BAY OF BENGAL PROGRAMME
Marine Fishery Resources Management

BOBP/REP/40
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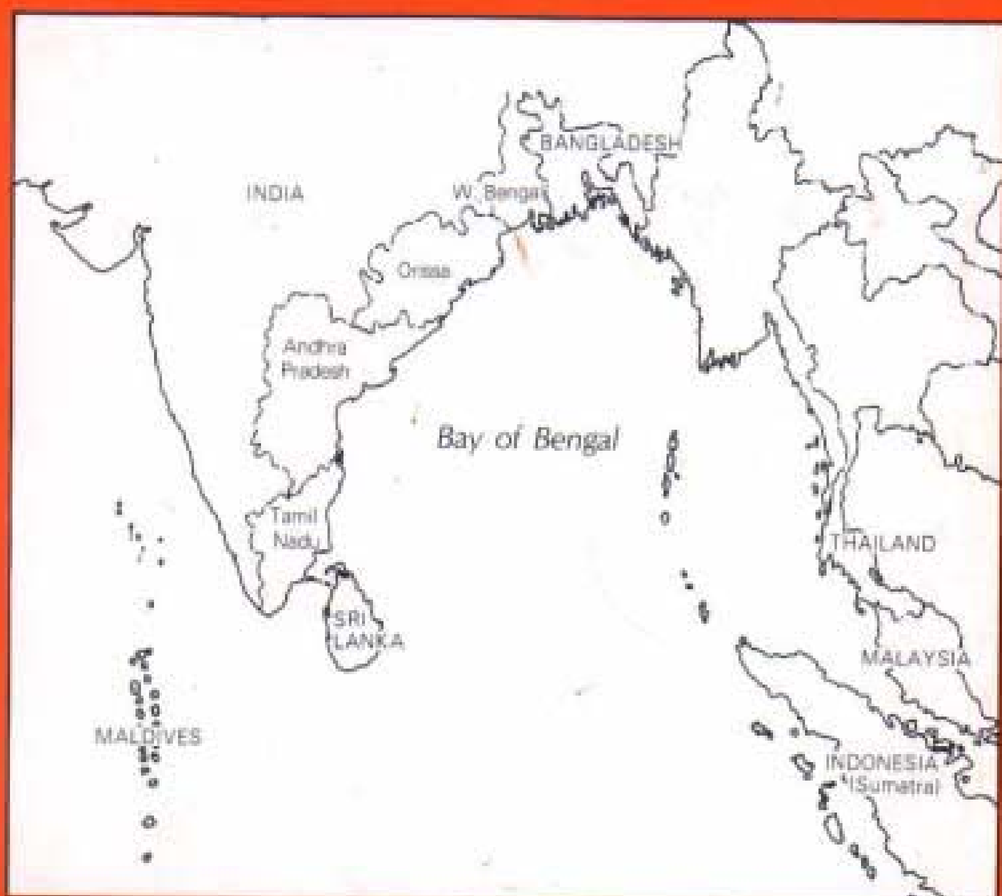
Tuna in the Andaman Sea



UNITED NATIONS DEVELOPMENT PROGRAMME

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BAY OF BENGAL PROGRAMME BOBP/REP/40

Marine Fishery Resources Management RAS/81/051

TUNA IN THE ANDAMAN SEA

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This report summarizes available knowledge on tuna resources in the Andaman Sea area. It is based on cooperative investigations by Thailand and Indonesia, and on decisions and discussions at two meetings of a working group established for the purpose, all under the auspices of the Bay of Bengal Programme (BOBP). The meetings were held in Colombo, Sri Lanka (October 1985) and Phuker, Thailand (August 1986).

Technical and financial support for the tuna resource investigations and the two working group meetings were provided by the project "Marine Fishery Resources Management in the Bay of Bengal" (RAS/81/051), which was a component of the BOBP. The project commenced January 1983 and terminated in December 1986. It was funded by the UNDP (United Nations Development Programme) and executed by the FAO (Food and Agriculture Organization of the United Nations). Its immediate objectives were to improve the practice of fishery resources assessment among member countries (Bangladesh, Sri Lanka, Maldives Thailand, Malaysia, Indonesia) and to stimulate and assist joint management activities between countries sharing fish stocks.

