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Marine Fishery Resources Management

MACKERELS IN THE MALACCA STRAITS BOBP/WP/30

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MACKERELS IN THE MALACCA STRAITS

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This paper attempts to summarize the present knowledge of the mackerel resources in the Matacca Straits which are believed to be shared by Indonesia, Malaysia and Thailand. It contains a summary report and individual country papers.

The material was put together following a technical working group meeting of scientists from the three countries. The meeting was held 12-16 December 1983 at the Fisheries Research Institute, Penan9, Malaysia. The Director of the Institute, Mr Mohd. Shaari bin Sam Abdul Latiff, opened the meeting and welcomed the participants, whose names are listed iii Appendix 5 of the paper.

This paper, and the working group meeting on which it is based, are an activity of the project 'Marine Fishery Resources Management in the Bay of Bengal,' RAS/81/051, which is funded by the UNDP (United Nations Development Programme), and executed by the FAO (Food and Agriculture Organization of the United Nations) under its Bay of Bengal Programme. Dr. K. Sivasubramaniarn, Senior Fishery Biologist of the project, acted as convenor of the meeting.

The project has a duration of four years; it commenced in January1983. Its immediate objective is to improve the practice of fishery resources assessment among participating countries and to stimulate and assist in joint assessment and management activities between countries shnring fish stocks.

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

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1. INTRODUCTION

With the establishment of Exclusive Economic Zones, more than 90% of the marine fish catches of the world are taken within the jurisdictions of the coastal states. This has increased the responsibility of the coastal states for developing, utilizing and managing the fish resources in their respective EEZs. Extended jurisdiction of each coastal state over a wider area of the sea, has also increased the need for collaboration and cooperation in controlling the exploitation and management of resources shared by adjacent countries.

One of the fish resources of the latter category in the Bay of Bengal area is the mackerel. The mackerels of the Malacca Straits are exploited by Indonesia, Malaysia and Thailand.

In pursuance of the objectives of the regional FAO/UNDP project for 'Marine Fishery Resources in the Bay of Bengal'—to stimulate and assist in joint assessment and management activities of countries sharing fish stocks—a technical working group meeting was convened. It was held December 12-16, 1983 in Penang, Malaysia. (A list of participants and observers is found in Appendix 5.) It was meant to evaluate the present status of the stock and identify areas of work to further knowledge of the resource. In particular, the meeting attempted to:

- review the status of the mackerel fishery in the Malacca Straits, the collection of data and the assessments made by respective countries,
- identify gaps and constraints, and consider steps required to overcome these,
- consider similar study approaches in the respective countries to permit collective evaluation of the information compiled and interpretation of the results of the combined effort,
- standardize fishing effort units, and
- prepare a work programme for follow-up action, in accordance with the recommendations to be made.

Background material for the discussions was prepared by participants from each country. It appears in this report in Appendices 1-4.

Since only the Malacca Straits are dealt with in the report, the names of the respective countries refer to the west coast of Thailand, the west coast of Peninsular Malaysia and the northeast coast of Sumatra only, unless otherwise stated.

2. GENERAL OBSERVATIONS

Several independent populations and/or stocks of a single species may be found within a given geographical area. These populations or stocks could arise from the species under consideration using different spawning grounds or using the same grounds at different periods of time. These spatial and temporal separations may be influenced by the proximity of ideal environmental conditions or by ecological boundaries which may restrict movement into a single spawning ground.

The stocks in a given area may also exhibit some mixing, particularly in areas where favourable feeding conditions prevail. Hence, a basic knowledge of the distribution of species, in relation to the environmental and spatial characteristics of the ecosystem of the Malacca Straits will be valuable, especially in developing a strategy for a suitable tagging programme.

If we are dealing with a common stock in the whole area, then the fishery in one part of the area will have its impact on the rest of the area in which the stock is distributed, irrespective of the EEZs involved and the degree of exploitation in other parts which may be adjacent to neighbouring states.

The effects of exploitation of young fish by one nation and older fish by another nation may not be felt by one another until the fishery on these components reduces the stock below the minimum level for maintenance of recruitment or spawning stock.

Confirmation of the *Rastrelliger* and *Decapterus* spp. in the Malacca Straits and their occurrence in the EEZs of the three participating nations are fundamental to any consideration of the shared mackerel stock.

Interaction and limitation of production models, caused by changes in the relative abundance of mixed species—as is evident in the Gulf of Thailand's demersal fishery—require examination for possible changes in the species composition patterns and catch rates of individual species in various EEZs. This should be attempted, even if some of the pelagic species are not the target species in fishing methods capturing mackerels.

Mapping of exploited areas of the EEZs and estimating the extent of their surface areas, as against the areas of the respective EEZs, is valuable for considering the relative coverage of the fishery in the respective EEZs and the possibilities for geographical expansion of the fishery in the future.

3. THE SPECIES

There are two types (genera) of mackerels in the Matacca Straits (commonly referred to as the chub mackerels and the scad mackerels (round scads)), namely *Rastreiiger* spp. and *Decapterus* spp. A list of the different species is given below:

Mackerels	
chub	scad
Rastrelliger	*Decapterus*
R. brachysoma *R. kanagurta* *R. faughni*	*D. maruadsi* *D. macrosoma* *D. russelli*

Of these species, *R. kanagurta* and *R. brachysoma* are by far the most important ones from a commercial point of view in all the three countries. *R. faughni,* although present in the Malacca Straits, does not contribute significantly to the production. The scientific name *R. neglectus,* sometimes used in the Malacca Straits area, is considered to be a synonym of *R. brachysoma.*

R. kanagurta and *R. brachysoma* are also caught around the Andaman Islands on the western side of the Malacca Straits. The abundance of *Decapterus maruadsi* and *D. macrosoma* has

been established in Thai and Malaysian waters while Indonesia considers *O. russell* as the main species in its waters. In view of the proximity of Malaysian waters, it is considered unlikely that there could be distinctly different species on the two opposite sides of the southern part of the Straits; 0. *russelli,* reported for Indonesia, is perhaps in fact 0. *maruadsi.* Thailand had also identified *D. maruadsias O. russeii* until some years ago. It was proposed that there should be an exchange of specimens to confirm the identification.

