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DEPARTMENT OF SEAFDEC

KUALA TERENGGANU, MALAYSIA

SEAFDEC MFRDMD RM/ 2

REPORT OF SECOND REGIONAL WORKSHOP

ON

SHARED STOCK IN THE SOUTH CHINA SEA AREA

ORGANISED BY

MARINE FISHERY RESOURCES DEVELOPMENT
AND
MANAGEMENT DEPARTMENT
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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18 — 20 July 1995

REPORT OF SECOND REGIONAL WORKSHOP
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REPORT OF THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia
18-20 July 1995

I. INTRODUCTION

1. At the invitation of the Marine Fishery Resources Development and Management Department of SEAFDEC (SEAFDEC/MFRDMD), the Second Regional Workshop on Shared Stock in the South China Sea area was held in Kuala Terengganu, Malaysia, from 18 to 20 July 1995.

2. The Workshop was attended by participants from Brunei Darussalam, Indonesia, Malaysia, Philippines, Thailand and Vietnam, as well as participants from SEAFDEC/MFRDMD. The list of participants appears as **Annex 1.**

OPENING CEREMONY

3. On behalf of the Government of Malaysia and the Southeast Asian Fishery Development Center, Mr. Mohd Mazlan bin Jusoh, Deputy Director General of Fisheries Malaysia, welcomed the participants to the workshop. In his opening address, Mr. Mazlan felt happy that the participants have responded positively by accepting the invitation to participate in this second workshop and to share their invaluable experiences for the betterment of fishery resources research in the region of Southeast Asia.

4. Such a gesture would consolidate the establishment of a permanent working group on shared stock for the implementation of the programme, in order to forge continuity and commitment of national research inputs, and to sustain the enthusiasm of the scientists and researchers involved.

5. Since this second workshop will focus on the various aspects of research related to the shared stock, Mr. Mazlan expressed the hope that a common approach in the research methodology can be formulated for the assessment and rational management of these stocks. He expressed confidence that the experiences shared would provide new and interesting perspectives for further discussions among the workshop participants. The Opening Address of Mr. Mohd Mazlan bin Jusoh appears as **Annex 2.**

6. Mr. Mazlan declared the Workshop open.

ADOPTION OF THE AGENDA AND TIME TABLE

7. The Agenda and Time Table, which appears as **Annex 3** was adopted.

ELECTION OF CHAIRMEN AND RAPPORTEURS

8. Messrs. Ismail Taufid Md. Yusoff, Keiichiro Mori, Cirlito Gonzales and Gede Sedana Merta were elected Chairmen of the Workshop sessions, while Messrs. Mohd Taupek Mohd Nasir, Ahmad Adnan Nuruddin, and Idris Haji Abdul Hamid were elected Rapporteurs of each session. Messrs. Mohd Taupek Mohd Nasir served as the Technical Rapporteur of the Workshop.

II. STATUS OF DATA COLLECTION AND MANAGEMENT RELATED TO SHARED STOCKS

9. In order to assess the present status of data collection and management related to shared stocks, each participating country presented their Country Status Reports, which include the updated data and information on the status of their marine fishery resources, catch-effort, biology and oceanography. The presentation of the status reports was followed by discussions among the participants of the Workshop.

10. The first paper, presented by Mr. Richard Rumpet of Sarawak, Malaysia (*see* **Annex 4**) was entitled "Country status report - Round Scads, Mackerels and Neritic tunas Fishery in Sarawak, Malaysia". Some of the points pointed out include the observed average annual landing of round scads for the period 1991-1993 at around 135 tonnes; an increase in the landings of the mackerels from 1990 to 1992, but declined in 1993; and the average annual landings of neritic tunas within the same period at slightly below 2000 tonnes.

11. The second paper "Country status report on The Current Study of Shared Fish Stocks in Sabah, Malaysia" is presented as **Annex 5** in this Workshop Report. In this paper, Mr. Edward Rooney Biusing stressed on the importance of pelagic species like mackerels, round scads and tunas in Sabah. He pointed out that Sabah contributed around 22% of the total mackerel production in Malaysia, 18% of the total round scad production and a notable 52% of the total tuna production. Major fishing gears employed for catching these pelagic are purse seine, gillnet and liftnet.

12. In the "Country status report: Pelagic Fishery Resources In Peninsular Malaysia", which appears as **Annex 6,** Mr. Samsudin Basir undertook a similar line of approach and noted that the tuna group on the west coast was actually dominated by the longtail tuna, *Thunnus tonggol*, with kawakawa, *Euthynnus affinis,* making up only a small percentage. Besides the major fishing gears listed out in Sabah, which can also be found operating in Peninsular Malaysia, he observed that a small proportion of tuna was also caught by trawlers.

13. The fourth paper "The Fishery and Biology of Roundscads, Mackerels and Neritic tunas in The Philippines" by Ms. Flerida M. Arce (*see* **annex 7**) provided a comprehensive description, among others, on the *Auxis* sp. and kawakawa landings in the shallow and deep-water fishing areas at various location in the Philippines. Unfortunately, she pointed out, very few studies have been conducted on the biological aspects of these fishes, as well as in the oceanography of Philippine waters.

14. From Brunei Darussalam, Mr. Idris Haji Abdul Hamid presented the fifth paper entitled "Mackerels, Round scads and Neritic tunas Fishery of Negara Brunei Darussalam" (*see* **Annex 8**). He pointed out that pelagic fishes constituted the highest percentage (23 %) in the expenditure on seafood by households in Brunei. Although a maximum harvest limit of 7,600 tonnes/year for the pelagics had been recommended, nevertheless they are still very much lightly exploited. He quoted the estimated landings from 1989 to 1993 as only around 723-840 tonnes. However, the current potential estimate is preliminary and pending the outcome of the forthcoming survey.

15. The sixth paper at this workshop was presented by Dr. Gede Sedana Merta, entitled "The Development of Marine Fishery in The South China Sea Area of Indonesia" (*see* **Annex 9**). In it he stated an Indonesian/FAO/DANIDA assessment workshop held recently had estimated the small pelagics and demersals, within the waters of the South China Sea Area of Indonesia, as being underexploited, and shrimps as fully exploited. Production from the small pelagic fisheries is on the rise due to an increase in the number of gears (mainly purse seiners) operating within this area.

16. On Thailand, Mr. Dhammasak Poreeyanond presented the seventh paper "The Occurrence of Neritic tunas and Oceanographic Parameters Observed from Purse Seine Survey" **(Annex 10).** From data collected in 1991-1993, he observed the composition of neritic tuna (such as frigate tuna and kawakawa) to be rather low among tunas caught offshore, but high in those caught from the coastal waters. Neritic tuna favours the shallow waters and can be quite abundant in the continental shelf areas of depth 50-80 metres. However, they show some interesting migration to the deeper areas due to a sharp thermal gradient occurring in 1992.

17. The eighth paper was on the "Status of Pelagic Fisheries along the Andaman Sea Coast of Thailand" (*see* **annex 11**) by Mr. Veera Boonragsa. His analyses appeared to indicate that the Indo-Pacific mackerel and sardines along the Andaman Sea coast of Thailand might perhaps be overfished, but that no sign of overfishing was observed for the round scads, small tunas and the other pelagics.

18. The ninth paper was from Vietnam, entitled "Some Biological Parameters and Fisheries Status of Shared Stock *Decapterus, Rastrelliger* and Tunas Coastal Seawaters of Vietnam" (*see* **Annex 12**), by Prof. Dr. Bui Dinh Chung. In it, he stressed on the importance of the pelagic resources to the commercial fisheries of Vietnam, and provided detailed accounts on the biology, behaviour, distribution and stock assessment of various species of round scads obtained at different times of the year from surveys. He has also outlined some of the various research activities conducted in the waters of Vietnam during the period 1959 - 1993.

III. STATUS OF THE SHARED STOCKS IN THE REGION

19. Dr. Hiroyuki Yanagawa presented the tenth paper entitled "Status of Fisheries Exploitation and Potential Yield on Round Scads and Mackerels in The Region" (*see* **Annex 13**). In it he pointed out the South China Sea Area as one of the most important areas for marine capture fisheries in the world, contributing around 10% of the world's total production. He then explained in detail the fisheries of three major species groups (round scads, Indian mackerels and Indo-Pacific mackerel) in this region.

20. The paper entitled "Status of Fisheries Exploitation and Potential Yield on Neritic Tunas in The Region of The South China Sea" (**Annex 14**) was the eleventh and presented by Mr. Raja Bidin Raja Hassan. The paper gives a general account on the status of tuna's exploitation in the region, with emphasis on the east coast of Peninsular Malaysia. Various tuna research activities, categorized as national and regional, in various stages of development, are mentioned. Potential for further expansion in tuna fishing also emphasized especially for Sarawak, Sabah and some part in Philippines waters.

21. The twelfth paper touches on the "Situation of The Stocks in The Region (Topics and Analysed Data)" and presented by both Dr. Mansor Mat Isa and Dr. Hideaki Kimoto (*see* **Annex 15**). Both workers attempted to estimate the stock status of *Decapterus* and *Rastrelliger* through length frequency analyses. Some important results obtained were the estimation of the von Bertalanffy Growth Function's parameters (K, L_∞, T_0), the spawning season, longevity, the natural mortality coefficient (M) and total mortality coefficient (Z).

IV. FORMULATION OF FRAMEWORK FOR COLLABORATIVE RESEARCH ON SHARED STOCKS

22. The last paper at this workshop was on the "Framework of The Collaborative Research Work on Environmental Study and Resources Survey" (**Annex 16**) and presented by Mr. Abdul Hamid b. Yasin. In this paper he stressed upon the importance of undertaking collaborative research among member countries of SEAFDEC, and outlined the proposed oceanographic and acoustic survey to be carried out by the research vessel, M.V. SEAFDEC in this year. The prime objectives of this study are to collect and analyse data and information for the management of fishery resources, and to train researchers form member countries on the use of modern research techniques applied within the collaborative study.

V. QUESTIONS AND DISCUSSIONS AFTER PRESENTATION OF PAPER

23. Most of the questions and remarks made at the end of the presentation are usually for the purpose of seeking clarification regarding certain ambiguity in the presentation. Nevertheless, where remarks are made in the form of suggestions or recommendations, they are listed out for consideration and adoption by the participants.

VI. RECOMMENDATIONS

24. The Workshop identified the following recommendations for the management of the shared stocks in the region:

1. In line with the Region's implementation of the provision of the UNCLOS regarding shared/straddling stocks of species between and among ASEAN and SEAFDEC member countries, it is imperative that information on these resources, as well as the environmental conditions affecting their distribution and abundance, be obtained.

2. Collaborative research efforts should focus on the assessment of the resources in the EEZ and international waters to serve as the scientific basis for recommending management option which can be agreed upon to properly utilize and share these resources. Data exchange should be further promoted.

3. To prove the possibility of interactions between the shared/straddling/transboundary stocks of some species of round scads, mackerels, neritic tunas and other pelagic groups between and among coastal countries in the Southeast Asian (SEA) region, there is a need to do collaborative works to determine similarity/dissimilarity in stocks and structure of their population through tagging, electrophoretic and mitochondrial DNA studies, morphology or any other means.

4. Very limited information on the relationship between production and environmental parameters in most SEAFDEC member countries is available. It has been observed that the environment has affected production of small pelagic fishes in the SEA region. In view thereof, collaborative oceanographic cruises and experimental fishing in contiguous areas of the Region should be conducted.

5. Statistical systems on catch and effort for all species, in general, and those regarded as shared stock, in particular, should be established and made accurate as soon as possible.

6. Collaborative research works on shared stocks of round scads, mackerels and tuna should be organised and conducted among the countries in the Southeast Asian region.

7. Some kind of management measures be instituted by member countries to arrest the continual decline in production of round scads.

8. Researchers from other countries should also be invited to participate as observers in the collaborative studies by M.V. SEAFDEC.

VII. CLOSING CEREMONY

25. In his Closing Remarks, the Chief of SEAFDEC/MFRDMD, Mr. Ismail Taufid Md. Yusoff, thanked the participants for their active participation during the Workshop. He expressed confidence that better collaborative efforts can now be forged for the management of shared stocks in this region.

ANNEXES

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OPENING ADDRESS

BY
MR. MOHD. MAZLAN BIN JUSOH
DEPUTY DIRECTOR GENERAL OF FISHERIES
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DEPARTMENT OF FISHERIES MALAYSIA

Distinguished Participants,
Ladies and Gentlemen,

A very good morning to all of you. On behalf of the Government of Malaysia and the South East Asian Fishery Development Center, I would like to extend to all of you, a warm welcome to The Second Regional Workshop On Shared Stock In The South China Sea Area, which will be held from today for three days, in this tranquil town of Kuala Terengganu in the east coast of Malaysia facing the South China Sea.

This second workshop is made possible through the approval of your recommendations made during the last workshop by the SEAFDEC Programme Committee.

I am happy that you have responded positively and again accepted the invitation to participate in this second workshop to further share your invaluable experience for the betterment of fishery resources research in this region. This gesture will further consolidate the establishment of a permanent working group on shared stock for the implementation of the programme, in order to forge continuity and commitment of national research inputs, and to sustain the enthusiasm of the scientists and researchers involved.

The South China Sea is one of the world's most productive area and harbours marine resources of great biodiversity, including fish species whose populations are migratory and henced distributed across the water boundaries of neighbouring countries of the region. Issues are bound to arise over the utilization of these resources, including overfishing, destructive fishing methods, habitat devastation, and lately the effects of marine pollution. These have implications on the viability and sustainability for the long term utilization of the fishery resources.

Article 123(c) of the United Nations Convention On The Law Of The Sea, encourages states bordering on enclosed or semi enclosed seas, such as the South China Sea, to cooperate with each other and that they shall "coordinate their scientific research policies and undertake where appropriate joint programmes of scientific research in the area".

Further Principle 7 of the Rio Declaration states that: "States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosysten".

As such coastal states are obliged to conserve the marine resources, protect and preserve the marine environment; and cooperate directly or through international organizations. With the establishment of the Marine Fishery Resources Development And Management Department (MFRDMD), SEAFDEC had already taken the necessary steps to address these obligations through the positive response and commitment in regional collaboration and cooperation among as well as non member countries.

I understand that the deliberation over the next few days will be focussed on various aspects of research related to shared stock in our region's waters. I am sure that by now we have found a common approach in the research methodology that can be formulated for the assessment and rational managemant of these stocks. I am sure that the experiences that will be shared during this workshop will provide new and interesting perspectives for further discussions among the workshop participants. I trust that this workshop will serve as an appropriate forum for sharing our experiences and for establishing lasting collaboration between professional colleagues and institutions.

I was informed that during the last workshop some ten recommendations were made for future consideration and further actions. I am glad to note that most of the recommendations have been considered and implemented, and as for the others I am sure that they will be looked into.

In another related move officers from MFRDMD have made consultative visits to member and non member countries in order to further enhance cooperation on collection and exchange of data with the various agencies and research institutions. The response was encouraging. However I am sure that further good data on marine fish biology and more reliable data on catch effort statistics will be made available once the mode of data exchange is consolidated.

MFRDMD has developed a computer programme for the processing of information related to marine fishery resources research. The system had just been tested and will be ready for implementation soon. This move will further enhanced data exchange between MFRDMD and member and non member countries. A brief explanation and demonstration of this system will also be dealt with during this workshop.

Collaborative studies between SEAFDEC member countries will take another leap foward with a collaborative acoustic and oceanographic survey to be conducted this year between the Training Department (TD) and MFRDMD using MV SEAFDEC. This survey will provide valuable data for resource managemant purposes in the South China Sea area.

In keeping with the objective of SEAFDEC to promote collaboration among the countries in the region for the proper development and management of the regional marine fishery resources, it is envisaged that substansive concrete areas of research and tangible activities will evolve from the workshop. I have every hope that this workshop will provide the impetus for what will eventually become a successful programme of collaboration, co-operation and mutual benefit between countries in the region.

Lastly, I take the opportunity to formally declare this Workshop open. I wish we will have successful deliberations and positive outcome from our discussions. I hope that you will also find time to visit some of Terengganu's tourist attractions before you leave for home.

AGENDA AND TIME TABLE

18 July 1995 (Tuesday)

0830 — Registration of participants.

0900 — Opening address of the workshop by Mr. Mohd. Mazlan bin Jusoh Deputy Director General of Fisheries, Malaysia.

0920 — Refreshments.

0940 — Election of the Chairman and Rapporteurs.

— Adoption of Agenda.

1000 — Country Status Reports: Malaysia 1 by Mr. Richard Rumpet.

1045 — Country Status Report: Malaysia 2 by Mr. Edward R. Biusing.

1130 — Country Status Report: Malaysia 3 Mr. Shamsuddin Basir.

1230 — Lunch Break.

1400 — Country Status Report: Philippines by Mr. Cirlito L. Gonzales.

1445 — Country Status Report: Brunei by Mr. Idris Haji Abdul Hamid.

1530 — Refreshments.

1545 — Country Status Report: Indonesia by Dr. I. Gede Sedana Merta.

19 July 1995 (Wednesday)

0900 — Country Status Report: Thailand 1 by Mr. Dhammasak Poreeyanond.

0945 — Country Status Report: Thailand 2 by Mr. Veera Boonragsa.

1030 — Refreshments.

1045 — Country Status Report: Vietnam by Prof. Dr. Bui Dinh Chung.

1130 — Status of Fisheries, Exploitation and Potential Yield on Round Scads and Mackerels in the Region – by Dr. Hiroyuki Yanagawa.

1230 — Lunch Break.

1400 — Status of Fisheries, Exploitation and Potential Yield on Neritic Tunas in the Region – by Mr. Raja Bidin Raja Hassan & Dr. Mohd Taupek Mohd Nasir.

1445 — Situation of the Stocks in the Region (Topics and Analyzed Data) by Dr. Mansor Mat Isa & Dr. Hideaki Kimoto.

1530 — Refreshments.

1545 — Framework of the Collaborative Research Works on Enviromental Study and Resource survey – by Mr. Abdul Hamid Yasin.

20 July 1995 (Thursday)

0900 — Any other Matters.

1030 — Refreshments.

1045 — Adoption of the Report

Closing Address.

1245 — Lunch.

1400 — Excursion.

ANNEXE 4

Annex 4

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / CR. 1

COUNTRY STATUS REPORT
MALAYSIA

(1) SARAWAK

STATUS REPORT: ROUND SCADS, MACKERELS AND NERITIC TUNAS FISHERY IN SARAWAK, MALAYSIA

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STATUS REPORT: ROUND SCADS, MACKERELS AND NERITIC TUNAS FISHERY IN SARAWAK, MALAYSIA

1. INTRODUCTION

Sarawak's 160,000 km^2 Exclusive Economic Zone (EEZ) stretches across the South China Sea and offers great opportunities for the development of both inshore and offshore fisheries.

Round scads, mackerels and neritic tunas formed part of the 29 fish species group classified as pelagic found in Sarawak waters. Two most common species of round scads found are *Decapterus russelli* and *Decapterus macrosoma.* The mackerels comprised of Barred Spanish mackerel *(Scomberomerus commersonii),* Spotted Spanish mackerel *(Scomberomerus guttatus),* Short-bodied mackerel *(Rastrelliger brachysoma)* and Indian mackerel *(Rastrelliger kanagurta).* Three species of neritic tunas have been found in Sarawak waters namely, kawakawa *(Euthynnus affinis),* long tail *(Thunnus tonggol)* and frigate *(Auxis thazard).*

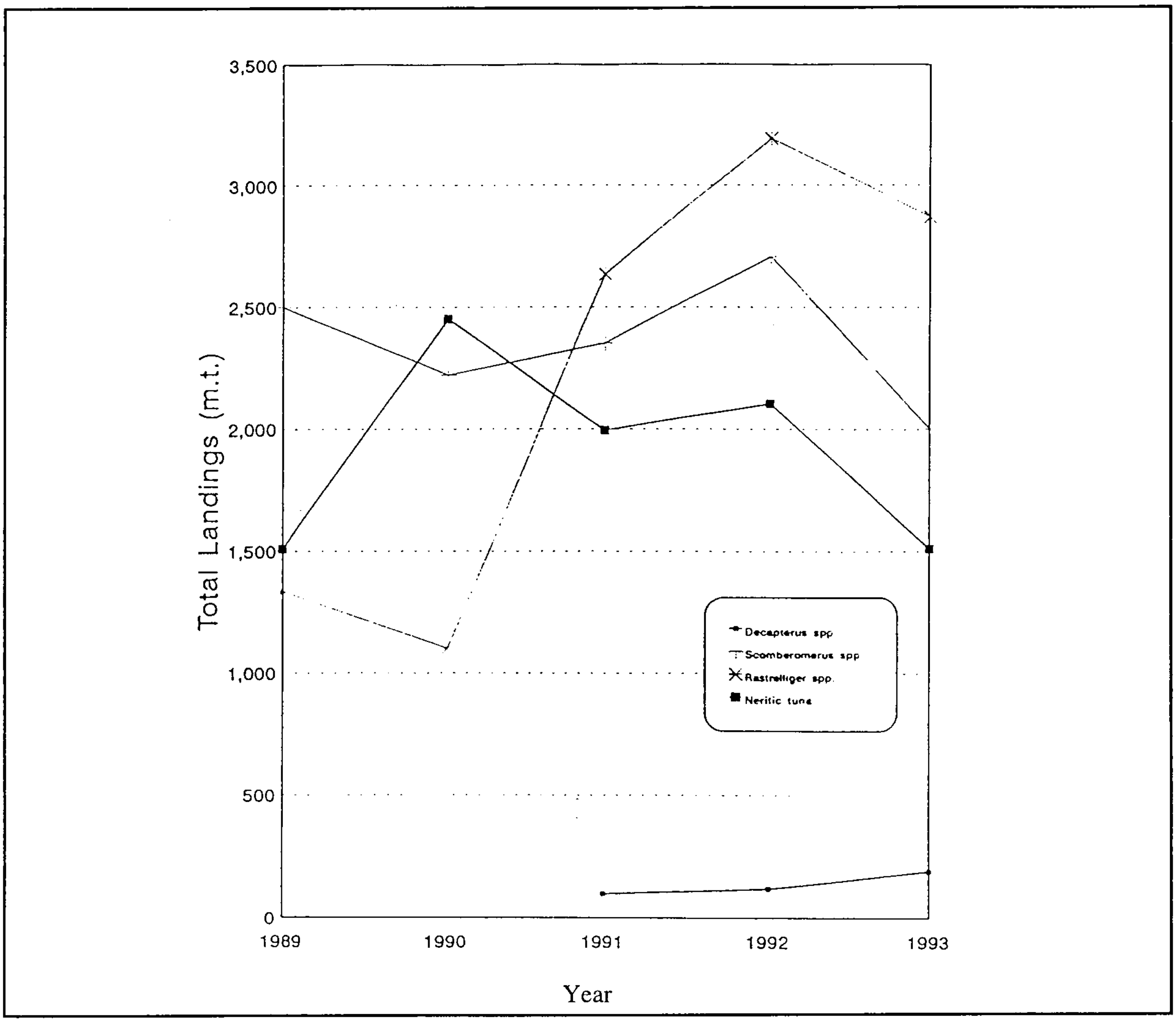
2. FISHERY STATUS

2.1. Landings trend

The total landings from marine fisheries in Sarawak decreased by 7.16% from 88,247 m.t. in 1992 to 81,924 m.t. in 1993. However, in terms of value, there was an increased of 4.36% from RM0.22 billion in 1992 to RM0.23 billion in 1993.

In 1993, the landings of round scads was 189.6 m.t. and this is very low compared to landings by other pelagics **(Table 1).** The average annual landing since 1991 is 134.9 m.t..

Fig. 1: Landings Trend of Round Scads, Mackerels and Neritic Tunas (1989 - 1993)



The mackerels have an increasing landings trend from 1990 to 1992 but decline in 1993 as shown in **Figure 1**. The landings of *Scomberomerus* spp. decreased by 25.98% from 2,706.5 m.t. in 1992 to 2,003.2 m.t. in 1993. *Rastrelliger* spp. also shows a decreased in landings by 10.09% from 3,192.6 m.t. in 1992 to 2,870.5 m.t. in 1993. Both mackerels have high average annual landings (1989-1993) of 2,356.8 m.t. and 2,226.5 m.t. respectively compared to round scads and neritic tunas.

The landings of neritic tunas decreased by 28.15% from 2,103.1 m.t. in 1992 to 1,511.3 m.t. in 1993. The average annual landings since 1989 to 1993 is 1,914.9 m.t..

Table 1 : Total Landings (m.t.) of Round Scads, Mackerels and Neritic Tunas in Sarawak by year (1989-1993)

Fish group/Year	1989	1990	1991	1992	1993	Average
Decapterus spp.	—	—	96.93	118.09	189.6	134.9
Scomberomerus spp.	2,500.11	2,221.85	2,352.36	2,706.50	2,003.18	2,356.8
Rastrelliger spp.	1,335.43	1,099.87	2,633.96	3,192.60	2,870.47	2,226.5
Neritic tunas	1,509.30	2,451.69	1,994.24	2,103.11	1,511.29	1,913.9

Source: Sarawak Annual Fisheries Statistics

2.2. Fishing gear

In 1993, a total of 587 units of trawl nets, 26 units of purse seine, 1797 units of gill/drift nets, 68 units of hooks and lines and 26 units of push/scoop nets were in operation in Sarawak.

The main gear use for catching pelagics are trawl nets, drift nets, purse seine and hook and lines as shown in **Table 2.** In 1993, 48.17% (965 m.t.) of *Scomberomerus* spp. were caught using drift nets compared to 44.33% (888 m.t.) by trawl net. The landings of *Rastrelliger* spp. is mostly by drift netters (56.18%) and 34.91% by trawlers. This shows that drift nets and trawl nets are the major fishing gears used for catching mackerels. Neritic tunas are mostly caught using gill nets and hook and lines (47.05% and 23.69% respectively).

Table 2: Total Landings (m.t.) of Round Scads, Mackerels and Neritic Tunas in Sarawak by gear (1993)

Fish group/Gear	Trawl net	Purse seine	Drift/Gill net	Hook and lines	Push/Scoop net
Decapterus spp.	22	68	92	—	8
Scomberomerus spp.	888	2	965	148	—
Rastrelliger spp.	1,079	255	1,736	—	20
Neritic tunas	18	424	711	358	—

Source: Sarawak Annual Fisheries Statistics

2.3. Catch-effort information

Neritic tunas samplings program in Sarawak waters was carried out in 1991. Information on length frequencies and catch-effort data were collected. Catch-effort data of drift nets catching tuna were collected monthly. It was found that most of the drift nets were between 5.00 g.r.t. and 40.00 g.r.t. and average fishing duration per trip was only one day. The average catch rate of drift nets was found to be 106.45kg/boat/trip. Using this information and the number of gears in operation, the total exploited biomass of neritics tuna in Sarawak waters in 1992 for all gears was estimated to be 2,147 m.t. and are comparable to the total landings i.e. 2,103 m.t. for the same year.

In the case of round scads and mackerels there was no catch-effort data collection for Sarawak waters. From 1994 and until now, data on length frequencies of Spanish mackerel and neritic tunas are being collected from three landings sites i.e. Mukah, Sibu and Miri.

3. STATUS OF EXPLOITATION AND POTENTIAL YIELD OF THE STOCKS

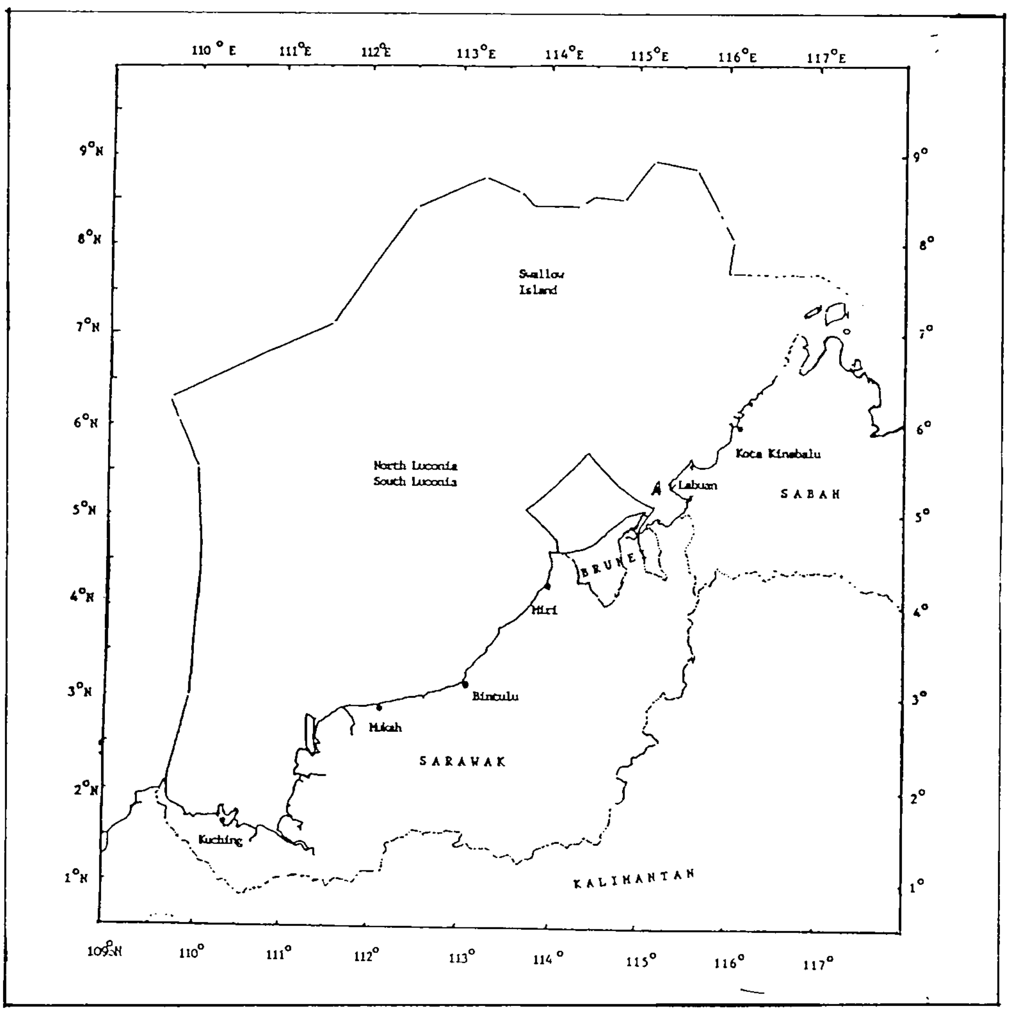
At present there is no estimates of total biomass of round scads, mackerels and neritic tunas for Sarawak waters. However, efforts are being made to estimate the biomass using the surplus production model with data obtained from Sarawak Annual Fisheries Statistics.

4. BIOLOGICAL INFORMATION

Results of an experimental surveys in the offshore (>60 n.m. from the coastline) waters of Sarawak showed that *Decapterus russelli* have a length range of 15.1 - 19.1 cm and a mean size of 16.9 cm (Hadil and Richard, 1991). The mean size is similar to the length at first maturity of scads found in Pahlawan waters i.e. 16.6 cm (Magnusson, 1970, Tiew *et. al.,* 1970 and Ronquillo, 1974). This indicates that *Decapterus russelli* could also have attained its length at first maturity. *Decapterus macrosoma* caught offshore in areas around Swallow reef are of bigger size (31.7 cm) compared to those (17.1 cm) found in inshore waters off Kuching (**Fig. 2**). The length-weight relationship for *Decapterus macrosoma* were found to be $W=0.01118L^{2.9532}$ ($n=186$, $r^2=0.9684$).

Preliminary result of the 1994 samplings of Spanish mackerel showed that *Scomberomerus commersonii* have a size range of 19 cm to 103 cm and there were found inshore. In the case of *Scomberomerus guttatus,* the size ranged from 12 cm to 75 cm. In offshore areas around Swallow reef the size of *Scomberomerus commersonii* ranging from 58.5 cm to 86.0 cm were comparatively bigger than those found inshore. The fish might be already matured compared to *Scomberomerus commersonii* caught in the Gulf of Thailand having size at first maturity of 58.6 cm (Chullason *et. al.,* 1973 and Supongpan and Chaayakul, 1979).