CONTENTS

SUMMARY

One of the activities of the project "Marine Fishery Resources Management in the Bay of Bengal" was to assist in the assessment of exploited tuna resources in the Andaman Sea area. Indonesia and Thailand participated in this activity, and Malaysia provided information about her tuna fishery on the west coast of Peninsular Malaysia. One component of the work was a tuna sampling programme. This was conducted in conjunction with the study on mackerels (BOBP/REP/39) in view of limitations of personnel and funds.

On the west coast of Thailand, tuna is captured mainly by 180 mackerel-cum-tuna purse seiners and 30 gillnetters. There are no fisheries aimed solely at tuna, but tuna are an important constituent of mixed-target fisheries. Estimating the tuna landings is somewhat problematic, as the burgeoning tuna canning industry, which consumes a substantial proportion of the catches, does not readily provide facts and figures on the sources of its supply. A few of the purse seiners seem to concentrate on catching tuna.

In Indonesia, the tuna fishery around Sumatra is mainly the troll fishery with about 170 boats on the west coast and some 200 boats purse seining in the north. Production in the west coast of South Sumatra Province is greater than in Banda Aceh and the west coast of North Sumatra Province.

In Malaysia, 300 to 400 purse seiners for small pelagics account for the bulk of tuna landed as incidental catches. The landings are primarily in Perlis, Kedah, Penang and Pangkor.

Despite the proximity among of the EEZs of the three countries, there are substantial differences in catch composition, largely due to the limited exploitation of the EEZs and the ecological differences between them. Catch compositions in the west coast of Peninsular Malaysia and the west coast of Thailand are however somewhat similar. The north and west coasts of Sumatra, which have an oceanic frontage, have access to skipjack and yellowfin tuna while the other two countries catch mainly insular species such as eastern little tuna, frigate tuna and longtail tuna.

Purse seine catch rates for tuna off Banda Aceh. though tuna catches are incidental, were higher than troll catch rates off the west Sumatra coast. The troll catch rates, however, were surprisingly higher than rates achieved elsewhere in the Indian Ocean. The catch rate at Banda Aceh was also higher than that for Thai and luring purse seines in Thailand.

In general, production fluctuated during 1980-1985, in the areas studied, without any noticeable trend, probably due to the absence of a specific fishery for tunas except on the west coast of Sumatra. Off Banda Aceh, the production of skipjack and small tuna showed a steady increase from 1977 to 1985. In Malaysia, the highest annual tuna production appears to have been in 1980, and in Thailand, production of small tuna seems to have increased from 1979 to 1985.

Seasons of good tuna catches are : Thailand — November to April ; Sumatra — June to August for most species; west coast of Peninsular Malaysia -April, May and August.

Only limited length frequency data are available in the study area and modal progressions are not very clearly evident in purse seine and troll catches and growth parameters estimated using the length frequency data available are not very satisfactory.

Peak maturity seasons for various tuna species are: longtail — January-April and August-September; eastern little tuna -January-April and August-December; frigate tuna — March (?) and September (?). Data available on peak seasons of occurrence of each species and their sizes in the areas studied were not sufficient to postulate any migration pattern.

Further, it is difficult to estimate the maximum sustainable yield of various tuna species with the data base available.

There is very little evidence that Thailand and Indonesia share stocks of *Auxis* and Euthynnus species; these are, in any case, insular species. Sharing of skipjack, longtail and yellowfin tuna stocks is likely to occur when the fishery expands towards the common EEZ boundaries.

1. INTRODUCTION

One of the activities of the FAO/UNDP project for "Marine Fishery Resources Management in the Bay of Bengal" was to assist in the assessment of exploited tuna resources in the Andaman Sea area. Initially it was anticipated that India would participate with Thailand and Indonesia in this programme; Malaysia was not interested because of the limited tuna potential off the west coast of Peninsular Malaysia. India's participation, however, did not materialise. There were delays in starting the work because of the limited number of biologists available in the countries that could be assigned to the investigations. Eventually, some of the biologists involved in the project's mackerel study in the Malacca Straits (BOBP/REP/39) had to participate in the tuna investigation programme also, and the tuna sampling programme was combined with that for mackerels*.