The estimated relative contribution (in %) to the landings of mackerels by the different species is shown below:

Species	*Thailand*	*Malaysia*
R. kanagurta	40	68
R. brachysoma	58	32
R. faughni	2	0
Sub-total	100	100
O. maruadsi	60	1001
O. macrosoma	40	762
Sub-total	100	—

[1] during most of the year
[2] only around July

For Indonesia, it has not been possible to establish the relative contributions. Among the *Decapterus* spp., *D. russelli* (or possibly *D. maruadsi)* is considered to be the dominant species, but during a bottom trawl survey, 0. *macrosoma* was the only mackerel species recorded.

4. PRODUCTION AND CATCH RATES

Production records of chub and scad mackerels have been available iii the three countries since the late 60s/early 70s; only Thailand has catch records of individual mackerel species. Malaysia and Indonesia have data only down to the genus level. This has unfortunately made it impossible to examine the spatial distribution of the two *Rastrelliger* species in the entire Straits. Examination of catch data from the west coast of Thailand reveals that *R. kanagurta* is predominant most of the year along the northern half of its coastline whi!e P. *brachysoma* is conspicuous in the south. (Appendix 1, Table 5). It, therefcre, appears that *R. brachysoma* is the predominant species in Thai waters close to the boundary with Malaysia. Though Malaysia has not been able to separate the soecies distributed, *R. brachysoma* appears predominantly in the trawl catches in the northern part of its coastal area.

The values of effort are based on the number of catching units under license or considered to be operational; estimates of the actual effort are not available. Within these limitations, the catches and catch rates since 1972 for *Rastrel/iger* spp. and *Decapterus* spp. are presented in Tables 1 and 2.

Most notable is the *Rastreiiger* production of Malaysia which has increased by leaps and bounds since 1977; it is about five times higher than the production of Indonesia (Fig. la). But the catch rates have been relatively low until 1979 (Fig. ib). Even in recent years of very high production, the catch rates have not exceeded those of Thailand. Contrary to the sharp increase of production in Malaysia, the trend in Indonesia and Thailand is one of slow decline (Fig. la).

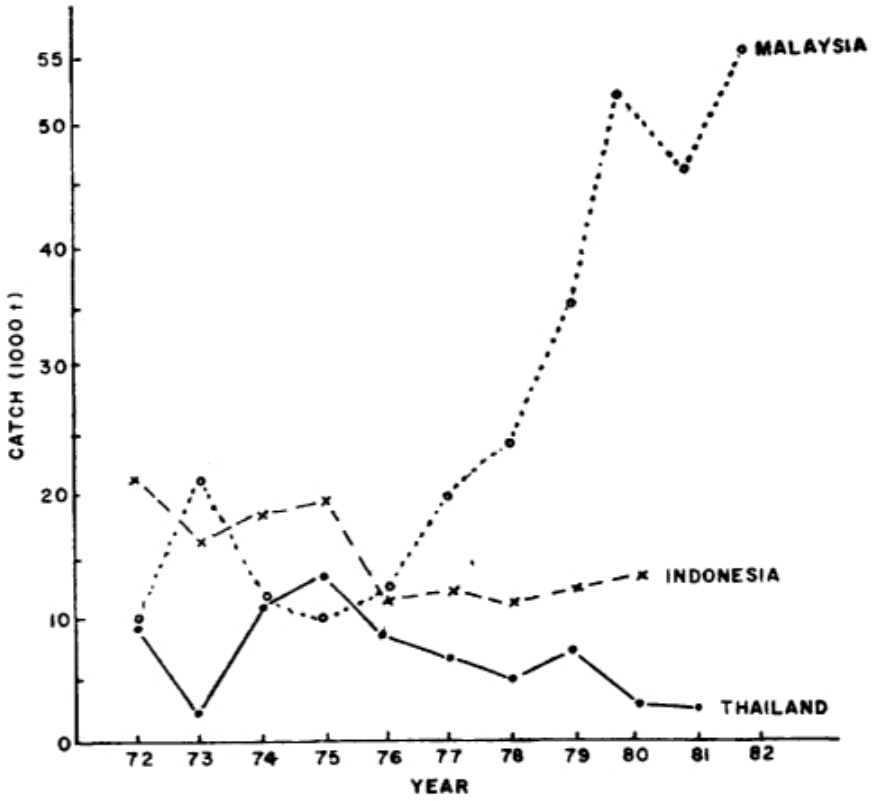

Fig. 1a. Variations in the annual production of *Rastrelliger* spp.