Fig. 2: Major Fishing Towns and Areas of Sarawak



In 1992, a study on the reproductive biology of kawakawa off the coast of Sarawak was conducted. The length at first maturity was estimated at 39.0 cm (Richard, 1993). This was comparable to the size of kawakawa caught in the Philippines waters which attained the first maturity stage at 38.5 cm (Ronquillo, 1963). In the Gulf of Thailand the size at maturity for kawakawa was found to be 37.5 cm (Klinmuang, 1978 and 1981; Cheunpan, 1984) which was a bit smaller compared to those found in Sarawak waters.

Tuna tagging project was carried out off Sarawak in July 1992. As of October 1993, a total of 3, 985 fishes were tagged and released. The breakdown of species and figures are as follows:

Species	No. of fish tagged
Euthynnus affinis	1,139
Thunnus tonggol	2,731
Auxis thazard	114
Katsuwonus pelamis	1

The tagging returns are very poor because until now only seven tagged fishes were recaptured and returned to Fisheries Research Institute, Sarawak. Preliminary results showed that the average growth rate was 0.13 cm/day for kawakawa and 0.16 cm/day for long tail tuna.

5. ACKNOWLEDGEMENT

The author wish to thank Y. Bhg. Dato' Haji Shahrom bin Haji Abdul Majid, the Director General of Fisheries Department of Malaysia, for his permission to present this paper. Thanks are also due to Mr. Henry Opang Luhat, the Chief of Fisheries Research Institute of Malaysia, Sarawak Branch, Kuching for his supports and comments in preparing the paper. Appreciation also goes to Mr. Albert Chuan Gambang and Mr. Hadil Rajali for their critical comments on the paper.

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ANNEXE 5

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / CR. 2

COUNTRY STATUS REPORT
MALAYSIA

(2) SABAH

STATUS REPORT: ON THE CURRENT STUDY OF SHARED FISH STOCKS IN SABAH, MALAYSIA[1]

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STATUS REPORT ON THE CURRENT STUDY OF SHARED FISH STOCKS IN SABAH, MALAYSIA[1]

EXECUTIVE SUMMARY

The marine fish landings in Malaysia had increased from 951,000 mt to 1,047,350 mt over the 1989-1993 period. In 1993, pelagic fishes contributed at least 34% of the estimated total marine landings. Carangids and scombrids formed the backbone of the marine capture fishery sector, where the important components were mackerels, round scads and tunas, whose combined landings were estimated to contribute at least 46% of the total pelagic landings. Purse seines contributed 48% of the pelagic landings followed by gillnets (19%) trawlnets (19%), liftnets (8%) and other type of gears (1-6%). During the same period, the pelagic landings in Sabah estimated about 89,130 mt (51% of the state's total marine landings) contributed about 24% of the country's pelagic fish production.

Mackerels (*Rastrelliger* spp.) which contributed about 19% (67,975 mt) of the total pelagic production were mainly landed by purse seiners (43% landings) and gillnets (24%). Sabah contributed about 22% (15,160 mt) of the total mackerel production, which were landed by purse seines (56%), liftnets (16%) and gillnets (12%).

Round scads (*Decapterus* spp.) which contributed about 18% (64,722 mt) of the total pelagic production were mainly landed by purse seiners (81%) and lifnets (12%). Sabah contributed about 18% (11,420 mt) of the total round scad production, which were landed by liftnets (58%) and purse seines (32%).

Tunas (mainly *Thunnus tonggol, T. allalunga, Euthynnus affinis, Auxis thazard*) which contributed about 10% (35,980 mt) of the total pelagic production in Malaysia were mainly landed by purse seiners (50%) and hook & line (18%). Sabah contributed about 52% (18,520 mt) of the total tuna production, which were landed by purse seines (40%), gillnet (33%) and hook & line (12%).

The studies on the biology and stock assessment of marine fishes are concentrated on west coast stocks, where 39 species (11 families) of commercial importance were covered including mackerels (3 species), round scads (3 species), tunas (4 species), selar scads (3 species) and hardtail scad *(Megalaspis cordyla)*. The present database available on these species consist of length frequency and biological data (2-6 years duration). These studies are currently funded under the national IRPA Program *(Intensification of Research in Priority Areas)*. This paper describes the status of some of the current studies on shared fish stocks in Sabah.

1. INTRODUCTION

The pelagic fisheries play an important role in the development of the marine capture fisheries sector in Malaysia. The marine fish landings in Malaysia in 1993 was estimated around 1,047,350 mt **(appendix 1)**, with pelagic fishes contributing about 34% of the landings **(appendix 2)**. Carangids and scombrids formed the backbone of the pelagic sector, with mackerels (*Rastrelliger* spp.), round scads (*Decapterus* spp.) and tunas as the principal species. During the 1993 period, the combined landings of these species in Sabah was estimated about 45,000 mt (27% of the national landings).

These species are presently also being exploited by other countries in the South East Asian region, forming the backbone of their respective coastal capture fishery sectors. Considering the importance of these species in the development of the pelagic fishery sector within the SEA region, various management measures are urgently needed. To ensure the sustainable exploitation of these resources, joint collaborative studies on the biology and capture fishery aspects of these stocks need to be carried out. The information obtained can be used as the basis for the improvement of existing management measures and policies pertaining to the sustainable exploitation and management of these resources within the region.

During the 1st SEAFDEC *workshop on shared stocks* held in 1994, among the common fish stocks which were identified as priority species for the proposed joint collaborative studies are mackerels, round scads and neritic tunas. This report deals with the fishery status and current studies carried out on these species in Sabah waters.

2. STATUS OF FISHERIES

2.1. Fishing Fleet

The pelagic sector in Malaysia involves both traditional and commercial gears, where among the important ones are: longline, purse seines, gillnets, bagnets and liftnets (including the traditional *selambau* and *bagang* gears in Sabah). In some areas, a significant volume of pelagic fishes were also landed by trawlers. Traditional gears are operated in the inshore coastal waters using non-powered or outboard engined boats, while commercial gears are operated using bigger boats (inboard and outboard engines) much further from the coastline. The gear breakdown of the 31,575 licensed fishing boats in Malaysia (1993 period) by GRT and HP (Horse power) categories are given in **appendices 4-5.**

Compared to 1992, the overall fishing fleet had decreased by 3%, caused by a marked reduction in the number of fishing boats in most categories in Peninsular Malaysia, mainly for non powered and outboard powered boats except for some increase in the number of inboard engined boats (>40 GRT class category). For Sabah, the fishing fleet size had increased by 8%, although there was some decrease in the trawler fleet (-1%) and other misc. gears (-10%).

The estimated breakdown of fishermen involved in the marine capture fisheries sector by fishing region, gear type and race (*bumiputeras* — indigenous locals, others— including legal/illegal foreign fishermen) for the 1992—1993 period are given in **appendix 6.**

Overall, the decrease in the fishermen population (80,278 fishermen) in 1993 by 5.6% over the 1992 period was caused by the marked reduction of fishermen in Peninsula Malaysia. The reduction of the fisherman population is in line with the government present fisheries management policy to reduce the number of fishermen so that each one will have a bigger share of the resources and only fishermen who are genuinely interested in fishing will stay in the industry. However, the fishermen population in East Malaysia (Sabah and Sarawak) in 1993 had increased respectively by 7% and 8% over the 1992 period, mainly due to the marked increase in the number of licensed fishing vessels. For Sabah, besides due to the expansion of the fishing fleet (mainly purse seiners and gillnets), it was also caused by the influx of illegal transient fishermen from neighboring countries, which was estimated to make up at least 20% of the present fishermen population in the state.

2.2. Overview of the present marine Landings

The marine fish landing in 1993 was estimated about 1,047,350 mt (retail value of RM3,269 million), which shows an increase of 2.33% over the 1992 period **(appendix 3).** Sabah contributed about 173,800 mt or about 17% of the marine landings. Pelagic landing was estimated around 366,000 mt or about 35% of the marine landings **(appendix 7).** During the same period, the pelagic landings in Sabah estimated around 89,130 mt or about 51% of the total marine landings in the state, contributed around 24% of the country's total pelagic landings.

The summaries of the pelagic landing breakdown in Malaysia by fishing region and gear group type are given in **appendix 8-9.** The breakdown figures given are only for dominant pelagic species.

In 1993, mackerels (*Rastrelliger* spp.), round scads (*Decapterus* spp.) and tunas were the dominant pelagic species landed (combined landings about 168,700 mt), contributing about 16% to the total fish landings. Mackerels were the most dominant species (67,975 mt), followed by round scads (64,722%) and tunas (35,980 mt). The combined total landings of these species had increased by almost 8% over the 1992 period, attributed by the increase in both round scad and tuna landings. However, the landings of mackerels had decreased by 12% over the 1992 period.

Most of the mackerel landings come from the west coast of Peninsular Malaysia (Straits of Malacca: 53%), followed by Sabah (22%) and east coast of Peninsular Malaysia (20%). The east coast of Peninsular Malaysia contributed about 66% of the round scad landings, followed by Sabah (18%) and Straits of Malacca (16%). For tunas, about 51.5% were landed in Sabah, followed by the east coast of Peninsular Malaysia (29%, mainly in Terengganu). The significant increase in the tuna landings from Sabah during the last 2-3 years was mainly due to the increase in the fishing fleet (purse seine and longline). The improvement of the present catch statistics sampling program in Sabah under the national *Fisheries Management Information System* (FMIS) might be another factor.

During the 1993 period (**appendix 8**), about 87% of the pelagic fishes were landed by purse seiners (41%), followed by gillnets (19%), trawlers (19%) and liftnets (8%). The combined landings of these gears had contributed about 83% of the total marine landings. Trawlers contributed about 54% of the total marine landings, followed by fish purse seiners (15%), gillnets (11%) and misc. traditional gears (8.4%). Other gears (hook and line, liftnet, other seine nets, anchovy purse seine: in order of importance) each contributed only between 2-4% of the total marine landings.

For purse seiners, the dominant pelagic species landed (in order of landing importance) were round scads, mackerels, tunas, sardines (mixed species), yellow trevally *(Selaroides leptolepis)* and selar scads (*Selar* spp.), which make up about a total of 87% of the present fish purse seine landings, which is about 13% of the total marine fish landings.

About 93% (63,355 mt) of the mackerel landings were contributed by fish purse seiners (42%), gillnets (29%) and trawlers (22%). For round scads, about 91% (59,032 mt) were landed by fish purse seiners (79%) and liftnets (12%). On the other hand, about 91% (32,700 mt) of the present tuna landings were landed by fish purse seiners (50%), gillnets (24%) and longline (17.5%).

2.3. Pelagic landings in Sabah

In Sabah, the seven important pelagic species in 1993 by order of landing volume were tuna (18,517 mt), mackerel (15,159 mt), round scad (11,415 mt), spanish mackerel (*Scomberomorus* spp.) (10,074 mt), sardines (6,235 mt), selar scad (*Selar* spp.) (4,277 mt) and hardtail scad *(Megalaspis cordyla)* (4,242 mt), which contributed about 78% of the estimated total pelagic landings (89,130 mt). Anchovies *(Engraulis, Stolephorus)* are important components of the *bagang* fishery. The present annual anchovy landings (500-2,000 mt) was believed to be grossly underestimated considering that more than 1,000 bagang units in active operation each year along the east coast (mainly unlicensed). The volume of dried anchovies from the east coast was believed to be substantial, estimated at least 2,000-4,000 mt/year.

2.3.1. *Tuna fisheries*

The annual tuna landings were estimated around 11,000-18,500 mt during the 1991-1993 period, with neritic species making up the backbone of the fishery. The main gears used in the fishery are purse seine, hook & line and drift gillnet, which contributed about 84% of the present tuna landings, with fish purse seine as the most dominant gear (39% tuna landings).

Neritic tuna landings were mainly represented by at least five species: *Euthynnus affinis, Sarda orientalis, Thunnus tonggol, Thunnus allalunga* and *Katsuwonus pelamis.* These species were mainly caught by purse seine, gillnet, liftnet and trawlnet. Oceanic species were caught mainly by gillnet and longline; where the important fishing grounds are in the Sulu Sea and Celebes Sea (between Lahad Datu and Semporna waters) and off the west coast (Palawan Trench). Data from past commercial longline operations and DOF Malaysia surveys had shown the presence of abundant oceanic tuna resources along the Palawan Trench (including the Spratly Islands), where the dominant species were bigeye *(Thunnus obesus)* and yellowfin *(Thunnus albacares).* The biological aspects of two neritic tuna stocks *(Euthynnus affinis, Thunnus allalunga)* on the west coast of Sabah sampled during the 1992-1994 period are given in **appendix 11.**

2.3.2. *Mackerel fisheries*

The annual mackerel (*Rastrelliger* spp.) landings were estimated in the region of 10,000-15,000 mt during the 1991-1993 period, with two species *(R. kanagurta, R. brachysoma)* making up the bulk of the landings. *R. faughni* is also landed but in much smaller quantities (landings very seasonal with significant annual variations).

Mackerels are mainly caught by purse seines besides other type of gears e.g. liftnet *(selambau* and *bagang),* drift gillnet and trawlnet. The important fishing ground are along the west coast and southern portion of the east coast (between Lahad Datu and Semporna). The Japanese mackerel *(Scomber australasicus)* is also a component of the mackerel fishery (annual landings : < 2,000 mt), where the main gears used are purse seine and liftnet.

R. kanagurta is more widely distributed and caught throughout the year compared to other species. *R. brachysoma* is also caught throughout the year but mainly in the inshore waters, while *R. faughni* which is very seasonal is mainly caught in deeper waters. Both *R. brachysoma* and *R. faughni* caught in Sabah waters consisted mainly of juveniles and immature sub adults (maximum size caught: 22-24 cm TL). For *R. brachysoma,* available data had shown that most of the landings were represented by 1—2 year classes. On the other hand, *R. kanagurta* is caught from young juveniles to mature adults (size range: 10-31 cm TL). Two specimens *R. kanagurta:* 36 cm TL, 650-750 gram & *R. brachysoma:* 37-38 cm TL, 750-850 gram) observed in Semporna (1984) indicated that both species can grow to large sizes. The biological aspects of three mackerel stocks *(Rastrelliger kanagurta, R. brachysoma, R. faughni)* on the west coast of Sabah sampled during the 1992-1994 period are given in **appendix 12.**

2.3.3. *Round scad fisheries*

The annual round scad *(Decapterus* spp.) landings were estimated around 7,000-12,000 mt during the 1991-1993 period, with three species *(D. macrosoma, D. maruadsi, D. russelli)* making up the bulk of the landings. *D. tabl* (identification still unconfirmed, mainly caught on the east coast) is also landed but in much smaller quantities. All four species were caught throughout the year but has different peak seasons with significant annual variations. The main gears used in the fishery are liftnet *(selambau)* and purse seine. About 50-70% of the present annual round scads landings comes from the west coast (4,000-6,000 mt), where more than 60% are landed by lifthets. The biological aspects of three round scad stock *(Decapterus macrosoma, D. russelli, D. russelli, D. maruadsi)* on the west coast of Sabah sampled during the 1992-1994 period are given in **appendix 13.**

2.3.4. *Spanish mackerel fisheries*

The annual spanish mackerel (*Scomberomorus* spp.) landings were estimated around 8,000-10,000 mt during the 1991-1993 period. The main gears used in the fishery are drift gillnet and hook & line. There are four species presently exploited by the fishery: i.e. *S. commerson, S. guttatus, S. lineolatus* and *S. queenlandicus* (identification still unconfirmed, characteristics similar to *S. sexfasciatus?).* The former three species formed the bulk of the fishery, while landings of the later were rather low in volume and very seasonal in nature. Not much information is available on the biology of these species except for some length-frequency data of west coast stocks sampled during the 1994 period.

2.3.5. *Sardine fisheries*

The annual sardine landings for the 1991-1993 period were estimated in the region of 4,000-6,500 mt. The main gears used in the fishery are liftnet and purse seine. The bulk of the sardine landings are mainly represented by *Dussumieria (D. sirm, D. hasseltii, D. fimbriata, D. acuta)* and *Herklosichthys quadrimaculatus* (species identification yet to be verified).

During peak seasons, the bulk of sardines caught by purse seiners along the west coast are sent direct to nearby fish meal plants because of marketing problems. It is generally believed that the present landings from purse seiners might have been underestimated. The volume of sardines landed by purse seiners to fish meal plants is not known and at present not monitored closely by the FMIS program. Not much information is available on the biology of sardines in Sabah waters except for legth-frequency and biological data of *Herklosichthys quadrimaculatus* and *Dussumieria acuta* (west coast stocks) sampled during the 1994 period.

2.3.6. *Selar scad fisheries*

The annual selar scad (*Selar* spp.) landings were estimated in the region of 1,500-4,500 mt during the 1991-1993 period. The main gears used in the fishery are liftnet, drift gillnet, purse seine, hook & line and trawlnet. Three species are exploited: *S. crumenopthalmus, S. boops* and *S. mate.* Among these, *S. crumenopthalmus* is the most important component in terms of landing contribution and market price, followed by *S. boops* and *S. mate.* It is believed that the present landings might have been underestimated. The biological aspects of two selar scad stocks *(S. crumenopthalmus, S. boops)* on the west coast of Sabah sampled during the 1992-1994 period are given in **appendix 14.**

2.3.7. *Hardtail scad fisheries*

The annual hardtail scad *(Megalaspis cordyla)* landing was estimated around 3,500-4,500 mt during the 1991-1993 period. This species is caught mainly by purse seine, drift gillnet and liftnet. The biological aspects of the hardtail scads stock on the west coast of Sabah sampled during the 1992-1994 period are given in **appendix 15.**

3. RESEARCH STATUS

Present studies on the marine fishes in Sabah (title: *Population dynamics, biological-reproduction and morphometrics of commercially important marine fish stocks along the west coast of Sabah, Malaysia)* are concentrated on west coast stocks using funds from the national IRPA *(Intensification of Research in Priority Areas)* program of the Ministry of Science, Technology and Environment.

The information from this study consisted of length frequency and biological data of about 39 species (11 families). The species covered in the present study are given in **appendix 10**. Due to lack of experienced manpower, most of the data are still unprocessed or semi-processed.

At present, due to manpower constraints, the data collection is concentrated on only one sampling site based in Kota Kinabalu. Previous field studies had indicated that a significant volume of these species that were landed at the various landing sites along the west coast were brought over to Kota Kinabalu for market disposal. In the incoming 7th Malaysian Plan (1996-2000), the present study will be more extensive covering more sampling sites throughout the coastline of Sabah.

Sample treatment:

a. **biological data:** Besides biological data (length, weight, gonad maturity stage), morphometric characters were also measured (note: from September 1994 onwards, the morphometric characters recommended during the 1st workshop on shared stocks in the SEA region were used in the study);

b. **determination of the maturity stages:** visual observation using the following maturity keys: stage I (immature), stage II (maturing), stage III (mature/ripe), stage IV (spent);

c. **otoliths samples:** samples representing each length class were taken for "ageing study" purposes in the near future.

Data treatment:

a. analysia of length frequency data: FISAT, Compleat ELEFAN, LFSA;

b. analysis of biological data: data input using MICROSTAT. Subsequent data analysis and presention of results were made using electronic spreadsheets (e.g. Lotus 123) and other relevant statistical analysis software (MICROSTAT, STATGRAPHICS, SYSTAT).

4. RECOMMENDATIONS

a. the use of standard statistical procedures (including software applications) pertaining to the preliminary treatment and subsequent analysis of biological and morphometric data among participating scientists;

b. future workshops should also emphasize on joint in-situ data analysis cum training as part of the human resources development of fisheries scientists in the region;

c. creation of fish Technical Working Groups (TWG) among participating fisheries scientists (e.g. round scad TWG, tuna TWG, mackerel TWG);

d. the usage of other methods (e.g. parasites, electrophoresis, DNA mitochondria) for fish stock differentiation purposes besides morphometric data;

e. a MFRDMD-SEAFDEC fishery biology database on shared stocks within the SEA region to be incorporated in a GIS (Geographical Information System) setup is proposed.

5. ACKNOWLEDGEMENTS

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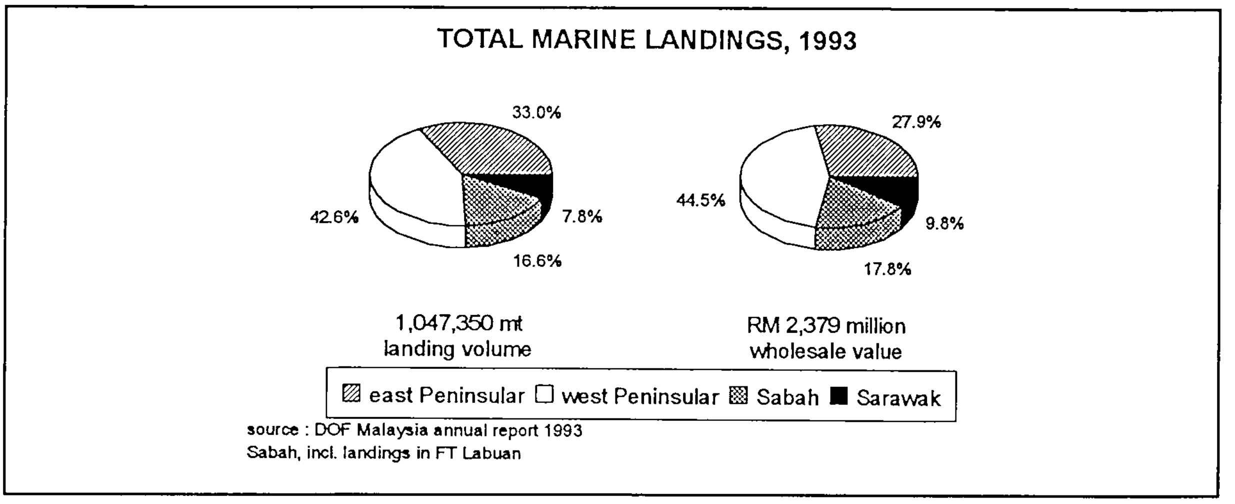
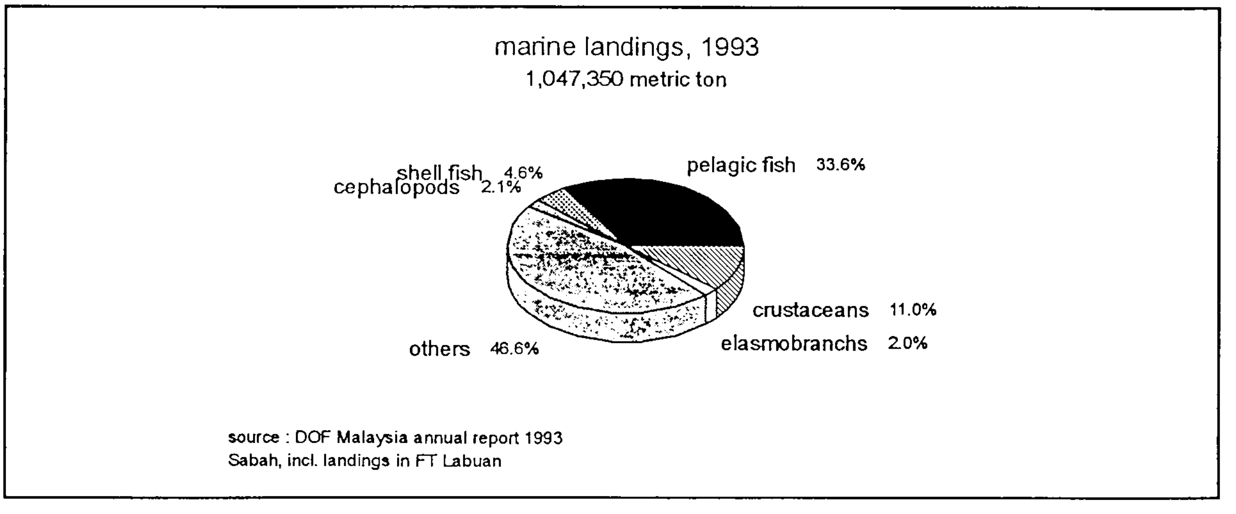
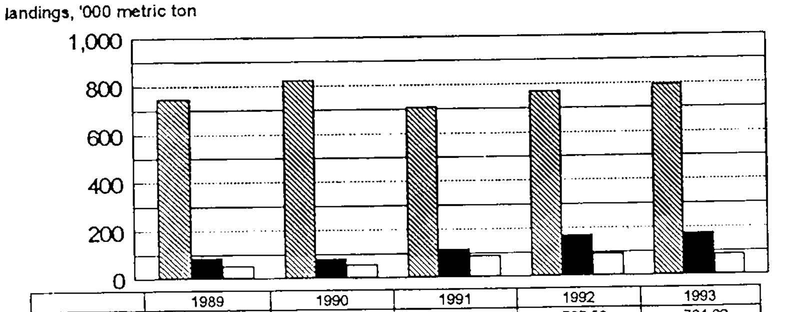
Appendix 1: Regional breakdown of marine landings in Malaysia



Appendix 2: Species breakdown of marine landings in Malaysia



Appendix 3: Annual marine fish landings, Malaysia 1989-1993



	1989	1990	1991	1992	1993
Pen. Malaysia	746.89	819.90	705.59	767.53	791.62
Sabah	84.35	78.88	115.74	167.74	173.81
Sarawak	51.25	52.52	86.61	88.24	81.92
TOTAL	882.49	951.30	907.94	1,023.51	1,047.35

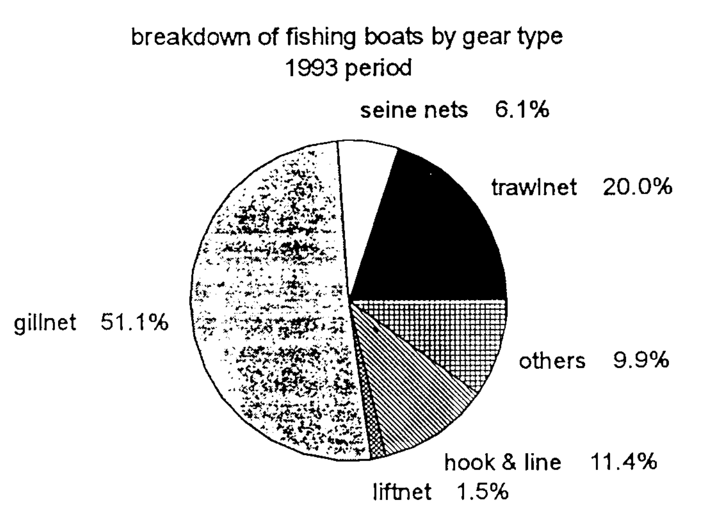
source : DOF Malaysia annual report 1993
Sabah, incl. landings in FT Labuan

Appendix 4: Fishing fleet breakdown by GRT (gross tonnage) and gear type, Malaysia 1993

				inboard engine powered/GRT category								
MALAYSIA, 1993 period	*grand total*	*non power*	*outboard powered*	*sub total*	*< 5*	*5-10*	*10-15*	*15-20*	*20-25*	*25-40*	*40-70*	*> 70*
Pen. Malaysia	20,020	463	5,206	14,351	2,496	5,539	1,761	1,514	503	1,064	1,018	456
Sarawak	2,941	9	748	2,184	473	660	417	128	126	112	132	136
Sabah	8,485	1,756	4,336	2,393	443	767	470	250	193	213	47	10
FT Labuan	129	1	111	17	0	1	0	0	0	1	5	10
TOTAL 1993 period	31,575	2,229	10,401	18,945	3,412	6,967	2,648	1,892	822	1,390	1,202	612
TOTAL 1992 period	32,550	2,267	10,879	19,404	3,627	7,009	2,787	1,968	815	1,439	1,156	603
% change	-3.0	-1.7	-4.4	-2.4	-5.9	-0.6	-5.0	-3.9	+0.9	-3.4	+4.0	+1.5

	Malaysia	*Peninsular Malaysia*		*inboard engine/GRT category (Pen. Malaysia)*						*Sabah/1*	*Sarawak*
Gear group	*grand total*	*non power*	*outboard powered*	*sub total*	*< 10*	*10-20*	*20-40*	*40-70*	*> 70*	*sub total*	*sub total*
Trawlnet	6,304	0	1	4,151	190	1,715	1,273	726	247	1,565	587
Purse seine	844	0	0	625	6	63	145	269	142	193	56
Anchovy purse seine	146	0	0	141	9	53	8	16	55	5	0
Other seine net	940	22	154	698	684	11	3	0	0	66	0
Gillnet	16,132	251	4,375	6,075	5,354	667	51	1	2	3,634	1,797
Liftnet	481	0	26	98	57	40	1	0	0	357	0
Hook and line	3,588	29	286	1,618	0	541	40	1	1	1,587	68
Bagnet	758	13	72	335	0	1	0	0	1	0	388
Others	2,382	148	292	610	0	184	46	5	8	1,207	45
TOTAL 1993 period	31,575	463	5,206	14,351	8,035	3,275	1,567	1,018	456	8,614	2,941
TOTAL 1992 period	32,550	632	6,223	14,999	8,505	3,476	1,590	973	455	7,959	2,737
% change	-3.0	-26.7	-16.3	-4.3	-5.5	-5.8	-1.4	+4.6	+0.2	+8.2	+7.5

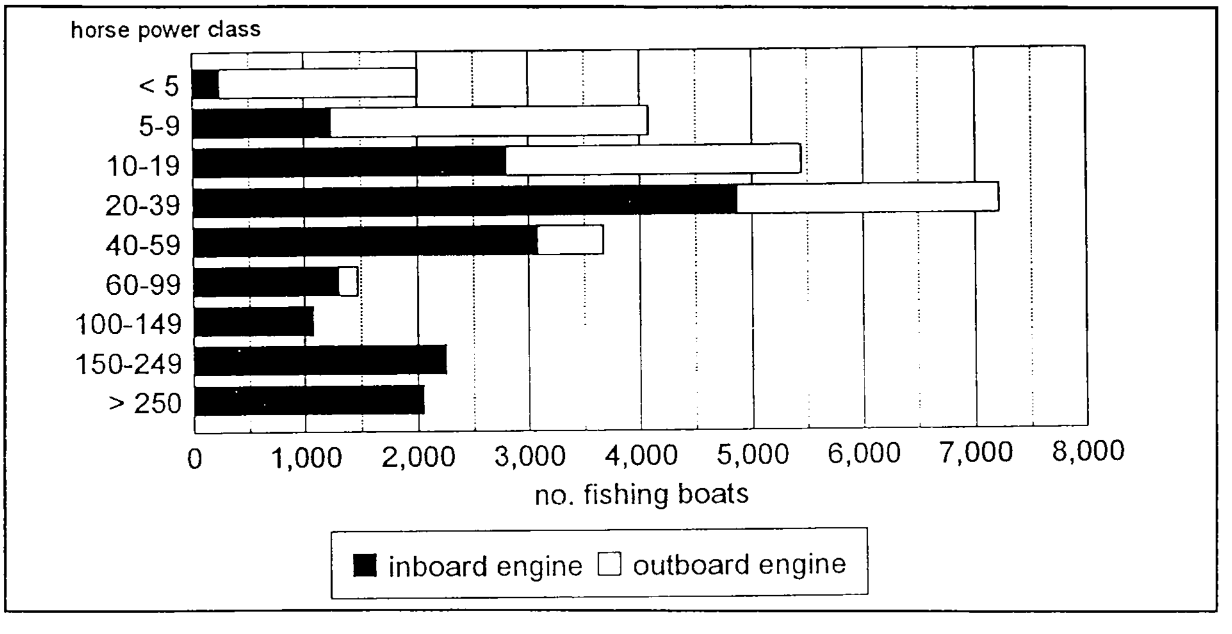
Source: DOF Malaysia annual report 1993,
1/including FT Labuan



Appendix 5: Fishing fleet breakdown by HP (horse power category)

a. **Inboard engined fishing vessels**				
HP horse power	*Peninsular Malaysia*	*Sabah 1/*	*Sarawak*	*Sub Total*
< 5	154	53	33	240
5-9	705	150	389	1,244
10-19	2,011	167	620	2,798
20-39	4,097	164	610	4,871
40-59	2,360	606	118	3,084
60-99	903	260	147	1,310
100-149	735	294	54	1,083
150-249	1,583	556	118	2,257
> 250	1,803	160	95	2,058
sub total	14,351	2,410	2,184	18,945
b. **Outboard engined fishing vessels**				
HP horse power	*Peninsular Malaysia*	*Sabah 1/*	*Sarawak*	*Sub Total*
< 5	1,485	235	52	1,772
5-9	2,178	465	201	2,844
10-19	927	1,675	57	2,659
20-39	555	1,629	168	2,352
40-59	61	327	209	597
60-99	0	114	61	172
100-149	0	2	0	2
150-249	0	0	0	0
> 250	0	0	0	0
Sub total	5,206	4,447	748	10,401
GRAND TOTAL	18,557	6,857	2,932	29,346