A meeting of a working group with biologists from Indonesia and Thailand was convened in Colombo (Sri Lanka) in October 1985, to discuss the information collected and improvements required. The second meeting of the working group was held in Phuket (Thailand) in August 1986. Malaysia participated actively in the second meeting and presented a working paper. The findings of the field investigations and the discussions at the two meetings are incorporated in this report. The materials from the participating countries used during the two meetings figure as annexures to this report.

The list of participants in the two meetings is given in the Appendix.

2. SAMPLING PROGRAMME

For reasons mentioned above, the tuna sampling programme was combined with the mackerel sampling programme in both Indonesia and Thailand. The sampling centres on the west coast of Thailand were the landing ports of Ranong, Takuopa, Tarmuong, Phuket, Krabi, Trang and Satul. In Sumatra, samplings were done at Banda Aceh, Padang and Lhok Sumawe, which are the primary tuna landing places. Samplings at landing places in Thailand were done twice a month while in Sumatra, they were undertaken daily. Samples were taken for catch, effort, species composition and length frequencies, during 1985/86.

*The areas covered by the sampling programme were the west coast of Thailand and West and North Sumatra provinces of Indonesia. Malaysian data cover the west coast of Peninsular Malaysia.

3. THE FISHERIES

The tuna production on the *west* coast of *Thailand* is accounted for primarily by purse seines and gillnets, which have several mixed target species such as mackerels, scads, hardtails, tuna and king mackerels. Hence the effort is not specific and may be considered to be equally directed on all these species. This being the case, fishing is done generally in areas where most of these fish occur and not specifically in areas where only tuna are abundant. Thus the fishery does not extend up to its outer EEZ boundary. The landings are higher in the southern part.

Purse seining for tuna showed an increase in 1985/86. Some mackerel purse seiners operate with tuna as the target species; some larger vessels operate larger purse seine nets, aimed at catching tuna, with a larger mesh size than in the mackerel nets. Because of the demand for tuna from canneries, catches are sometimes transferred directly to the cannery, either by trucks or by fishing vessels. As a result, estimation of the landing has become problematic: the tuna canneries do not readily provide facts and figures on the sources of their supplies. Since tuna are the target species in some instances but incidental catches in others, estimation of realistic effort values is also causing some anxiety.

The luring purse seiners are more popular than the Chinese purse seiners. The former belong to three different classes — < 14 m, 14-18 m and >18 m. The larger class is the most numerous among the estimated 183 mackerel-cum-tuna purse seiners. Some 30 gillnetters belonging to similar size ranges also contribute to the tuna landings.

The fishing area has expanded from the northern to the southern coast. Production figures show that Takuopa and Taimuang areas north of Phuket contributed a little less to the total landings than areas south of Phuket in 1985.

The Indonesian fishery around Sumatra is primarily a troll fishery off South Sumatra province (Padang) and a purse seine fishery in Banda Aceh and Lhok Sumawe. The production is higher on the west coast of South Sumatra province than in Aceh and the west coast of North Sumatra province ; sometime ago, the highest was in Aceh but the production seems to have declined slightly over the years, while it has increased in West Sumatra. Production in Indonesia is higher than in Thailand.

On the west coast of Sumatra, trolling boats range from 7 to 18 m in length (16-55 hp). Of about 170 boats, 60 are small in size (20 hp). Some 200 (mainly 15 m LOA) mackerel and tuna purse seiners contribute to the tuna production from other areas such as Banda Aceh and Lhok Sumawe. In addition, about 800 units of gillnetters make a relatively small contribution to tuna catches. The number of small boats (smaller than 20 hp) involved in the troll fishery for tuna has increased by 30% between 1980 and 1985 but there is no increase in the number of larger boats (larger than 20 hp). No significant differences in the catch rates of these two classes of boats were observed, as they appear to be operating in the same fishing grounds and with a similar number of trolling lines.

