2(t)[3]	For the shelf (t)
8- 10	24,915	2.487	8.1942	204,158
11-15	19,265	1.475	4.9100	94,591
16 - 18	18,890	0.590	2.0053	37,880
19 -20	30,775	2,269	7.7120	237,337
21	17,935	4.438	15.2447	273,414
Sub-total	111,780	—	7.5808	847,380
GRAND TOTAL	111,780	—	12.3876	1,384,683

It will be seen from the above table that the annual tertiary production for the entire shelf area is about 1,385,000 **t** which is closer to the value obtained by George *et. al,* (1977) by their second method indicated earlier. As pointed out in the case of Sri Lanka, since the basic figures considered relate to a much wider area including both the shelf and the oceanic regions, the actual level of tertiary production for the shelf must be more than the figures computed above. Elsewhere in this paper, similar calculations made for Thailand and Malaysia — where the species composition of fisheries is almost comparable to the east coast of India — indicate that the current yield or the highest recorded yield or the MSY arrived at from catch and effort data is either nearly 100% or even more of the level of tertiary production. It would, therefore, appear that an assumption of 75% of the estimated tertiary production as the potential yield may not be unrealistic. In that case, the potential yield would work out to 1,039,000t. Since nearly 80% of the shelf area falls within the currently exploited area, the yield could be bifurcated into 823,000t for the present area of exploitation and 216,000t in the area beyond and up to the edge of the continental shelf.

In order to obtain some idea of the reasonableness of the above estimates, the results of acoustic surveys conducted *byR.V. Rastrelligerof the* UNDP/FAO Pelagic Fishary Project during 1972-75 wereconsulted. (Anon.,1975, 1976 a & b). For the area within *8°-10°N*and eastof 77°30'E, during June to October (southwest monsoon period), the standing biomass ranged from 54,000 to 778,000 **t with** an average of 405,000 **t.** During November to May (northeast monsoon period), the range was 12,000 to 213,000 **t** and the average 100,000 t. The tertiary production of this area, *vide* table above, is 204,000t and 128,000t for the above respective seasons.

While the results of the acoustic surveys confirm that the tertiary production, in so far as the comparable area is concerned, is an under-estimate, it would be necessary to conduct similar

1 From Joseph ***et al(1976)***
2 From Cushing (1971), pages 28-29

Since the area of 10 square becomes narrower with increasing distance from the equator to north, corrections have been made for computing the 50 square area from the standard area on the equator. The figures in column 3 are divided by this computed area to obtain the figures in column 4.

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surveys on the remaining part of the east coast to get a clearer and surer picture of the resources position. The above comparison also lends qualitative support to the earlier assumption of 75% of the tertiary production as the potential yield, because 50% of the standing biomass is almost identical to 75% of the tertiary production for the same area: around 250,000 **t.**

The continental shelf around the Andaman and Nicobar group of islands is very narrow, estimated at 16,056 sq km (Jones and Banerji, 1973). Estimates of potential yield vary widely. Except for one study, the estimates are based either on organic productivity or possible yield per unit area. Jones and Banerji (1973) suggested a potential yield of 12,000t from the shelf area consisting of 4,000 t of demersal resources and 8,000 t of pelagic resources. Kumaran (1973) estimated a yield of 50,000 t for 300,000 sq km of area around the islands, which would get reduced to about 2700 t for the continental shelf region.

Taking into account certain records on primary production, a projection of 1,070,000t was made for an area of 129,600 sq nautical miles of potential fishing grounds (Anon., 1976d). This would also get reduced to 38,600 t for the shelf waters. George *et al.* (1977) suggested 160,000t as the potential yield. Sudarsan (1978) estimated a standing stock of 45,000t of demersal resources by employing the swept area method. As earlier pointed out, because of certain necessary conditions, this estimate would amount to potential yield. Thus, for the shelf area, we have a range of 2,700 to 160,000 **t** as the total potential yield and 4,000 to 45,000 **t** as the potential yield from demersal resources.

Cushing (1971) has computed a tertiary production of 200-220,000 t for the upwelling period of 90 days in an area of 100,000 sq km around the Andamans. From the illustration presented by him on the distribution of tertiary production in the 5°-15°N and 90°-95°E, an average annual production of 3.738 million tonnes can be computed within 5° square area. After employing the necesssry correction factor for computing the total area of 5° square, a tertiary production of 12.316 t per sq km is obtained. On this basis, the tertiary production for the shelf area amounts to about 198,000t. Because of the topography of the shelf, studded with reefs and corals, and also the fact that certain areas are not approachable, perhaps 50% of this production may **be** taken as the potential yield.