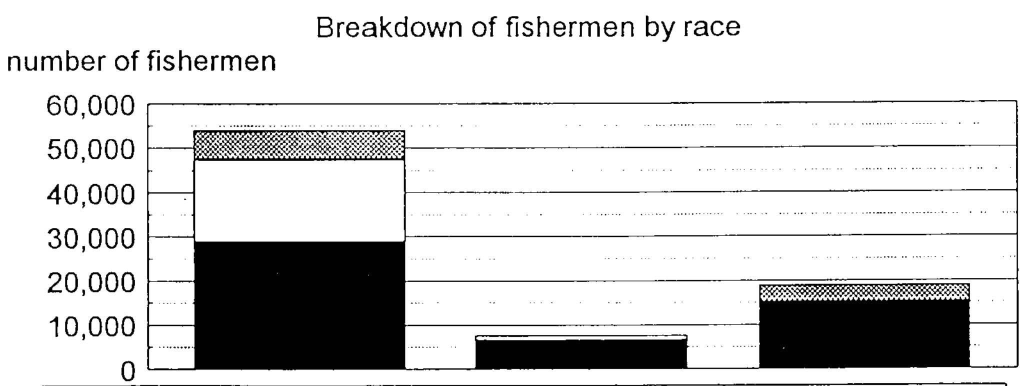
Source: DOF Malaysia annual report 1993,
1/including FT Labuan



Appendix 6: Fishermen population breakdown by gear group, Malaysia

Fishing region/ fishing gear	*Period*	*Peninsular Malaysia*	*Sabah 1/*	*Sarawak*	*Sub Total*	*% change*
Trawlnet	1992	14,061	4,625	2,560	21,246	-3.4
	1993	13,346	4,573	2,595	20,514	
Fish purse seine	1992	11,779	1,453	298	13,530	+2.1
	1993	11,781	1,717	318	13,816	
Anchovy purse seine	1992	2,591	88	0	2,679	-10.7
	1993	2,304	88	0	2,392	
Other seine nets	1992	2,124	201	0	2,325	-11.9
	1993	1,850	199	0	2,049	
Gillnets	1992	21,425	5,408	3,070	29,903	-10.4
	1993	17,620	5,707	3,474	26,801	
Liftnets	1992	413	882	0	1,295	-6.6
	1993	332	877	0	1,209	
Hook and lines	1992	4,706	3,074	192	7,972	-5.7
	1993	3,919	3,368	231	7,518	
Other gears	1992	3,311	1,959	865	6,135	+23.0
	1993	2,058	2,317	372	7,545	
Sub total	1992	60,410	17,690	6,985	85,085	-5.6
	1993	53,887	18,846	7,545	80,278	
% Change 1992-1993		- 10.8	+6.5	+8.0	-5.6	

Source: DOF Malaysia annual report 1993,
1/including FT Labuan



	Pen. Malaysia	Sarawak	Sabah
Bumiputera ■	28,766	6,513	14,929
Chinese □	18,466	1,031	130
Indians □	245	0	0
others ▨	6,410	1	3,777
TOTAL	53,887	7,545	18,836

source : DOF Malaysia annual report 1993
Sabah, incl. landings in FT Labuan

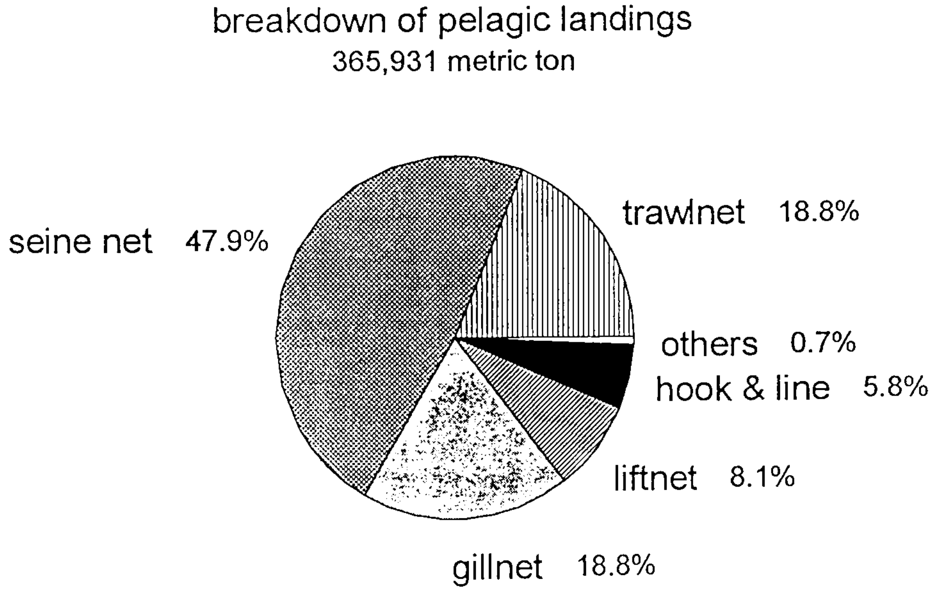
Appendix 7: Summary of regional marine landings, Malaysia 1993

			EAST MALAYSIA		WEST MALAYSIA			
Local Name	*English Name*	*Scientific Name*	*Sabah*	*Sarawak*	*East coast*	*West coast*	*sub total (metric ton)*	*% total landing*
***a.* Pelagic Landings**								
Kembong	Mackerel	*Rastrelliger* spp.	15,159	3,090	13,622	36,104	67,975	6.5
Selayang	Round Scad	*Decapterus* spp.	11,415	190	42,610	10,507	64,722	6.2
Kayu	Tuna	Mixed species	18,517	1,511	10,492	5,460	35,980	3.4
Selar Kuning	Yellow Trevally	*Selaroides leptolepis*	1,136	246	25,128	2,946	29,456	2.8
Tamban	Sardine	Mixed Species	6,235	1,567	14,111	5,023	26,936	2.6
Bilis	Anchovies	Mixed Species	1,837	1,916	8,230	12,802	24,785	2.4
Tenggiri	Spanish Mackerel	*Scomberomorus* spp.	10,074	2,003	4,347	4,411	20,835	2.0
Selar	Selar Scad	*Selar* spp.	4,277	1,595	10,807	3,844	20,523	2.0
Cincaru	Hardtail Scad	*Megalaspis Cordyla*	4,242	1,644	4,699	4,724	15,309	1.5
Bawal	Pomfrets	Mixed Species	2,432	2,195	871	4,631	10,129	1.0
Puput	Shad	*Pellona* spp.	681	1,206	300	6,225	8,412	0.8
Timah	Hairtails	*Trichiurus* spp.	767	1,079	1,467	4,123	7,436	0.7
Ikan Yu	Sharks	Mixed Species	2,436	1,679	1,485	694	6,294	0.6
Demudok	Horse Mackerel	*Caranx* spp.	3,705	137	1,009	771	5,622	0.5
Parang-2	Wolf Herring	*Chirocentrus dorab*	186	537	1,326	2,449	4,498	0.4
Alu-2	Barracuda	*Sphyraena* spp.	1,654	265	937	1,036	3,892	0.4
Belanak	Mullet	*Valamugil* spp.	1,536	27	54	1,481	3,098	0.3
Cermin	Trevally	*Caranx, Alectes*	658	638	1,521	244	3,061	0.3
Kebasi	Gizzard Shad	*Anodonstoma* spp.	219	166	27	2,633	3,045	0.3
Talang	Queenfish	*Scomberoides* spp.	1,295	312	123	579	2,309	0.2
Pisang	Rainbow Runner	*Elagastis Bipinnulatus*	242	0	127	262	631	0.1
Layar	Marlin/Sailfish	Mixed Species	388	0	81	0	469	0.0
Terubuk	Longtail Shad	*Hilsa* spp.	0	370	0	45	415	0.0
Bulan-2	Indo Pacific Tarpon	*Megalops* spp.	40	38	14	7	99	0.0
TOTAL PELAGIC LANDINGS (metric ton)			89,131	22,411	143,388	111,001	365,931	34.9
Percent (%) total pelagic landings			24.4%	6.1%	39.2%	30.3%	100%	
Percent (%) pelagic to total marine fish landings			51.3%	27.4%	41.6%	24.9%		
***b.* Other marine landings**								
Ikan Baja	Trash Fishes	Mixed Species	9,896	16,562	113,080	156,840	296,378	28.30
Udang	Shrimps	Mainly Penaeids	18,617	10,397	8,766	72,928	110,708	10.57
Lain-lain	Other Fishes	Mixed Species	56,164	32,554	79,869	105,746	274,333	26.19
TOTAL MARINE FISH LANDINGS (metric ton)			173,808	81,924	345,103	446,515	1,047,350	
Percent (%) total marine fish landings			16.6%	7.8%	33.0%	42.6%		100%
PELAGIC LANDING COMPOSITION BY FAMILY CATEGORY								
			East Malaysia		*West Malaysia*			
			Sabah	*Sarawak*	*East coast*	*West coast*	*Sub total (metric ton)*	*% total landings*
Scombridae (tuna, spanish mackerel. mackerel, etc.)			44,138	6,604	28,542	45,975	125,259	12.0
Carangidae (scads, trevallies, horse mackerels, etc.)			26,728	4,762	85,897	23,615	141,002	13.5%
Others (sardine, anchovys, clupeid, barracuda, etc.)			18,265	11,045	28,949	41,411	99,670	9.5%

Source: DOF Malaysia annual report 1993,
1/ Sabah including landings for FT Labuan

Appendix 8: Summary of marine pelagic landings by gear type, Malaysia 1993 (metric ton)

		Fishing Gear Category								
			Seine Nets							
English Name	*Scientific name*	*Trawl*	*Fish Purse Seine*	*Anchovy Purse Seine*	*Other Seine Nets*	*Gillnet*	*Liftnet*	*Hook and Line*	*Others*	*Total*
Mackerel	*Rastrelliger* spp.	15,191	28,598	840	26	19,566	2,479	1,219	56	67,975
Round Scad	*Decapterus* spp.	3,863	51,344	1,115	0	434	7,688	270	8	64,722
Tuna	Mixed Species	86	17,888	254	1,320	8,500	1,621	6,308	3	35,980
Yellow Trevally	*Selaroides leptolepis*	8,574	14,075	147	0	549	5,833	102	176	29,456
Sardine	Mixed Species	1,761	17,568	1,186	100	1,637	4,481	129	74	26,936
Anchovies	Mixed Species	634	55	19,900	21	1,345	2,311	0	519	24,785
Spanish Mackerel	*Scomberomorus* spp.	3,584	553	0	0	9,575	1,575	5,545	3	20,835
Selar Scad	*Selar* spp.	3,926	10,446	208	0	1,818	1,644	2,315	166	20,523
Hardtail Scad	*Megalaspis Cordyla*	4,762	6,720	24	2	1,731	939	1,116	15	15,309
Pomfrets	Mixed Species	3,992	1,310	0	1	3,566	797	0	463	10,129
Shad	*Pellona* spp.	3,354	75	0	0	4,951	0	3	29	8,412
Hairtails	*Trichiurus* spp.	5,928	120	41	0	1,290	18	33	6	7,436
Sharks	Mixed Species	3,216	4	0	7	2,466	0	582	19	6,294
Horse Mackerel	*Caranx* spp.	1,997	358	0	17	1,017	60	1,886	287	5,622
Wolf Herring	*Chirocentrus Dorab*	2,028	39	31	0	2,386	1	12	1	4,498
Barracuda	*Sphyraena* spp.	2,326	192	0	11	506	24	703	130	3,892
Mullet	*Valamugil* spp.	294	20	0	34	2,550	8	3	189	3,098
Trevally	*Caranx, Alectes*	1,742	208	0	0	472	1	425	213	3,061
Gizzard Shad	*Anodonstoma* spp.	911	12	0	13	2,045	2	0	62	3,045
Queenfish	*Scomberoides* spp.	519	34	0	9	1,553	18	129	47	2,309
Rainbow Runner	*Elagastis Bipinnulatus*	32	233	0	0	160	0	198	8	631
Marlin/Sailfish	Mixed Species	41	0	0	0	257	0	171	0	469
Longtail Shad	*Hilsa* spp.	4	0	0	0	396	0	15	0	415
Indo Pacific Tarpon	*Megalops* spp.	15	9	0	0	48	0	0	27	99
Sub Total		68,780	149,861	23,746	1,561	68,818	29,500	21,164	2,501	365,931
% Over total pelagic landings		18.8	41.0	6.5	0.4	18.8	8.1	5.8	0.7	100%
Total marine landings		561,942	160,269	24,003	20,360	117,515	31,262	44,153	87,846	4,047,350
% pelagic over total marine fish landings		12.2%	93.5%	98.9%	7.7%	58.6%	94.4%	47.9%	2.9%	34.9%
Source: DOF Malaysia annual report 1993										



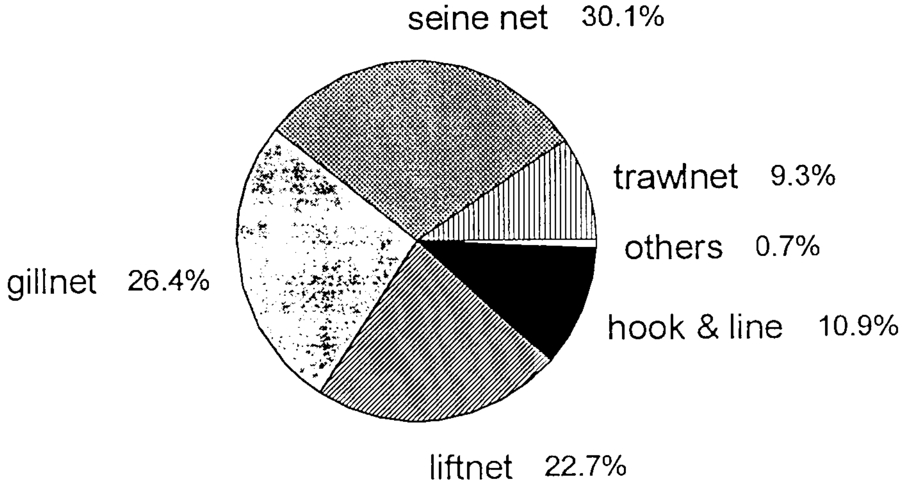
Appendix 9: Summary of marine pelagic landings by gear type, Sabah (metric ton)

		Fishing Gear Category								
			Seine nets							
English Name	*Scientific Name*	*Trawl*	*Fish Purse Seine*	*Anchov Y Purse Seine*	*Other Seine Nets*	*Gillnet*	*Liftnets*	*Hook and Line*	*Others*	*Sub Total*
Mackerel	*Rastrelliger* spp.	1,731	7,614	828	26	1,823	2,471	630	36	15,159
Round Scad	*Decapterus* spp.	827	2,522	1,115	0	322	6,629	0	0	11,415
Tuna	Mixed Species	5	7,228	175	1,320	6,065	1,538	2,186	0	18,517
Yellow Trevally	*Selaroides leptolepis*	406	16	147	0	358	130	79	0	1,136
Sardine	Mixed Species	0	2,588	33	100	2	3,431	50	31	6,235
Anchovies	Mixed Species	1	0	335	21	7	1,424	0	49	1,837
Spanish Mackerel	*Scomberomorus* spp.	523	150	0	0	5,177	1,575	2,649	0	10,074
Selar Scad	*Selar* spp.	422	806	125	0	957	1,192	747	28	4,277
Hardtail Scad	*Megalaspis Cordyla*	564	1,309	24	2	1,012	938	388	5	4,242
Pomfrets	Mixed Species	155	31	0	0	1,448	748	0	50	2,432
Shad	*Pellona* spp.	554	1	0	0	122	0	3	1	681
Hairtails	*Trichiurus* spp.	163	45	0	0	515	17	25	2	767
Sharks	Mixed Species	830	3	0	7	1,234	0	360	2	2,436
Horse Mackerel	*Caranx* spp.	1,101	11	0	15	946	51	1,453	128	3,705
Wolf Herring	*Chirocentrus Dorab*	7	0	0	0	179	0	0	0	186
Barracuda	*Sphyraena* spp.	593	136	0	2	281	22	565	55	1,654
Mullet	*Valamugil* spp.	8	0	0	28	1,402	8	3	87	1,536
Trevally	*Caranx, Alectes*	210	0	0	0	231	0	186	31	658
Gizzard Shad	*Anodonstoma* spp.	119	0	0	10	34	2	0	54	219
Queenfish	*Scomberoides* spp.	78	5	0	7	1,036	18	108	43	1,295
Rainbow Runner	*Elagastis Bipinnulatus*	4	0	0	0	125	0	111	2	242
Marlin/Sailfish	Mixed Species	0	0	0	0	255	0	133	0	388
Indo Pacific Tarpon	*Megalops* spp.	3	0	0	0	10	0	0	27	40
Sub Total		8,304	22,465	2,782	1,538	23,541	20,194	9,676	631	89,131
% Over total pelagic landings		9.3	25.2	3.1	1.7	26.4	22.7	10.9	0.7	100%
Total marine landings		48,380	23,983	2,782	2,204	40,772	20,921	22,620	12,146	173,808
% pelagic over total marine fish landings		17.2	93.7	100	69.8	57.7	96.5	42.8	5.2	51.3

Source: DOF Malaysia annual report 1993
1/ estimates for Sabah include FT Labuan

breakdown of pelagic landings

89,131 metric ton



Appendix 10: List of species currently covered by DOF Sabah fish stock assessment program

Scientific Name	*Length Frequency Data Collection*	*Biological-reproduction Data Collection* [1]	*Morphometric Studies* [2]		
			1994 period	*1995 period (april 1995)*	*Total*
SCOMBRIDAE (14 species)					
01. Euthynnus affinis	Y	Y	0	75	75
02. Katsuwonus pe'amis	Y	Y	30	0	30
03. Rastrelliger kanagurta	Y	Y	0	75	75
04. Rastrelliger brachysoma	Y	Y	0	51	51
05. Rastrelliger faughni	Y	Y	0	0	0
06. Sarda orientalis	Y		0	0	0
07. Scomber australasicus	Y	Y	0	0	0
08. Scomberomorus commerson	Y		0	0	0
09. Scomberomorus guttatus	Y		0	0	0
10. Scomberomorus lineolatus	Y		0	0	0
11. Scomberomorus queenslandicus	Y		0	0	0
12. Auxis thazard	Y	Y	0	0	0
13. Auxis rochei	Y	Y	0	0	0
14. Thunnus alalunga	Y	Y	0	0	0
CARANGIDAE (10 species)					
01. Decapterus macrosoma	Y	Y	0	25	25
02. Decapterus maruadsi	Y	Y	0	94	94
03. Decapterus russelli	Y	Y	0	0	0
04. Megalaspis cordyla	Y	Y	0	150	150
05. Selar boops	Y	Y	0	25	25
06. Selar crumenophthalmus	Y	Y	0	75	75
07. Selar (Atule) mate	Y	Y	150	125	275
08. Selaroides leptolepis	Y	Y	0	0	0
09. Seriolina nigrofasciata	Y	Y	0	75	75
10. Alepes djeddaba	Y		0	0	0

Scientific name	*Length Frequency Data Collection*	*Biological-reproduction Data Collection* [1]	*Morphometric Studies* [2]		
			1994 period	*1995 period (april 1995)*	*Total*
OTHER FAMILIES (15 species)					
01. Abalistes stellaris	Y	Y	0	20	20
02. Dussumeria acuta	Y	Y	30	0	30
03. Herklosichthys quadrimaculatus	Y	Y	60	0	60
04. Gerres filamentosus	Y	Y	46	30	76
05. Lactarius lactarius	Y	Y	0	50	50
06. Nibea semifasciata	Y	Y	0	0	0
07. Nemipterus japonicus		Y	0	0	0
08. Nemipterus nemurus		Y	0	0	0
09. Nemipterus peronii	Y	Y	30	100	130
10. Priacanthus macracanthus	Y	Y	0	0	0
11. Priacanthus tayenus	Y	Y	0	150	150
12. Sphyraena forsteri	Y		0	0	0
13. Sphyraena jello	Y		0	0	0
14. Sphyraena obtusata	Y	Y	60	0	60
15. Siganus javus	Y	Y	80	0	80
Total: 39 species (11 families)	**sub total**		486	1,120	1,606

Note:

Y : Yes, covered in the study.

1/ : Inclusive of morphometric characters measured: TL (total length), FL (fork length), SL (standard length), BD (maximum body depth), HL (head length), PL (pectoral fin length), ED (eye diameter), SD1 (distance from head tip to 1st dorsal fin) and SD2 (distance from head tip to 2nd dorsal fin).

2/ : Morphometric characters recommended during the MFRDMD-SEAFDEC 1st Workshop on shared stocks in the SEA region.

Appendix 11: Biological aspects of tuna stocks along the west coast of Sabah, Malaysia

a. ***Auxis thazard*** (n-365) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	381.67	48.71	12.76	254-511
FL (fork length)	356.79	45.55	12.77	238-469
SL (standard length)	333.82	42.50	12.73	227-455
BD (body depth)	85.97	12.03	14.00	57-115
BW (body weight)	856.52	307.95	35.95	225-2000
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	4.16	0.15	3.61	3.82-4.53
FL/HL	3.73	0.08	2.16	3.55-3.96
FL/SD 1	3.31	0.08	2.53	2.10-3.55
FL/SD 2	1.60	0.03	1.68	1.53-1.69
TL/SL	1.14	0.02	1.40	1.11-1.18

Morphometric relationships	*correlation (r)*
FL = 1.5739 + 0.9307 TL	0.9954
SL = 2.9955 + 0.8668 TL	0.9936
SL = 2.3102 + 0.9201 FL	0.9959
Log_{10} FL = 0.0110 + 0.9929 Log_{10} TL	0.9961
Log_{10} SL = 0.0179 + 0.9844 Log_{10} TL	0.9946
Log_{10} SL = 0.0020 + 0.9494 Log_{10} FL	0.9966
Length-weight relationships	
Log_{10} BW = -5.2020 + 3.142 Log_{10} TL	0.9927
Log_{10} BW = -5.1202 + 3.1461 Log_{10} FL	0.9908
Log_{10} BW = -5.0672 + 3.1610 Log_{10} SL	0.9884
Log_{10} BW = -2.4715 + 2.7824 Log_{10} BD	0.9664

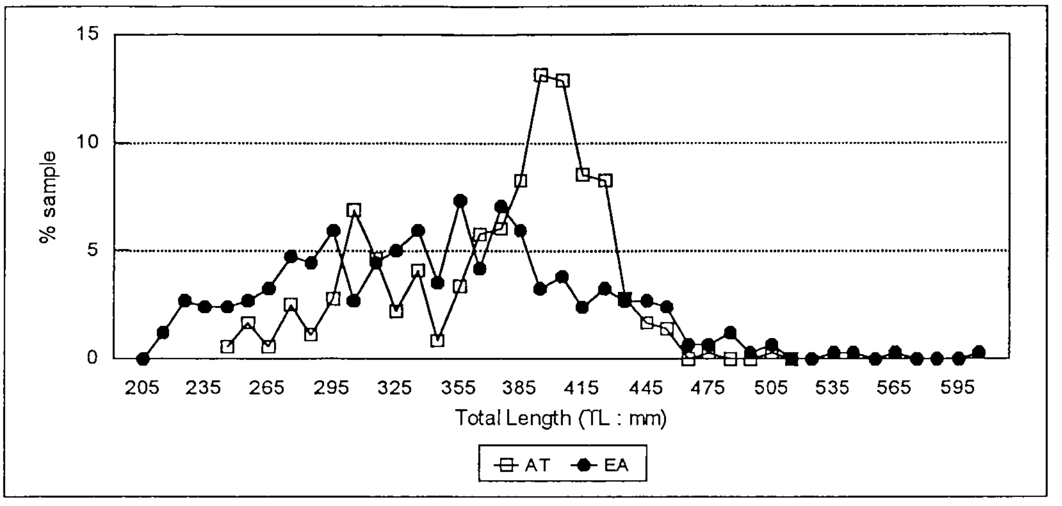
b. ***Euthynnus affinis*** (n-341) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	346.46	73.54	21.23	214-780
FL (fork length)	318.88	66.98	21.00	198-713
SL (standard length)	299.11	62.92	21.04	185-668
BD (body depth)	77.84	18.53	23.81	42-185
BW (body weight)	650.67	514.29	79.04	126-6550
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	4.13	0.22	5.41	3.57-4.79
FL/HL	3.71	0.09	2.68	3.46-3.94
FL/SD 1	3.40	0.09	2.68	3.15-3.64
FL/SD 2	1.71	0.04	0.02	1.60-1.81
TL/SL	1.16	0.02	1.76	1.12-1.22

Morphometric relationships	*correlation (r)*
FL = 4.0029+ 0.9088 TL	0.9790
SL = 3.6533 + 0.8528 TL	0.9967
SL = 0.0274 + 0.9379 FL	0.9984
Log_{10} FL = 0.0047 + 0.9840 Log_{10} TL	0.9857
Log_{10} SL = 0.0187 + 0.9822 Log_{10} TL	0.9875
Log_{10} SL = 0.0223 + 0.9978 Log_{10} FL	0.9982
Length-weight relationships	
Log_{10} BW = -4.8855 + 3.0080 Log_{10} TL	0.9938
Log_{10} BW = -4.8861 + 3.0514 Log_{10} FL	0.9942
Log_{10} BW = -4.7927 + 3.0479 Log_{10} SL	0.9926
Log_{10} BW = -2.2535 + 2.6492 Log_{10} BD	0.9857

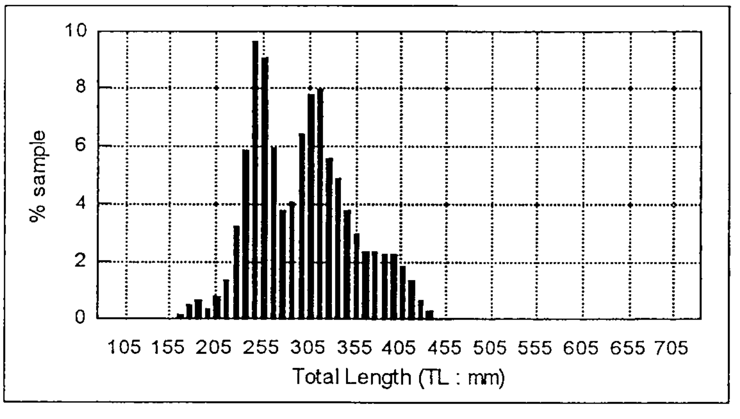
NOTE: Length (in mm units), BW (in gram), HL (head length), SD 1 (distance from head tip to 1st dorsal fin), SD 2 (distance from head tip to 2nd dorsal fin)

continue : appendix 11
LENGTH FREQUENCY DISTRIBUTION OF FISH SAMPLES (BIOLOGICAL STUDIES)
(AT = *Auxis thazard*, EA = *Euthynnus affinis*)

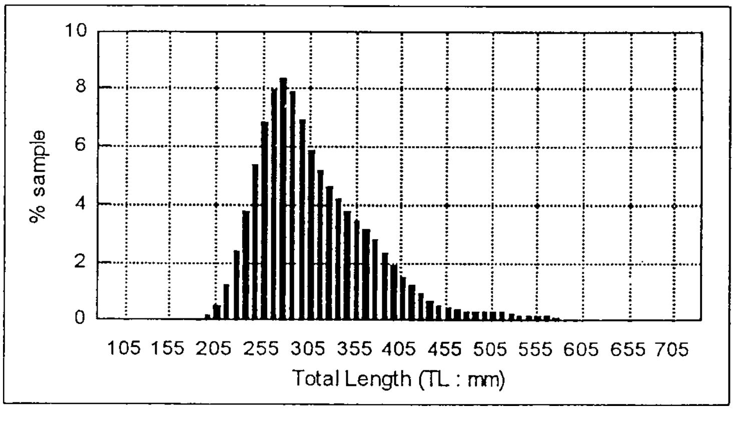


Pooled length frequency data of tunas (1992-1994 period) for stock assessment studies

a. *Auxis thazard* (n = 19,329 measurements)



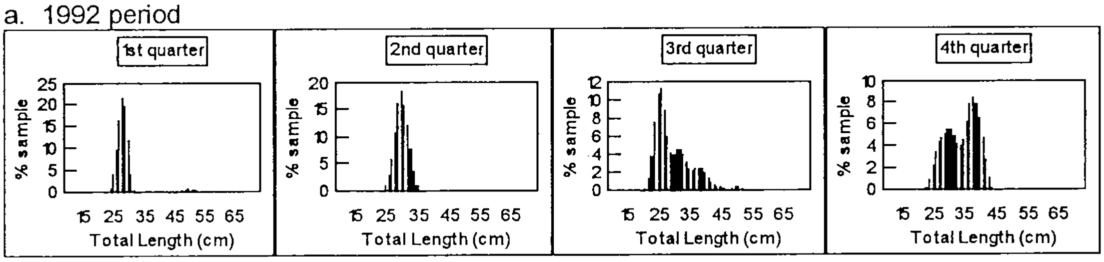
b. *Euthynnus affinis* (n = 16,353 measurements)