No significant or noteworthy changes were observed in the tuna catches on the west coast of Peninsular Malaysia. About 300-400 mackerel purse seiners (15-25 m) continue to be the main contributors to the production; hence landings are primarily in Perlis, Kedah, Penang and Pangkor and catch rates do not appear to have changed since 1980 or even earlier.

The mackerel-cum-tuna catching purse seine nets have the following dimensions.

		Thailand	Malaysia	Sumatra
Length	(m) .	400-1200	400-800	400-1200
Depth	(m) .	50-120	80-120	20-60
Mesh Size	(mm).	20-90	25	25-90

4. SPECIES COMPOSITION AND DISTRIBUTION

Skipjack *(Katsuwonus pelamis)* and yellowfin tuna *(Thunnus albacares)* are the dominant species in the troll fishery off the west coast of Sumatra. Eastern little tuna *(Euthynnus affinis),* frigate tuna *(Auxis thazard)* and bigeye tuna (Thunnus obesus) are other species that make noticeable contributions to the production in that area. Frigate tuna, skipjack and longtail tuna appear to be dominant in the Banda Aceh area. Frigate tuna, eastern little tuna and the longtail tuna (Thunnus tonggol), are the dominant species in Thailand. Yellowfin and bigeye tuna are completely absent in the Thai production. In spite of the proximity of the two EEZs, there are significant differences in catch composition that are due to the limited exploitation of the EEZs and the ecological differences in the two EEZs. The composition in Malaysia is similar. to that of Thailand.

Composition of the tuna species caught by Thailand, Malaysia and Indonesia in the Andaman Sea area (percentage).

	FT	ELT	SKJ	LOT	YFT	Remarks
Thailand	54	28	0	18	N	Purse seine catch
Malaysia	10	30	0	60(?)	N	Purse seine catch
Indonesia						
W. coast of Sumatra	5	4	78	X	13	Troll catch
N. coast of Sumatra	53	NA	27	20	X	Banda Aceh (only 5 monthsdata P. seine)
E. coast of Sumatra	X	X	N	X	N	P. seine

FT = Frigate tuna

ELT = Eastern little tuna

SKJ = Skipjack tuna

LOT = Longtail tuna

YFT = Yellowfin tuna

X = Species present but no estimate available

N = No landings

NA = No information available

The north and west coasts of Sumatra, which have oceanic frontage, have access to the skipjack and yellowfin tuna. The other areas show similarities in the species caught. However, the occurrence of longtail and yellowfin tuna in the surface fishery off Banda Aceh has to be verified, as also perhaps the very high percentage of longtail tuna in Malaysia.

Frigate tuna and eastern little tuna are distributed widely in the Andaman Sea and Malacca Straits, except in the extreme southern part. The longtail has a similar distribution but is evidently *more* concentrated in the north, along the coast of Thailand. Longtail tuna does not appear to be a common species on the west coast of Sumatra, though it may be caught close to Banda Aceh. The catch rate (in number of fish caught) of larger tuna declines from north to south, in the area studied, much more rapidly than that of smaller tuna. Skipjack and yellowfin are found off the west coast of Sumatra and further north around and beyond the Andaman islands, but a suitable fishery for these species does not exist in the area at present.

5. CATCH RATES

Catch/boat/day in the troll fishery off the west coast of South Sumatra (small craft 84.6 kg/day and large craft 133 kg/day) is not higher than the catch/boat/day in the purse seine fishery in Banda Aceh (345 kg/day) despite the fact that tuna are incidental catches of purse seiners. However, the troll catch rates are considered very good in comparison with levels in other areas of the Indian Ocean. Surprisingly, the proportion of frigate and eastern little tuna in the troll catches is very low, compared with the pattern elsewhere, such as in Sri Lanka or Seychelles. This may be due to the use of single hook type troll lines as against the multiple hook types which are extremely effective on these smaller species.

The annual catch rate of tuna in the purse seine fishery of Thailand, for the years 1978 to 1985, appears to show heavy fluctuation, without any steady trends (83 — 222 kg/day; 95 kg/day, in 1985), because tuna is not the only target species in this fishery.