Judging from the present situation of exploited resources, it would appear that for small-scale fisheries, the chances for increasing production would be greater in the Orissa-West Bengal belt and in the southern most region of Tamil Nadu – namely, around the peninsular curve, Gulf of Mannar and Palk Bay regions.

FISHERY RESOURCES OF BANGLADESH

Exploited resources: The current marine fish production is placed at 100,000t and the five-year average at 91,000t, although these figures are not based on any systematic survey of fish landings. The catches are assumed to be on the increase due to increased motorisation of the traditional craft. As much as 95% of the catch is credited to the traditional sector. The important fishes are *Hllsa,* Bombay duck, ribbon fishes, round scad, Spanish mackerel, cat fishes, threadfins, croakers, pomfrets, eels, red snappers, grunts, sharks, rays and prawns. The most important area of fishing activity is off Chittagong district, on the eastern seaboard of the Bangladesh coast, from where 70% of the catch is reported. The next important area, which accounts for 13% of the harvest, is Patuakhali, almost in the middle of the Bangladesh coastline. The bulk of the catch, 75%, comes from fixed bag nets and gill nets.

Some 46,000 boats in the traditional small-scale sector—accounting for 98% of the total fishing fleet — engage in coastal and estuarine fishing. They are either dug-out or plank-built. Of these, about 1,000 are motorised gill netters. The non-mechanised boats operate mainly gill nets, set bag nets, and stake nets. Modern commercial trawlers currently in operation are 102 — 14 operated by the Bangladesh Fisheries Development Corporation, 75 under joint venture with Thailand and five under agreement with Kuwait; recently eight vessels have been imported by private parties.

It would appear that the rates of fish yield are 190 t per km of coastline, 2.8 t per sq km of exploited area and 0.58 t per fisherman.

Exploitable resources: Based on trawl surveys conducted in 1968-71, the standing stock of demersal resources was estimated to be about 264-373,000 t (average 318,000 t), of which about 175,000 t may represent the potential yield from the demersal stock, besides 9,000 t from prawn resources (West, 1973). According to another survey report, the minimum annual sustainable yield from demersal resources including shrimp is placed at 157,000t (Anon., 1972). Tiews (1966) estimated a potential yield of 120,000t for the shelf area, whereas according to Jones and Banerji (1973), the potential harvest is 98,000 t. A recent acoustic survey conducted for about 15 days in November-December 1979 indicated a standing stock of 150,000 t (Chowdhuryetal., 1980).

Except for the quantification of a standing stock of 60,000 t based on the recent acoustic survey (Chowdhury *et al,* 1980), the pelagic resources have not been subjected to any serious assessment. It has been surmised that the potential should be fairly large and promising; there are some indications that this could be about 200-250,000 t (Jones and Banerji, 1973; Anon., 1977).

Computations made from the distribution map of tertiary production given by Cushing (1971) indicate an annual tertiary production of about 6.2 million tonnes per 5° square, which would amount to 21.359t per km^2. This means a level of 1.4 million t of tertiary production in the continental shelf waters of Bangladesh. Since the species composition of the area suggests that much of the stocks may belong to the third trophic level, and the tertiary productivity data relate largely to shelf areas, it may be expected — as first proximation — that 50% of the above standing stock, namely about 700,000 t, represent a sustainable harvest.

Cushing (1971) has given a primary production of 21.6 million t of carbon for 270 days in an area of 96,000 km^2 off Orissa. This would give an average primary production of 0.616 $g^c/m^2/$ day. Using this value, the factor 0.075 for converting the primary production into wet weight production, and extending these values to the adjacent area of Bangladesh waters, one gets an annual tertiary production figure of about 1.1 million t. If this is considered as the standing stock, of which 50% is exploitable, the potential yield wo d be about 550,000 t. However, if we consider the potential yield as 0.024 of the gross ccrbon production as worked out by Jones and Banerji (1973), the resultant figure would be about 354,000t.

Thus, we have two sets of figures: (i) a total harvestable yield of 359,000t, assuming that the pelagic stock would be equal to the estimated potential of demersal resources obtained from the trawl survey (175,000) plus the estimated yield of 9,000t from the prawn resources and (ii) an optimistic figure of 700,000 t and a lower figure of 354,000-550,000 t as the potential yield based on organic productivity data. For the purpose of immediate development, it may perhaps be prudent to err on the conservative side and consider the lowest of the figures, namely 350-360,000 t, as the potential yield from the shelf waters. Of this about 175-180,000 t may be accessible to small-scale fisheries as against the present harvest of 95,000 t from this sector.