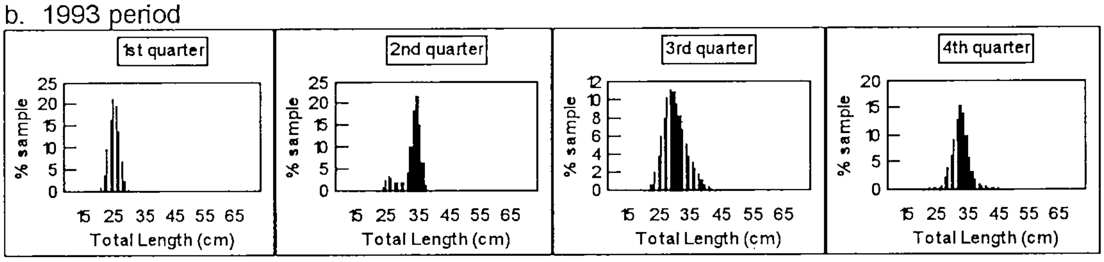
continue : appendix 11

QUARTERLY LENGTH FREQUENCY DISTRIBUTION OF *Euthynnus affinis*

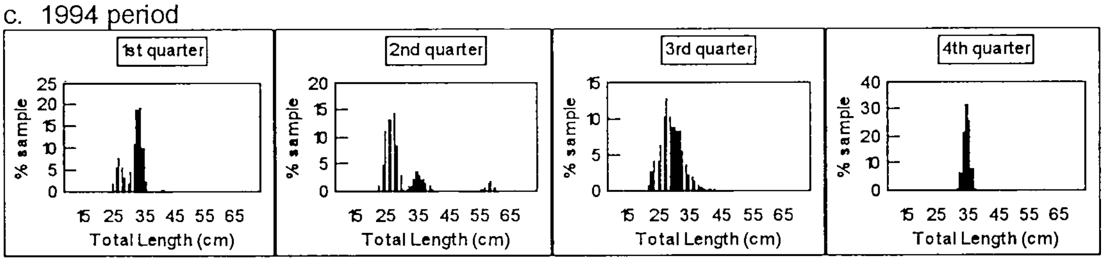
a. 1992 period



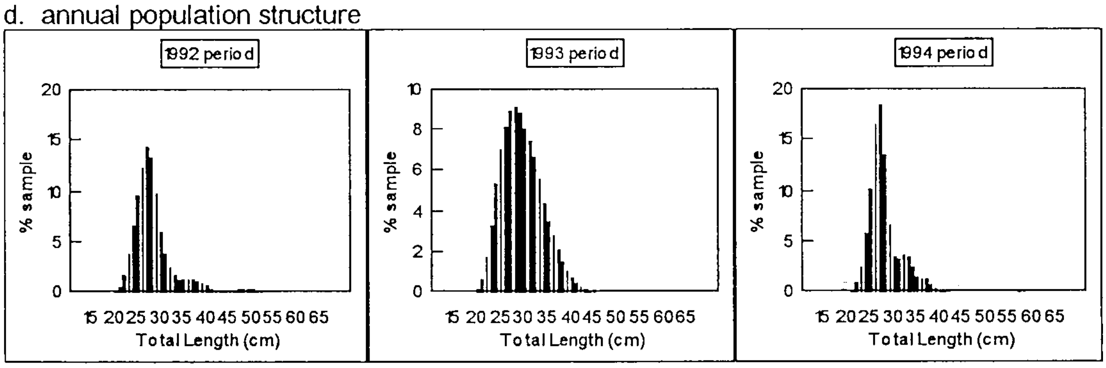
b. 1993 period



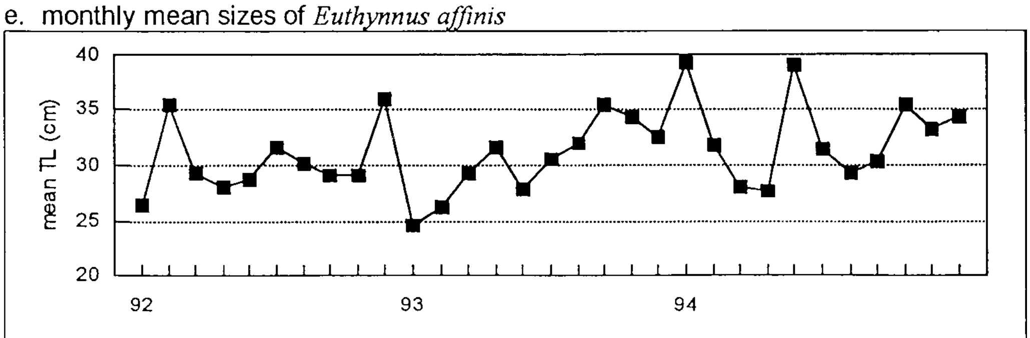
c. 1994 period



d. annual population structure



e. monthly mean sizes of *Euthynnus affinis*



Appendix 12: Biological aspects of mackerel (*Rastrelliger* spp.) stocks along the west coast of Sabah

a. ***Rastrelliger faughni*** (n-75) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	196.43	11.11	5.65	160-220
FL (fork length)	178.36	9.02	5.06	149-198
SL (standard length)	164.59	9.08	5.52	135-183
BD (body depth)	39.39	2.28	5.80	32-44
BW (body weight)	86.31	16.92	19.60	45-25
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	4.53	0.07	1.47	4.35-4.71
FL/HL	3.89	0.07	1.76	3.74-4.03
FL/SD 1	3.06	0.07	2.27	2.92-3.19
FL/SD 2	1.73	0.02	1.44	1.69-1.81
TL/SL	1.19	0.01	0.59	1.18-1.21

Morphometric relationships	*correlation (r)*
FL = 21.1454 + 0.8004 TL	0.9854
SL = 4.7948 + 0.8135 TL	0.9947
SL = -11.9332 + 0.9897 FL	0.9829
Log_{10} FL = 0.2306 + 0.8812 Log_{10} TL	0.9855
Log_{10} SL = 0.0139 +0.9726 Log_{10} TL	0.9948
Log_{10} SL = 0.2041 + 1.0751 Log_{10} FL	0.9833
Length-weight relationships	
Log_{10} BW = -5.8156 + 3.3777 Log_{10} TL	0.9687
Log_{10} BW = -6.5492 + 3.3663 Log_{10} FL	0.9658
Log_{10} BW = -5.6973 + 3.4413 Log_{10} SL	0.9649
Log_{10} BW = -3.2489 + 2.2489 Log_{10} BD	0.9553

b. ***Rastrelliger brachysoma*** (n-522) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	181.14	16.52	9.12	141-217
FL (fork length)	161.37	14.40	8.92	125-194
SL (standard length)	146.67	12.66	8.63	110-175
BD (body depth)	45.28	4.52	9.98	32-55
BW (body weight)	77.90	20.69	26.56	35-130
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	3.57	0.11	3.01	3.28-3.95
FL/HL	3.58	0.10	2.78	3.33-3.89
FL/SD 1	3.04	0.07	2.23	2.90-3.24
FL/SD 2	1.77	0.03	1.70	1.69-1.86
TL/SL	1.23	0.02	1.75	1.20-2.30

Morphometric relationships	*correlation (r)*
FL = 4.6003 + 0.8653 TL	0.9882
SL =7.0622 + 0.7694 TL	0.9794
SL = 4.7601 + 0.8783 FL	0.9790
Log_{10} FL = 0.0154 + 0.9709 Log_{10} TL	0.9890
Log_{10} SL = 0.0147 + 0.9526 Log_{10} TL	0.9802
Log_{10} SL = 0.0245 + 0.9699 Log_{10} FL	0.9797
Length-weight relationships	
Log_{10} BW = -4.9469 + 3.0235 Log_{10} TL	0.9837
Log_{10} BW = -4.8819 + 3.0630 Log_{10} FL	0.9784
Log_{10} BW = -4.7739 + 3.0727 Log_{10} SL	0.9716
Log_{10} BW = -2.4065+ 2.5905 Log_{10} BD	0.9546

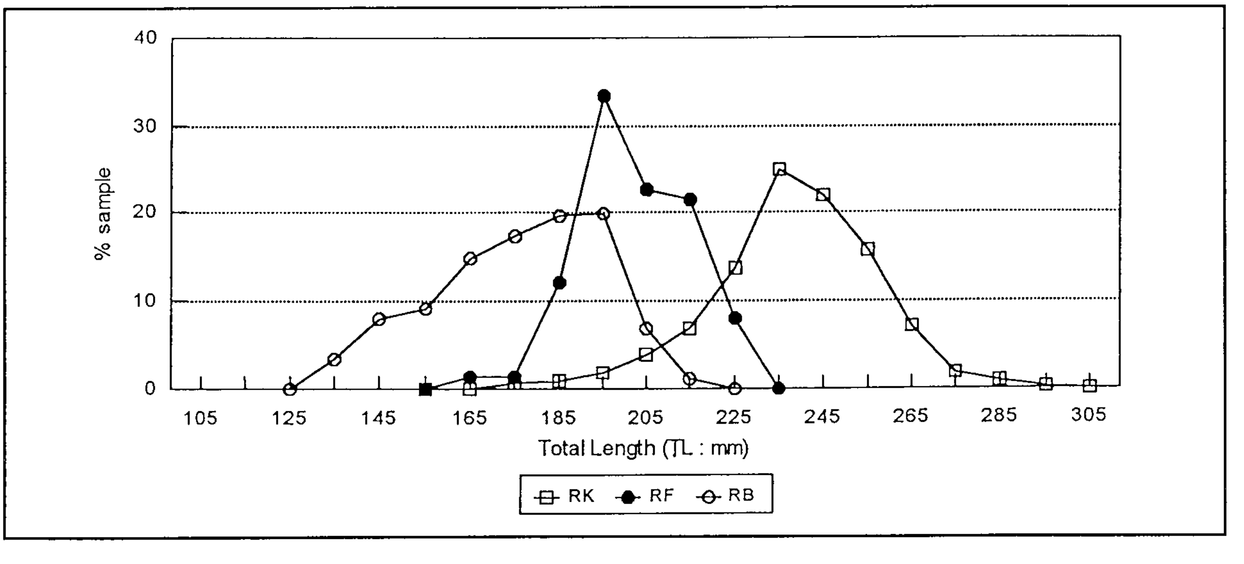
c. ***Rastrelliger kanagurta*** (n-1998) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	236.58	18.47	7.81	162-298
FL (fork length)	212.06	16.18	7.63	147-270
SL (standard length)	195.17	15.32	7.85	135-255
BD (body depth)	51.08	4.61	9.03	37-68
BW (body weight)	162.65	41.44	25.48	40-360
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	4.16	0.16	3.83	3.85-4.59
FL/HL	3.65	0.10	2.81	3.36-3.90
FL/SD 1	2.90	0.09	3.15	2.67-3.08
FL/SD 2	1.69	0.03	1.82	1.60-1.77
TL/SL	1.21	0.02	1.82	1.16-1.27

Morphometric relationships	*correlation (r)*
FL = 7.9555 + 0.8627 TL	0.9846
SL = 4.2976 + 0. 8068 TL	0.9726
SL = -0.7369 + 0.9238 FL	0.9759
Log_{10} FL = 0.0462 + 0.9605 Log_{10} TL	0.9854
Log_{10} SL = 0.0243 + 0.9750 Log_{10} TL	0.9743
Log_{10} SL =0.0432 + 1.0030 Log_{10} FL	0.9770
Length-weight relationships	
Log_{10} BW = -5.5909+ 3.2821 Log_{10} TL	0.9669
Log_{10} BW = -5.6179 + 3.3607 Log_{10} FL	0.9651
Log_{10} BW = -5.1821 + 3.2233 Log_{10} SL	0.9502
Log_{10} BW = -2.3974+-2.6919 Log_{10} BD	0.9553

NOTE: Length (in mm units), BW (in gram), HL (head length), SD 1 (distance from head tip to 1st dorsal fin), SD 2 (distance from head tip to 2nd dorsal fin)

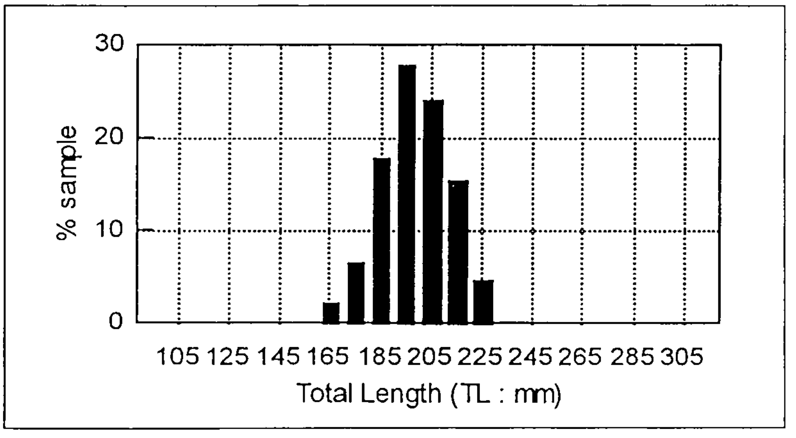
LENGTH FREQUENCY DISTRIBUTION OF FISH SAMPLES (BIOLOGICAL STUDIES)
(RK = *Rastrelliger kanagurta*, RF = *Rastrelliger faughni*, RB = *Rastrelliger brachysoma)*



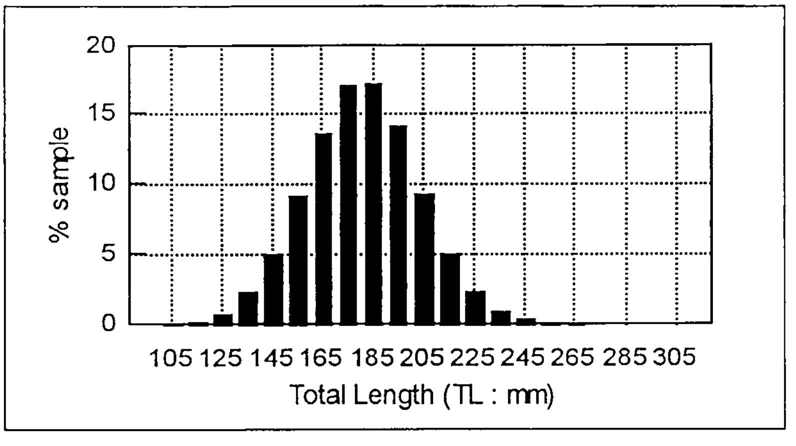
continue: appendix 12

Pooled length frequency data of *Rastrelliger* spp. (1992 – 1994 period) for stock assessment studies

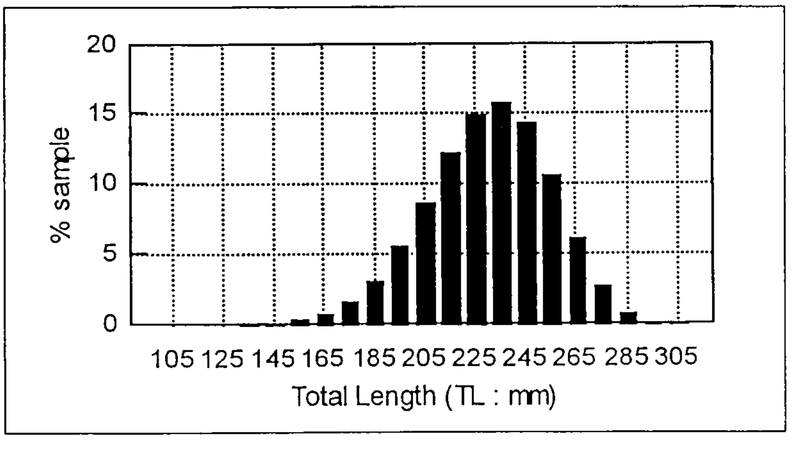
a. *Rastrelliger faughni* (n = 391 measurements)



b. *Rastrelliger brachysoma* (n = 32,709 measurements)



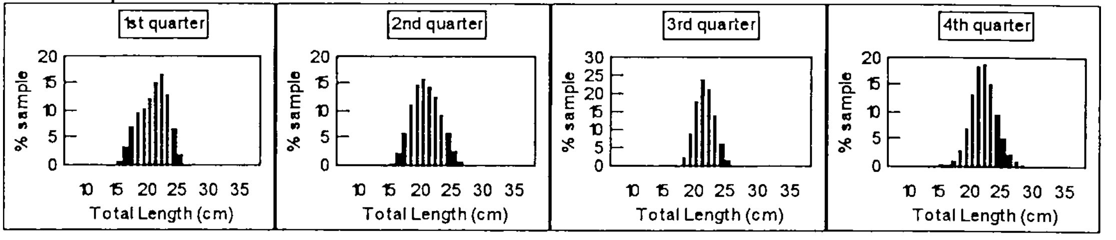
c. *Rastrelliger kanagurta* (n = 45,485 measurements)



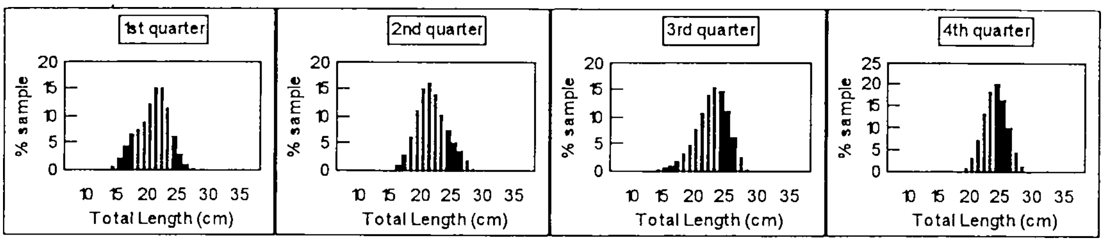
continue: appendix 12

QUARTERLY LENGTH FREQUENCY DISTRIBUTION OF *Rastrelliger kanagurta*

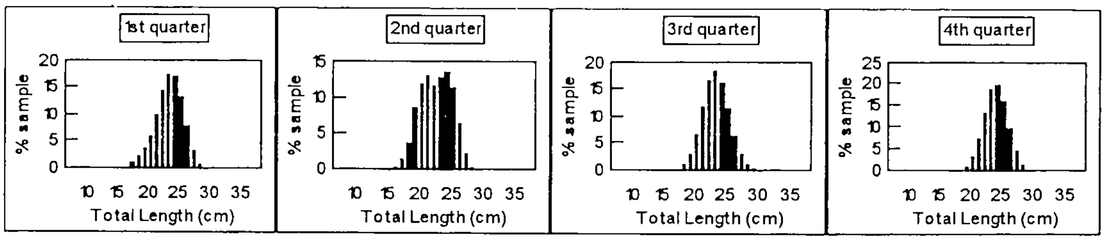
a. 1992 period



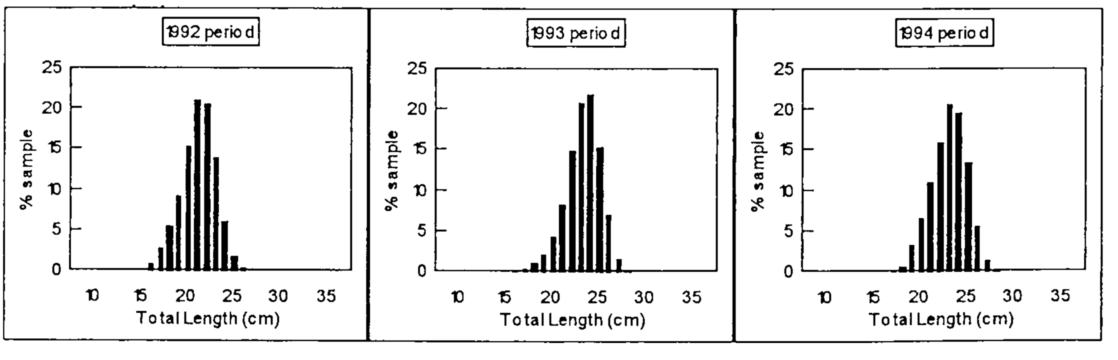
b. 1993 period



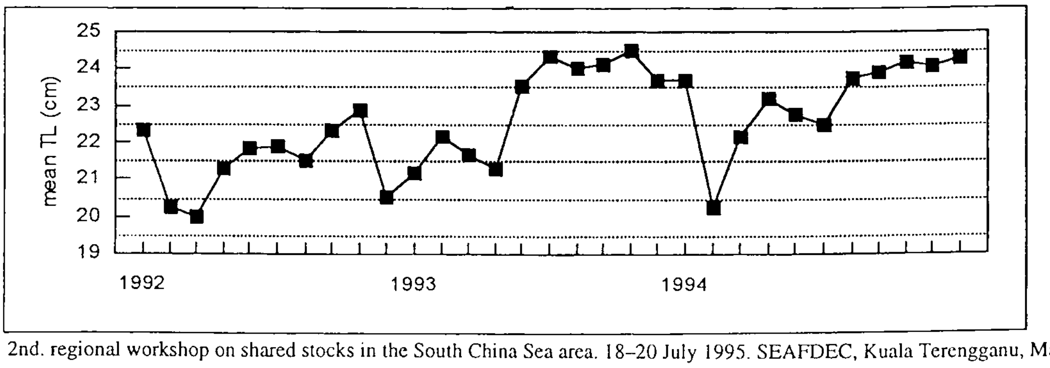
c. 1994 period



d. Annual population structure



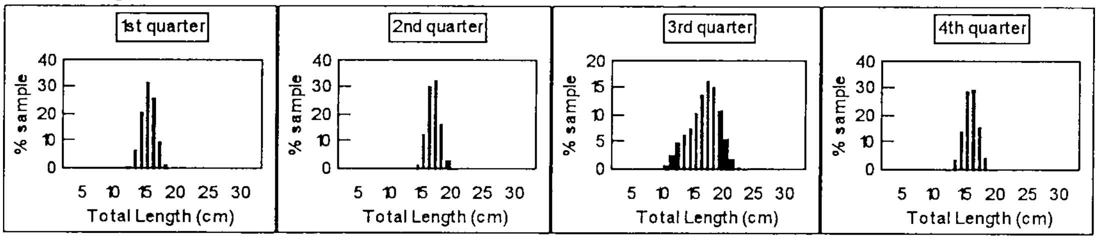
e. Monthly mean sizes of *Rastrelliger kanagurta*



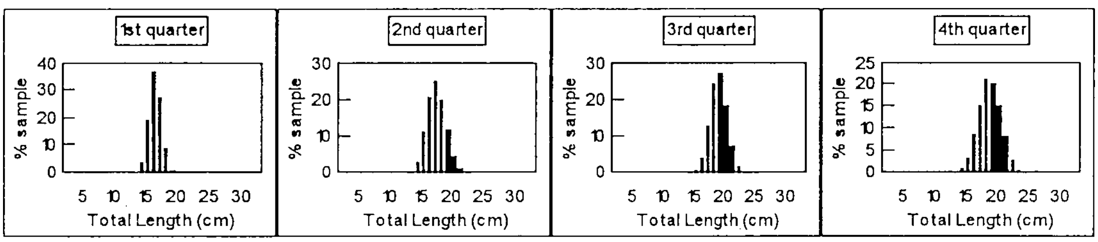
continue: appendix 12

QUARTERLY LENGTH FREQUENCY DISTRIBUTION OF *Rastrelliger brachysoma*

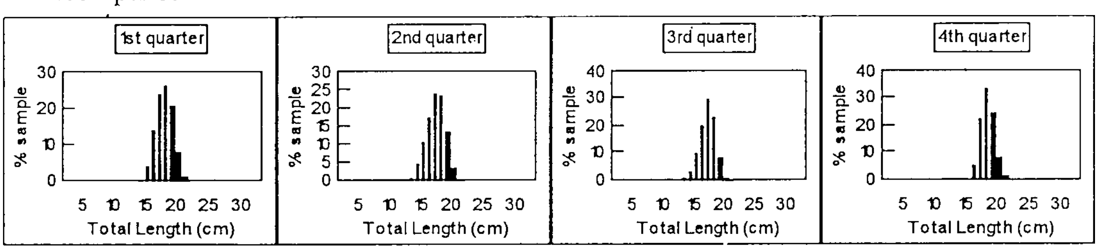
a. 1992 period



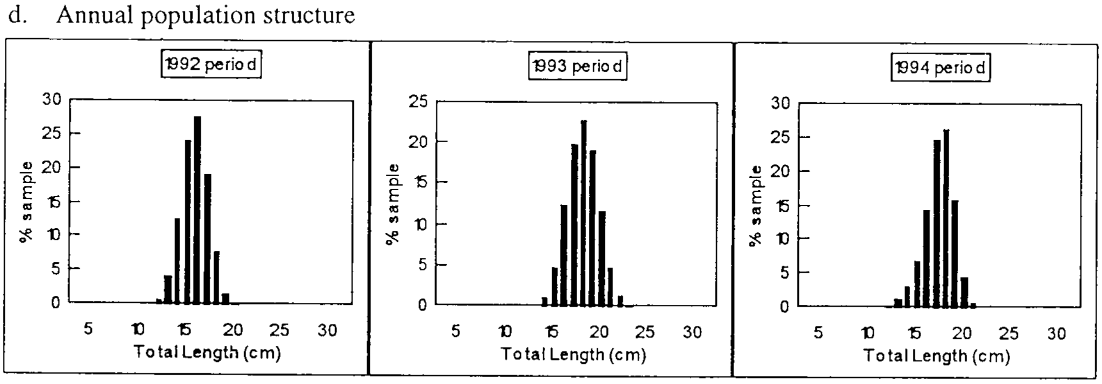
b. 1993 period



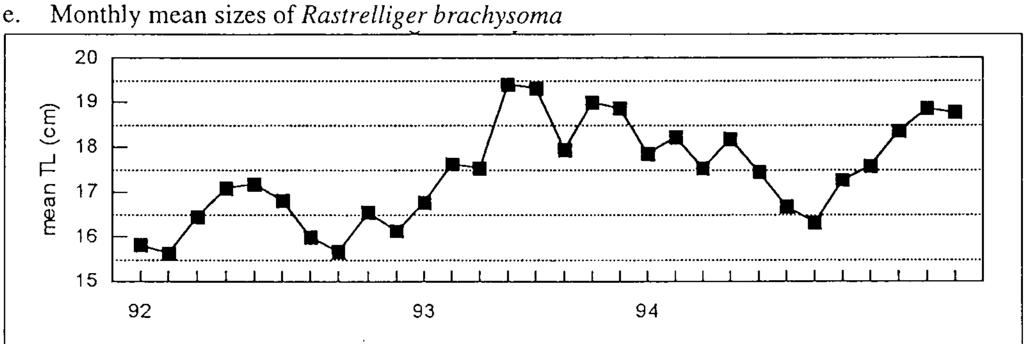
c. 1994 period



d. Annual population structure



e. Monthly mean sizes of *Rastrelliger brachysoma*



Appendix 13: Biological aspects of round scad *(Decapterus)* stocks along the west coast of Sabah

a. ***Decapterus macrosoma*** (n-283) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	179.66	21.51	11.97	129-240
FL (fork length)	165.07	19.75	11.96	115-220
SL (standard length)	154.17	18.27	11.85	108-202
BW (body weight)	64.06	23.95	37.38	22-155

Morphometric relationships	*correlation (r)*
FL = 1.1121 + 0.9126 TL	0.9940
SL = 3.3065 + 0.8387 TL	0.9888
SL = 3.0887 + 0.9152 FL	0.9895
Log_{10} FL = -0.0302 + 0.9971 Log_{10} TL	0.9931
Log_{10} SL = -0.0342 + 0.9857 Log_{10} TL	0.9882
Log_{10} SL = -0.0085 + 0.9828 Log_{10} FL	0.9892
Length-weight relationships	
Log_{10} BW = -4.8717 + 2.9541 Log_{10} TL	0.9904
Log_{10} BW = -4.6892 + 2.9208 Log_{10} FL	0.9831
Log_{10} BW = -4.6223 + 2.9297 Log_{10} SL	0.9797

b. ***Decapterus maruadsi*** (n-263) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	184.17	15.79	8.57	155-263
FL (fork length)	167.81	14.24	8.48	140-234
SL (standard length)	155.25	14.32	9.22	124-220
BW (body weight)	66.49	19.21	28.90	40-170

Morphometric relationships	*correlation (r)*
FL = 4.9895 + 0.8841 TL	0.9807
SL = -6.2324 + 0.8768 TL	0.9672
SL = -9.8262 + 0.9837 FL	0.9782
Log_{10} FL = 0.0289 + 0. 9694 Log_{10} TL	0.9783
Log_{10} SL = -0.1794 + 1.0463 Log_{10} TL	0.9628
Log_{10} SL = -0.1888 + 1.0696 Log_{10} FL	0.9752
Length-weight relationships	
Log_{10} BW = -5.0089 + 3.0109 Log_{10} TL	0.9413
Log_{10} BW = -4.8123 + 2.9772 Log_{10} FL	0.9222
Log_{10} BW = -4.1823 + 2.7358 Log_{10} SL	0.9295

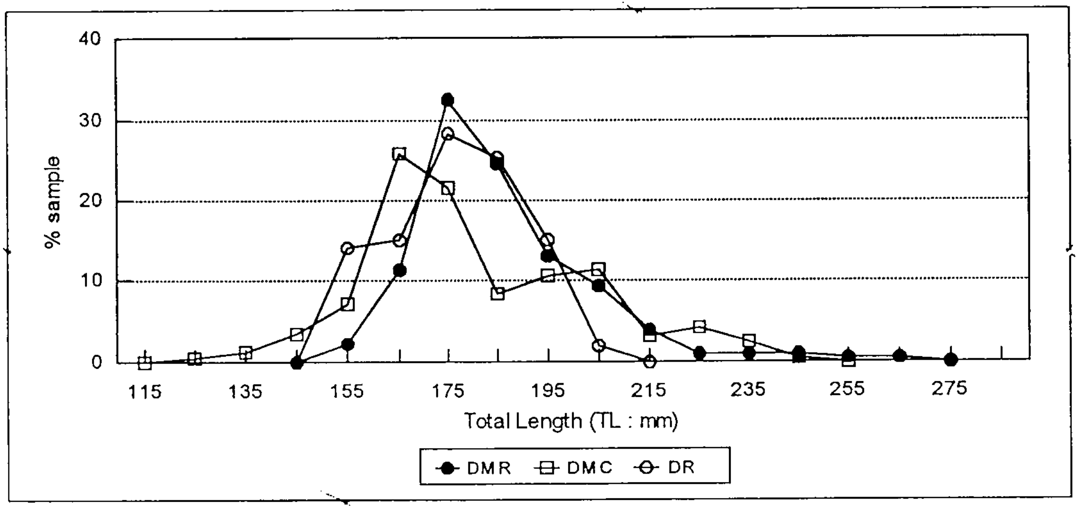
b. ***Decapterus russelli*** (n-100) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	175.47	12.34	7.03	152-202
FL (fork length)	162.46	11.14	6.86	141-186
SL (standard length)	147.85	12.18	8.24	125-175
BW (body weight)	49.18	9.44	19.19	33-70

Morphometric relationships	*correlation (r)*
FL = 7.2256 + 0.8842 TL	0.9790
SL = -19.0959 + 0.9509 TL	0.9633
SL = -26.5306 + 1.0733 FL	0.9821
Log_{10} FL = 0.0665 + 0.9554 Log_{10} TL	0.9794
Log_{10} SL = -0.3768 + 1.1345 Log_{10} TL	0.9650
Log_{10} SL = -0.4503 + 1.1850 Log_{10} FL	0.9833
Length-weight relationships	
Log_{10} BW = -4.2008 + 2.6230 Log_{10} TL	0.9485
Log_{10} BW = -4.2839 + 2.7006 Log_{10} FL	0.9526
Log_{10} BW = -3.0395 + 2.1783 Log_{10} SL	0.9260

NOTE: Length (in mm units), BW (in gram), HL (head length), SD 1 (distance from head tip to 1st dorsal fin), SD 2 (distance from head tip to 2nd dorsal fin)

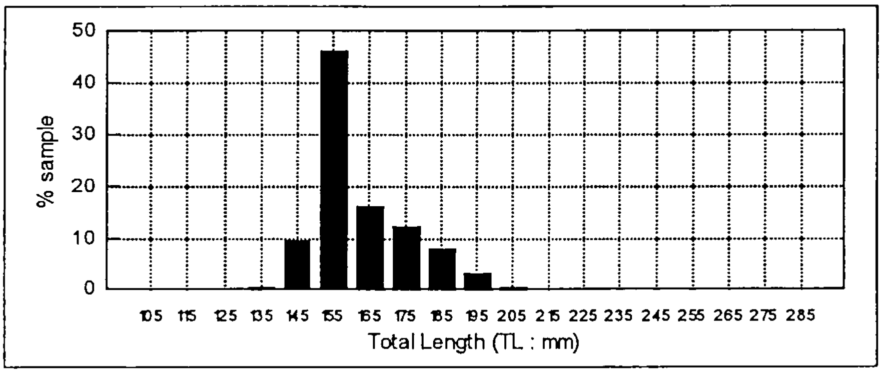
LENGTH FREQUENCY DISTRIBUTION OF FISH SAMPLES (BIOLOGICAL STUDIES)
(DR = *Decapterus russelli*, DMC = *Decapterus macrosoma*, DMR = *Decapterus maruadsi)*



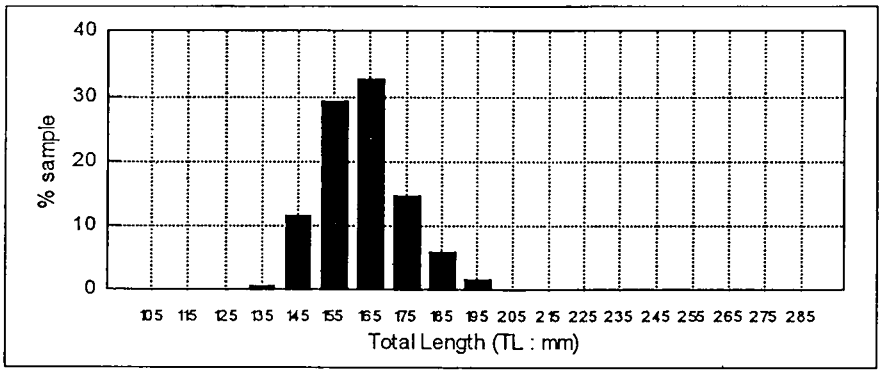
continue: appendix 13

Pooled length frequency data of *Decapterus* spp. (1992 – 1994 period) for stock assessment studies