The purse seine catch rate in Banda Aceh (1984/85) appears to be higher than that of the Thai and luring purse seines in Thailand.

Experimental tuna purse seining by the Japanese Marine Fisheries Resources Research Centre, between 1979 and 1983, off the west coast of Sumatra showed the catch composition to be similar to that of traditional fisheries (Watanabe, Y. 1985) *. The catch rates in the offshore range exhibited the presence of reasonably large sized schools in the area, The catch per set during different seasons were as follows.

March — May 1979	9.3 t
May — July 1979	6.9 t
January — February 1980	12.1 t
March — April 1980	7.7 t
May — June 1980	15.0 t
July — August 1980	Very poor results, few sets outside EEZ
October — December 1981	13.1 t (one set with 50t)
November 1982 — March 1983	12.9 t

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* Watanabe,Y., 1985. Review of experimental purse seine operation in the Indian Ocean by Japan Marine Fisheries Resources Research Centre. Expert consultation on stock assessment of tuna in the Indian Ocean. 28 Nov. — 2 Dec. 1985 Colombo, Sri Lanka. Compilation of working documents, TWS/85/24 ; pages 141-149.

6. PRODUCTION TRENDS

The annual tuna production in the three areas has been fluctuating largely because the fishing effort has not been systematically directed on the tuna except in Sumatra. In Thailand, the production of longtail tuna fluctuated between 745 metric tons and 3,188 m. tons in the period 1979-1985. The range of production was between 1,002 mt and 4,701 mt in Malaysia between 1972 and 1983 while it was between 10,857 mt and 17,938 mt during 1976-l 984 in Indonesia.

However, off Banda Aceh, the production of small tuna and skipjack shows a steady increase from 1977 to 1985. Banda Aceh had higher production than the west and east coasts of Sumatra. In Malaysia the production appears to have peaked in 1980, with Perak recording the highest monthly production. In Thailand, no clear trends were observed in overall production and in the production of longtail tuna, but the production of small tuna has increased steadily from 1979 to 1985.

7. SEASONALITY

The seasons of good tuna catches or high catch rates in Thailand, Malaysia and Indonesia are summarised below :

Area	Peak Season
Thailand	November to April
Indonesia	June to August for most species; also November to April for some species
Banda Aceh	Yellowfin -August and November
	Skipjack -August, September and January, February.
	Auxis spp. -August and January-February
Padang	Yellowfin — May
	Skipjack — August
	Frigate tuna -August
Malaysia	April, May and August

Seasonality not well defined in Thailand probably because the effort was not specifically focused on tuna alone.

8. SIZE COMPOSITION

Length frequency distributions are available for four species occurring in the study area but they do not cover the entire Malacca Straits and the Andaman Sea area. They do not represent the wide size ranges commonly observed for the same specie= elsewhere. Very small sizes of small tuna that are known to occur are not well represented in the length-frequency samples and very large sizes are not evident, probably because they are found further offshore and outside the Malacca Straits waters. Larger sizes have been recorded for small tuna and skipjack on the west coast of Sumatra. Longtail tuna of over 50 cm is rarely caught in the area, and it is conjectured that it emigrates from the area on reaching that size. Modal progressions are also not clearly evident in the samples from purse seines and troll lines. It is probable that small-sized small tuna aggregating with larger-sized mackerels constitute the major component of their catch. The use of mackerel purse seines with small mesh size permits the capture of juveniles which are observed frequently as incidental catches.

Japanese purse seine trials between 1979 and 1983, off west Sumatra, indicated that the skipjack caught were of the medium size range (46-52 cm) and small size range (32-36 cm), with occasional large size (60 cm) fish. The proportion of small size fish increased from February to March. In June, medium size fish disappeared and only small ones remained.

9. GROWTH PARAMETERS

Some length-frequency data, collected during the BOBP-assisted sampling programme, were available for frigate tuna, eastern little tuna, skipjack, longtail tuna and yellowfin tuna from certain locations within the study area and were analysed using the ELEFAN I program. The results obtained from the 1985 and 1986 data are presented below.