FISHERY RESOURCES OF BURMA

Exploitedresources: The average annual catch during 1974-78 was 361,000 t increasing from about 308,000 tin 1974 to 396,000 tin 1978 (FAO Yearbook of Statistics, Vol. 46). Break-up figures of this catch are, however, not known. According to a Fishery Country Profile (Anon., 1977b), out of the reported catch of 349,000 t in 1974-75, the offshore fishing fleet contributed 23,000t, the coastal mechanised boats 60,000t and the traditional non-mechanised boats 266,000t. The latter can be further bifurcated into 130,000t from inshore fisheries, mainly traps, and 136,000 t from the coastal fisheries. Thus, 93% of the catches appear to come from small-scale fisheries – 76% from the non-mechanised sector and 17% from the small mechanised sector. It is learnt that out of 47,000 fishing vessels, 95% belong to the small non-mechanised category; a little less than 4,000 boats are mechanised, mostly with outboard engines. The strength of the offshore fleet run by the People's Pearl and Fishery Corporation is 65, ranging in size from 45 to 150 ft in length which conduct trawling and gill netting operations (Anon., 1978c).

The predominant fishing techniques are various types of traps and drift nets operated from both mechanised and non-mechanised boats. Long lines, bottom gill nets, purse-seines and trawls are employed in offshore waters (Anon., 1977b). The important fishes appear to be sardines, anchovies, *H/Isa,* scads, jack mackerel, chub mackerel, Spanish mackerels, Bombay duck, hairtails, mullets, tunas, cat fishes, goat fishes, threadfins, sea perches, grunts, red snappers, rock cods, croakers, slip mouths, threadfin breams, pomfrets, sharks, skates, rays and prawns (Hayashi, 1971 ; Anon., 1978c).

The average annual catch indicates a return of about 129t per km of coastline, about 4t per fisherman and about 3.3 t per km^2, if it is presumed that the exploitation is largely confined to the inshore waters up to 50 m depth.

Exploitable resources: Indications of potential yield from demersal resources of the continental shelf are 625,000t (Shomura, in Gulland, 1971) and 326,000t (Jones and Banerji, 1973). Jones and Banerji (1973) have also suggested an additional yield of 400,000t from pelagic resources. The total marine fisheries potential has been projected as 1,510,000t comprising 780,000t of demersal and 730,000t of pelagic resources (Anon., 1978c). The distribution figures of tertiary production in the area 10°-20°N and 90°-100°E (Cushing, 1971) would indicate a tertiary production of 2.155 million t per 5° square, or 7.248 t/km2. The continental shelf area has been estimated to be in the range of 212,000 to 250,000 km^2 (FAO, 1971; Shomura, in Gulland, 1971 ; Jones and Banerji, 1973). On the basis of these figures, the tertiary production in the continental shelf area would range between 1.5 and 1.8 million t. The possible potential yield, considered from the conventionally assumed angle, would be 750-950,000 t as compared to the current yield of about 400,000 t.

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FISHERY RESOURCES OF THAILAND

Exploitedresources: The average annual fish production (1973-77) is about 246,000 t, comprising 186,000t of demersal fishes, 37,000t of pelagic fishes, 10,000t of crustaceans, 9,000t of clams, mussels and oysters and 4,000 t of squids and cuttlefishes. The total catch started increasing rapidly after 1966, when it was at the level of about 30,000t, to about 291,000 tin 1973, which is the highest recorded catch. Thereafter, it has declined to about 219,000 t in 1977; in between, it has fluctuated. The general increase was mainly due to rapid development of trawl and purse seine fisheries. During the period of expansion, all sizes of boats increased in number but during recent years, the number of larger sizes, 18-25 m, has declined and the number of smaller sized boats, less than 14 m, has increased. Recently, the efforts of gill netting and push netting have increased, more than those of trawling and purse seining.

The returns from pelagic as well as demersal resources are more during the first half of the year, The peak period for the pelagic fishery is October-April and for the demersal fishery, March-June. Higher catches are found to have come from the northern areas and the catch rates are generally higher in the depth 30-60 m.

The important pelagic fishes are mackerels, scads, trevallies, sardines, and little tunas. Among the demersal varieties, the important ones are sharks, rays, croakers, cat fishes, threadfin breams, and big-eye snappers. Recently, the squid fishery has greatly expanded and the jelly fish fishery has also been developed. Current experimental efforts indicate possibilities of developing lift net fishing for small pelagics and pole and line fishing for large pelagics.