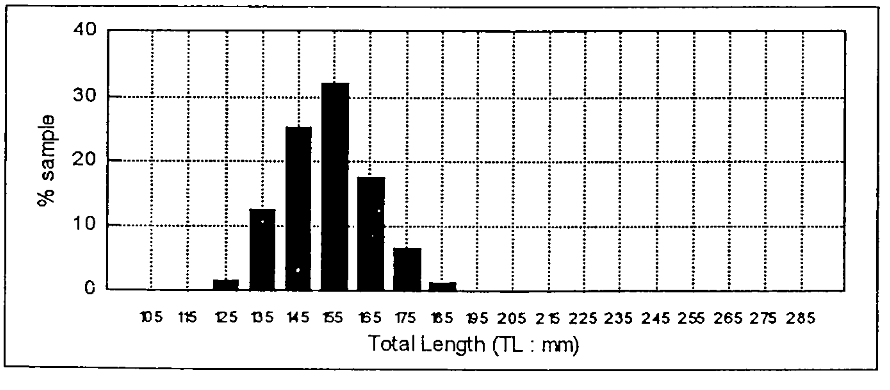
a. *Decapterus macrosoma* (n = 52,267 measurements)



b. *Decapterus maruadsi* (n = 57,009 measurements)



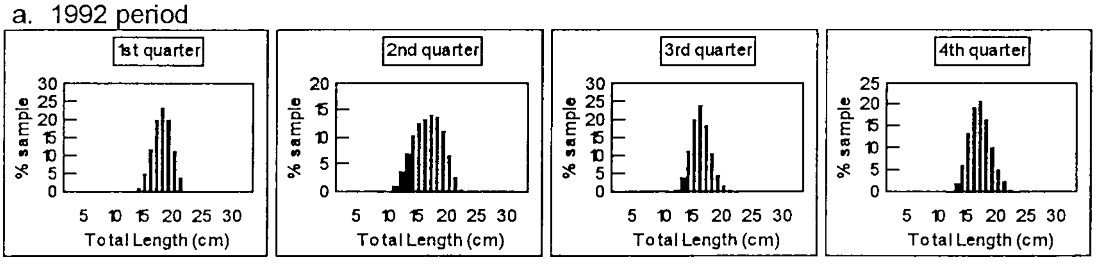
c. *Decapterus russelli* (n = 10,313 measurements)



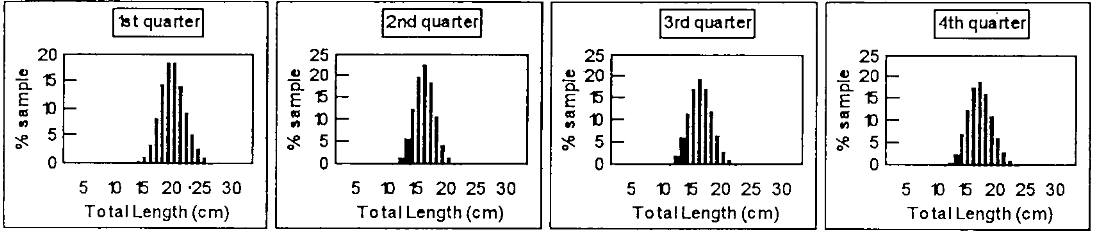
continue: appendix 13

QUARTERLY LENGTH FREQUENCY DISTRIBUTION OF *Decapterus macrosoma*

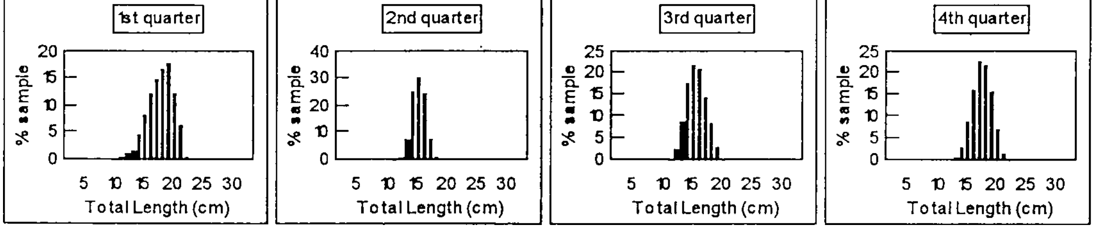
a. 1992 period



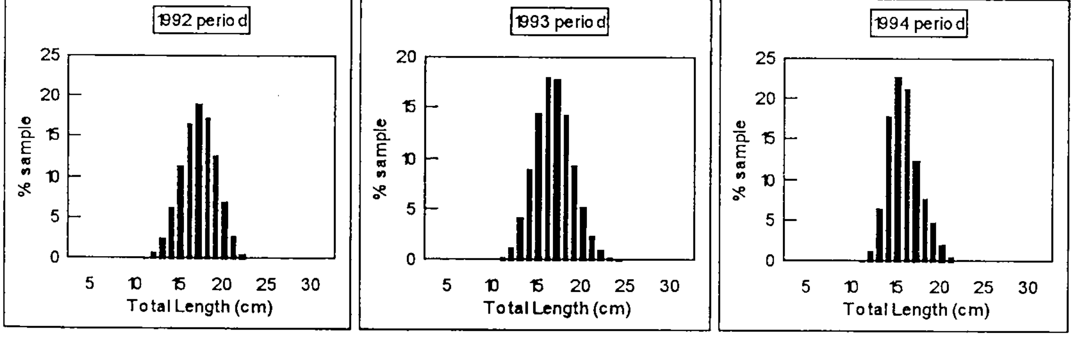
b. 1993 period



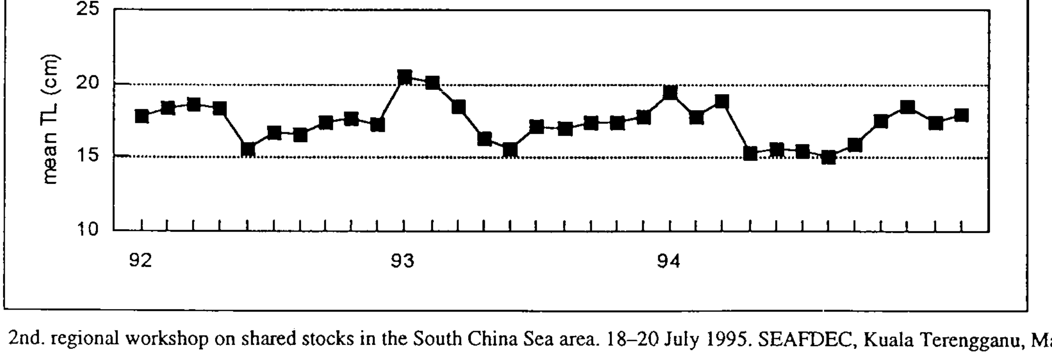
c. 1994 period



d. annual population structure



e. monthly mean size of *Decapterus macrosoma*



Appendix 14: Biological aspects of Selar scad *(Selar)* stocks along the west coast of Sabah

a. ***Selar crumenopthalmus*** (n-497) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	241.73	14.25	5.90	204-276
FL (fork length)	213.45	12.50	5.85	176-244
SL (standard length)	194.74	10.95	5.62	161-220
BD (body depth)	56.40	4.16	7.38	46-71
BW (body weight)	183.33	31.76	17.33	110-282
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	3.79	0.17	4.48	3.36-4.31
FL/HL	3.31	0.08	2.49	3.08-3.58
FL/SD 1	2.75	0.06	2.31	2.61-2.90
FL/SD 2	1.90	0.03	1.62	1.82-1.98
TL/SL	1.24	0.02	1.85	1.16-1.33

Morphometric relationships	*correlation (r)*
FL = 7.4050 + 0.8524 TL	0.9721
SL = 18.4643 + 0.7292 TL	0.9488
SL = 13.9158 + 0.8472 FL	0.9665
Log_{10} FL = 0.0251 + 0.9668 Log_{10} TL	0.9725
Log_{10} SL = 0.1213 + 0.9097 Log_{10} TL	0.9508
Log_{10} SL = 0.1207 + 0.9311 Log_{10} FL	0.9675
Length-weight relationships	
Log_{10} BW = -4.4194 + 2.8020 Log_{10} TL	0.9395
Log_{10} BW =-4.3088 + 2.8195 Log_{10} FL	0.9398
Log_{10} BW = -4.3276 + 2.8767 Log_{10} SL	0.9228
Log_{10} BW = -1.1364 + 2.0644 Log_{10} BD	0.8624

*b. **Selar boops*** (n-50) (weight = gram, length = mm)

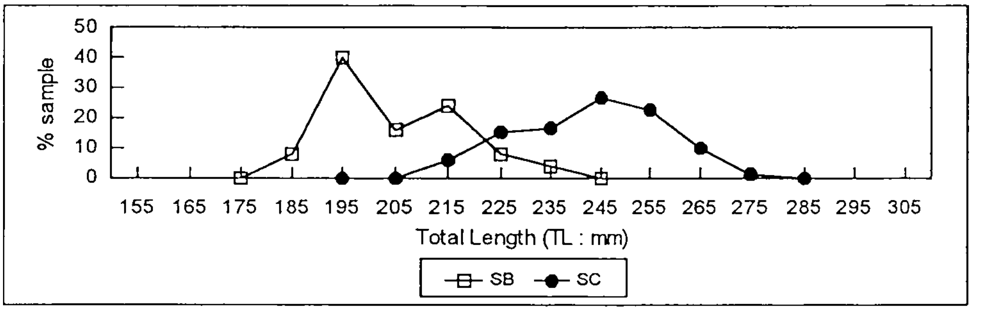
Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	202.96	11.73	5.78	187-230
FL (fork length)	179.58	11.23	6.25	164-204
SL (standard length)	166.54	9.75	5.85	151-188
BD (body depth)	51.30	2.84	5.53	47-58
BW (body weight)	109.26	19.13	17.51	82-163
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	3.50	0.09	2.59	3.33-3.77
FL/HL	3.49	0.06	1.83	3.33-3.67
FL/SD 1	2.93	0.07	2.22	2.80-3.13
FL/SD 2	1.98	0.04	1.89	2.05
TL/SL	1.22	0.02	1.36	1.16-1.26

Morphometric relationships	*correlation (r)*
FL =-10.2556 + 0.9352 TL	0.9768
SL = 2.5861 + 0.8078 TL	0.9722
SL =14.2362 + 0.8481 FL	0.9774
Log_{10} FL = -0.1871 + 1.0541 Log_{10} TL	0.9770
Log_{10} SL = -0.0584 + 0.9881 Log_{10} TL	0.9718
Log_{10} SL = 0.1483 + 0.9197 Log_{10} FL	0.9759
Length-weight relationships	
Log_{10} BW = -4.5784 + 2.8658 Log_{10} TL	0.9735
Log_{10} BW = -3.7449 + 2.5637 Log_{10} FL	0.9396
Log_{10} BW = -4.0885 + 2.7561 Log_{10} SL	0.9519
Log_{10} BW = -2.8452 + 2.8532 Log_{10} BD	0.9305

NOTE: Length (in mm units), BW (in gram), HL (head length), SD 1 (distance from head tip to 1st dorsal fin), SD 2 (distance from head tip to 2nd dorsal fin)

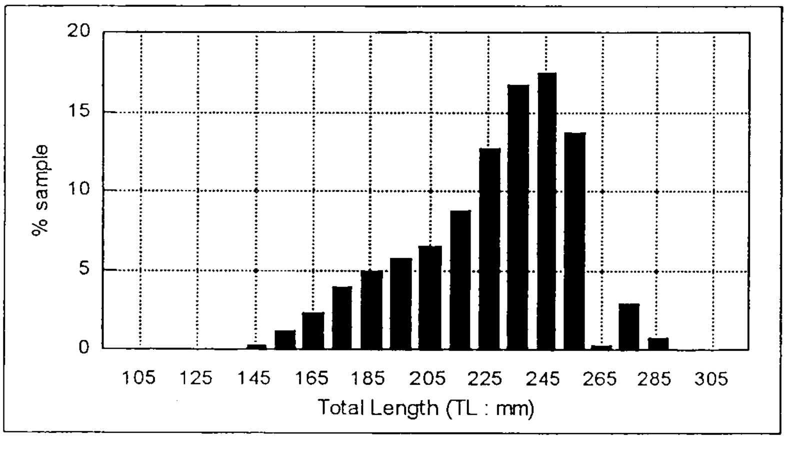
continue: appendix 14

LENGTH FREQUENCY DISTRIBUTION OF FISH SAMPLES (BIOLOGICAL STUDIES)
(SC = *Selar crumenopthalmus*, SB = *Selar boops*)

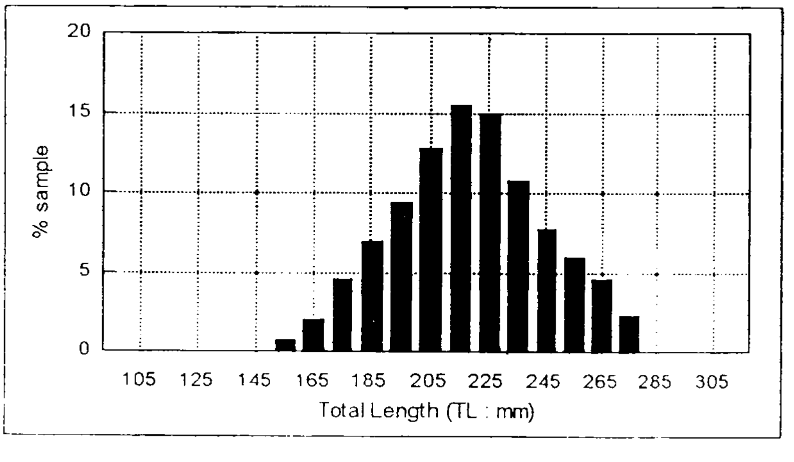


Pooled length frequency data of Selar spp. (1992 – 1994 period) for stock assessment studies

a. *Selar crumenopthalmus* (n = 21,750 measurements)



b. *Selar boops* (n = 1,248 measurements)



Appendix 15 : Biological aspects of hardtail scad *(Megalaspis cordyla)* stock along the west coast of Sabah

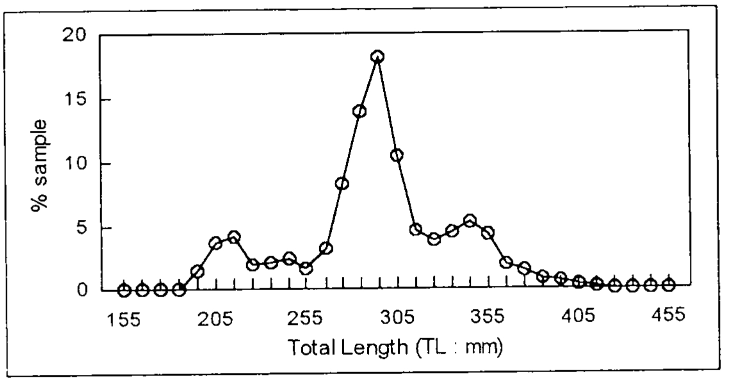
Megalapsis cordyla (n-850) (weight = gram, length = mm)

Variable	*mean*	*sd*	*CV (%)*	*range of values*
TL (total length)	292.08	43.52	14.90	190-420
FL (fork length)	266.57	39.99	15.00	173-380
SL (standard length)	250.38	37.83	15.11	163-361
BD (body depth)	59.36	8.27	13.93	38-84
BW (body weight)	261.66	106.36	40.65	60-680
Morphometric ratio	*mean*	*sd*	*CV (%)*	*range of values*
FL/BD	4.49	0.26	5.76	3.84-4.78
FL/HL	3.12	0.20	6.47	2.67-3.67
FL/SD 1	3.29	0.10	3.07	2.99-2.86
FL/SD 2	2.22	0.05	2.38	2.00-2.46
TL/SL	1.17	0.02	1.55	1.09-1.27

Morphometric relationships	*correlation (r)*
FL = -1.2538 + 0.9160 TL	0.9976
SL = -2.2350 + 0.8650 TL	0.9959
SL =-0.9331 + 0.9434 FL	0.9973
Log_{10} FL = -0.0519 + 1.0048 Log_{10} TL	0.9978
Log_{10} SL = -0.0917 + 1.0099 Log_{10} TL	0.9962
Log_{10} SL = -0.0373 + 1.0043 Log_{10} FL	0.9975
Length-weight relationships	
Log_{10} BW = -4.7340 + 2.8921 Log_{10} TL	0.9893
Log_{10} BW = -4.5699 + 2.8723 Log_{10} FL	0.9894
Log_{10} BW = -4.4280 + 2.8454 Log_{10} SL	0.9867
Log_{10} BW = -2.8947 + 2.9674 Log_{10} BD	0.9795

NOTE: Length (in mm units), BW (in gram), HL (head length), SD 1 (distance from head tip to 1st dorsal fin), SD 2 (distance from head tip to 2nd dorsal fin)

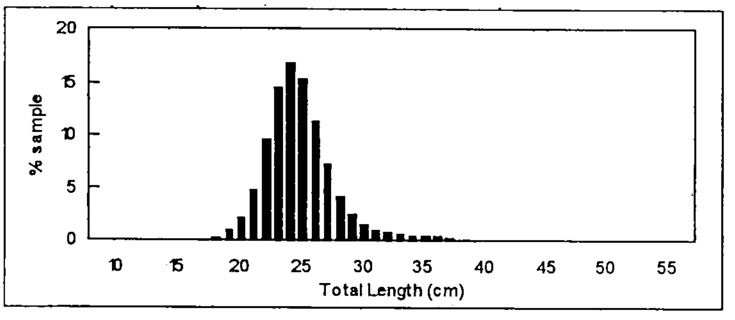
LENGTH FREQUENCY DISTRIBUTION OF FISH SAMPLES (BIOLOGICAL STUDIES)



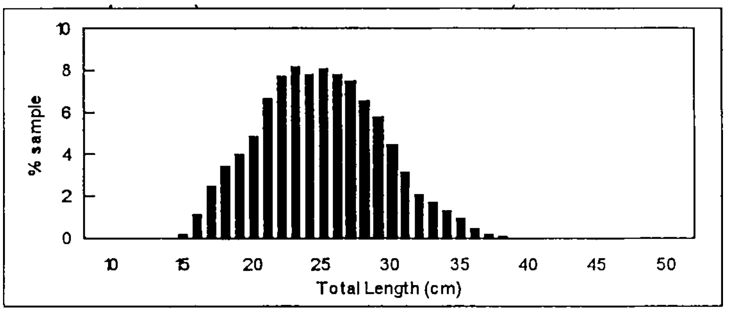
continue: appendix 15

Annual population structure of *Megalaspis cordyla* stock

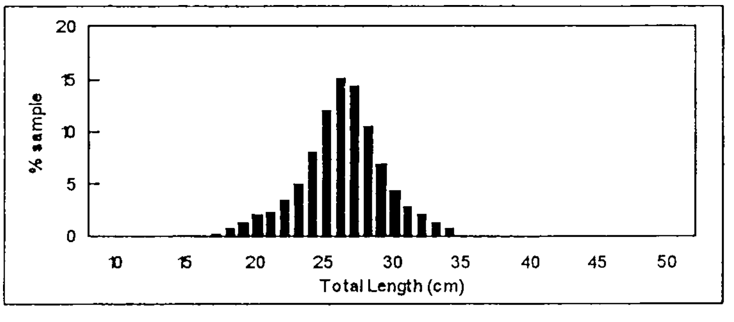
a. 1992 period (n = 8,277 measurements)



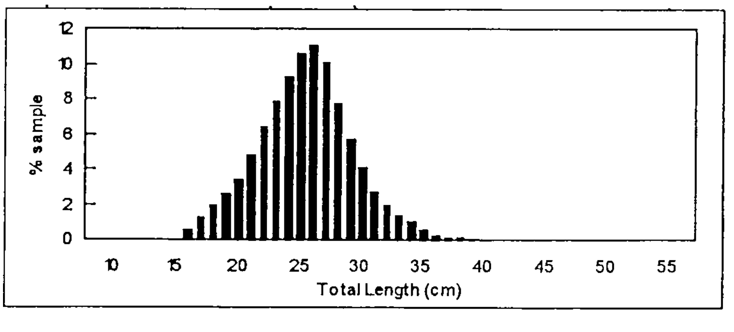
b. 1993 period (n = 26,712 measurements)



c. 1994 period (n = 20,900 measurements)



d. Pooled 1992–1994 period (n = 55,889 measurements)



ANNEXE 6

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK
IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / CR. 3

COUNTRY STATUS REPORT
MALAYSIA

(3) PENINSULAR MALAYSIA

COUNTRY STATUS REPORT: PELAGIC FISHERY RESOURCE IN PENINSULAR MALAYSIA

By

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COUNTRY STATUS REPORT: PELAGIC FISHERY RESOURCE IN PENINSULAR MALAYSIA

1. INTRODUCTION

With the declaration of her exclusive Economic Zone, Malaysia waters has increased from 47,000 sq. mi. to 160,000 sq. mi. This bring the potential national income from fisheries sector particularly through deep sea fishing industries. At present more than 456 licences have been issued for the vessels of more than 70 GRT in the Peninsular Malaysia out of which 142 of them are purse seines. Total landing in the Peninsular Malaysia in 1993 had increased by 3.4 % from the previous year to 791,618 tonnes. The west coast of Peninsular Malaysia shows more significant increased mostly contributed by trawlers from 293,57 tonnes in 1992 to 446,515 tonnes in 1993. In year 1993 the total landing in the east coast had dropped from 473,995 m.t in 1992 to 345,103 tonnes in 1993 (**Fig. 1**). Trawl nets contribute 60.5% and 56.8% of the total landing by all gears in the west and east coast respectively. In term of number, drift nets and purse seines form the second and the third largest fishing gears behind trawlers in the west coast while purse seines and hook and lines have the largest number in the east coast.

2. TOTAL ANNUAL PRODUCTION AND CATCH RATES

The annual production of *Rastrelliger* spp. seems to decrease gradually from 1984 to 1993 (**Fig. 2**). The total landings of the *Rastrelliger* spp. by all gears had dropped by 28.8% from 69,877 tonnes in 1984 to 9,726 m.t. in 1993. The west coast recorded bigger decrease of the total landings of the *Rastrelliger* spp. compared to the east coast by 47.7% and 16% respectively. In contrast, the total landings of the *Decapterus* spp. in the east coast shows an increase by 200% from 13,890 tonnes in 1984 to 42,410 tonnes in 1993 while the total landings of the *Decapterus* spp. in Peninsular Malaysia in 1993 had increased by more than 120% compared to year 1987 (**Fig. 2**).

The total landings of the small tuna by all gears in the Peninsular Malaysia look constant from 1984 until 1993 (**Fig.1**) with exceptance of the total landings in 1987 where it showed a slight increase. The total landings in 1984 was 17.723 tonnes and ropped to 15,952 tonnes in 1993. The landings of the small tuna in the east coast is 3 time higher than the landings in the west coast. **Fig. 1** shows that in 1989, the total landings for these three group species which dropped drastically in the east coast and increased back in the following year especially the *Decapterus* species. The maximum sustainable yield for the *Rastrelliger* spp. and *Decapterus* spp. in the west coast calculated through surplus production model estimated to be 45,629 tonnes and 8,419 tonnes respectively and their fMSY in term of horse power are 88,631 and 1,108,126. This bring out the idea that the *Rastrelliger* stock in the west coast waters is slightly under exploited while the catch of the *Decapterus* spp. show the other way round. The estimated potential yield of small tuna solely in the east coast waters with regard to MSY is between 14,000 to 16,000 tonnes.

Apart from tuna landings by local boats in the west coast, there are Taiwanese boats using Penang Harbour as a landing base for their tuna catches. Their catches from Indian Ocean fishing areas comprised mostly of oceanic species such as albacore *(Thannus alalunga)*, yellowfin *(Thannus albacares)* and bigeye *(Thannus obesus)* (Hsu & Liu, 1990). The total monthly landings pattern of the catches show a clear seasonality with the highest landing occured in December/January while the lowest recorded landings were in the middle of the year. Total monthly landings ranged from 136-2,040 tonnes over the period of 1990-1994 (Chee, 1994).

Fig. 2 shows the different in catch rates by two major fishing gears; purse seines and drift nets in the west and east coast of Peninsular Malaysia. In 1991, there was a sudden drop of the catch rates from these two gears to the range of 13.07 - 4.78 tonnes and 0.42 - 0.73 tonnes for purse seines and drift nets respectively. This fenomena occured probably due to a drastic increase of effort level (total no. of boats) in 1991.

3. LANDINGS PATTERN AND FISHING SEASON

Generally, the total monthly landings of small tuna in the west coast from 1990 to 1993 appeared to be constant ranging between 500 -1,000 tonnes, but between April to June the landings increased above 10,000 tonnes (**Fig. 4**). The total production in 1993 had increased by 15.2% for the west coast while the east coast recorded an increase of 31.1% during the same period. In the east coast, the fishing activities on the small tunas actively occured immediately after the end of the north-east monsoon February till October.

For the *Rastrelliger* spp., the fishing season in the east coast seem to start from August till October just immediately before the north-east monsoon where the landings range from 1,500 - 2,300 tonnes. While in the west coast there is no clear fishing seasons were observed and total monthly landings ranged from 2,000 - 4,500 tonnes. However, the total catch of the *Rastrelliger* spp. appeared to drop in August except in year 1990 **(Fig. 4).**

The fishing season of the *Decapterus* spp. in the east coast occurs at the same period as of the *Rastrelliger* spp. But, in the west coast the total monthly landings fluctuated between 500 tonnes to 1,700 tonnes and decreasing toward the end of the year. **Fig. 6** shows variation in monthly catch rates by purse seiner in one of the landing centre in the west coast. The catches appeared to be higher during March till October and start to lower toward the end of the year.

4. FISHING GEARS AND FISHING AREAS

Purse seine, drift net and trawler are the major fishing gears that catch *Rastrelliger* spp. in the west coast waters. Annual total landings in 1993 of the *Rastrelliger* spp. by trawlers and purse seines had drop in catches by 35% and 66% respectively. On the same period the drift nets have recorded an increase in catch by 50.6% **(Table 1).** For the small tuna and round scad, purse seines contributed more that 87% and 80% respectively of the total annual production in the west coast. There are two operation method of the purse seine where they use FAD (tuas) and sportlight to lure the fish, but the later method is more common and widely used by the fishermen. The trawlers of more than 70 GRT frequently operating using high opening trawl nets and *Rastrelliger brachysoma* form a dominant species caught by this gear.

Purse seines form the major fishing gear to catch small tuna, *Rastrelliger* spp. and *Decapterus* spp. in the east coast. The landings *Rastrelliger* spp. by this gear had dropped from 12,497 tonnes in 1987 to 9,807 tonnes in 1993. In contrast, the landing *Decapterus* spp. and small tuna record the increase by 6.6% and 50% respectively. Other fishing gears that contribute to the small tuna landings in the east coast are longlines and drift nets with the former form the second important gear after purse seines.

The majority of the drift nets fishermen operate along the coast line within 5nm from the shore with a depth range from 5 - 10 m. In the north western waters, the main fishing grounds for bigger GRT purse seines, extended from 10 nm from the coast toward Pulau Perak **(Fig. 5).** In the east coast, most of the purse seines operate around FAD areas more than 20 nm from the shore.

5. MAJOR PELAGIC SPECIES

The catch composition of the tuna group in the west coast is dominated by *Thannus tonggol* while *Euthynnus affinis* make up only small percentage. In the mackerel group, *Rastrelliger brachysoma* form the most abundance species. There are three species in Genus *Restralliger* occur in the west coast; *R. brachysoma, R. kanagurta* and *R. fughni.* Small pelagic caught by the purse seine nets in the west coast waters, mainly from species *Euthynnus affinis, Thannus tonggol, Decapterus* spp., *Rastrelliger kanagurta. Rastrelliger brachysoma,* and *Rastrelliger faughni* **(Table 2).** For the *Rastrelliger* spp. *Rastrelliger kanagurta* normaly caught by using FAD while the *R. brachysoma* from the main *Rastrelliger* spp. caught by high opening trawlers. Other common pelagic species are *Atule mate, Sardinella fimbriata, Selaroides leptolepis* and *Scombermorus* spp. that are also caught by purse seine nets.

The main neratic tuna species in the east coast water comprise of *Euthynnus affinis, Thannus tonggol* and *auxis thazard* where the first two species form the main spp. caught by purse seine nets, lift nets and hook and lines. Generally, *Rastrelliger kanagurta* is the dominant species and may be the only *Rastrelliger* spp. caught in the east coast waters. For the *Decapterus* spp., it consists of *Decapterus ruselli, D. maruadsi* and *D. macrosoma* (ANON, 1978). However, in the west coast waters the *Decapterus maruadsi* appeared to be the main and most common spp. caught by purse seine nets whereas in the east coast, *Decapterus ruselli* is the major species.

6. FISHERIES BIOLOGY

Biological informations of all the small pelagic and tuna species still do not cover various aspects comprehensively. The total length and weight of the *R. kanagurta* ranging from 94 - 277 mm and 71.1 - 257.2 g respectively. The combine length-weight relationship of bot juvernile, male and female is W = 3.04 x 10-6 L3.245 (Mansor, 1994). For the *Decapterus ruselli,* the size of length and weight ranging from 97 - 168 mm and 9.1 - 167.7 g respectively. While the combined length-weight relationship is W = 7.53 x 10-6 L 3.052 (Mansor, 1994).

The growth and mortality parameter recorded by Mansor (1994) for species *R. kanagurta* and *D. ruselli* from the east coast sample are shown in **Table 3.** In the west coast, the average size of *Rastrelliger kanagurta* and *Rastrelliger brachysoma* are ranged from 168 - 228.3 mm and 160 - 197 mm respectively.

Table 3: Growth and mortality parameters of *R. kanagurta* and *D. ruselli* (* average values from west coast samples).

	Loo	*K*	*M*	*F*
R. kanagurta	252-322 29.2*	0.42-1.33 0.65*	101-214	1.56-1.56
Decapterus ruselli	235-322	0.56-1.10	1.01-2.07	0.13-3.23
Euthynus affinis	65*	0.5*		

Irregular availability of sample for certain species were the limiting factor on biological sampling. This restricted the ability to provide comprehensive informations of the biological aspect particularly on species maturity. **Table 3** shows gonadosomatic indices for small pelagic and tuna species. For *Rastrelliger kanagurta,* highest values of gsi were recorded in March, April and August while for *Rastrelliger brachysoma,* the values seem to be high in all the year round except in August giving suggestion that *R. kanagurta* spawned twice a year while *R. brachysoma* spawned throughout the year.

Study on food habit of small tuna species in the east coast, shows the primary food items of the species consist of squid, anchovies, indian mackerels and filefishes (Zainuddin and Noordin, 1994). Landing pattern of the tuna species seems to exhibit similar trend of these prey particularly the squid and indian mackerels that prove close prey-predator relationship between tuna and these respective preys.

7. OCEANOGRAPHICAL INFORMATIONS

Very few data regarding oceanography informations on the coastal and offshore fishing areas are availabled. However, since 1992, study on fisheries oceanography have been carry out in the west coast particularly in the coastal areas off the northwest Peninsular Malaysia. Monthly data collection for certain parameters are still being carried out and it will be part of future fisheries research activities. On the deep sea fishing areas, the oceanographical data collection will be carried out along with the regular monthly monitoring to locate the main offshore fishing areas by using Resource Management Vessel (Kapal Pengurusan Sumber).

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Table 1: Major fishing gears used in the small pelagic fisheries in Peninsular Malaysia

WEST COAST		1987	1988	1989	1990	1991	1992	1993
	Small tuna	6	1	0	14	5	26	37
Trawlers	*Rastrelliger* spp.	16695	11858	15879	16543	10610	14600	10822
	Decapterus spp.	308	304	712	1708	898	1083	2084
	Small tuna	6056	3193	3384	4416	4836	7644	4795
Purse seines	*Rastrelliger* spp.	32380	18687	14775	20365	11940	17245	10922
	Decapterus spp.	13304	10578	12899	13850	5743	5886	8415
	Small tuna	605	1841	281	196	209	524	625
Drift nets	*Rastrelliger* spp.	7085	9427	12248	18365	12830	14221	14355
	Decapterus spp.	0	0	0	0	0	0	8
EAST COAST								
	Small tuna		22	10	30	46	37	26
Trawlers	*Rastrelliger* spp.	206	1525	569	894	1284	1745	1559
	Decapterus spp.	10	345	331	397	702	597	930
	Small tuna	2721	8529	2737	3670	4020	3199	5441
Purse seines	*Rastrelliger* spp.	12497	12494	9671	8461	12046	8746	9807
	Decapterus spp.	37665	23891	24612	33793	38160	26816	40339
	Small tuna	4303	872	1848	1708	1297	1091	1099
Drift nets	*Rastrelliger* spp.	161	286	133	597	480	1408	1652
	Decapterus spp.	0	3	1	0	0	0	12
	Small tuna	35	11	13	30		1	83
Lift nets	*Rastrelliger* spp.	26	8	136	46		7	8
	Decapterus spp.	1672	399	1802	547		385	1059
	Small tuna	11699	6258	5351	4558	4456	3574	3761
Long-lines	*Rastrelliger* spp.	631	569	168	138	511	595	270
	Decapterus spp.	1305	421	206	122	232	413	

Table 3: Average percentage of Gonadosomatic indices of small pelagic and tuna groups in the west coast of Peninsular waters.