Growth parameters for frigate tuna (FT), skipjack (SKJ) and yellowfin tuna (YET) off the west coast of Sumatra and for frigate tuna, (FT), eastern little tuna (ELT) and longtail tuna (LOT) on the west coast of Thailand

	West coast of Sumatra			Thailand				
	FT	SKJ	YFT	FT		ELT		LOT
	1985	1986	1986	1985	1986	1985	1986	1986
Growth constant value K/annum	0.85	0.62	0.50	0.84	0.63	0.84	0.60	0.45
Asymptotic length L_∞ cm	62	86	170	41	44	43	48	95

The Indonesian data gave relatively high asymptotic length (L,) values, while Thailand data showed relatively low values, influenced mainly by the small maximum sizes observed in the samples. This has influenced the K values obtained.

Application of the Bhattacharya method (for the separation of modal groups) and the Ford-Walford plot gave the following results for Thailand :

Growth parameters of longtail tuna, eastern little tuna and frigate tuna in Thailand

	LOT	ELT	FT
Asymptotic length (L, cm)	61.7	54.8	46.6
Growth constant (K)	0.59	0.51	0.56

it was observed that the L_∞ values derived by this method also were rather low, especially for longtail and frigate tuna. This may be due to the small sample sizes and their narrow size ranges. No longtail tuna were measured above 50 cm, and the longest frigate tuna in the samples was 40 cm. Not more than 2 or 3 modes, representing year-classes, were identified while using the Bhattacharya method ; this led to very few data points for the Ford-Walford plot. In one eastern little tuna length-frequency distribution three modal groups were recognised, resulting in the estimation of growth parameters, although L_∞ values still seemed low.

Although the results in this study were not very satisfactory due to inadequacy of the length-frequency sampling, the ELEFAN methods have proved their applicability to length-frequency data with wider-size ranges in other countries.

In the case of longtail tuna in Thailand, if we assume that the first modal group in the spawning season represents one-year-old fish from the previous spawn of the same cohort, then the modal groups identified are as follows:

Cohorts of spawning season	Group I	Group II	Group III
February-March	19.5-24.4 cm	31.4-31.9 cm	44.4 cm
September- December	23.5 cm	37 cm	40.6-45.1 cm

However, if the first group observed in one spawning season is from the cohort of the preceding spawning season, it will be less than a year old (about 6 months) and the second group, would be about one year old.

Yesaki (unpublished), using the length-frequency of longtail tuna caught during the pole and line survey on the west coast of Thailand, estimated the growth parameters as K-0.38 and L_∞ =95 cm. He also infers that fish of 30 cm and 47 cm length are one and two year-old fish respectively and that the age at maturity is two years,

10. MATURITY AND SPAWNING

Fish egg and larval surveys conducted between February 1980 and July 1981 off the west coast of Thailand showed the presence of relatively higher concentrations of longtail tuna larvae during February than during March and April, and their absence in other months, Gonad maturity stages studies in the same area during the UNDP/FAO pole and line fishery survey* showed the following peak seasons of maturity :

Longtail tuna : January-April and August-September

Eastern little tuna : January-April and August-December

Frigate tuna : March ? September?

* Anonymous, 1985 : Tuna resources and fisheries in Thailand, Department of Fisheries, Bangkok, Thailand.

It is felt that the main spawning season for longtail is around January according to the number of ripe and spent fish in the catches, and this is supported by the larval abundance in February. Eastern little tuna also records a major spawning in February-April.

These results are also supported by the occurrence of juveniles of eastern little tuna and frigate tuna (1 O-l 5 cm) in the purse seine catches in Thailand, Malaysia and North Sumatra in April/May.

11. SEASONAL MOVEMENTS

The peak seasons of occurrence of each species and their sizes in the various areas covered by this study were investigated by tabulating the production, the catch rates and the size compositions during the peak seasons by area. The data available were not enough to bring out any pattern of distribution. However, since larvae of longtail tuna have been observed within the area, the presence of longtail tuna juveniles close to all thiee countries is possible. The larger size group, about 50 cm in fork length, has been observed off Thailand. It is believed that fish of this size may be migrating out of the area, northward, or moving into a deeper-swimming layer in the Bay of Bengal. L *ongline* surveys conducted by Thailand in 1985 in the Andaman Sea area failed to show evidence of their occurrence in the deep swimming layers. Even the frigate tuna and eastern little tuna appears to spawn within the Andaman Sea and Malacca Straits areas, and juveniles of these species were a!so observed off the coasts of all three countries at the same time of the year.