There are about 1,700 registered fishing vessels, some 68% of which are less than 14 m in length and 24% in the 14-18 m category. The number of fishing gears employed is about 1800; the important gears are trawl (37%), gill net (34%), push net (16%) and purse seine (7%). The trawls account for about 80% of the catch ; the bulk of the balance is contributed by purse seine and gill nets.

The total fishing population is estimated at 39,000 of which the active fishermen number about 11,000. From the available records, it would appear that the rates of fish production are about 332 t per km of coastline, 5.6 t per sq km of the exploited area and 22.0 t per fisherman.

Exploitable resources: Almost all the estimates for the west coast of Thailand refer only to demersal resources. Tiews (1966) estimated a potential of 56,000t while Jones and Banerji (1973) placed the potential at 58,000 t, besides 20,000 t of pelagic resources for the shelf area. Using the density value of 2.5t per km given by Shomura (in Gulland, 1971), the potential yield from demersal resources is 145,000 t. From trawl survey data for 1965, Isarankura (1971) made a conservative estimate of a standing demersal stock of 308-448,000 t for the area up to less than 100 m depth (about 60% of the shelf area). One half of this average standing stock, i.e. 380,000t, may represent the potential yield. However, on the basis of catch and effort data relating to the period 1965-68, he indicated only 85,000t as the maximum sustainable yield. Marr *et al.* (1970), after examining additional data, concluded that the MSY will be probably around 150,000 t. At the Workshop on the Fishery Resources of the Malacca Straits (Anon., 1976c), the MSY was estimated as 200,000t and the optimum fishing effort as 1.3 million trawling hours. From the country status paper of Thailand, it is seen that the MSY has been calculated to be of the order of 205,000t, corresponding to a fishing effort of 1.65 million trawling hours, which was probably reached in 1974. In 1976-77, the fishing effort nearly doubled the optimum effort and the present situation, therefore, appears to be one of over-exploitation.

Regarding the pelagic resources, it is seen from the country status paper that the estimated MSY is about 61,000 t, a level which is yet to be reached. The estimated MSY for mackerel is 20,000 t at the total effort of about 38,000 days by Thai purse seine. The highest catch obtained was 23,000t in 1973. The current catch has declined to 4,700t. The MSY of sardines has been estimated as 5,000 t. This level was reached in 1976, whoreafter the catches declined due to increase in fishing effort. The MSY of anchovies is placed at 7,700 t. The highest catch obtained was 7,500 tin 1974, after which the catch, the effort and CPUE have declined.

The tertiary production, calculated from the values given by Cushing (1971) for the area off west Thailand, is 6.412 t/km^2 per year. Estimations made by the author on the results obtained by Wium-Anderson (1977) indicate a production rate of 6.926 *t*, very close to that obtained from Cushing's data. Converting these values to the shelf area up to 100 m and 200 m depth, the total tertiary production is 278-283,000t and 366-372,000t respectively. The MSY for the former depth contour thus represents about 95% of the tertiary production and the actual yield has exceeded the estimated tertiary production in 1973.

To summarise the information on potential yield, the estimate based on catch and effort data is 266,000 t (pelagic 61,000 t and demersal 205,000 t); on the basis of trawl survey, 190,000 t of demersal resources up to about 100 m depth and about 31 0,000 t up to the shelf.

FISHERY RESOURCES OF MALAYSIA

Exploited resources: The average fish landings on the west coast of peninsular Malaysia during the five year period 1973-77 amount to about 308,000 t with a range of 271,000 to 378,000 t. The highest recorded catch in 1977, which is about 28% more than the previous year, is attributed to an increase in trash fish and prawn landings by the trawlers and increase from the pelagic resources (especially *Rastreiiger* and squids), as well as in cockle production. Of the variety of fishing gears employed, otter trawls for demersal resources and purse seines for pelagic resources have yielded the bulk of the catch. In 1977, trawl nets accounted for 60% of the **catch and seine nets for 14%.**

The coastal fisheries resources are those which are found within 50-60 miles off the coastline. Of the average catch of the five year period mentioned above, the demersal resources form 48%, pelagic resources 19%, prawn resources 15% and "others" 18%. Under the "others" crabs, cuttlefishes, squids, sergestid shrimps and cockles are included. The demersal resources comprise a large number of varieties, but those which are classified under food fishes are the higher-priced snappers and groupers, and the low-value fishes belonging to the group of sciaenids, flat fishes, threadfin breams, mullets, cat fishes, and lizard fishes. Among the pelagic fishes, the important ones are the mackerels *(Rastreiiger),* anchovies, scads, trevallies, tunas, sardines and herrings.