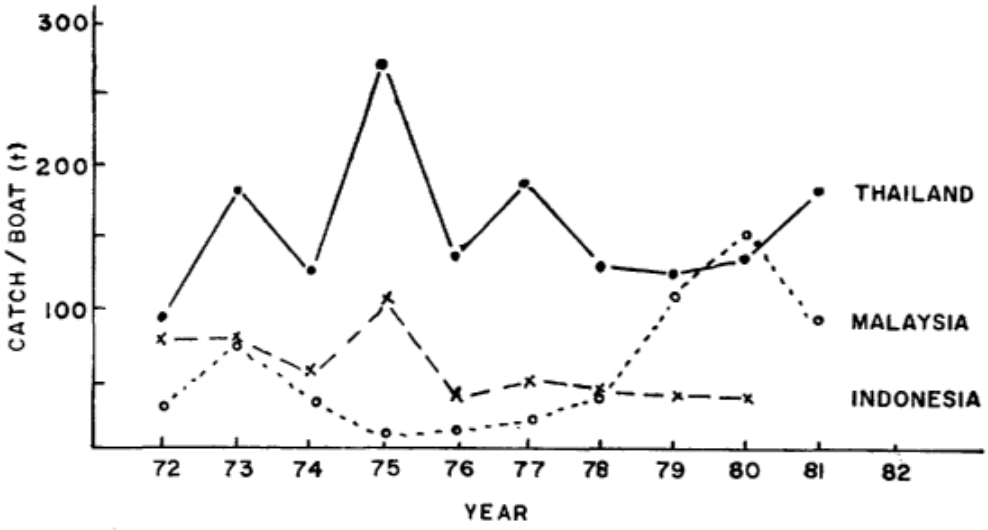

Fig. 1b. Variations in the annual catch rate of *Rastrelliger* spp.

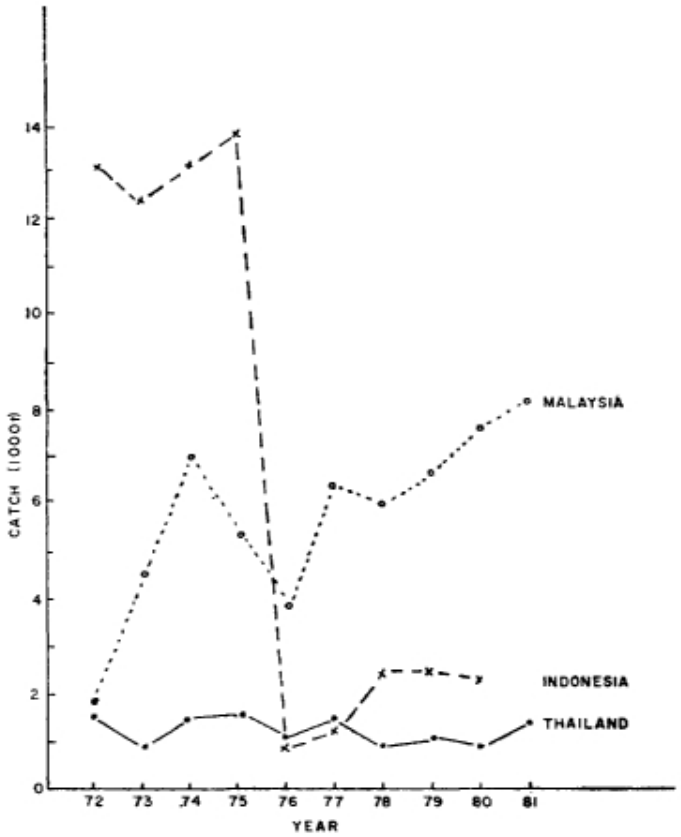

Fig. 2a. Variations in the annual production of *Decapterus* spp.

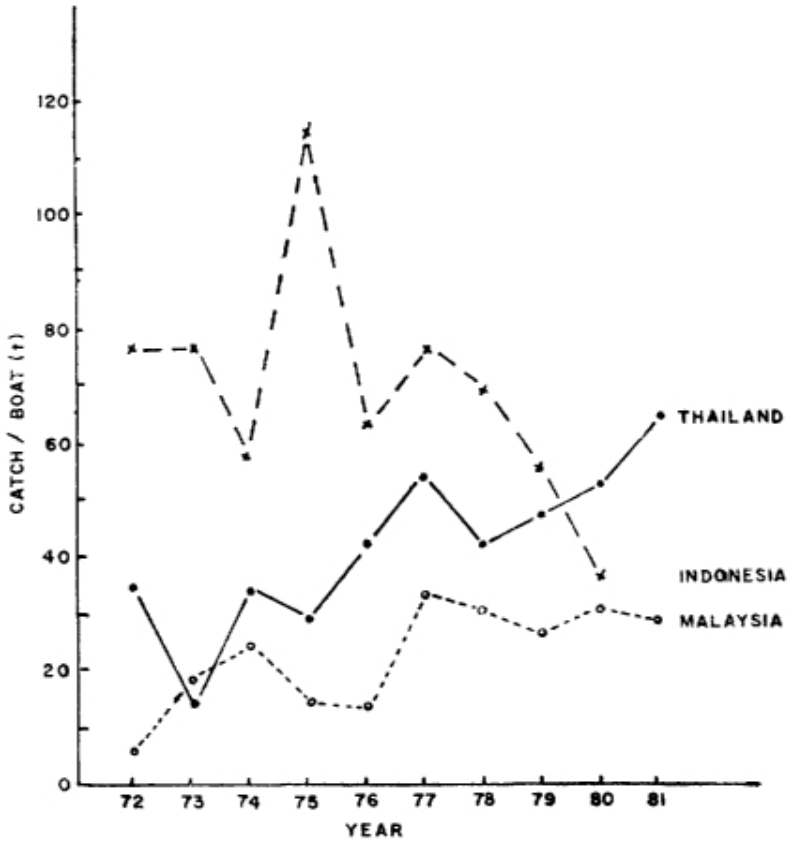

Fig. 2b. Variations in the annual catch rate of ***Decaptews***

The picture for *Decapterus* spp. after 1976 shows similarities to that of the *Rastreiiger* spp. (Fig. 2a). The upward trend in Malaysia is, however, not so pronounced and the production in Indonesia and Thailand appears to be stable rather than declining. Though Malaysian production has been much higher than those of Indonesia and Thailand, since 1977, its catch rate has been the lowest during the period excluding, perhaps, 1980 (Fig. 2b).