From these observations, it is indirectly inferred that these three species are distributed widely in the Malacca Straits and the Andaman Sea, that they move freely within the area and intermingle to form one entity. In Banda Aceh, one notices phenomena observed in both Malacca Straits and the west coast of Sumatra. On the west coast of Sumatra, the ecology and species distribution are regarded as typical of an open sea environment. Pole and line (live bait) surveys done by FAO during 1979-1981 and tuna longline surveys carried out by Thailand in 1985 beyond the shelf area of the west coast of Thailand have also shown occurrence of skipjack and yellowfin tuna respectively.

The longtail tuna and the eastern little tuna may be regarded as the two primary contributors to the tuna resource on the continental shelf araa off Thailand, Malaysia and the east coast of Sumatra. Beyond the continental shelf, skipjack and yellowfin tuna may be available for exploitation in the north and west coasts of Sumatra, opposite the west coast of Thailand.

12. MAXIMUM SUSTAINABLE YIELD AND EXPLOITATION RATE

Attempts have been made to estimate the maximum sustainable yield and the exploitation rate by applying production models and the ELEFAN II program respectively, at a national level. It was noted that the validity of these methods for resources such as tuna that are highly migratory and found beyond the EEZs of most countries, depends on the coverage of the area of distribution for the data required. For example, stocks of eastern little tuna and frigate tuna are found distributed along the entire Malacca Straits ; the MSY analysis for these species should be based on data from the whole area. In the case of longtail tuna, the area of distribution is expected to be much wider, and extends outside the Malacca Straits. But effective application of these methodologies is difficult because the extent of the distribution is unknown, and information on the catches of this species from adjacent areas is absent. For the yellowfin and skipjack tuna on the west coast of Sumatra, the distribution of stocks may be even wider, while the extent of the exploitation outside this coast is unknown.

Difficulties also exist in estimating the tuna fishing effort of purse seiners which fish for many other species and thus form a mixed species fishery. There is a need for direct estimation cf fishing effort based on criteria to be identified for classifying the effort on the various species and for standardizing the effort for each group of fish.

There are strong possibilities of expanding the tuna fisheries on the west coasts of Sumatra and Thailand, but perhaps this cannot be said about Malaysia because of the shallowness of the EEZ.

13. TUNA LONGLINE CATCH TRENDS IN THE ADJACENT AREA

The hooking rates of yellowfin and bigeye tuna in and around the Andaman Sea area were extracted from the computer printout provided by the Indo-Pacific Tuna Programme (Tables 1 and 2). The monthly hooking rates indicated that the first half of the year is better than the second half for both bigeye and yellowfin tuna in this area.

The annual hooking rates for both species fluctuated widely without a clear trend. The hooking rate for yellowfin tends to decline towards the equator, whereas that of bigeye tuna appears to increase. Korea achieved equally good hooking rates for bigeye tuna, even in the higher latitudesof the Bay of Bengal, unlike Japan and Taiwan. The Korean longline fishery does not exhibit a consistently higher hooking rate for bigeye tuna than the Japanese or Taiwanese fisheries in all the five grids within the area.

Mean weights of bigeye tuna recorded by the Taiwanese longline fishery tend to show an increase towards higher latitudes; this may influence the performance of the gear fishing at different depth ranges.

Thailand is conducting experimental tuna longline operations in its EEZ on the west coast. Indonesia has closed down its longline base on Sabang Island, north of Sumatra.

14. SHARED STOCKS

There is very little evidence of sharing of tuna stocks by Thailand and Indonesia at present, as the production is primarily of *Auxis* and *Euthynnos* species. These being more insular, the stock may be independent. However, expansion of their fishery towards the common EEZ boundary would lead to exploitation of skipjack, longtail and perhaps yellowfin tuna, and these are very likely to belong to common stocks.