The prawn resources belong solely to the penaeid group, in which *Metapenaeus, Parapenaeopsis* and *Penaeus* are the major genera. The otter trawl is now the major gear employed for the prawn fisheries. It accounts for about three-fourths of the total prawn landings, which have been fluctuating between 38,000 and 52,000t (average: 45,000t) during 1973-77.

There are about 49,000 fishermen. The number of licensed vessels is about 17,000, of which 83% are powered (69% by inboard engines and 14% by outboard engines). The majority of the engines is below 40 hp and only a small percentage are above 100 hp. Of the licensed fishing gears, drift/gill nets account for 44%, while trawl nets, seine nets, bag nets and shellfish collectors constitute 15%, 9%, 7% and 16% respectively. However, all the gears licensed are not in operation; the trawl nets estimated to be in operation are reported to be greater in number than those actually licensed.

The data available indicate that on the basis of average catch, the yield is about 342 t per km of coastline, 6.5 t per sq km of exploited area and 6.3 t per fisherman.

Exploitable resources: Various estimates of optimum potential yield from the demersal fish stocks have been made. Earlier, the MSY was estimated at around 90-94,000t (Pathansali, 1973). It was first re-estimated as 103,000 (Pathansali, 1976) and then as 160,000 t (Anon., 1976c). The actual landings exceeded the above respective estimates in 1972, 1973 and 1977. Although the total demersal fish landings – both the food fish and trash fish components – have been increasing over the years, there is a progressive decline in catch rates for both the food fish and the trash fish. Thus, the demersal resources are being maximally exploited, particularly in the northern half of the coast.

With regard to pelagic resources, the potential yield was estimated at between 81,000 and 91,000 t (Pathansali, 1973; Chong, 1976). Of this potential, the maximum yields for *Rastreiiger* and *Stolephorus* were estimated at 41,000 t and 30,000 t respectively and for other species such as *Megalaspis, Decapterus,* and *Scomberomorus* at 10,000-20,000 **t. The total** pelagic stock was subsequently re-estimated at 70,000t (The National Delgation, 1974) and 88,000 (Anon,, 1976c). The annual landings of pelagic fishes exceeded the lowest estimated potential during 1968-71 and the highest estimated potential in 1968 and 1969. After 1971, the catches have declined below the lowest estimate. It has been found that the *Rastreiiger stock* is overexploited and that a reduction in fishing effort is urgently required (Anon., 1978 a&b). Although *Decap-*

terus is subjected to rather high fishing effort, the potential is considered to be substantially above the present catch.

While the data for other groups are incomplete, the only stock showing evidence of full exploitation, may be even over-fishing, is that of *Stolephorus* (Anon., 1976c and 1978b). The general assessment is that, by and large, the pelagic resources are being fully, if not over-exploited.

The MSY of prawns has been estimated to be in the region of 40-45,000t (Pathansali, 1973). This was revised to 53,000t with an indication that the prawn landings from the northern half of the west coast is probably very close to the maximum yield (Anon., 1976c). Hall (in Gulland, 1971) indicated 42,000 t as the potential yield for prawns and shrimps.

Pathansali (1973) indicated that, in addition to demersal, shoaling pelagic and prawn resources, there may be 38-40,000 t of other varieties; he estimated a total potential yield of 249-260,000 t.

The other resources estimates are those of Prasad *et al.* (1970) who have placed the pelagic resources at a level of 100,000t. At the rate of yield per sq km indicated by Menasveta *et al.* (1973), the potential comes to about 43,000t. On the basis of a trawl survey conducted in 1965, Isarankura (1971) has evaluated a standing stock of 372-542,000t for an area up to 100 m contour off Malaysia north of 5ºN and computed the rate of standing stock as 22-33 t per sq km. If this rate is also extended to the region south of 5°N, the standing demersal stock would be in the order of 400-600,000 t for the west Malaysian shelf area up to 100 m depth. Applying the rate of potential yield of 2.5 t per km^2 for the Thai-Malay region, as assumed by Shomura (in Gulland, 1971), the potential demersal resources would be 119,000 t On the basis of values given by Cushing (1971) for the square 5º-10ºN and 95°-100ºE adjacent to the west coast of Thailand, the rate of tertiary production works out to 6.412 t per km^2. If we presume the same rate of production for the west coast of Peninsular Malaysia, the tertiary production comes to about 304,000 t.

In short, the MSY of all resources, on the basis of catch and effort data, is 301,000t (pelagic 88,000t, demersal 160,000t and prawns 53,000t). The other estimates of total potential yield indicate about 350,000 t. The computed tertiary production is nearly equivalent to the MSY but is much lower than the current yield.