	R. kanagurta		*R. brachysoma*		*A. thazard*		*E. affinis*		*D. maruadsi*	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
January			5.7	5						
February			3.6	4.2	0.26	0.57	0.71	1.24		
March	2.7	3.2	4.2	4.6						
April	3.3	2.8	2	1.4	0.06	0.09	0.04	0.02	0.96	1.64
May	0.2	0.4	4.8	3.6					0.03	0.01
June	0.3	0.4	4.8	3.2	0.49	0.64	0.05	0.01	1.71	2.61
July	0.6	0.8	3.7	4.8					2.62	1.42
August	2.1	2.1	0.2	0.6			3.55	7.07		
September			2.68	2.29						
October	1.61	1.58	3.7	3					0.1	0.32
November			5.8	4					0.46	1.25
December			2.9	2.2					5.72	10.56

ANNEXE 7

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / CR. 4

COUNTRY STATUS REPORT
PHILIPPINES

THE FISHERIES AND BIOLOGY OF ROUNDSCADS MACKERELS AND NERITIC TUNAS IN THE PHILIPPINES

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THE FISHERIES AND BIOLOGY OF ROUNDSCADS MACKERELS AND NERITIC TUNAS IN THE PHILIPPINES

I. INTRODUCTION

The Philippines is one of the major fishing nations of the world and was ranked 11th by weight of landings in the Food and Agriculture Organization (FAO) Fisheries Yearbook for 1988 (FAO 1988).

The Fisheries sector accounted for about 5.0% of the Country's Gross Domestic Product and about 17.0% of the Gross Value Added in Agriculture. It provides livelihood to about a million people; 5% of the country's labor force are in fisheries (Bureau of Fisheries and Aquatic Resources [BFAR], 1994).

The fisheries sector is classified into municipal and commercial fisheries and aquaculture. The municipal fisheries or small-scale, nearshore fisheries refers to fishing activities which utilize boats of less than three gross tons and those which use gears that do not require motorized boats. The municipal waters wherein municipal fishers operate extend up to 15 km (as embodied in the Local Government Code). The commercial fisheries or offshore fisheries refers to fishing activities that utilize fishing vessels over three gross tons and operate from over 15 km to the EEZ and international waters.

The Philippine marine waters is divided into 24 statistical fishing areas as recommended by FAO **(Figure 1)** for the collection of catch data. Landed catch by species (following ISSCAP) and by gear from major and minor commercial and municipal landing centers are monitored at regular intervals every month. The catches by species by gear by statistical fishing area are summarized and raised to obtain the monthly totals. The annual values are obtained from the monthly totals.

The Philippine fisheries is a multi-species, multi-gear and multi-vessel fisheries. Fishing activities is dependent on the monsoon season and are, in general, associated with *payaos*, a fish aggregating device.

The total annual marine fish landings from 1978 to 1993 ranged from 1.2 metric tons to 1.7 metric tons with a mean of 1.4 metric tons, 43% of which came from the commercial fisheries sector **(Table 1, Fig. 2).**

The roundscad, mackerels and neritic tunas form about 28% of the total marine fish landings and are generally consumed locally. However, there are undocumented values of frozen roundscads exported as baits, frigate and kawakawa as raw materials for canning.

Very few studies have been conducted on the fisheries and biology of roundscad, mackerels and neritic tunas as well as in oceanography of Philippine waters. Oceanographic cruises were conducted in some areas of the Philippines **(Figure 3).**

This paper presents a collation of all the available data and information on these pelagic fish groups and oceanography. Possible collaborrative research undertakings between and among SEAFDEC member countries are presented.

II. FISHERIES AND BIOLOGY

a. *Status of the fisheries, catch-effort information and fishing gears*

ROUNDSCADS

From 1978 to 1994, the catch of roundscads ranged from 105,013 metric tons to 274,017 metric tons with a mean of about 163,911 metric tons from the commercial fisheries. These accounted for an average of 26.4% of the commercial catch 13.3% of the total marine fish catch. The annual catches gradually increased from 1988 to 1992 but gradually decreased from 1992 to 1994 **(Table 2, Fig. 4).**

The major gears used to exploit the roundscads are purse seines, bagnet, trawl, ringnet for the commercial fisheries sector. Under the municipal fisheries sector, the gillnet is the most important. Other municipal gears are hook and line, baby purse seine/ringnet, baby bagnet, beach seine, fish corral, round haul seine and baby trawl.

The 10 most important fishing grounds are West Sulu Sea, Visayan Sea, Moro Gulf, East Sulu Sea, South Sulu Sea, Lamon Bay, Cuyo Pass, Tayabas Bay, Batangas Coast and Bohol Sea. The fishing season is throughout the year with peaks during summer, March to May, particularly in the Sulu Sea area. In Lamon Bay facing the Pacific side, the peak season is from June to August (Calvelo, *et al.* 1987).

In the regular tuna landed catch monitoring under the Philippine Tune Research Project (PTRP) conducted in Moro Gulf and South Sulu Sea areas, from 1993 to 1994, the roundscad catches were likewise recorded. Total catch and catch per unit effort were computed for purse seine, ringnet and handline. These data are presented in **Tables 6 to 11.**

The catch-per-unit effort (CPUE), expressed in metric tons (mt) per trip day (derived from the individual vessel unloadings only), in Moro Gulf ranged from 0.1 to 1.9 mt/trip day for purse seine vessels. The monthly CPUE seems to be declining from February to May 1993 but increasing from March to July 1994. The total catch in May of 1993 is higher than that of the same period in 1994; and those in July/August 1994 **(Fig. 5a).** The CPUE for ringnet vessels is very variable. The highest was 1.3 mt/trip day obtained in June and September 1994. The total catch for 1994 was better than that of 1993 (Fig. 5b).

In the South Sulu Sea area, based on landings at Puerto Princesa, Palawan, the CPUE of purse seine vessels vary greatly from 0.1 mt/trip day to 10.3 mt/trip day in April 1994 (Fig. 5c). The CPUE of ringnet vessels in 1994 ranged from 0.1 mt/trip day in January to 0.7 mt/trip day in August (Fig. 5d). Although these data are preliminary, variations in the monthly total catch and CPUE for both years may indicate the seasonality of the species.

MACKERELS

The annual catches of mackerels ranged from 43,736 mt to 90,023 mt with a mean of 68,554 mt. The annual catches from the commercial and municipal sectors did not vary much from year to year **(Table 3, Fig. 6).** The mackerels contribution to the total marine fish production for the last 16 years was 4.6% and 5.8% to the commercial fisheries sector.

The ten most important fishing grounds for mackerels are Sulu Sea, Visayan Sea, Lamon Bay, Sibuyan Sea, Moro Gulf, Samar Sea, Tayabas Bay, Bohol Sea, Camotes Sea and Cuyo Pass.

For the period 1978-1987, the most important commercial fishing gears were purse seine, trawl and ringnet. Gillnet, hook and line and baby purse seine/ringnet were the most important municipal fishing gears.

The mackerels occur seasonally in almost all fishing grounds depending on the prevailing monsoon wind.

Data for total catch and catch-per-unit effort obtained from the PTRP landed catch and effort monitoring indicated that the mackerels occurred only in South Sulu Sea and caught by ringnets. The CPUE ranged from 0.1 to 0.3 mt/trip day **(Fig. 7).**

FRIGATE/BULLET TUNA

The landings of the two species of *Auxis* were not separated in the fisheries statistics report. The statistical enumerators are not able to recognize one from the other.

The total annual landings of frigate/bullet tunas from 1978 to 1994 ranged from 45,975 mt in 1978 to 125,655 mt in 1992 with a mean of 91,460 mt **(Table 4, Fig. 8).** It was observed that 8.4% of the total marine fish landed by the commercial fisheries sector is contributed by this group. Of the tuna species, the *Auxis* spp. is the most important in terms of landed weight. The catch trends of *Auxis* and kawakawa from 1978 to 1987 for shallow-water and deep-water fishing areas are shown in **Figures 9** and **10,** respectively. The *Auxis* landings in shallow-water fishing areas show marked annual fluctuations, especially in Guimaras Strait, Ragay Gulf, Samar Sea and, to a lesser extent, in Tayabas Bay and Visayan Sea. On the other hand, *Auxis* landings in the deeper areas are more stable. The most productive shallow-water and deep-water fishing areas for *Auxis* are Visayan Sea and Moro Gulf, respectively (Yesaki *et al.* 1991).

The major gears exploiting the frigate/bullet tunas are purse seine/ringnet, and bagnet for the commercial fisheries sector while hook and line, baby purse seine/ringnet and gillnet are for the municipal fisheries sector.

The catch-per-unit effort of purse seine vessels in Moro Gulf frigate tuna ranged from 0.1 mt/trip day to 0.9 mt/trip day for January 1993 to December 1994. The total catch in 1993 was higher than that of 1994 by about 120 mt but the CPUE for 1994 was higher. For the ring net vessels, the CPUE declined from March to July but seem to be improving on the latter half of the year and became very varia in 1994 **(Figs. 11 a & b).**

For the bullet tuna, the CPUE of purse seine vessels ranged from 0.2 mt/trip day to 3.5 mt/trip day in 1993 and from 0.1 mt/trip day to 1.2 mt/ trip day in 1994. The total catch decreased from 867 mt in 1993 to 275 mt in 1994 with a corresponding decrease in CPUE also **(Fig.12a).** For the ringnet vessels, the CPUE for bullet tuna seem to be very variable which probably indicate effects of seasonality in recruitment **(Fig. 12b).**

In the South Sulu Sea, the CPUE of purse seine vessels for frigate tuna ranged from 0.1 to 0.8 mt/trip day in 1993 and from 0.1 to 3.9 mt/trip day in 1994 **(Fig. 13a).** The ringnet catch of frigate tuna was high in September 1993 but the CPUE was only 0.1 mt/trip day **(table 10).** For the bullet tuna it was from 0.1 to 1.9 mt/trip day. The CPUE increased abruptly from 0.1 mt/trip day in January 1994 to 1.9 mt/trip day in March 1994 (Fig. 14a). For the ring nets the monthly total catch of bullet tuna was exceptionally high at 30 mt in April 1993 but decreased to 0.2 mt in February 1994 **(Fig. 14b).** The total catch of handline vessels was highest in October 1993 with a corresponding high CPUE **(Fig. 14c).**

KAWAKAWA

Historical catch data for the kawakawa from 1978 to 1994 ranged from 7,269 mt in 1979 to 36,056 mt in 1994 with a mean value of 17,331 mt for the commercial sector. Those of the municipal sector ranged from 9,546 mt in 1994 to 36,421 mt in 1993 with a mean at 22,723 mt **(Table 5).** The commercial landings increased gradually from 1978 to 1989, declined in 1990 and started to increase again from 1992 to 1994. The municipal landings steadily increased from 1978 to 1983, declined slightly in 1984 and started to increase again from 1986 to 1989 **(Fig. 15).**

The kawakawa landings are generally higher in the shallow-water than in the deep-water fishing areas (Yesaki *et al,* 1991). The catch trends of kawakawa from 1978 to 1987 for shallow-water and deep-water fishing areas are shown in **Fig. 9 & 10,** respectively.

The ten most important fishing grounds for kawakawa are Cuyo Pass, Ragay Gulf, Visayan Sea, Moro Gulf, Sibuyan Sea, Davao Gulf, Bohol Sea, Tayabas Bay, Guimaras Strait and Sulu Sea.

The gears exploiting the kawakawa are similar to that for all the tunas. All commercial fishing gears catch various groups of fishes and operate under *payaos* or free school. Generally, there is no target species, but depending on the demand, they can choose which species to capture particularly if they are fishing under *payaos.*

The total catch and catch-per-unit effort purse seine, ring net and handline vessels in Moro Gulf is presented in **Figure 16.** Seasonality in the catch is indicated and CPUE trends are very variable.

In the South Sulu Sea area, the total catches from purse seine vessels were high only in February 1993 at 70 mt and December 1994 at 80 mt. The CPUEs were as low as 0.1 mt/trip day to as high as 1.2 mt/trip day **(Fig. 17a).** For the ring net vessels the total catch was highest in August 1993 at 81 mt but the CPUE was only 0.3 mt/trip day. In August 1994, the total catch was only about 13 mt but the CPUE was also 0.3 mt/trip day **(Fig. 17b).**

b. Status of exploitation and potential yield of the stock

Recent studies conducted on the small pelagic fisheries which include roundscad and mackerels concluded that the present stocks are fully exploited (Dalzell *et al.*, 1988). Even small bays have been found to be overexploited. Unless appropriate management measures are implemented, the resources may not be able to recover.

However, the resources in the northeastern, eastern, southeastern and western Philippines are believed to be under-exploited yet. Further, even the resources in the EEZ are not explored.

c. *Biology*

ROUNDSCADS

Five species of roundscads are recorderdin Philippine waters, namely: *Decapterus macrosoma, D. maruadsi, D. kurroides, D. russelli and D. macarellus.*

Dalzell *et al.* (1987) stated that there is a probability that the northern and central Philippine roundscad fishery rely on the stocks of D. *macrosoma* and D. *russelli.* Low salinity lower than 30 ppt and the density of zooplankton strongly influences the distribution and movement of roundscad. They are caught at water depths ranging from 20-25 fathoms to 100 fathoms. (Tiews, *et al.,* 1970). Ronquillo (1975) stated that roundscad are around the periphery of the Sulu Sea Basin which lies within the 200-m isobath. Tiews (1962) suggested that as the roundscad increase in size they change from a pelagic to a demersel habitat.

The growth and mortality parameters for the roundscad species in the Philippines are given in Table 12. The life span of the species of roundscad is 2.8 years for *D. russelli,* 2.8 years for *D. macrosoma* (Ingles & Pauly, 1984) and 4.2 years for *D. maruadsi* (Corpuz *et al.,* 1985).

The mean lengths at first capture for D. russelli was 4.5 cm and 12.9 cm for *D. macrosoma* by ringnets in Camotes Sea (Jabat & Dalzell, 1988).

The computed values for length-weight relationships for *D. macrosoma* was 0.005639 $L^{3.159}$ and for *D. russelli* was 0.0099771 $L^{3.015}$ indicating that both species grow isometrically.

The spawning period for *D. macrosoma* and *D. russelli* is protracted from November to March in Palawan waters and extend up to May in Manila Bay (Tiews, *et al.*, 1970). Around Calagua Island of Lamon Bay, *D. macrosoma* and *D. maruadsi* are in the maturing and immature stages with very few matured individuals during the south west monsoon (Calvelo, *et al.,* 1991). The presence of fish eggs and larvae of the family Carangidae in Lamon Bay and approaches indicate that these areas are their spawning grounds. The extensive fishing grounds for roundscads may as well be their spawning areas as very small sizes are captured thereat.

D. macrosoma and *D. russelli* are recruited into the fishery between 10 to 12 cm in length towards the end of their first year of life (Tiews, *et al.,* 1970; Ingles & Pauly, 1984). Recruitment occurs from January to April (Dalzell, *et al.,* 1987). For the Camotes ringnet fishery, two recruitment peaks were observed in a year, suggesting that these peaks were associated with the two major monsoon periods in the Philippines (Jabat & Dalzell, 1988).

The sex ratio of *Decapterus* differed by species and by area. There was more male *D. russelli* but more female *D. macrosoma* observed in Manila bay. In palawan waters there was a one-to-one ratio between males and females of both species (Tiews, *et al.,* 1970). In Camotes Sea, the male-to-female ratio was 1:05 : 1.0 for *D. russelli* while the females dominated the males by a ratio of 1.2 : 1 in *D. macrosoma* and *D. maruadsi* (Calvelo, 1991). For the Sulu Sea stocks, male to female ratio was 1.04:1.0 for *D. macrosoma* and 1.8:1 for *D. maruadsi* while that of *D. macarellus* in Moro Gulf is 1.8 : 1 (Calvelo, MS).

Fecundity (number of eggs/fish) values obtained for *D. macrosoma* were from 67,900 to 106,200 eggs while for *D. russelli* were from 28,700 to 48,000 (Tiews, *et al.,* 1970).

D. macrosoma is a rypical zoopplankton feeder while *D. russelli* feeds on smaller fishes and larger species of *Decapterus* spp. feed on benthic organisms. Both species also consume stolephorid eggs (Tiews, *et al.,* 1970).

MACKERELS

Three species belonging to the genus *Rastrelliger,* namely: *Rastrelliger brachysoma, R. kanagurta* and *R. faughni* are present in Philippine waters. The latter two species appcar to be offshore or open-water forms (manacop, 1956; Tiews, 1958). Two species of *Scomber* are also present, namely: *Scomber australasicus* and *S. japonicus.*

They were widely distributed in Philippine waters but their occurence is seasonal. Little information on the identity of the various stocks of mackerels in Philippine waters is available. FAO (1985) suggested that the mackerel population of the Southern Sulu Sea and Northern Palawan are contiguous with those of the northern Celebes Sea and western coast of Borneo. However, the degree of mixing between Rastrelliger populations from adjacent waters and the Philippines will remain unknown unless tagging experiments are carried out.

R. brachysoma is a coastal or inshore fish and subsists principally on microplankton while *R. kanagurta* is an open-sea fish and feeds mostly on macroplankton such as larval shrimps and fishes as determined from stomach content analysis (Manacop, 1956).

The spawning grounds were presumably in deeper waters since no fish with fully ripe gonads were captured from the commercial fishing grounds (Buzeta, 1978). *R. brachysoma* spawn from June to February in Manila bay. The fecundity of *R. brachysoma* in Manila Bay was estimated to be 11,300 to 119,300 eggs for fishes 16-22 cm TL (Tan, 1970).

The exploited population of *R. kanagurta* in Camotes Sea consisted of fishes from 9.0 cm to 25 cm and those of R. faughni, from 10.0 cm to 26 cm.

The recuitment patterns for these sepcies vary from area to area even within the same species but are generally either unimodal or bimodal (Dalzel, & Ganaden, 1988).

The growth and mortality parameters for *R. bracysoma, R. kanagurta* and *R. faughni* are presented in **Table 13.** The growt parameter estimates for *R. kanagurta* and R. brachysoma suggest that the life span of these mackerels is between 1.5 and 2 years (Ingles & Pauly, 1984; Dalzell & Ganaden, 1987).

NERITIC TUNAS

The neritic tunas of the Philippines consisted mainly of two species of *Auxis, A. thazard* and A. rochei (frigate/bullet tunas) and *Euthynnus affinis* (kawakawa or eastern little tuna). These are locally referred to as "tulingan, turingan or aloy". Two other species have been occasionally observed: *Thunnus tonggol* (longtail tuna) and *Sarda orientalis* (oriental bonito) but they are not recorded in the fisheries statistics and probably included under any of the tuna species on record.

Very few studies on the biology of the neritic tunas, *Auxis thazard, A. rochei* and *Euthynnus affinis* have been conducted in the Philippines.

The tuna sampling program established by FAO/UNDP/IPTP in the Philippines from 1980 to 1991 was able to generate a volume of length measurements for these species but we are not able to process and analyze these data. Barut (1988) tabulated the size ranges of the tuna species from 1985 to 1987. Following has been extracted from that table for the size ranges from ringnet catches at various landing sites:

SPECIES	1985	1986	1987	AREA
A. thazard	21 - 39 cm	21 - 39 cm	12 - 44 cm	Labuan Zamboanga
A. rochei	11 - 39	21 - 30	12 - 34	Labuan Zamboanga
E. affinis	21 - 49	21 - 48	11 - 54	Labuan Zamboanga
A. thazard	14 - 29	20 - 33	24 - 38	Opol, Mis. Or.
A. rochei	15 - 29	16 - 29	20 - 23	Opol, Mis, Or.
A. thazard	20 - 43	13 - 28	—	Sta Cruz, Davao
A. rochei	17 - 29	10 - 20	—	Sta Cruz, Davao
A. thazard	18 - 37	20 - 31	17 - 37	Gen. Santos City
A. rochei	17 - 28	19 - 27	16 - 37	Gen. Santos City
E. affinis	16 - 31	20 - 25	18 - 29	Gen. Santos City

Using the size limits for these species, *i. e.,* 38.0 cm for *A. thazard* and *A. rochei* and 42.0 cm for *E. affinis,* the exploited stocks are more or less juveniles. The catches of purse seines in 1984 are 94% juvenile frigate, 27% juvenile bullet and 62% juvenile kawakawa. Those of the ringnets were 69%, 97% and 74% respectively. However, it appears that there is continuous recruitment into the fishery of these species as through the years the size composition did not differ.

Estimation of growth and mortality parameters were not attempted for *A. rochei* and *A. thazard* as the length distributions are truncated. *A. rochei* were reported to reach 17, 29, 35 and 42 cm (FL) at age of 1 to 4 years, respectively. The modal size of *A. rochei* captured around payaos in Camotes Sea is 21 cm which suggest that the fishery may be based on fish of 1 to 2 years of age, assuming similarity in growth rates (Jabat & Dalzell, 1988).

The spawning season of *A. rochei* in Batangas, occur in March, May to July and November to Desember. The male to female ratio is 1.2 : 1.0 and the length-weight relationship is $4.529 \times 10^{-3} L^{3.36}$ (Yesaki, *et al.,* 1991).

Tunas captured by trolling during exploratory fishing were examined for maturity. The smallest ripe, spawning and spent female kawakawa found during the survey were 40, 45 and 40 cm, respectively (Wade 1950b). Bunag (1956) measured ova diameters of 30 fish (to determine maturity) and correlated the development of ova to the various maturity stages. The smallest mature and spent females examined were 49.0 cm and 47.7 cm, respectively. Ronquillo (1963) collected 144 kawakawa with lengths ranging from 33.1 to 65.2 cm and observed that females from 38.5 to 65.0 cm have gonad indices greater than 3.0 which indicates that kawakawa attains maturity at 38.0 cm.

Wade (1950b) concluded that spawning occurred throughout the year. Spawning or spent females were found in January-July and October-November. The highest gonad index occurred in March (Ronquillo, 1960). Bunag (1956) concluded from the polymodal distribution of ova diameters that kawakawa spawned more than once during a spawning season but was not able to determine the spawning frequency.

Wade (1950b) found males and females from 30 cm to 69 cm but the males were dominant in sizes 50 cm and above.

Kawakawa larvae were collected in Ragay Gulf, Burias Pass and Ticao Pass at temperatures ranging from 24.7° C and at salinities 33.53 o/oo to 34.66 o/oo (Abuso, 1988).

III. OCEANOGRAPHIC AND ENVIRONMENTAL PARAMETERS RELATED TO MARINE FISHERIES

Very few environmental data are available in the southern Philippine waters where most of the shared stocks are located . Most of the more recent data are from areas with toxic red tide problems such as Manila Bay, Masinloc Bay, Zambales and Maqueda Bay, Samar.

In the early 1950's, Megia and Villadolid (1953) analyzed the oceanographic data gathered by *Spencer F. Baird* from 1947-1950. The paper analyzes the water mass movement, including that of southeastern Mindanao waters.

In 1965 to 1969, the Cooperative Study of the Kuroshio was undertaken jointly by several government agencies. The study collected data on water temperature, salinity and zooplankton, among other things.

During the Winter Cruise, Eastern Mindanao waters had one of the maximum densities of zooplankton. Fish eggs density was also high but not for fish larvae. The same pattern of abundance for zooplankton was noted for the Summer Cruise but the exact opposite of the Winter Cruise was observed for fish eggs and larvae.

A few hydrological data are available in April and May 1976 from Balabac Strait, Cagayan de Sulu and Turtle Island. The data, however, are limited to surface water temperature, salinity and dissolved oxygen.

The surface water temperature was almost uniformly distributed with the exception of a station near Tawi-tawi Island which had relatively high temperature despite its reading at 0800 hrs. Similar to surface water temperature, surface water salinities and dissolved oxygen concentration were high with ranges from 33.18 ppt to 34.91 ppt and 4.23 ml/L to 4.82 ml/L, respectively.

In addition, a one-year bimonthly oceanographic data were taken in 1977-1978 in Malampaya sound, northern Palawan. The surface temperature showed a decreasing trend from the onset of the northeast monsoon season, reaching its minimum values in February. The temperature increased considerably in May 1978, attaining its peak in June, then it exhibited a decreasing trend towards the end of the southwest monsoon period.

The vertical profile of water temperature for October and December 1977 showed a water mass which appears to be an upwelling near the central islands. The occurrence of an upwelling which was noted from the temperature profile in October and December 1977 in the central part of the Sound was also noted from the vertical distribution of salinity in the area for the same period.

The average dissolved oxygen values were above 4 ml/L and practically uniform throughout the survey period.

The zooplankton biomass higher in the Inner Sound than in the Outer Sound in all survery months, except in February 1978. The increase of zooplankton volume in February in the Outer Sound may be due to the increase in its volume near the entrance during the period.

Due to scarcity of hydrological data that will be correlated with the distribution and abundance of shared resources in the area, it is important that an environmental assessment within the region be carried out collaboratively.

IV. RECOMMENDATIONS FOR COLLABORATIVE RESEARCH

In line with the Region's implementation of the provision of the UNCLOS regarding shared/straddling stocks of species between and among ASEAN and SEAFDEC member countries, it is imperative that information on these resources, as well as the environmental conditions affecting their distribution and abundance are obtained.

Collaborative research efforts then should focus on the assessment of the resources in the EEZ and international waters to serve as the scientific basis for recommending management options which can be agreed upon to properly utilize and share these resources. The possibility of contiguity of and interactions between the shared/straddling/ transboundary stocks of some species of roundscads, mackerels, neritic tunas and other pelagic groups between and among neighboring countries in the SEA region connot be discounted. To prove this, there is a need to do tangging and/or electrophoretic and mitochondril DNA (mt DNA) studies to determine similarity/dissimilarity in stocks and structure of their population. These could be carried out collaboratively or individually by countries through exchange of experimental materials and information.

Very limited information on the relationship between production and environmental parameters particularly in the Philippines and SEAFDEC member countries is available. It has been observed that the environment has affected production of small pelagic fishes in Southeast Asia and the South Pacific. In view thereof, collaborative oceanographic cruises and experimental fishing in contiguous areas of the Region should be conducted. A Regional Program can be developed and source funds for its implementation with member countries, sending scientists to participate in the implementation. Consultants can be hired to effectively and efficiently generate the information required by the Program.

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Table 1: Annual marine fish production trends (mt) from Philippine waters (1978-1993)

Year	*Commercial*	*Municipal*	*Total*
1978	505,840	775,932	1,281,772
1979	500,747	737,587	1,238,334
1980	488,478	762,405	1,250,883
1981	494,768	709,989	1,204,757
1982	526,273	708,016	1,234,289
1983	519,316	770,988	1,290,304
1984	513,335	789,975	1,303,310
1985	511,987	785,132	1,297,119
1986	546,230	807,275	1,353,505
1987	591,192	816,247	1,407,439
1988	599,995	838,366	1,438,361
1989	637,138	882,369	1,519,507
1990	700,564	895,040	1,595,604
1991	759,815	913,524	1,673,339
1992	804,866	854,687	1,659,553
1993	845,431	803,194	1,648,625
X	596,623	803,170	1,399,794

Table 2: Annual production trends of roundscads (mt) from Philippine waters (1978-1994)

Table 3 : Annual production trends of mackerels (mt) from Philippine waters (1978-1994)

Year	*ROUNDSCADS*			*MACKERELS*		
	Commercial	*Municipal*	*Total*	*Commercial*	*Municipal*	*Total*
1978	115,030	18,939	133,969	30,459	27,798	58,257
1979	114,868	31,338	146,206	24,537	32,349	56,886
1980	111,316	20,813	132,129	22,129	24,384	46,513
1981	120,857	29,090	149,947	24,344	23,046	47,390
1982	150,266	32,987	183,253	22,001	21,735	43,736
1983	131,261	33,792	165,053	34,684	28,214	62,898
1984	105,013	26,570	131,583	29,127	31,715	60,842
1985	106,262	25,446	131,708	33,759	32,615	66,374
1986	151,298	24,557	175,855	33,454	32,022	65,476
1987	154,059	30,352	184,411	36,613	31,440	68,053
1988	149,213	29,474	178,687	39,621	40,470	80,091
1989	179,873	29,948	209,821	38,032	36,930	74,962
1990	220,379	28,921	249,300	51,910	37,399	89,309
1991	246,960	30,370	277,330	49,299	40,724	90,023
1992	274,017	22,962	296,979	37,287	48,811	86,098
1993	245,504	26,545	272,049	44,692	38,788	83,480
1994	210,312	22,901	233,213	46,803	38,221	85,024
X	163,911	27,353	191,264	35,221	33,333	68,554

*Preliminary values only (BAS)

Sources of basic data: BFAR Fisheries Statistics of the Phil. 1978-1983.
BAS Fishery Statistics, 1984-1993.

Table 4: Annual production trends of frigate/bullet (mt) from Philippine waters (1978-1994)

Table 5: Annual production trends of eastern little tuna (kawa-kawa) (mt) from Philippine waters (1978-1994)

Year	*FRIGATE/BULLET TUNAS*			*EASTERN LITTLE TUNA*		
	Commercial	*Municipal*	*Total*	*Commercial*	*Municipal*	*Total*
1978	20,897	25,078	45,975	9,444	14,410	23,854
1979	39,694	40,215	79,909	7,269	15,825	23,094
1980	53,310	43,564	96,874	9,958	14,772	24,730
1981	47,141	31,107	78,248	13,071	17,820	30,891
1982	39,862	27,501	67,363	14,442	32,082	46,524
1983	34,097	40,122	74,219	12,459	36,421	48,880
1984	47,360	32,945	80,305	18,832	23,067	41,899
1985	53,478	42,240	95,718	18,673	22,387	41,060
1986	44,196	43,029	87,225	20,348	22,097	42,445
1987	57,670	40,362	98,032	22,613	24,321	46,934
1988	66,746	38,690	105,436	22,192	34,074	56,266
1989	75,683	41,862	117,545	25,169	32,730	57,899
1990	46,026	42,775	88,801	8,519	35,243	43,762
1991	49,997	43,239	93,236	17,017	30,833	47,850
1992	60,214	65,441	125,655	21,447	10,496	31,943
1993	56,897	53,460	110,357	17,124	9,546	26,670
1994	58,276	51,653	109,929	36,056	10,166	46,222
X	50,091	41,370	91,460	17,331	22,723	40,054

*Preliminary values only (BAS)

Sources of basic data: BFAR Fisheries Statistics of the Phil., 1978-1983.
BAS Fishery Statistics, 1984-1993.