The Malaysian fishery for *Rastreliger* spp. extends over the entire EEZ. The relative density expressed in yield per unit area is estimated at 0-8 t/km2. In Thailand and Indonesia the *Rastreiiger* spa. fisheries cover only about half of the respective EEZ's and the relative density is about 0-3 and 0-35 t/km2, respectively.

		Thailand	Malaysia	Indonesia
EEZ	(km2)	111,000	69,413	100,000
Area covered by the fishery	(km2)	44,000	62,275	55,000
Yield per unit area* *(Rastrelliger* spp.)	(km2)	0.3	0.8	0.35

*The density estimates are based on production in the year with the highest catch rate for the respective Countries.

Table 1

Catch and catch rates of *Restre/liger* **spp. by country (1972-82)**

Year	Thailand		Malaysia		Indonesia	
	Catch (tonne)	Catch rate (tonne/boat)	Catch (tonne)	Catch rate (tonne/boat)	Catch (tonne)	Catch rate (tonne/
1972	9968	91	9763	33	21350	77
1973	23334	184	21675	76	16179	76
1974	11170	124	12313	37	18533	57
1975	13701	274	9987	24	19512	114
1976	8470	135	12414	26	11470	39
1977	6993	189	19570	45	12386	46
1978	4678	126	23804	61	10999	38
1979	7392	119	34154	120	12073	35
1980	2773	126	51869	173	13114	34
1981	2480	177	45027	91	—	—
1982	—	—	54719	81	—	—

Note: Catch rates are based on catch records and effort by all types of P. seines in Malaysia, Indonesian P. seines in Indonesia and Thai P. seines in Thailand.

Table 2

Catch and catch rates of *Decapterus* spp. by country (1972-82)

Year	Thailand		Malaysia		Indonesia	
	Catch (tonne)	Catch rate (tonne/boat)	Catch (tonne)	Catch rate (tonne/boat)	Catch (tonne)	Catch rate (tonne/boat)
1972	1475	37	1814	6	13076	77
1973	811	14	4849	18	12264	76
1974	1416	34	7021	23	13162	57
1975	1535	28	5332	15	14053	114
1976	1074	42	3695	14	758	63
1977	1450	54	6398	33	1362	76
1978	**886**	**41**	**6025**	**30**	**2536**	**69**
1979	1044	47	6599	26	2593	55
1980	895	54	7459	30	2257	36
1981	1500	65	8194	27	—	—
1982	—	—	9408	27	—	—

Note: catch rates are based on catch records and effort by aH types of P. seines in Malaysia; Indonesian P. seines in Indonesia and Chinese P. seines in Thailand.

5. FISHING EFFORT

Many different fishing methods, craft and gear are employed in the capture of mackerels in the three countries. The main characteristics are summarized in Table 3.

There is a large variation in the effectiveness of the unit effort values even within each category and, of course, more so between the different categories. No serious attempts have been made to correlate size and power of craft to gear, or catch rate to size of craft and gear, of the units operating in the Malacca Straits.

In Thailand, data on catching units are available for different types of purse seiners (Thai purse seiner, Chinese purse seiner and luring seiner). The efficiency of the Chinese type has, for instance, been estimated to be two-thirds of the Thai type. Some information from the Gulf of Thailand fishery might also be relevant to the west coast in attempts to correlate the variables. An example is the relationship between length of vessel and length of net for lamp luring purse seiners in the Gulf of Thailand established by the Marine Fisheries Division.

Length of net (m) x 35.23 > length of vessel (m) — 105 with a correlation factor of 0.91.

There is also other information available from the same area on, for instance, catch per haul and catch per day for different sizes of vessels.

In Malaysia, there is an indication that the non-luring purse seine is 40% more effective than the luring purse seine. But, this result is only an unconfirmed preliminary observation because it was based on a comparison of the catches by non-luring purse seine fishery in the central part with those of the luring purse seine fishery in the northern part of the west coast. The

former is primarily a night operation and the latter tends to be more of a day time operation with coconut leaf as lure. Even night luring with lights is conducted vvith the help of petromax kerosene lamps placed above water (on rafts). In Thailand, luring purse seiners use underwater and above-surface electric lamps powered by generators on board. Light attraction contributes very significantly to higher catch rates for mackerels in Thailand.

The trawl catches of mackerel in Malaysia have increased substantially since 1976, although there have been great fluctuations from year to year (Table 1, Appendix 3). There might have been a slight increase in the trawl fleet but reliable information to this effect is not available. The catch rates of mackerels by high opening bottom trawls have increased, and the mackerel is the target species of this trawl fishery. Even the drift/gillnet fishery has shown an increase in mackerel catches though not to the same degree as that of the trawl fishery. In view of the increasing contribution to the mackerel production by high opening trawls in Malaysia, sampling of trawl catches needs to be incorporated in the mackerel study programme.

The characteristics presented in Table 3 show that none of the gear categories is compatible for the three countries. The luring purse seines and the vessels for their operation are compatible in Thailand and Malaysia but unfortunately this system of fishing does not exist in Indonesia. Another system with fewer differences between countries and applied in all three is the 'purse seine' (Thai purse seine, Malaysian purse seine and Indonesian purse seine). The total effort for mackerel production standardized to this method of capture was considered to bring the effort units of the three countries to the highest level of compatibility with the information available at present.