GENERAL REMARKS

The information detailed in earlier pages is summarised in Tables I and IIa & b.

It may be noticed from Table I, which lists the important exploited species/groups in the coastal waters of the Bay of Bengal, that there is a general similarity in the important exploited stocks both in the pelagic and demersal groups. Among the pelagic resources, the clupeoids, scombroids, and carangids are the dominant groups in all the countries. Among the clupeoids, *Sardine/la* and *Stolephorus* are important in all the countries except in Bangladesh. The importance of *H/Isa* is limited to the upper east coast of India, Bangladesh and Burma. Among the Scombroids, *Rastre//iger* is important in all the countries and the Spanish mackerel in all except Thailand and Malaysia. The tuna group is exploited to a large extent in Sri Lanka and it is growing in importance in the Burma-Malaysia belt. Carangids are represented by many genera, the more important of which are *Decapterus, Megalaspis, Carangoides* and *Caranx.* Of the rest, the hair tails are significant in the coastal areas extending from Sri Lanka to Burma, whereas the importance of Bombay duck, like *H/Isa,* is confined to a region covered by the upper east coast of India, Bangladesh and Burma. In recent years, squids and cuttlefishes have emerged as an important fishery in Thailand,

The demersal resources are more varied than the pelagic resources in species composition. The elasmobranchs, snappers/groupers, croakers and prawns are important in all the countries; so is the case with cat fishes, except in Sri Lanka. The importance of other groups is confined to certain sub-regional pockets. Although the leiognathids are reported important only in the lower east coast of India and Burma, the generally low level of exploitation and inadequacy of data in the other areas of the western Bay of Bengal are probably the reasons why their importance has not surfaced so far. Again, the leiognathids maybe found in good numberin Thailand and Malaysia, but are regarded there as trash fish. Pomfrets are significant from the upper east coast of India to Burma. The threadfin breams are reportedly abundant only on the eastern seaboard of the Bay of Bengal. The importance of grunts and threadlins appears to be restricted to Bangladesh and Burma.

From Table IIa, which gives at a glance an idea of the present yield in the shelf waters of the Bay of Bengal, it may be observed that on the western side of the Bay of Bengal, the yield per km of coastline increases from south to north, but on the eastern side, it increases from north to south. On the other hand, a different picture is obtained as far as the returns per **sq km** of exploited area are concerned; it decreases from south to north in the western Bay of Bengal countries but increases from north to south on the opposite side. The highly rewarded fishermen are those in Malaysia and Thailand, each of whom harvests about 22 t; the returns for their counterparts in the other countries are very low, between 2 and 6 t. Pooling the data, it is seen that on the western seaboard of the Bay of Bengal, the average annual fish production is 605,000t with an average yield of 129t per km of coastline, 4.18t per km^2 of exploited area and 1.65 **t** per active fisherman; on the eastern seaboard the respective figures are 915,000 t, and 206 t, 4.58 **t** and 6.06 **t.** While the coastal catch of the Bay of Bengal is shared between the west and the east at the ratio of 40:60, the annual tertiary production ratio is the reverse.

It is therefore obvious that fish production on the west coast can be considerably increased. On the whole, for the entire Bay of Bengal region (excluding Andaman and Nicobar group of islands), the annual production is 1.52 million **t** with an average return of 167 t per km of coastline, 4.4 **t** per km2 of exploited area and 2.9 **t** per fisherman.

With regard to the potential yield from shelf waters, Table IIb would appearto indicate that the most significant increase may have to come from India and Bangladesh, about 2.5 to 3.5 times the present production. In Sri Lanka and Burma, the increase may be about twice the present production. In Thailand, the additional yield has to result mainly from coastal tunas, squids and cuttlefishes. The situation in Malaysia is one of almost maximum exploitation. For the region as a whole, it appears that the sustainable yield from the shelf could be doubled from the present level of 1.5 million tonnes; incidentally, it may be mentioned that the tertiary production in this area is about 5.3 million t.