Table 6: Monthly landings and catch per unit effort data from Moro Gulf based on landings of purse seine vessels (1993-1994) 1/

MONTH and YEAR	*ROUNDSCAD*		*FRIGATE TUNA*		*BULLET TUNA*		*KAWAKAWA*		*ALL SPECIES*	
	Total Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*
January '93	0.4	—	9.7	0.4	—	—	—	—	49.2	1.8
February	112.2	1.9	49.7	0.8	74.9	1.3	26.0	0.4	386.1	6.5
March	52.7	0.8	35.1	0.5	91.5	1.3	16.0	0.2	366.0	5.3
April	50.0	0.8	24.3	0.4	211.6	3.5	2.8	0.1	482.2	8.0
May	151.0	0.2	147.7	0.2	140.3	0.2	4.1	—	29641.1	45.5
June	23.9	0.6	16.1	0.4	—	—	—	—	322.4	8.1
July	7.8	0.1	12.2	0.2	20.2	0.4	2.7	0.1	262.1	4.9
August	11.5	0.1	10.9	0.1	87.3	0.9	14.2	0.1	755.5	7.4
September	43.2	0.3	71.1	0.6	98.6	0.8	55.8	0.4	807.2	6.3
October	4.4	0.1	41.9	0.6	95.9	1.5	27.9	0.4	519.9	7.9
November	8.6	0.1	47.9	0.7	26.3	0.4	9.7	0.1	464.5	6.8
December	6.6	0.1	10.5	0.2	20.6	0.4	4.7	0.1	372.0	6.5
TOTAL	472.2	0.5	477.0	0.4	867.2	0.9	163.8	0.2	34428.2	11.4

MONTH and YEAR	ROUNDSCAD		FRIGATE TUNA		BULLET TUNA		KAWAKAWA		ALL SPECIES	
	Total Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*
January '94	50.4	0.5	57.3	0.6	15.4	0.2	3.4	—	662.0	6.4
February	6.4	0.1	22.6	0.4	33.5	0.6	4.3	0.1	284.5	5.3
March	3.5	0.1	9.4	0.4	14.6	0.6	1.9	0.1	117.4	4.7
April	5.4	0.2	20.9	0.9	12.6	0.5	4.0	0.2	202.3	8.3
May	16.8	0.4	10.3	0.2	8.2	0.2	1.2	—	186.7	3.9
June	39.2	0.5	59.9	0.8	90.6	1.2	6.5	0.1	447.7	5.9
July	57.2	0.6	40.8	0.4	39.1	0.4	26.4	0.3	628.7	6.2
August	57.3	0.4	40.8	0.3	8.9	0.1	40.8	0.3	658.5	4.5
September	7.9	0.2	30.0	0.8	7.2	0.2	27.0	0.7	179.6	4.9
October	7.7	0.4	16.1	0.8	2.8	0.1	4.1	0.2	85.5	4.4
November	0.5	—	12.7	0.3	13.9	0.4	2.5	0.1	85.7	2.3
December	3.9	0.1	32.5	0.6	28.0	0.5	10.7	0.2	267.0	5.1
TOTAL	256.2	0.3	353.4	0.5	274.9	0.4	32.8	0.2	3805.7	5.4

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpublished).

* Raised catch from sample boat total catches using % coverage and % days sampled.

** Catch per unit effort derived from the individual vessel unloaded catch only.

*** 98.3% of this (29,126.2 mt) is Yellowfin and Skipjack>.

Table 7: Monthly catch and catch per unit effort from Moro Gulf based on landings of ringnet vessels (1993-1994) 1/

MONTH and YEAR	ROUNDSCAD		FRIGATE TUNA		BULLET TUNA		KAWAKAWA		ALL SPECIES	
	Total Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*
January '93	55.7	0.5	97.0	0.8	168.6	1.4	46.0	0.4	1082.5	8.9
February	—	—	166.3	0.8	255.5	1.3	37.7	0.2	840.2	4.2
March	68.1	0.3	241.1	0.9	272.5	1.0	21.9	0.1	1547.4	5.7
April	35.2	0.2	83.8	0.5	13.4	0.1	2.5	—	667.9	3.8
May	32.4	0.1	84.6	0.3	213.0	0.6	36.5	0.1	1039.1	3.0
June	12.7	—	96.4	0.3	128.1	0.4	40.7	0.1	949.4	3.2
July	166.5	0.4	89.9	0.2	148.1	0.4	0.5	—	2387.9	6.3
Augst	42.6	0.2	76.7	0.3	241.7	0.9	21.2	0.1	1145.0	4.3
September	19.8	0.1	112.8	0.8	155.0	1.1	57.9	0.4	1353.4	9.8
October	216.7	0.6	167.5	0.5	193.9	0.5	35.1	0.1	2212.8	6.2
November	70.4	0.3	103.7	0.5	62.2	0.3	4.3	—	1167.2	5.7
December	94.4	0.7	134.6	1.0	156.6	1.2	9.3	0.1	1245.8	9.3
TOTAL	814.3	0.3	1454.2	0.5	2008.4	0.7	313.5	0.1	15638.6	5.7
January '94	63.9	0.6	55.4	0.5	46.8	0.5	4.9	0.1	783.6	7.6
February	45.1	0.2	217.4	0.9	122.2	0.5	22.5	0.1	1373.2	5.4
March	27.1	0.1	132.7	0.5	255.0	0.9	16.6	0.1	1514.7	5.2
April	117.1	0.5	109.3	0.5	172.7	0.8	4.1	—	960.7	4.4
May	130.7	0.5	227.1	0.9	119.3	0.5	9.3	—	1660.0	6.6
June	239.2	1.3	303.5	1.7	290.6	1.6	36.8	0.2	1844.0	10.2

MONTH and YEAR	ROUNDSCAD		FRIGATE TUNA		BULLET TUNA		KAWAKAWA		ALL SPECIES	
	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE*8 (mt/trip day)
July	108.1	0.4	147.8	0.5	235.4	0.8	6.7	—	1453.5	4.8
August	212.1	1.2	148.0	0.8	189.8	1.1	34.2	0.2	2718.8	15.1
September	480.8	1.3	266.4	0.7	853.6	2.2	28.0	0.1	2708.5	7.1
October	268.7	0.6	235.1	0.5	974.6	2.1	30.6	0.1	3084.2	6.6
November	160.2	0.6	172.9	0.6	904.1	3.4	28.3	0.1	2268.5	8.5
December	62.4	0.2	160.2	0.6	429.1	1.6	21.3	0.1	1803.8	6.6
TOTAL	1915.6	0.6	2175.8	0.7	4593.1	1.4	243.1	0.1	22174.0	7.3

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpubli shed).

* Raised catch from sample boat total catches using coverage and dau sampled.

** Catch per unit effort derived from the individual vessel unloaded catch only.

Table 8: Monthly catch and catch per unit effort from Moro Gulf based on landings of handline vessels (19)

MONTH and YEAR	FRIGATE TUNA		BULLET TUNA		KAWAKAWA		ALL SPECIES	
	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)	Total* Catch (mt)	CPUE** (mt/trip day)
January '93	6.8	2.0	9.7	3.0	6.6	2.0	266.6	69.0
February	6.6	2.0	3.3	1.0	3.7	1.0	246.5	61.0
March	2.9	1.0	—	—	3.9	1.0	300.2	59.0
April	0.3	—	—	—	—	—	174.4	117.0
May	2.7	1.0	3.4	1.0	2.4	—	367.2	77.0
June	2.8	—	1.9	—	0.9	—	397.0	66.0
July	8.7	2.0	3.2	1.0	3.5	1.0	403.0	75.0
Augst	0.6	—	—	—	3.6	1.0	213.9	48.0
September	7.0	1.0	2.3	—	8.3	1.0	316.5	48.0
October	6.8	1.0	1.9	—	15.1	2.0	530.4	69.0
November	0.4	—	3.9	1.0	4.4	1.0	433.9	73.0
December	—	—	—	—	—	—	402.0	68.0
TOTAL	45.4	1.0	29.5	1.0	52.2	1.0	4051.5	67.0
January '94	3.2	1.0	4.3	1.0	0.5	—	266.2	56.0
February	5.0	1.0	9.8	2.0	14.3	3.0	306.8	57.0
March	15.8	2.0	12.2	2.0	1.1	—	482.8	61.0
April	5.0	—	5.6	—	3.6	—	676.6	59.0
May	4.8	1.0	1.5	—	1.6	—	367.3	6380
June	7.1	1.0	5.1	1.0	1.4	—	321.5	63.0
July	3.5	—	2.5	—	9.2	1.0	479.6	52.0
August	2.1	—	0.3	—	2.8	—	191.9	33.0
September	5.7	1.0	5.7	1.0	11.5	2.0	219.6	35.0
October	2.7	—	0.6	—	2.8	—	318.2	39.0
November	17.2	1.0	16.5	1.0	3.5	—	560.6	45.0
December	6.8	1.0	14.8	1.0	3.9	—	570.1	52.0
TOTAL	78.8	1.0	78.7	1.0	56.2	1.0	4761.2	50.0

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpublished).

* Raised catch from sample boat total catches using % coverage and % days sampled.

** Catch per unit effort derived from the individual vessel unloaded catch only.

Table 9: Monthly catch and catch per unit effort data from South Sulu Sea based on the landings of handline vessels (1993-1994)1/

MONTH and YEAR	*FRIGATE TUNA*		*BULLET TUNA*		*KAWAKAWA*		*ALL SPECIES*	
	Total Catch (mt)*	*CPUE** (kg/trip day)*	*Total* Catch (mt)*	*CPUE** (kg/trip day)*	*Total* Catch (mt)*	*CPUE** (kg/trip day)*	*Total* Catch (mt)*	*CPUE** (kg/trip day)*
1993								
January	—	—	—	—	—	—	131.2	36.0
February	3.3	2.0	1.3	1.0	6.5	4.0	125.6	71.0
March	6.7	4.0	4.9	3.0	5.1	3.0	190.6	103.0
April	2.7	1.0	—	—	0.5	—	254.1	88.0
May	1.4	—	0.9	—	0.3	—	202.9	57.0
June	—	—	—	—	0.6	—	114.5	82.0
July	—	—	0.1	—	—	—	189.9	87.0
August	4.5	3.0	4.0	3.0	12.4	9.0	151.4	104.0
September	4.0	3.0	2.0	1.0	12.0	9.0	131.7	94.0
October	3.3	3.0	8.7	7.0	9.5	8.0	150.0	121.0
November	2.9	1.0	3.1	1.0	1.7	1.0	222.1	83.0
December	5.9	3.0	4.8	2.0	1.4	1.0	198.4	92.0
TOTAL	34.7	2.0	29.8	2.0	50.0	3.0	2062.4	85.0
1994								
January	4.6	3.0	2.9	2.0	3.1	2.0	144.7	80.0
February	4.2	2.0	2.8	2.0	2.1	1.0	107.0	62.0
March	10.5	3.0	5.7	2.0	4.9	2.0	232.2	71.0
April	3.7	2.0	1.9	1.0	1.7	1.0	136.2	79.0
May	1.8	1.0	2.8	1.0	—	—	147.2	59.0
June	5.3	1.0	4.0	1.0	4.0	1.0	261.7	74.0
July	3.0	1.0	1.9	1.0	3.4	2.0	148.8	69.0
August	2.4	2.0	0.5	—	2.3	2.0	55.9	53.0
September	2.1	3.0	2.2	4.0	4.3	7.0	39.7	66.0
October	3.2	4.0	3.4	4.0	1.1	1.0	61.2	68.0
November	1.0	1.0	0.6	410	0.8	1.0	44.5	58.0
December	1.9	8.0	0.9	4.0	0.3	1.0	44.1	178.0
TOTAL	43.7	2.0	29.6	2.0	28.0	2.0	1423.2	73.0

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpublished).
* Raised catch from sample boat total catches using % coverage and % days sampled.
** Catch per unit effort derived from the individual vessel unloaded catch only.

Table 10: Monthly catch and catch per unit effort data from South Sulu Sea based on the landings of ringnet vessels (1993-1994)1/

MONTH and YEAR	*ROUNDSCAD*		*MACKERELS*		*FRIGATE TUNA*		*BULLET TUNA*		*KAWAKAWA*		*ALL SPECIES*	
	Total Catch (mt)*	*CPUE** (kg/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (kg/trip day)*
1993												
January	0.7	—	—	—	12.1	0.1	5.1	0.1	7.4	0.1	32.9	
February	1.3	—	—	—	2.3	—	—	—	17.9	0.1	39.5	
March	20.3	0.1	0.5	—	6.7	—	7.4	—	13.4	0.1	72.4	
April	3.4	—	—	—	18.2	0.1	30.0	0.2	15.3	0.1	125.3	
May	2.0	—	16.6	0.1	18.5	0.1	2.6	—	25.3	0.1	136.6	
June	—	—	0.6	—	1.3	—	1.4	—	5.5	0.1	30.3	
July	—	—	11.6	0.1	20.7	0.1	—	—	10.8	0.1	96.1	
August	—	—	1.3	—	41.1	0.1	—	—	80.6	0.3	154.7	
September	—	—	2.1	—	45.7	0.1	5.0	—	27.4	0.1	100.0	
October	—	—	13.3	0.1	3.8	—	3.6	—	25.1	0.2	62.6	
November	—	—	34.1	0.2	15.1	0.1	—	—	27.5	0.1	101.3	
December	—	—	55.1	0.2	6.1	—	—	—	40.5	0.2	175.6	
TOTAL	27.7	0.1	135.2	11.3	191.6	0.1	55.1	—	296.7	0.1	1127.3	
1994												
January	8.0	0.1	13.7	11.3	7.2	0.1	0.4	—	8.5	0.1	57.4	
February	48.8	0.3	14.6	0.2	3.4	—	0.2	—	12.6	0.1	133.5	
March	62.8	0.2	53.3	0.1	1.4	—	—	—	19.3	0.1	169.5	
April	13.2	0.3	6.6	0.2	0.1	—	1.0	—	6.8	0.2	45.4	
May	16.8	0.4	3.4	0.2	0.1	—	0.7	—	5.3	0.1	37.6	
June	85.9	0.3	8	0.1	—	—	5.7	—	31.9	0.1	167.1	
July	38.4	0.6	8.6	—	—	—	2.5	—	22.3	0.4	100.3	
August	25.5	0.7	5.1	0.1	—	—	2.1	0.1	12.7	0.3	56.1	
September	11.2	0.2	2.9	0.1	—	—	2.0	—	10.6	0.2	34.2	
October	21.0	0.6	5.7	—	—	—	1.4	—	10.7	0.3	45.8	
November	20.9	0.2	3.1	0.2	7.3	0.1	1.9	—	10.6	0.1	53.8	
December	10.2	0.5	—	—	—	—	0.5	—	4.2	0.2	25.0	
TOTAL	362.7	0.3	125.0	0.1	19.5	—	18.4	—	155.5	0.2	925.7	

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpublished).

* Raised catch from sample boat total catches using % coverage and % days sampled.

** Catch per unit effort derived from the individual vessel unloaded catch only.

Table 11: Monthly catch and catch per unit effort data from South Sulu Sea based on the landings of purse seine vessels (1993-1994) 1/

MONTH and YEAR	*ROUNDSCAD*		*FRIGATE TUNA*		*BULLET TUNA*		*KAWAKAWA*		*ALL SPECIES*	
	Total Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*	*Total* Catch (mt)*	*CPUE** (mt/trip day)*
1993										
January	1.8	—	—	—	18.1	0.2	—	—	443.7	3.9
February	17.4	0.1	77.6	0.2	21.6	0.1	67.4	0.2	4357.3	12.2
March	99.2	0.6	19.1	0.1	15.3	0.1	11.3	0.1	594.3	3.8
April	—	—	—	—	—	—	—	—	347.4	2.3
May	12.7	1.1	9.6	0.8	—	—	—	—	107.1	9.3
June	51.9	0.2	13.8	—	—	—	27.6	0.1	*** 27322.1	85.0
July	—	—	—	—	—	—	—	—	471.3	8.2
Augst	0.7	—	—	—	—	—	6.7	0.1	726.2	11.3
September	21.8	0.2	58.4	0.5	26.4	0.2	31.7	0.3	801.9	7.3
October	8.4	0.1	15.6	0.1	—	—	9.6	0.1	663.7	5.4
November	—	—	27.3	0.3	37.1	0.2	17.9	0.2	698.9	8.7
December	—	—	—	—	—	—	—	—	3751.8	18.2
TOTAL	213.9	0.2	221.4	0.1	118.5	0.1	172.2	0.1	40285.7	14.2
1994										
January	0.5	—	0.8	0.1	0.9	0.1	0.3	—	79.0	6.3
February	79.7	3.6	16.7	0.9	20.7	0.9	14.0	0.6	1030.9	45.9
March	—	—	39.3	3.9	19.3	1.9	—	—	88.6	8.8
April	280.8	10.3	3.1	0.1	9.3	0.3	—	—	1122.4	411.3
May	52.3	1.2	15.9	0.4	28.3	0.6	5.3	0.1	507.1	11.4
June	20.4	0.4	24.0	0.5	13.0	0.3	15.9	0.3	319.5	6.9
July	2.3	0.1	—	—	5.9	0.2	2.1	0.1	836.9	26.8
August	21.1	0.5	6.1	0.2	0.7	—	5.1	0.1	151.6	3.7
September	3.1	—	5.1	0.1	47.2	0.5	56.0	0.6	2384.9	24.7
October	11.6	0.1	6.9	0.1	16.6	0.2	30.4	0.3	2124.6	21.6
November	31.5	0.4	—	—	2.5	—	9.8	0.1	263.2	3.4
December	44.9	0.7	—	—	6.7	0.1	80.5	1.2	1230.5	17.7
TOTAL	548.2	1.1	117.9	0.2	171.1	0.3	219.4	0.4	10139.2	18.2

1/ Preliminary data from the tuna landed catch monitoring under PTRP (unpublished).
* Raised catch from sample boat total catches using % coverage and % days sampled.
** Catch per unit effort derived from the individual vessel unloaded catch only.
*** 99.4% (27,161.8) of this yellowfin and skipjack.

Table 12: Growth and mortality parameters for roundscad species in the Philippines1/

Species	*Location*	*Loo*	*K*	*Lmax*	*Tmax*	*Q*	*M*	*Reference*
Decapterus macrosoma	Cmotes Sea	25.0	0.88	—	—	2.74	1.73	Jabat and Dalzell (1988)
	Manila Bay	31.5	0.65	28.0	3.63	2.81	1.33	Ingles and Pauly (1984)
	Manila Bay	31.5	0.71	28.0	3.32	2.85	1.41	Ingles and Pauly (1984)
	Palawan	27.0	0.90	25.0	3.10	2.82	1.72	Ingles and Pauly (1984)
	Palawan	26.8	0.71	25.0	4.04	2.71	1.47	Ingles and Pauly (1984)
	Palawan	26.5	1.00	25.0	3.04	2.85	1.85	Ingles and Pauly (1984)
	Palawan	27.8	0.83	25.0	2.50	2.81	1.61	Ingles and Pauly (1984)
	Palawan	33.0	0.50	31.0	5.92	2.74	1.10	Ingles and Pauly (1984)
	Palawan	27.5	1.25	21.0	1.30	2.88	2.12	Ingles and Pauly (1984)
	Palawan	25.0	1.20	20.0	1.50	2.88	2.12	Ingles and Pauly (1984)
	Palawan	25.5	0.85	22.0	2.20	2.74	1.68	Ingles and Pauly (1984)
	Palawan	25.50	0.80	22.0	2.20	2.72	1.62	Ingles and Pauly (1984)
	Palawan	33.0	0.65	30.0	3.90	2.85	1.31	Ingles and Pauly (1984)
	Palawan	30.0	0.74	27.0	3.30	2.82	1.47	Ingles and Pauly (1984)
	Samar Sea	23.0	1.25	22.0	—	2.82	2.19	Corpuz et al (1985)
	Ragay Gulf	25.5	1.26	23.0	—	2.91	2.12	Corpuz et al (1985)
D. maruadsi	Burias Pass	27.7	0.82	22.0	—	2.63	1.67	Corpuz et al (1985)
	Samar Sea	23.55	0.81	23.0	—	2.65	1.64	Corpuz et al (1985)
	Ragay Gulf	23.5	0.52	22.0	—	2.46	1.22	Corpuz et al (1985)
D. kurroides	Davao Gulf	25.0	0.80	—	—	2.39	1.62	Gonzales (1991)
D. russelli	Manila Bay	27.0	0.80	23.0	2.60	2.77	1.59	Ingles and Pauly (1984)
	Manila Bay	30.0	0.54	26.0	4.00	2.69	1.19	Ingles and Pauly (1984)
	Manila Bay	26.9	0.69	24.0	3.40	2.70	1.44	Ingles and Pauly (1984)
	Manila Bay	26.0	0.73	24.0	3.80	2.69	1.51	Ingles and Pauly (1984)
	Manila Bay	33.0	0.45	28.0	4.54	2.69	1.03	Ingles and Pauly (1984)
	Camotes Sea	33.7	0.36	—	—	2.61	0.89	Jabat and Dalzell (1988)

1/ Lifted from Dalzell *et. al.*

Table 13: Growth and mortality parameters for the mackerel species in the Philippines

Species	*Location*	*Loo*	*K*	*Lmax*	*Tmax*	*Q*	*M*	*Reference*
Rastrelliger brachysoma	Samar Sea	24.5	1.28	22.0	1.7	2.89	2.17	Corpuz et al (1985)
	Samar Sea	25.0	1.30	23.0	2.1	2.91	2.32	Corpuz et al (1985)
	Samar Sea	25.5	1.45	23.0	1.7	2.97	2.19	Corpuz et al (1985)
	Manila Bay	34.0	1.10	30.0	2.1	3.10	1.84	Ingles and Pauly (1984)
	Samar Sea	25.0	1.60	22.0	1.4	3.00	2.56	Ingles and Pauly (1984)
	Manila Bay (1958-60)	34.0	0.98	—	—	—	—	BFAR files (unpublished)
	Visayan Sea (1983)	34.0	0.98	—	—	—	—	BFAR files (unpublished)
	Visayan Sea (1984)	32.5	1.20	—	—	—	—	BFAR files (unpublished)
	Samar Sea (1984)	29.75	1.30	—	—	—	—	BFAR files (unpublished)
	Leyte Gulf (1985)	34.0	0.98	—	—	—	—	BFAR files (unpublished)
R. faughni	Camotes Sea	25.9	1.45	—	—	2.99	2.44	Jabat and Dalzell (1988)
R. kanagurta	Illana Bay (1984)	39.0	0.72	—	—	3.04	—	BFAR files (unpublished)
	Illana Bay (1983)	39.0	0.72	—	—	3.04	—	BFAR files (unpublished)
	Guimaras Strait (1985)	27.8	1.65	—	—	3.10	—	BFAR files (unpublished)
	Samar Sea (1984)	26.5	1.60	—	—	3.05	—	BFAR files (unpublished)
	Visayan Sea (1984)	37.0	0.70	—	—	2.98	—	BFAR files (unpublished)
	Visayan Sea (1983)	29.5	1.50	—	—	3.12	—	BFAR files (unpublished)
	Visayan Sea (83-87)	38.0	0.80	—	—	3.06	—	Guanco (1991)
	Samar Sea	27.5	1.30	25.0	2.0	2.99	2.11	Corpuz et al (1985)
	Samar Sea	28.0	1.31	26.0	2.0	3.01	2.13	Corpuz et al (1985)
	Palawan waters	28.0	1.55	25.0	1.5	3.08	2.43	Ingles and Pauly (1984)
	Camotes Sea	25.5	1.50	—	—	2.99	2.45	Jabat and Dalzell (1988)

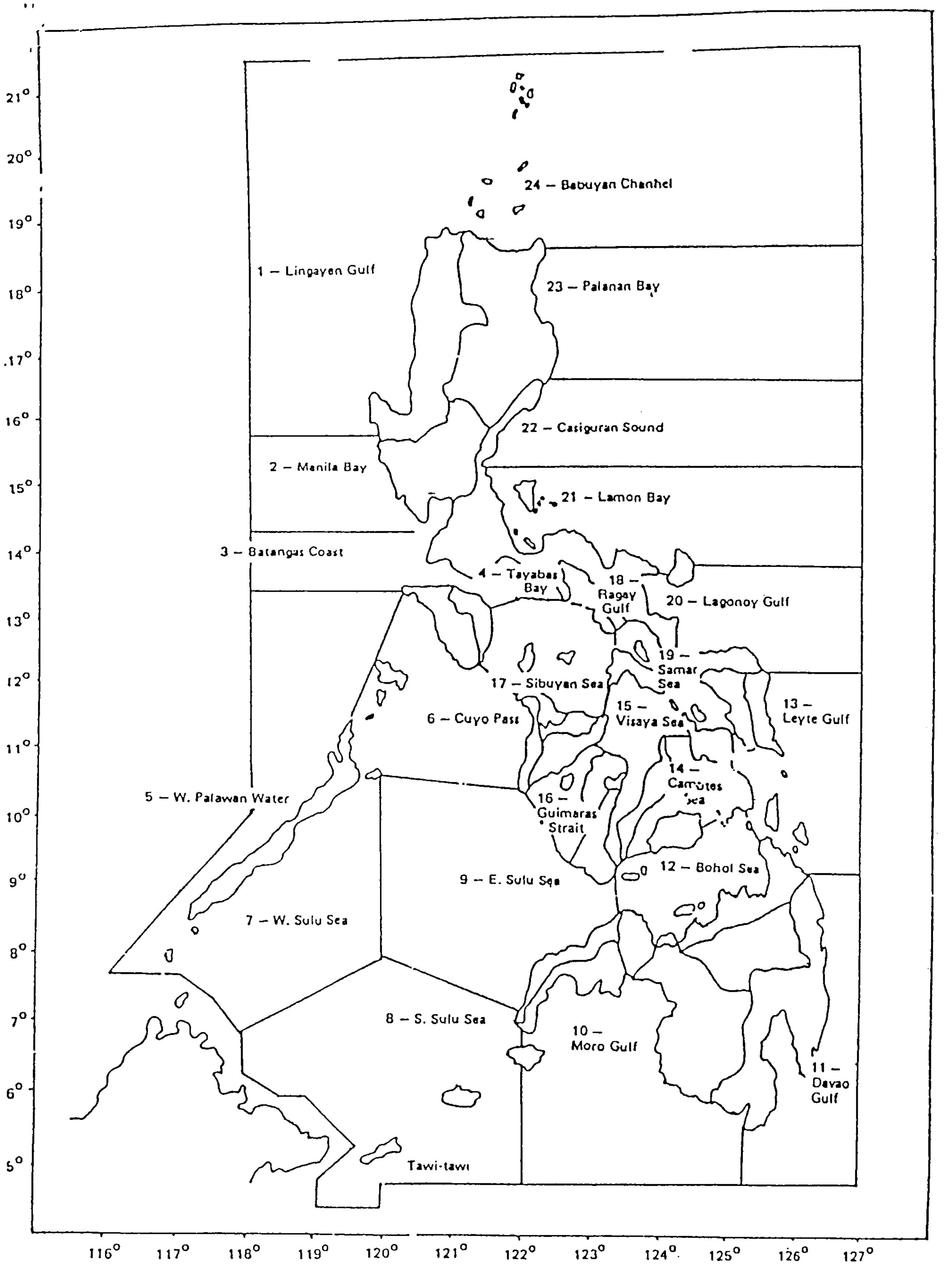

Figure 1. Map pf the Philippines showing the 24 statistical fishing areas.

ANNEXE 8

Annex 8

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 – 20 July, 1994

SEAFDEC / MFRDMD / WS / 95 / CR. 5

COUNTRY STATUS REPORT
BRUNEI DARUSSALAM

MACKERELS, ROUND SCADS AND NERITIC TUNAS FISHERIES OF NEGARA BRUNEI DARUSSALAM

By

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Fisheries of Negara Brunei Darussalam

MACKERELS, ROUND SCADS AND NERITIC TUNAS FISHERIES OF NEGARA BRUNEI DARUSSALAM

1. INTRODUCTION

Pelagic capture fishery plays an important role as one of the contributor to the annual domestic fish requirement in Negara Brunei Darussalam. Of all households expenditure on seafood in the country, 23% goes to pelagic fishes and only 15% on demersals as can be seen from the **Table** below.

Table 1: Expenditure on Seafood in Brunei, by Category

Pelagics	23%
Shrimp and prawns	22%
Cured fish products	16%
Demersals	15%
Other fish	9%
Other Crustacea and molluscs	4%
Canned fish	3%
Other	8%
	100%

Source of Data: Statistics Division, EPU, Ministry of Finance.

Out of the total of 23% expenditure on pelagics, 14% spending is on the small pelagic fishes and the rest 9% goes to large pelagics. For the purpose of this workshop, the paper deals with the fisheries of mackerels, round scads and neritic tunas only, although data on the other pelagics are also included.

2. FISHING GROUND AND TYPES OF GEAR EMPLOYED

Brunei Darussalam has an EEZ totalling rounghly 38,600 sq. km., of which, the continental shelf area is about 8,600 sq. km.

Fishing is carried out in the continental shelf area, the majority within the 10 to 50 metre depth range. **Figure 1** shows the main areas where scads, selars, mackerels and neritic tunas are normally caught.

The presence of offshore oil installations is of vital importance to the pelagic fishing whereby these structures served as artificial reefs and aggregating devices for both migratory and residential fishes to obtain shelter, food and reorientation point. In addition to these oil installations there are also FADs deployed by fishermen for the purse seine, ring net and hand lines fisheries.

Table 2 shows the number of licensed fishermen according to gear.

Table 2: Number of Licensed Fishermen by Gear

	1984	*1990*	*1992*	*1993*	*1994*
Purse Seine	2	3	3	5	3
Demersal Trawl	4	10	10	15	17
Small ring net	31	20	31	32	42
Drift gill net	82	24	59	58	34
Bottom set gill net	34	127	135	121	104
Handlines	162	227	279	279	253

Source of Data: Department of Fisheries.

Table 3: Type of Gear and Target Groups

Gear	*Operational Depth of Water*	*Target Groups*	*By Catches*
1. Purse Seine	20 — 50 m	Mackerels, selars, scads neritic tunas, sardines, black pomfret	King mackerel, hard tail scad
2. Small ring net	10 — 30 m	Mackerels, selars, sardines, anchovies	Round scads, neritic tunas
3. Drift gill net	10 — 30 m	King mackerel, black pomfret, hard tail scad	Neritic tunas
4. Bottom set gill net	10 — 25 m	Demersal and pelagics (small mackerels and neritic tunas)	King mackerel, round scads
5. Hand-lines	5 — 60 m	A wide range of demersals and pelagics. The pelagics include trevallies, mackerels, selars, neritic tunas, scads	Larger tuna species sardine
6. Demersal trawl	20 — 70 m	Demersal fishes	A number of pelagic groups, notably
mackerel, selars, scads and neritic tunas			

Table 3 indicates the type of gear and the targeted groups of fishes. The purse seine, small ring net, drift gill net, bottom set gill net and hand-lines are the main gear utilised by fishermen to catch the pelagics. However, a substantial amount of pelagics are also caught by the demersal trawlers.

Table 4: Pelagic Catch Composition of Four Artisanal Gear, 1991

Species/ Gear	*Small Ring Net*	*Drift Gill Net*	*Bottom Set Gillnet*	*Hand Lines*
Round scads	40%	—	3%	2%
Mackerels	38%	—	9%	1.5%
King mackerels	—	26%	—	16%
Neritic tunas	8%	72%	4%	1.5%
Skipjack tuna	14%	2%	62%	*52.8%
Selars	—	—	20%	26%
Hardtail scad	—	—	2%	0.2%

* Trolling.

The majority of mackerels, round scads and neritic tunas landed in the country are caught using purse seine, hand-lines and bottom set gill nets. **Table 4** shows the catch composition of four main artisanal fishing gears for the year 1991.

3. LANDING TRENDS, CATCH COMPOSITION AND SEASONALITY

Table 5: Annual Landings of Selected Pelagic Fishes from 1989 to 1994 (in tonnes)

No.	*Species/year*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*
1.	(Round scads *(Decapterus* spp.)	74.24	29.82	11.54	9.31	37.14	22.55
2.	*R. brachysoma*	20.86	17.72	31.99	36.82	72.53	63.98
3.	*R. kanagurta*	240.89	160.27	127.34	53.58	58.28	33.35
4.	King mackerels *(S. commerson and S. guttatus)*	68.40	83.87	92.49	99.02	83.96	41.16
5.	Tuna *(A. thazard E. affinis and K. pelamis)*	67.83	72.33	85.38	64.61	74.53	54.13
6.	Selar *(S. mate, S. melanoptera and S. leptolepis)*	171.61	283.45	165.55	80.86	89.89	79.69
7.	*Sardinella gibbosa*	43.06	23.96	18.21	8.29	11.38	14.78
8.	*Sardinella fimbriata*	3.11	4.26	10.70	298.32	386.78	2.54
9.	*Megalaspis cordyla*	33.58	28.08	12.05	31.56	25.39	11.00
	TOTAL	723.58	703.76	555.25	682.37	839.88	323.18

Source of Data: Department of Fisheries.

Table 5 on the previous page shows the annual landings of selected pelagics.

The majority of landings from 1989 to 1991 comprised of the small mackerel *(Rastrelliger kanagurta)* and selar *(Selar mate* and *Selar melanoptera).* However the year 1992 to 1994 saw the decrease in the landings of these two dominant groups. The landings of the other small mackerel *(Rastrelliger brachysoma),* showed a notable increase from 31.9 tonnes in 1991 to 72.5 tonnes in 1993.