In view of the fact that the Thai purse seine is specifically directed to the capture of *Rastrelliger* spp. and Chinese purse seine to the capture of *Decapterus* spp. in Thailand waters, that country standardizes the effort on the two varieties to the respective gears mentioned. In Malaysia, the effort is brought to an average level for all types of purse seines, as catch rates cannot as yet be estimated for any particular type of purse seine. In fact, the effort values are not direct estimates in these cases and have been obtained by dividing the total production of chub or scad mackerels by all types of geers, by the catch rate of mixed purse seines in Malaysia, Thai purse seine or Chinese purse seine (for chub and scads, respectively) in Thailand, and the only type of purse seine in Indonesia. The catch rates are derived by using the number of units of the gear as the index of effort and the number of trips or number of fishing days estimated through sampling procedures. (Thailand is also measuring the effort by number of boat-days.) In fact, the catch rate estimated by sampling conducted by the Research Institute in Penang for a particular year was found to be 50-60% higher than that derived by the normal procedure adopted. The very high production of mackerel in Malaysia from 1980 to 1982 has resulted in proportionate increase in the fishing effort values estimated by the procedure that has been adopted but this large increase in the fishing effort will not be evident if the catch rates derived from the sampling programme of the Research Institute are applied.

Table 3

Main characteristics of craft and gear contributing to the mackerel production

		THAILAND			MALAYSIA			INDONESIA		
								Encircling		
		P.S.	*T.*	*G.N.*	*P.S.*	*T.*	*G.N.*	*P.S.*	*T.*	*G.N.*
Craft	Size (m)	14 - 25	10 - 30	10 - 18	15 - 25	18 - 25	10	15	15	12
	Power (hp)	120 - 420	50 - 500	50 - 200	120 - 250	200 - 350	6 - 36	32 - 42	15 - 33	7 - 33
	Endurance (days)	1	4 - 5	1	1	1	1	1	1	1
P. Seine	Target spp.	Mackerel, Sardine			Mixed pelagic			Small & medium pelagic		
	Size (m)	(800-1200) × (70-120)			(400-800) × (80-120)			(400-600) × (40-60)		
	Mesh (mm)	18 - 90			25			25 - 90		
	Operation	Day & night; echo sounder, sonar			Day & night, 1			Night		
C.P. Seine	Target spp.	Mackerels			Mixed pelagic					
	Size (m)	(600-1200) × (60-80)								
	Mesh (mm)	18-25								
	Operation	Day & Night								
L.P. Seine	Target spp.	Scads, sardines			Mixed pelagic					
	Size (m)	(400-800) × (50-80)								
	Mesh (mm)	18-25								
	Operation	Day & night								
Trawl (2-seam)	Target spp.	Mixed								
	Size (m)	12-40 (headrope)			25 (headrope)					
	Mesh (mm)	20-25 (cod-end)			25 (cod-end)					
D. Seine	Target spp.							Demersal		
	Mesh (mm)							12-18 (cod-end)		
Gillnet	Target spp.				Mixed pelagic			Mixed pelagic (small)		
	Size (m)				800 (variable)			600		
	Mesh (mm)				25-100			25-50		
Gillnet (encircl.)	Target spp.	Sardine, mackerel						Small pelagic		
	Size (m)	(300-500) × (20-30)						600 × 40		

P.S. — purse seiner; T — trawler; G.N. — gillnetter; C — Chinese; L — Luring; D — Danish.

6. MAXIMUM SUSTAINABLE YIELD

Using the 'purse seine' as the common gear, the total effort standardized at that level and the total production of *Rastreliger,* an attempt was made to examine the overall trend in the Malacca Straits. The maximum sustainable yield (MSY) derived was 54,841 tonnes which is slightly less than that derived by addition of the separate estimates for the three countries (Table 4). All the effort points were found to be on the right hand side of the parabola. The calculations were also repeated by standardizing the total effort on chub mackerel in the Malacca Straits to the levels of the Thai purse seine, Malaysian purse seine and Indonesian purse seine. The MSY in terms of Thailand and Indonesia standards was less than the first estimate and that by Malaysia standard was almost the same as the first estimate (Table 4). The correlation coefficient was equally significant in two estimates with equally high MSY values. This indicates that the total production in the Straits exceeded the MSY in 1973 and is close to or above the MSY since 1979.

The estimates also indicate that Thailand exceeded her MSY only in 1973 but the production since then has been nearly half or less than half the MSY. Yet the effort put into this fishery has continuously diminished.

Malaysia exceeded her MSY in 1978 but the production has continued to increase to two to two and a half times the MSY in 1980, 1981 and 1982. The validity of the figures for the last three years may have to be reconfirmed.

Indonesia exceeded her MSY as far back as 1972, but the production has been close to the MSY since 1976. The abnormality of the figures for the pre-1976 period has caused some difficulties even in fitting a production model and perhaps needs rechecking.

In the case of *Decapterus* spp. the Indonesian catch data for 1972 to 1975 could not be used due to certain abnormalities and hence data for 1976-1980 were used in the pooled analyses. The combination of effort, as determined for the Thailand, Malaysia and Indonesia purse seines, gave an MSY of 9,121 tonnes and the effort standardized to the level of the Malaysian purse seine also gave a very similar value (Table 5). The total effort at the level of the Indonesian purse seine standard, gave an MSY of 11,326 tonnes which is very close to the MSY estimated independently for the three countries (11,200 tonnes). Standardization of effort at the level of the Chinese purse seine in Thailand, failed to produce any reasonable correlation with catch rates and hence the MSY estimation with this series of effort values was abandoned.