For the small-scale fisheries, there seems to be scope for an additional catch of 50-70,000 t in Sri Lanka. In India, development efforts in the southernmost and northernmost regions may yield 200,000 t. Similarly, there is good scope in the Bangladesh coastal waters for increasing production at least by 100,000 t. Blessed with a large shallow water region and with a biological productivity rate slightly better than its southern contiguous regions, the prospects for small-scale fisheries in Burma are by far the most promising with the possibility of an additional, 300,000t. In Thailand, the scope is very limited; the likely possibilities are development of small pelagics and squids and cuttlefishes. In Malaysia, as far as capture fisheries are concerned, there does not seem to be any scope for augmenting catches in the small-scale fisheries **sector.**

Barring certain exceptions, it appears that interest in stock assessment studies is low in the Bay of Bengal region, for various reasons — lack of data; lack of expertise; doubts about the usefulness of such studies; doubts about the enforceability of solutions arising from such studies, etc. This situation has to change, subject of course to national priorities. The national governments must also have a number of options before evolving a national policy for small-scale fisheries development. It is here that the scientists engaged in stock assessment have a vital and dynamic role to play, because only these studies would lead to identification of different options. It is also seen that whore some data are available, quantitative stock assessments have not made any significant advance. Where results are available, these are largely found in scientific journals, and they have not "trickled down" to the administrators and the industry.

It is seen that stock assessment studies in the region employing conventional models are limited only to the application of Scheafer's logistic model, and that too only in Thailand and Malaysia; to some extent this applies also to prawn investigations in India. No attempt has been made to employ the analytical or yield-per-recruit model, and to obtain long-term estimates, mainly because of incompleteness in biological studies. The latter either stop short of estimating growth parameters or do not proceed beyond that level to employ these parameters for stock assessment.

In multispecies fisheries, it has been contended that in the absence of selective fishing all the species can be considered as one stock for practical purposes. However, the problem cannot be so simplified. It has to be recognised that the components of such a stock have different feeding habits, some preying on others or competing with others for the same food; the levels of potential yield from both prey and predator populations may be different; length/age composition, recruitment and growth parameters of the constituents may be different; moreover, the situation is not only one of multiplicity of species but also one of multiplicity of gear, of different efficiencies, capturing the same species. We have also to take into consideration the effect of changes in any particular fishery and its relation to other fisheries capturing the major commercial species. It may be a case of large trawlers versus small mechanised vessels, small mechanised vessels versus traditional non-mechanised boats, or a combination of these efforts. Thus, multispecies systems require multidisciplinary approaches. It is essential that a fairly good, accurate and comprehensive collection of the right type of data is ensured. At the same time, scientists have the responsibility to provide advice and guidelines to the administrators and the industry with the available data.

For better employment of the basic concepts of stock assessment, it is necessary to know the length/age composition and growth parameters; information on these is sorely lacking for many of the important tropical species. Attempts have to be made to fill up this lacuna. Information available on certain species in neighbouring areas can be used advantageously by countries not having such local information on the same species, thus effecting a considerable saving in time and cost.

It is interesting to note from the estimates of tertiary production that the conventional assumption —that one-third to one-half of tertiary production can be considered as the potential yield—

does not hold good, at least in areas like Thailand and Malaysia. In these countries, the estimated maximum sustainable yield of the stocks based on catch and effort data is nearly 100% of the tertiary production in the area of exploitation, and the actual yield has exceeded the total tertiary production. It is almost certain that the tertiary production has been underestimated in this paper because the basic data employed are an average of both the shelf and oceanic regions. The tertiary production in the coastal waters should be much higher than the estimates. Perhaps if these estimates of tertiary production are doubled for the coastal exploited waters, the conventional assumption may hold good. It is also possible that the efficiencies of energy transfer from one level to the next are higher than those presumed while computing the level of tertiary production.

It should be clearly understood that the estimates of likely sustainable yield given in Table IIb are only broad indications and should not be utilised for taking important policy or executive decisions on expanding existing fisheries or developing new fisheries. These estimates would certainly include stocks which would not provide economic returns in the context of current market trends or the present knowledge of harvesting technology. The total fish population may also contain certain stocks, the removal of which may upset the ecological balance and affect the economic yields of other exploited stocks. There may also be surplus stocks of the exploited species in the total potential yield, the increased harvesting of which may pose problems for (or provoke conflicts with) the traditional sector. Careful consideration of these factors is essential before any recommendations to introduce new methods are made. However, in the absence of more precise information, these estimates may provide some clues to areas where administrative action could spur fisheries development. It would then be necessary to carefully monitor such development.

An area to which repeated attention has been drawn is that of biological interactions. It is, *perse* an important problem, the magnitude of which cannot be ignored or minimised, However, it has to be admitted that the development of suitable theoretical models to describe these interactions, and the data required to fit the models to real-life situations are so voluminous that the countries of the region cannot afford them. Studies could, however, be initiated of the historical records of the fisheries in relation to oceanographic properties of the environment and the biology of important constituents of commercial catches; this would be a first step towards an understanding of the multispecies system.