15. RECOMMENDATIONS

1. Tuna production estimates are at present made largely by statisticians. Scientists too need to be involved in arriving at independent production estimates.
2. Fish egg and larval surveys should be continued and expanded to cover other areas and seasons.
3. The quality of the statistics collected should be improved and sampling programmes should be intensified and the coverage made broader. Expansion of data collection calls for removing personnel and financial constraints that now exist. It is also necessary for biologists to participate in sampling programmes to improve the quality of sampling.
4. A newsletter or similar material may have to be used to enlighten field officers and fishermen on activities relating to research data collection and the benefits that arise therefrom. This should help secure the cooperation of fishermen in data and information collection.

5. In view of the tuna production level in Malaysia, the attention of the Malaysian Fisheries Research Institute may be drawn to the need to establish a tuna sampling programme.

6. In Thailand, tuna investigation on the west coast is one of the priority areas in fisheries; it is suggested that activities such as intensive survey of spawning areas, estimation of biological parameters and tagging will be carried out.

Table 1

Catch rates of yellowfin tuna (Number/l000 hooks) in the Japanese, Korean and Taiwanese tuna longline fishery in the area — 90-100°E and 0°-15°N

5" x5" Grid		1976	1977	1978	1979	1980	1981	1982	Number/ 1000 hooks (Average)
95°-100°, 10°-15°	J	2.7	—	—	—	—	—	—	2.7
	K								
	T								
95°-1 00°, 5°-10°	J	0	0	0	1.3	—	—	—	1.3
	K	3.9	—	13.7	6.6	2.3	—	—	8.0
	T								
95°-1 00°, 0°-5°	J								
	K	3.8	3.7	4.0	3.2	1.8	—	—	3.5
	T	—	—	—	—	2.3	—	1.8	2.1
90°-95°, 10°-15°	J								
	K	—	—	2.1	—	9.6	—	—	8.8
	T	—	—	—	5.6	—	0.5	6.4	3.8
90°-95°, 5°-10°	J	1.9	—	0	3.8	—	—	—	1.4
	K	3.8	9.6	2.3	2.4	3.3	—	—	3.9
	T	—	—	1.9	1.2	1.9	3.3	1.6	2.6
90°-95°, 0°-5°	J	0	—	6.1	7.7	3.7	—	—	6.1
	K	5.6	5.6	4.1	2.9	1.5	—	—	3.5
	T	—	—	4.3	2.8	3.1	2.4	2.4	2.8

J -Japan K—Korea T -Taiwan

Table 2

Catch rates of bigeye tuna (Number/1000 hooks) in the Japanese, Korean and Taiwanese tuna longline fishery in the area — 90°-100°E, 0°-15°N

5° Grid		1976	1977	1978	1979	1980	1981	1982	Number/ 1000 hooks (Average)
95°-100°, 15°-10°	J	2.3	—	—	—	—	—	—	2.3
	K	—	—	—	—	—	—	—	—
	T	—	—	—	—	—	—	—	—
95°-100°, 5°-10°	J	—	—	—	1.3	—	—	—	1.3
	K	4.5	—	18.7	3.2	4.0	—	—	9.7
	T	—	—	—	—	—	—	—	—
95°-100°, 0°-5°	J	—	—	—	—	—	—	—	—
	K	4.4	8.4	13.7	5.9	15.0	—	—	12.0
	T	—	—	—	—	2.7	—	2.2	2.5
90°-95°, 15°-10°	J	—	—	—	—	—	—	—	—
	K	—	—	7.5	—	0.5	—	—	1.3
	T	—	—	—	10.1	—	1.0	1.0	3.2
90°-95°, 5°-10°	J	7.7	—	0.8	2.1	—	—	—	5.0
	K	4.9	9.2	6.0	3.3	4.4	—	—	5.3
	T	—	—	2.8	7.3	2.6	4.0	5.2	4.4
90°-95°, 0°-5°	J	4.9	—	8.4	12.8	12.6	—	—	11.1
	K	7.4	9.9	11.6	7.2	7.5	—	—	8.6
	T	—	—	8.6	7.6	8.4	6.4	7.3	7.5

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