The MSY for Thailand and Indonesia have not been exceeded yet. Malaysia's production has exceeded its MSY since 1977 but the catch appears to be stable at a slightly lower level from 1980. The overall production in the Malacca Straits does not appear to have exceeded the overall MSY.

It is noted that the MSY for *Restrelliger* in the Malacca Straits was estimated to be about 95,000 tonnes and that of *Decapterus* about 24,000 tonnes in **1976.1** However, the estimated production of *Restreliger* by Thailand for the years 1971-1973 was overestimated during the 1976 workshop, as can be seen from the revised figures available now for the same period.

'Report of the Workshop on the Fishery Resources of (he Ma/acca Straits—Part I, March 29 to April 2 1979, Jakarta. SCS/Gen/76/2. Part II. SCS/Gen/76/6

Table 4

MSY of *Rastreiiger* spp. in the Malacca Straits, as estimated for effort standardized to the effIciencies of various types of purse seiners employed in the respective countries

Year	Total Catch	Malacca Straits Purse seine standard		Thailand Purse seine standard		Malaysia Purse seine standard		Indonesia Purse seine standard	
		Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
	(t)	(PS)	Ct/PS)	(PS)	(t/PS)	(PS)	(t/PS)	(PS)	(t/PS)
1972	40781	680	59.97	448.1	91	1236.5	32.98	531	76.8
1973	61188	623	98.22	332.5	184	800.5	76.44	802	76.3
1974	42011	747	56.24	338.8	124	1126.6	37.29	741	56.7
1975	43200	632	68.35	157.7	274	1775.6	24.33	379	114.1
1976	32354	837	38.65	239.7	135	1240.6	26.08	840	38.5
1977	38949	743	52.42	206.1	189	870.4	44.75	847	46.0
1978	39481	719	54.91	313.3	126	644.9	61.22	1053	37.5
1979	53618	691	77.59	450.6	119	447.1	119.92	1528	35.1
MSY(t)		54841		48476		54356		49094	
Optimal effort (no of PS)		498		333		914		1,104	
(corr. coeff.)		—0.84		—0.80		—0.83		—0.706	
MSY(t) (Estimate by country)		58765		20074		21000		17691	

Note: Effort according to standards mentioned in Table 1
PS—Purse seiners

Table 5

MSY of *Decapterus* spp. in the Malacca Straits, as estimated for effort standardized to the efficiencies of the various types of purse seiners employed in the respective countries

Year	Total Catch	Malacca Straits Purse seine standard		Thailand Chinese Purse seine standard		Malaysia Purse seine standard		Indonesia Purse seine standard	
		Effort	CPUE	Effort	CPUE	Effort	CPUE	Effort	CPUE
	(t)	(PS)	(t/PS)	(PS)	(t/PS)	(PS)	(t/PS)	(PS)	(t/PS)
1976	5527	308	17.94	131.3	42.1	406.4	13.6	87.45	63.2
1977	9210	242	33.06	171.2	53.8	283.4	32.5	121.50	75.8
1978	9447	259	36.47	228.2	41.4	314.9	30.0	137.91	68.5
1979	10236	323	31.69	216.9	47.2	393.1	26.0	185.43	55.2
1980	10611	332	31.96	198.3	53.5	359.7	29.5	291.51	36.4
MSY(t)		9121				9724		11326	
Optimal effort (no of PS)		292		Cannot be		292		258	
(corr. coeff)		—0.539		determined		—0.797		—0.889	
MSY(t) (Estimate by country)		11.200		2,700		5,800		2,700	

Note: Effort according to standards mentioned in Table 2.
PS—purse seiners

7. PROBLEMS AND LIMITATIONS

Having reviewed and analyzed the available information and data on the mackerels in the Malacca Straits, the working group discussed the many problems and limitations encountered during their work. Several gaps will have to be filled and errors rectified in order to improve the assessment of the stocks and their exploitation.

It is felt that as regards accuracy, the data obtained from routine statistics are far from satisfactory. It is a crucial deficiency since most of the stock assessment work is based on such catch and effort data. There is, for instance, no breakdown of the catch by species except for the *Rastrel/iger* spp. in Thailand; the actual effort in number of units is unknown since the statistics are geared to administrative requirements. The problem lies both in the classification and the collection of data. The drastic revisions in catch and effort values made in the past illustrate this point. A higher degree of reliability of data could probably be attained by close cooperation between research and statistics units. The problem concerns all the countries.

A serious limitation encountered during analysis is the inadequacy of the gear classification and the correlation between different gears. It concerns the individual countries, particularly Malaysia, as well as the area as a whole.

Sampling programmes are conducted by the research institutes in Phuket and Penang while Indonesia is yet to establish such programmes for the north-east coast of Sumatra. The ongoing sampling programmes, however, suffer from insufficient frequency and meagre content. A particular gap in Malaysia is the absence of sampling of *Rastre/liger* spp. at trawl landing sites. The sites of existing and proposed sampling stations are indicated in Fig. 3.

Very little biological work, e.g., egg and larvae studies, morphometric measurements, tagging, etc., has been undertaken of the species under investigation. Shortage of funds and manpower is said to be the main cause of these problems and limitations.

In exploring remedial action, the possibilities of employing some of the recently introduced methodologies based on the length structure approach were considered. Although some reservations were exoressed, it was agreed that the information to be collected would permit various analytical approaches and, therefore, did not restrict the group to the application of only simplified approaches to the study of the mackerel stock(s). In view of the difficulties in obtaining certain variables—such as age structure and mortality rates—for the numerous species in the tropical ecosystem, without prolonged investigation, the length structure approach could be applied to evaluate the status and determine the yield of the stocks. This would also be useful for comparison with the estimates obtained by conventional approaches, until the sampling programme becomes effective and vital variables such as age, growth and mortality are determined.