There are at least two areas in the Bay of Bengal region, namely, the Gulf of Mannar and the Wadge Bank, where a fund of data is available from different methods of resources evaluation. A critical comparative study of all the information/data, keeping in view the present exploited situation, the species composition of the catches, the trophic levels they belong to and the changes, if any, in the composition of present-day catches as compared to those of earlier years would certainly be a very rewarding exercise. Such a study would indicate to what extent the stock estimates obtained by various methods are reasonable, and whether any rough conversion factor could be employed to make these estimates mutually comparable. This would, in turn, pave the way towards solving both short-term and long-term needs — of evolving quick and reliable methods of assessing the exploitable resources for initial developmental planning, and for evolving a long-term approach for tropical multispecies fisheries.

Table I

IMPORTANT EXPLOITED SPECIES/GROUPS (*) IN THE COASTAL WATERS OF THE BAY OF BENGAL COUNTRIES

Species/Groups	Sri Lanka	India	Bangladesh	Burma	Thailand	Malaysia
Pelagic						
Sardines	*	*		*	*	*
Anchovies	*	*		*	*	*
Hilsa		*	*	*		
Bombay duck			*	*		
Hair tails	*	*	*	*		
Carangids	*	*	*	*	*	*
Rastreiiger	*	*		*	*	*
Spanish mackerel	*	*	*	*		
Tunas	*			*	*	*
Squids/cuttle fishes					*	
Demersal						
Elasmobranchs	*	*	*	*	*	
Snappers	*	*		*	*	*
Groupers	*	*		*		*
Croakers	*	*	*	*	*	
Threadfins			*	*		
Threadfin breams				*	*	*
Leiognathids		*		*		
Catfishes		*	*	*	*	*
Pomfret		*	*	*		
Grunts			*	*		
Prawns	*	*	*	*	*	*

Note:—Exploited species for the Burma coast have been itemized on the basis of available information—which is not complete or precise.

Table IIa

PRESENT YIELD IN THE SHELF WATERS OF THE BAY OF BENGAL COUNTRIES

Present Yield	Sri Lanka	India East Coast	India Andaman & Nicobar	Bangladesh	Burma	Thailand	Malaysia
Average annual production ('000 t) (Five-year average)	128	386	1.4	91	361	246	308
Highest production ('000 t)	147	431	1.6	100	396	291	378
Current production ('000 t)	147	388	1.6	100	396	219	378
Exploited area (km²) within the depth indicated	24,372 (0-200 m)	88,535 (0-75 m)	1,200	32,000 (0-24 m)	108,400 (0-50 m)	44,000 (0-100 m)	47,420 (0-100 m)
Coastline (km)	1,200	3,010	—	480	2,800	740	900*
Number of active fishermen ('000)	58	152	—	156	91	11	49
Average yield per km of coastline (t)	106.7	128.2	—	189.6	128.9	332.4	342.2*
Average yield per km² of exploited area (t)	5.3	4.4	1.2	2.8	3.3	5.6	6.5
Average yield per fisherman (t)	2.2	2.5	—	0.6	4.0	22.0	6.3
Shelf area (km²)	24,372	111,780	16,000	65,555	217,500	58,060	47,420
Total tertiary production ('000 t)	304	1,386	197	1,403	1,566	372	304
Rate of tertiary production (t/km²)	12.5	12.4	12.3	21.4	7.2	6.4	6.4**

* Rough estimate.

** Values for Thailand adopted.

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Table IIb

POTENTIAL YIELD IN THE SHELF WATERS OF THE BAY OF BENGAL COUNTRIES

Potential Yield ('000 tonnes)	Sri Lanka	India		Bangladesh	Burma	Thailand	Malaysia
		East Coast	Andaman & Nicobar				
Demersal Resources							
Trawl survey	—	343	45	157-184		310	200-300
Acoustic survey	80			150			—
Catch and effort data	—	—	—	—	—	85-205	90-213
Otherestimates	52-60	463-672	4	98-120	326-780	56-145	119
Pelagic Resources							
Acoustic survey	170			60			—
Catch and effortdata		124	—	—		61	81-91
Other estimates	90	143-463	8	200-250	400	20	43-100
Total							
Acoustic survey	250			210			
Catch and effort data		—		—	—	266	301
Biological productivity data	300	600-1039	989	354-700	750-900	372*	304*
Other estimates	142-150	815-14.09	3-160	348-359	726-950	78	350
All estimates combined	142-300	600-1409	3-160	210-700	726-950	78-371	301-350
Likely sustainable yield	250-300	1000-1050	90-100	350-360	750-900	300-350	300-320

* Estimated total tertiary production in the shelf.

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