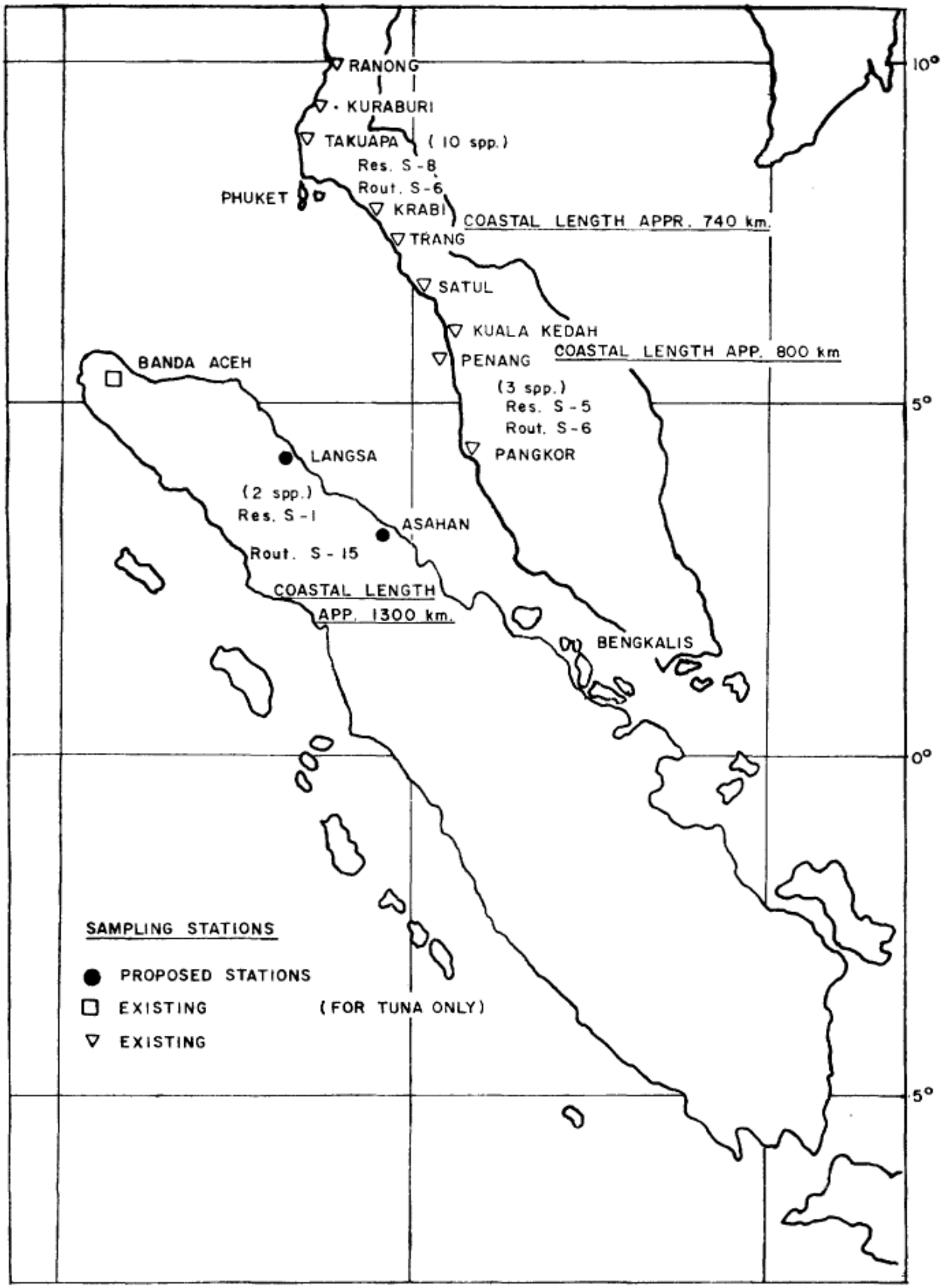

Fig. 3. Locations of existing and proposed sampling Stations for mackerels in the Malacca Straits.

8. WORK PROGRAMME

The existing systems for collecting data for research purposes were reviewed in respect of each of the participating countries. The sampling stations and the staff available were discussed in the light of the data to be collected. It was believed that the existing sampling stations in Malaysia were sufficient but occasional sampling close to the southern end would be advisable. In the case of Thailand, one of the two sampling stations close to Phuket would not be needed. In Indonesia, there is a need to establish research sampling stations in the Malacca Straits.

The specific work items to be carried out and standards to be adopted were identified as follows;

1. Routine sampling at identified landing sites. At least 10% of the total number of boats should be sampled. The frequency of sampling should be monthly, some time between new moon and full moon.

2. Determination of catch composition by size and type of fishing boats and fishing gear (purse seine, luring and non-luring, trawl and drift/gillnets). The weight should be recorded at landing sites, before sorting by size at stations where price varies with size of fish.

3. Landing records of *Rastre/liger* and *Decapterus* by species and by type of gear as specified in (2) above. If species of each variety are not separated before sale, eye estimates of proportions are to be made.

4. Length measurements (standard, total or fork) of *Rastre/liger* and *Decapterus* by species and type of gear. Standard, total or fork length can be measured, provided each country independently calibrates one length against another for conversion purposes. This will facilitate the use of data already collected. Measuring boards are to be used and measurements are to be at 5 mm intervals.

5. Estimates of fishing effort (number of vessels, number of trips, number of days) and if possible number of settings of hauls per day. These can be obtained from the national statistics but the researchers will check on the effort periodically to correct and supplement the data as found necessary.

6. Correlation of size of craft/horsepower with size of gear and with catch rates for standardization of effort. Cross calibration experiments with a boat of a size common to all the three countries will be difficult because a vessel of the size of the largest purse seiner in Indonesia will not be able to sail out with one standard net to cover the fishing grounds of all the three countries. Hence, it was decided that standardizing the catch rates of the mackerel species in each country to a particular range in the size of craft, size of gear and operational technique would be a reasonable and practicable approach. The specification proposed for standardization is as follows:

Length of craft (m)	15 – **20**
Power of craft (hp)	**150** – 200
Gear	'Purse seine'
Length of net (m)	600 – **800**
Mode of operation	non-luring

7. Morphometric measurements to determine the length-weight relationship. These should include standard length of fish, snout to eye, snout to first dorsal fin, pectoral fin length, and height of fish (just behind the operculum). A caliper should be used.

8. Information on fishing grounds and operations. Researchers should go out with fishing vessels to observe the fishing area, modes of operation, number of schools fished, etc., at least once or twice a year.

9. Egg and larval surveys. These are not vital for the time being and should only to be implemented if funds permit.

10. Tagging. Thailand will continue her annual tagging programme on *A. brachysoma.* Further tagging experiments need not be implemented, unless ample funds are available, before more basic biological information has been collected.

It was considered possible to undertake the above work within the present staff and funding limitations of the research establishments of member countries, with a minor supplementary input from the regional project.

9. CONCLUSIONS

The analysis of available information on mackerels in the Malacca Straits does not indicate clearly whether the *Rastrelliger* spp. and *Decapterus* spp. exploited by the three nations belong to common stocks or not. Tagging experiments conducted by Thailand show that *R. brachysoma* in the southern coast of Thailand does migrate into the northern waters of Malaysia. It is also observed that the north-south migration of this species was limited to the Trang area in Thailand and to Kedah in Malaysia. This is in conformity with the coastwise production trend shown for *R. brachysoma.* The length frequency data made available are limited to one year and the number of samples from some of the stations is low. Though some trends are indicated, no definite conclusion could be drawn at this stage, except for general observations made in the reports of the respective countries. A noteworthy observation is the reversal of the production and catch rate trends for *Rastreiiger* in Malaysian waters as against those of Thailand and Indonesia, the latter exhibiting similar variations. The peak production year for *Rastre//ige,* in Thailand and Indonesia was 1975 whereas this was the year of the least production in Malaysia.

The applied estimates of effort values are indices rather than absolute effort figures. Hence the derived catch rates also have the same degree of validity. Unusual results were observed in some instances, such as the production trend of *Decapterus* in Indonesia and the production and effort estimates for the *Rastre/liger* catches for 1980-82 in Malaysia. These data had to be left out of the analysis and have to be reassessed.

The results indicate that Malaysia's production of *Rastrelliger* spp. exceeded the MSY in 1978 but production seems to have continued to increase up to recent years; Indonesia's production exceeded the MSY in 1972 but has subsequently been fluctuating close to this value; Thailand exceeded its MSY in 1973 but the production since then has been nearly half or less than half the MSY.

It appears that Thailand's effort on the mackerels has been shifted to other target species such as tunas and hardtail scads. The overall production of *Rastreiiger* spp. seems to have exceeded the MSY only in 1973, excluding the production by Malaysia in 1980-1982.

The production of *Decapterus* spp. by Thailand and Indonesia does not appear to have exceeded their respective MSY's but it has done so in the case of Malaysia, since 1977. The overall production does not present evidence of having exceeded the overall MSY.

These estimations are based on available data, with limited reliability, which do not permit much further analysis or interpretations. The most serious information gaps are found in Indonesia where very little research sampling on the mackerels is being, or has been, carried out systematically; it is understood that Indonesia is likely to commence activities along the recommended lines, beginning early 1984.

10. RECOMMENDATIONS

In finalizing the deliberations of the Penang meeting the working group put forward the following **recommendations.**

1. The work programme, as proposed and agreed to by the participants, should be implemented to improve the reliability and to obtain additional information required for better assessment of the mackerel stocks.

2. Improvement of the national fisheries statistics should be undertaken in order to increase the reliability of data used by the stock assessment workers. This will enhance the analysis and supplement the data collected by the research units. There should be regular consultations between the scientific officers and the fisheries statisticians and the data collected by the research division should be used for adjustments and corrections of the data collected by the statistical units.

3. In the case of Indonesia, sampling stations should be established and officers recruited for the execution of sampling programmes as soon as possible, if meaningful research work on the mackerels is to be carried Out. The Sumatra area does not appear to be on the priority list in Indonesia, as far as fisheries research is concerned.

4. The regional project should assist and provide necessary facilities to the participating institutions, and to the personnel concerned with this specific study in the Malacca Straits, on matters concerning standardized analytical approaches, independent and collective analysis of data and collection of information by them.

5. The concerned scientists in the three countries should maintain regular contact with one another, and also the project, regarding progress and problems connected with the execution of the work programme.

6. There should be opportunities for the scientists to meet one another, as and when it is found necessary, for effective implementation of the work programme. Regular meetings should be held to review and assess progress, depending on the extent of progress and on the emergence of serious problems that call for joint discussion and cannot be solved by correspondence.

7. The national expertise in stock assessment and resource management should be upgraded through training courses at various levels.

8. The project should assist in obtaining financial support for a joint tagging programme, if **the participating countries are unable to provide necessary funds.**

9. The project should assist in arranging for financial support for satisfactory execution of **the work programme.**