The landings of King Mackerels, Neritic Tunas and Hardtail scad show slight annual variations without a clear discernible trend. The year 1992 and 1993 saw an exceptionally high volume of sardines (Sardinella fimbriata) being landed.

Table 6A and **6B** show the monthly landings of purse seiners and demersal trawlers respectively for the year 1993. It is interesting to note that the demersal trawlers land more *R. brachysoma* than *R. kanagurta,* and the situation is reversed in the purse seiners. These landing data clearly indicated the all-year-round availability of the small mackerels, king mackerels, selars, scads and skipjack tuna. Although the neritic tunas species *(Auxis thazard* and *Euthynnus affinis*) are not clearly represented both in the catches of purse seiners and trawlers, records obtained from the artisanal fishermen and market statistics as well as the author's personal observations indicate that these species are available in the coastal waters through out the year. **Fig. 2** shows the monthly distribution of pelagics for the year 1993.

The total landing for 1994 is the lowest amongst all the landings over the past six years. One probable explanation would be due to the oil exploration work whereby extensive Seismic Surveys were conducted within the onshelf area thereby rendering the deployment of sufficient number of FAD to aggregate the fish. The purse seine fishery in particular, was severely affected and ceased operational in August of that year. This is reflected in the 1994 monthly landings of purse seiners (see **table 7A** and **7B**), in which the total landings is only about 17% of 1993 landings. The trawlers on the otherhand, are not affected and the rest of the pelagic landings for 1994 were contributed by the artisanal sector.

Table 6A: Monthly Landing of Purse Seiners 1993 (in kgs.)

No.	*Species*	*Jan.*	*Feb.*	*Mac*	*Apr.*	*May*	*Jun*	*July*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Total*
1.	*Decapterus maruadsi*	0	3,841	4,136	382	2,973	0	0	0	896	0	0	0	12,228
2.	*Auxis thazard*	0	0	0	0	0	0	0	0	0	0	2,449	496	2,945
3.	*Euthynnus affinis*	0	0	0	853	0	84	0	0	80	135	199	60	1,411
4.	*Katsuwonus pelamis*	0	105	3,692	269	0	62	254	23	193	387	437	0	5,422
5.	*Megalaspis cordyla*	0	0	0	280	50	0	0	0	0	0	0	0	330
6.	*Rastrelliger brachysoma*	0	0	370	1,557	49	765	19,507	0	82	142	3,622	245	26,339
7.	*Rastrelliger kanagurta*	0	12,370	32,993	23,178	28,815	32,269	0	15,821	13,131	11,201	12,557	4,796	187,131
8.	*S. commerson*	0	0	0	0	16	0	0	0	1,064	0	0	0	1,080
9.	*S. guttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	*Selar mate*	0	1,763	1,777	1,606	10,455	7,543	5,524	5,844	5,627	2,997	1,196	1,060	45,392
11.	*Selar kalla*	0	0	0	0	0	0	0	0	42	0	0	0	42
12.	*Selar melanoptera*	0	10,902	30,119	12,820	4,077	1,559	559	335	700	768	6,178	3,783	71,800
13.	*Selaroides leptolepis*	0	0	0	0	382	1,195	1,590	1,155	629	844	677	361	6,833
	TOTAL	0	28,981	73,087	40,945	46,817	43,477	27,434	23,178	22,444	16,474	27,315	10,801	360,953

Source of Data: Department of Fisheries.

Table 6B: Monthly Landing of Pelagic Fishes by Demersal Trawlers 1993 (in kgs.)

No.	*Species*	*Jan.*	*Feb.*	*Mac*	*Apr.*	*May*	*Jun*	*July*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*	*Total*
1.	*Decapterus* spp.	1,064	6,509	202	385	694	5,335	460	320	1,309	1,561	2,300	4,773	24,912
2.	*Euthynnus affinis*	0	0	0	0	0	0	0	0	0	0	0	122	122
3.	*Katsuwonus pelamis*	0	0	0	0	0	0	0	0	0	0	0	25	25
4.	*Megalaspis cordyla*	1,710	1,524	1,001	56	238	292	497	654	780	1,162	685	1,636	10,235
5.	*Rastrelliger brachysoma*	176	1,433	11,630	355	457	9,626	805	4,619	10,201	6,570	1,819	9,470	57,161
6.	*Rastrelliger kanagurta*	520	141	0	0	457	263	9	59	172	312	474	391	2,798
7.	*S. commerson*	1,782	2,994	1,179	500	526	1,145	781	1,677	1,667	1,526	985	1,912	16,674
8.	*S. guttatus*	0	0	0	0	0	0	124	25	17	286	293	0	745
9.	*Selar mate*	174	852	272	47	0	0	25	42	291	299	141	580	2,723
10.	*Selar kalla*	0	119	0	0	0	0	0	0	0	0	0	0	119
	TOTAL	5,426	13,572	14,284	1,343	2,372	16,661	2,701	7,396	14,437	11,716	6,697	18,909	115,514

Source of Data: Department of Fisheries.

Table 7A: Monthly Landings of Purse Seiners 1994 (in kgs)

No.	Species	Jan.	Feb.	Mac	Apr.	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	*Decapterus maruadsi*	0	20	1,474	321	896	980	227	0	0	0	0	0	3,918
2.	*Auxis thazard*	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	*Euthynnus affinis*	105	0	0	24	0	232	22	0	0	0	0	0	383
4.	*Katsuwonus pelamis*	46	65	0	0	93	0	0	0	0	0	0	0	204
5.	*Megalaspis cordyla*	0	0	0	0	0	0	0	0	0	0	0	0	0
6.	*Rastrelliger brachysoma*	225	0	0	0	0	0	0	0	0	0	0	0	225
7.	*Rastrelliger kanagurta*	3,714	5,424	2,618	8,021	5,210	4,344	583	0	0	0	0	0	29,914
8.	*S. commerson*	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	*S. guttatus*	0	0	0	0	0	0	0	0	0	0	0	0	0
10.	*Selar mate*	2,406	1,391	713	6,553	1,516	930	367	0	0	0	0	0	13,876
11.	*Selar kalla*	0	0	0	0	0	0	0	0	0	0	0	0	0
12.	*Selar melanoptera*	3,349	2,700	2,601	3,225	142	0	0	0	0	0	0	0	12,017
13.	*Selaroides leptolepis*	0	0	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	9,845	9,600	7,406	18,144	7,857	6,486	1,199	0	0	0	0	0	60,537

Source of Data: Department of Fisheries.

Note: Only (2) purse seine vessels operational. They stop operating in August (Please see text for explanation).

Table 7B: Monthly Landings of Pelagic Fishes by Demersal Trawlers 1994 (in kgs.)

No.	Species	Jan.	Feb.	Mac	Apr.	May	Jun	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1.	*Decapterus* spp.	2,371	2,852	881	3,082	844	1,618	571	1,128	1,726	644	579	2,340	18,636
2.	*Euthynnus affinis*	0	0	0	0	0	0	0	0	0	0	0	0	0
3.	*Katsuwonus pelamis*	0	0	0	0	0	0	0	0	94	37	0	0	131
4.	*Megalaspis cordyla*	910	3,901	2,224	1,871	339	37	637	570	230	424	488	550	12,181
5.	*Rastrelliger brachysoma*	11,525	3,224	1,272	889	1,736	2,688	12,818	4,044	5,129	3,982	10,211	6,237	63,755
6.	*Rastrelliger kanagurta*	1,504	256	903	34	325	0	0	110	0	0	264	44	3,440
7.	*S. commerson*	1,959	1,659	1,706	1,068	337	0	620	581	649	587	915	893	10,974
8.	*S. guttatus*	228	99	44	0	0	0	0	0	0	44	104	96	615
9.	*Selar mate*	50	161	315	1,596	37	0	97	175	30	15	0	70	2,546
	TOTAL	18,547	12,152	7,345	8,540	3,618	4,343	14,743	6,608	7,858	5,733	12,561	10,230	112,278

Source of Data: Department of Fisheries.

4. STOCK ESTIMATION, POTENTIAL YIELD AND STATUS OF EXPLOITATION

A preliminary survey on the pelagic biomass was conducted in June 1989. The survey, which was done during the mid-south west monsoon period, may have missed the seasonal fluctuation in abundance of the small pelagics. **Fig. 3** illustrates the density distribution of the small pelagics on the continental shelf of Brunei Darussalam. As with the various other observations within the region, the abundance of small pelagics tend to decline with depth. **Table 8** gives the estimate of biomass and composition of small pelagics in Brunei Darussalam onshelf waters.

Table 8: Biomass Estimate of Small Pelagics (on Shelf Waters, 0 — 200 m depth)

Genera/Group	*Biomass (tons)*	*Relative abundance (%)*
Dussumieria spp.	3,705	24.0
Carangoides spp.	3,580	23.2
Decapterus spp.	3,230	21.0
Ariomma spp.	2,550	16.5
Selar spp.	1,400	9.1
Rastrelliger spp.	270	1.8
Others	680	4.4
Total	15,415	100.00

Source of Data: Department of Fisheries (1989).

Silvestre et al (1992) come up with estimates of potential yield of the onshelf area as can be seen from the table below.

Table 9: Estimates of Potential Yield of Pelagics and Proposed Maximum Harvest Limit

Resources	*Potential yield estimate (ton/yr.)*	*Proposed maximum harvest limit (ton/yr.)*
Small pelagics	7,700	6,000
Large pelagics	2,100	1,600
Total:	9,800	7,600

Source of Data: Silvestre et al (1992).

A maximum harvest limit of 7,600 ton/yr. for the pelagics is recommended. The assessments conducted so far give indication that the pelagic resources are lightly exploited. The total pelagic harvested during the year 1989 to 1993 was from 723.58 to 839.88 tons per year which give the yield to biomass ratio of 0.07 to 0.08. These values of Y/B indicate an overall light exploitation of the pelagic resources of the onshelf area. The maximum harvest of 839.88 tons in 1993 accounts for only about 11% of the total proposed maximum harvest in a year. However these estimates are only preliminary and another survey concerning the small pelagics are scheduled to be in Sept./Oct. of 1995 and Feb./March of 1996.

5. BIOLOGICAL, OCEANOGRAPHIC AND ENVIROMENTAL PARAMETERS RELATED TO MARINE FISHERIES

Apart from length-weight frequency of specific groups or species of fish (Pelagics and demersals), some oceanographic as well as physico-chemico parameters pertaining to water quality of the sea water obtained from various sampling stations within the Brunei Bay and the offshore areas, there is very little or no information available concerning the migration pattern, geographic limits of the stock, distribution depth, and other biological information with regard to growth, mortality, age, recruitment, spawning and nursery ground, fecundity, sex ratio, food and feeding habit, particularly the prey-predator relationship on round scads, mackerels and neritic tunas.

Realising the importance of these informations to the biological and management advisory team, the department is planning to undertake studies in the area of ecosystem and multi species fisheries.

A pelagic resources survey would be conducted in Sept./Oct. of 1995 and Feb./Mar. of 1996. Divided into two phases, the survey is designed to take into account the seasonality of the small pelagics within the onshelf as well as offshore areas. A study on the gut contents of neritic tunas has just started in May of 1995.

The constraint faced by the department is the lack of qualified personnel to undertake the specific research works and along this line collaborative research works particularly concerning the pelagics and other migratory species which are shared by neighbouring Malaysian States of Sabah and Sarawak and the other South East Asian countries, are needed.

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ANNEXE 9

Annex 9

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 - 20 July, 1994

SEAFDEC / MFRDMD / WS / 95 / CR. 6

COUNTRY STATUS REPORT
INDONESIA

THE DEVELOPMENT OF MARINE FISHERY IN THE SOUTH CHINA SEA AREA OF INDONESIA

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THE DEVELOPMENT OF MARINE FISHERIES IN THE SOUTH CHINA SEA AREA OF INDONESIA

1. INTRODUCTION

Indonesia is an Archipelagic State, which has more than 13,000 islands. Besides, Indonesia is also a maritime state which has about 5.8 millions km ^{2} of marine waters, or about 70% of the state. The waters consists of internal, territorial and EEZ waters, which are estimated to about 2.8, 0.3 and 2.7 millions km ^{2} respectively.

South China Sea Area of Indonesia is one of the wide area of marine waters, consist of many islands, bordering to Riau, Jambi, South Sumatra and West Kalimantan Provinces. The marine fisheries resources are mostly utilized by fishermen from provinces bordering to this area, but also from other provinces, mainly from Central Java, Jakarta and chartered boats. Compare to Malacca Straits and Java Sea, the marine fisheries in this area are still under-developed. Since about 1986 the marine fisheries in the IEEZ of South China Sea Area have developed remarkably, starting from 45 boats in 1986 to 1,189 boats in 1983 (foreign and nasional boats), or increasing about 91.8% annually (Directorate General of Fisheries, 1984b). The number of foreign flag boats (chartered) operating in this area have fluctuated, from 4 boats in 1986 increased to 396 in 1988 and decreased to only 45 in 1990. The number of boats then increased remarkably to 381 in 1992 and decreased again to 195 boats in 1993.

The data presented in this report were collected from Jambi, South Sumatra and West Kalimantan Provinces. Since the data from Natuna and other Islands (belongs to Riau Islands Regency) could not be separated from other regencies in Riau Province, the data from this area were excluded in this report.

2. THE EXISTING FISHERIES

2.1. Fishing Gears

There were various gears used by fishermen in the area, such as payang, danish seine, beach seine, purse seine, drift, encircling, shrimp and set gill nets, lift net, troll line, guiding barriers or stow nets, and traps. The most important gears used are presented in **Appendix Table 1.** Troll line was increasing very fast, faster then purse seine and any other gear. Purse seine developed in this area since 1984, increasing about 11.6% annually (1984 – 1992). Payang was also increasing, but not as fast as purse seine.

From about 1986 – 1988, some purse seiners from Central Java have been operating to this area (Potier and Petit, 1994 in Potier and Nurhakim, 1994). At the present time the number of seiners operating in this area are still increasing. The seiners operating to South China Sea from Central Java mostly were large seiners and also medium seiners.

The boat used were dominated by non-powered boats, which were decreasing every year about 1.1%. Powered boats were increasing about 7.8% and 3.4% annually from outboard and inboard motors respectively (**Appendix Table 2**). This was due to the motorization policy by the government which was started in about 1976. The inboard motors are ranging from < 5 GT to 30–50 GT class boats. Number of foreign flaged (chartered) and Indonesia flaged boats by type of gears operating in the IEEZ of South China Sea in 1993 are presented in **Table 1.**

Table 1: Number of Foreign and Indonesia Boats Operating in the IEEZ of Indonesia by Type of Gear (1993)

Fleets	*Type of Gears*								
	LL	*PS*	*GN*	*FN*	*FC*	*PU*	*AL*	*PL*	*Total*
Indonesia	2	48	17	126	0	0	0	0	183
Foreign	19	80	82	407	5	47	3	0	643
Total	21	128	99	533	5	47	3	0	836
%	2.6	15.3	11.8	63.8	0.7	5.3	0.5	0	100

Remarks: LL = long liner; PS = purse seiner; GN = gill netter; FN = fish net; FC = fish carrier; PU = shrimp net (with fish excluder device); AL = squid jigging; PL = pole and liner

Source: Directorate General of Fisheries (1994a).

2.2. Production

Generally, the species are recorded as species groups in the Fisheries Statistics of Indonesia. There are 15 species groups of small pelagic, 4 large pelagic and 20 demersal fishes were coming from this area. Skipjack, hardtail scad, rainbow runner were recorded individually, not mixed with other species. The production by species of pelagic fishes from 1988 to 1992 is presented in **Appendix Table 3**. The average dominant species for five years period (1988 – 1992) were *Sardinella* spp., followed by sardines, *Scomberomorus* spp., *Rastrelliger* spp. In **Appendix Table 4** is presented the total production of marine fisheries by species groups in South China Sea Area (Jambi, South Sumatra and West Kalimantan Provinces) for 11 years periods (1982 – 1992). The production of total small pelagic fish in this area was increasing about 4.7% annually. This due to the increasing number of purse seiners, payang and other gear operating in this area. The production by dominant gears are presented in **Appendix Table 5.** It can be seen that the production of purse seine gears were increasing remarkably by about 42.1% in the period of 1984 to 1992. Almost all gear's production were increasing, but shrimp gill nets.

2.3. Level of Exploitation

The marine fisheries potentials in South China Sea Area was assessed in 1991. During the INDONESIA/FAO/DANIDA Workshop on the Assessment of the Potential of Marine Resources of Indonesia held in Jakarta on 13 – 24 March 1995, the marine fisheries potentials in this area were re-assessed. The results of the reassessment of marine fisheries potential in South China Sea Area is presented in **Table 2** (Venema, 1995).

Table 2: The Marine Fisheries Potentials in South China Sea Area

Resources (0)	*1991 Estimates (1,000 ton)* (1)	*1995 Estimates (1,000 ton)* (2)	*Landings in 1993 (1,000 ton)* (3)	*Level of Exploitation* (4)
Small pelagics	330	357	75	Under-exploited
Demersal fish	131.2	715	58	Under-exploited
Shrimps:				
– All species	11.7	21.7	21.9	Fully-exploited

Source:– Venema (1995).

The level of exploitation for small pelagic and demersal fisheries are still underfishing. There are still enough rooms for expansion. Shrimp fisheries have already been over-exploited. No estimates for large pelagics could be established.

3. RESEARCH ACTIVITIES

The FAO/SEAFDEC Workshop on Shared Stocks in Southeast Asia held in Bangkok on 18 – 22 February 1985, reviewed the possible shared stocks in this area, for pelagic fish, demersal fish, shrimps and prawns and cephalopods (FAO/SEAFDEC, 1985). There is no any research activities carried out yet in South China Sea Area of Indonesia to support the identification of shared stocks. Due to limitation of budget, men power and fasilities, the research activities carried out according to priorities. A proposal has been submitted to the government to carry out research in this area starting in 1996/1997 fiscal year.

The Java Sea Pelagic Fishery Assessment Project (the collaboration of ORSTOM, France and Research Institute for Marine Fisheries, Jakarta) which was established in 1991, has been monitored the catch landings of seiners which were operating in the South China Sea Area. The data collection are carried out in some landing sites in Central Java. The catch and effort data collected at Pekalongan by the project for large and medium purse seiners are presented in **Appendix Table 6**. Length frequency distributions were also recorded from large and medium seiners for some important small pelagic species. Length frequency data for 1994 have been published (Sadhotomo and Potier, 995). In **Appendix Figure 2, 3** and **4** are presented length frequency distributions for *D. ruselli, D. macrosoma* and *R. kanagurta* caught by large seiners in fishing ground A.

Large seiners from Central Java have length between 20 - 35 metres, with an inboard engine at least 160 HP, and a crew of 30 to 40 men and the length of a trip is about 40 days. Medium seiners, 15 – 20 m long and with an inboard engine of about 35 to 100 HP operating between 6 to 15 days per trip (Potier and Sadhotomo, 1994). The species caught by these seiners mainly are *Decapterus ruselli* and *D. macrosoma, Rastrelliger kanagurta, Selar crumenophthalmus, Sardinella gibbosa, Sardinella lemuru, Selaroides leptolepis* and small tunas.

4. CONCLUSIONS

1. The production of small pelagic fisheries is incresing due to the increasing of the gear operating in this area, mainly purse seine gears (chartered as well as national boats).

2. The number of non-powered boat were decreasing about 1.1% annually, but number of powered boats were increasing about 7.8 and 3.4% per year for outboard and inboard motors respectively.

3. Up to present, data collection are carried out by The Java Sea Pelagic Fishery Assessment Project from Central Java seiners operating in South China Sea Area.

4. Small pelagic and demersal fisheries are still under-exploited, but shrimp has been fully-exploited.

5. Research activities are urgently needed to support shared stock identification, utilization and management in the area.

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Appendix Table 1: The Development of Some Main Gears Used in South China Sea Area

Year	*Payang*	*Beach Seine*	*Purse Seine*	*Drift G.N.*	*Enc. G.N.*	*Shrimp G.N.*	*Set G.N.*	*Trammel Net*	*Troll Line*
1982	341	269	—	3,678	389	2,648	1,582	—	—
1983	392	435	—	4,206	379	2,560	1,498	—	—
1984	450	443	2	3,708	329	2,456	1,762	703	42
1985	431	753	2	3,076	321	2,300	1,864	747	45
1986	599	656	2	3,754	471	2,199	1,864	1,137	96
1987	649	649	4	3,711	465	2,358	1,452	1,004	90
1988	661	429	4	3,108	411	2,268	1,766	1,023	132
1989	1,064	332	4	3,331	330	2,532	1,839	984	130
1990	824	437	6	3,749	533	2,462	1,566	909	106
1991	1,094	407	12	3,363	432	2,423	1,663	936	177
1992	817	383	6	3,525	465	2,521	1,721	808	161
Increased (%)	9.1	3.6	11.6	– 0.4	1.8	– 0.5	0.9	1.8	14.4

Source: — Directorate General of Fisheries, (1984 – 1994).

Appendix Table 2: The Development of Non-Powered and Powered Boats

Year	*Non-Powered Boats*	*Powered Boats*	
		Outboard Motor	*Inboard Motor*
1982	8,056	1,400	4,433
1983	7,706	1,935	5,054
1984	5,761	2,382	5,645
1985	7,086	2,346	5,419
1986	5,775	2,349	5,052
1987	7,301	2,650	6,595
1988	7,314	2,887	7,173
1989	6,918	2,744	7,274
1990	7,405	2,813	7,036
1991	7,043	2,884	5,286
1992	7,198	2,957	6,170
Increased (%)	– 1.1	7.8	3.4

Source: – Directorate General of Fisheries (1982 – 1992).

Appendix Table 3: The Production by Species of Small Pelagic Fishes, 1988 – 1992

Unit: Ton

Species	*1988*	*1989*	*1990*	*1991*	*1992*	*Average*
– Barracudas *Sphyraena* spp.	550	598	603	656	570	595.4 (0.8)
– Roundscards *Decapterus* spp.	—	—	—	256	—	51.2 (0.1)
– Trevalies *Selar* spp.	5380	6969	7161	7586	7462	6911.6 (9.5)
– Hardtail scads *M. cordyla*	140	129	153	168	156	149.2 (0.2)
– Queen fishes *Chorinemus* spp.	1004	1291	1682	1576	1638	1438.2 (2.0)
– Rainbow runner *E. bipinnulatus*	107	97	119	120	122	113.0 (0.2)
– Mullets *Mugil* spp.	1688	1995	1999	2133	2129	1988.8 (2.7)
– Needle fishes *Trichiurus* spp.	52	57	70	70	84	66.6 (0.1)
– Anchovies Engraulidae	7589	5805	5677	5835	5557	6092.6 (8.3)
– Rainbow sardines *Dussumieria* spp.	1467	1947	2196	2288	2336	2046.8 (2.8)
– Fringscale sardinellas *Sardinella* spp.	18975	16634	16273	15070	15259	16442.2 (22.4)
– Indian oil sardines *S. lemuru* *A. sirm*	10431	7920	8082	8126	8250	8561.8 (11.7)
– Wolf herrings *Chirocentrus* spp.	3162	5327	5265	4685	4779	4643.6 (6.4)
– Tolishads/Chinese herrings *I. toli*	32	125	132	—	—	57.8 (0.1)
– Indian mackerels *Rastrelliger* spp.	5953	8932	9064	8653	9157	8351.8 (11.4)
– Seerfishes *Scomberomorus* spp.	7641	8508	9050	8537	9003	8547.8 (11.6)
– Tunas *Thunnus* spp.	—	18	—	91	93	40.4
– Skipjacks *K. pelamys*	106	41	—	6	473	125.2 (0.2)
– Small tunas *Euthynnus* sp., *Auxis* spp., etc.	5456	6520	7192	7065	7998	6846.2 (9.4)
Total	69733	72913	74718	72921	75066	73070.2

Source: – Directorate General of Fisheries (1990 – 1994).
– Figure in brackets are per cent.

Appendix Table 4: Production of Marine Fishery in Southern Part of South China Sea Area by Group of Species

Unit = ton

Year	*Pelagic*		*Sharks/ Rays*	*Demersal*	*Shrimps*	*Total*
	Small	*Large*				
1982	46,724	17,513	9,025	41,363	6650	121,275
1983	48,850	17,299	7,139	42,930	6184	122,402
1984	54,408	13,722	7,263	42,790	8791	126,974
1985	66,989	12,221	9,451	31,669	8743	129,073
1986	60,552	12,732	8,050	49,507	12012	142,853
1987	65,101	12,850	7,790	45,202	11266	142,235
1988	73,453	13,203	9,306	41,891	11568	149,511
1989	70,670	15,087	11,106	47,633	10088	154,584
1990	71,670	16,242	11,036	51,920	9493	160,391
1991	71,729	15,701	10,431	49,019	8950	155,830
1992	73,894	17,567	11,326	52,247	8874	163,908
Increase (%)	4.7	0.0	2.3	2.4	2.9	3.1

Source: – Directorate General of Fisheries (1984 – 1994).

Appendix Table 5: The Development of Catch by Gear for Some Important Gears

Year	*Payang*	*Beach Seine*	*Purse Seine*	*Drift G.N.*	*Encir G.N.*	*Shrimp G.N.*	*Set G.N.*	*Trammel Net*	*Troll Line*
1982	11,947	1,344	—	38,349	3,996	10,161	8,607	—	—
1983	11,195	2,150	—	38,752	3,845	8,197	10,142	—	—
1984	13,282	1,832	116	32,353	4,781	9,156	6,813	2,774	334
1985	10,281	2,824	204	29,059	4,193	8,206	8,512	3,484	1,128
1986	12,784	2,852	981	33,272	3,148	8,402	9,047	9,863	1,083
1987	14,306	4,292	742	30,359	2,579	9,459	11,021	3,243	586
1988	15,363	2,923	805	35,047	2,573	8,913	18,555	4,198	549
1989	23,356	3,083	1,780	36,072	4,047	9,381	17,574	3,866	590
1990	16,823	3,227	1,978	37,582	4,005	9,754	17,775	3,440	869
1991	19,066	3,596	1,277	39,649	3,824	8,663	13,458	3,490	574
1992	19,828	3,792	1,930	41,948	4,194	9,042	13,409	3,120	604
Increased (%)	5.2	10.9	42.1	0.9	0.5	1.2	4.5	1.4	7.7

Source: – Directorate General of Fisheries (1984 – 1994).

Appendix Table 6: Number of Boats, Days at Sea, Catch of Pelagic Fish by Seiners from Central Java Recorded from Pekalongan Landing Place

Year	*Number of Boats*	*Days at Sea*	*Catch (kgs)*	*Fising Ground*	*CPUE (Kg/Day)*
Large Seiner					
1992	106	2,974	3,074,177	A	1,033.7
	2	69	49,596	C	718.8
1993	123	3,896	5,350,179	A	1,373.2
	132	4,367	5,801,881	B	1,328.6
	1	37	40,235	C	1,087.4
1994	96	3,327	4,637,703	A	1,394.0
	2	46	70,545	C	1,533.6
Average				A	1,267.0
				B	1,328.6
				C	1,113.3

Year	*Number of Boats*	*Day at Sea*	*Catch (kgs)*	*Fising Ground*	*CPUE (Kg/Day)*
Medium Seiner					
1991	6	112	84,593	A	755.3
	29	296	143,710	C	485.5
1992	6	86	71,193	A	827.8
1993	4	56	84,861	A	1,517.4
	7	149	224,148	B	1,504.3
1994	17	670	722,313	A	1,078.1
	1	180	189,717	B	1,054.0
Average				A	1,044.6
				B	1,279.2
				C	485.5

Remarks: — Source: — The Java Sea Pelagic Fishery Assessment Project.
— For fishing grounds, see **Appendix Figure 1.**

ANNEXE 10

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 - 20 July , 1995

SEAFDEC / MFRDMD / WS/95 / CR. 7

COUNTRY STATUS REPORT
THAILAND

(1) GULF OF THAILAND

THE OCCURRENCE OF NERITIC TUNAS *(Auxis thazard AND Euthynus affinis)* AND OCEANOGRAPHIC PARAMETERS OBSERVED FROM PURSE SEINE SURVEY 1991 — 1993

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THE OCCURRENCE OF NERITIC TUNAS
(Auxis thazard AND Euthynus affinis)
AND OCEANOGRAPHIC PARAMETERS OBSERVED FROM PURSE SEINE SURVEY
1991 — 1993

1. INTRODUCTION

The neritic tuna is the most economically important pelagic fish in the Gulf of Thailand and Andaman Sea. During the year 1983 to 1992, the total catch of tuna had raised from 69,218 to 169,072 mt. which mostly caught by purse seiners. Tuna catch from the Andaman Sea contributed only 8% of the total production (Annual Fisheries Statistic 1992). The main species were frigate tuna *(Auxis thazard)*, Kawakawa *(Euthynnus affinis)* and longtail tuna *(Thunnus tongol)*.

In 1991 – 1993, during the period of pre-monsoon season (March–May) R/V "CHULABHORN" made the cruises to carry out tuna purse seine survey with the employment of anchored FADs in the Andaman Sea EEZ of Thailand. The operations were made along the continental area at 300–900 m depth between Latitude 6°–9° N and Longitude 96°–99° E which aiming to obtain the information of tuna catch data and oceanographic conditions for describing the variation of the availability and distribution of tuna resources **(Fig. 1).**

This paper attemps to highlight some finding on catch, species and size composition of two common small tuna including the oceanographic aspects found in the waters off the West Coast of Thailand.

2. CATCH AND SPECIES COMPOSITION

Based on the data collected during the year 1991–1993, the results of purse seine survey generally gave a moderate catch. The average catch rate was about 800 Kg./set, mainly consisting of skipjack (SKJ), yellowfin tuna (YFT), frigate tuna (FRI) and kawakawa (KAW). The summary of the survey on the occurrance of FRI *(A. thazard)* and KAW *(E. affinis)* is shown as below:–

Year	*Average catch rate (Kg. set)*	*Average comp. (%)*	
		FRI	*KAW*
1991	786	2.4	0.1
1992	710	10.5	12.2
1993	943	1.8	0.2

The occurrence of percentage composition of these two species found to be rather low for the offshore survey and only one peak observed in 1992. Normally, they were found to be high component from coastal fishery and to be abundant in the continental shelf area at the depth of 50–80 m (Boonragsa 1986) However, it showed some interesting of migration to the deeper area, being far away from the shore at the depth of 300–900 m.

3. SIZE DISTRIBUTION

The data collected on size distribution from the purse seine catches is summarised for FRI and KAW as shown in **Fig. 2a and b.**

Frigate tuna; as can be seen in Fig. 2a it contributed the small part of the catches during the month of March to May. The length of fish ranged from 24 to 35 cm and expressed in one size group with its mode 26.3 cm.

Kawakawa; it represented in high amount in 1992 and occurred by specimens in size range of 27–33 cm with one size group of its mode 30.1 cm **(Fig. 2b).**

The average size distribution of FRI and KAW showed that they occurred in size range not more than 40 cm which were rather bigger than those reported in 1986 (Boonragsa 1986) for the same period but to be smaller than the catches in the Gulf of Thailand in 1989 (Churnpan 1993).

4. OCEANOGRAPHIC OBSERVATION

The oceanographic survey was also conducted simultaneously with fishing survey throughout the cruises in order to collect environmental data for describing the variation of the availability and distribution of tuna resources as the destail given in **table 1–3.**

4.1 Temperature

	1991		*1992*		*1993*	
	March	*May*	*March*	*April–May*	*April*	*May*
Av. surface temp. (C°)	29.18	30.96	28.70	30.72	29.98	30.72
Av. temp. at 200 m depth.	12.39	13.73	13.48	15.60	15.36	15.56

From the above information of the Andaman Sea survey related to fishing, were found that tuna catch rate on May was higher than March and April due to the increased temperature about 1–2°C.

4.2 Salinity

	1991		*1992*		*1993*	
	March	*May*	*March*	*April–May*	*April*	*May*
Av. surface sal. (ppt.)	32.68	32.31	32.57	34.92	32.66	32.88
Av. sal. at 200 m depth.	34.92	34.89	33.01	34.82	34.80	34.62

From the above data, it could be seen that during March to May the salinity in the Andaman Sea varied not more than 1 ppt. and the difference in vertical to 200 m depth was about 2 ppt. So, such appearent parameter might not affect to tuna distribution and abundance in this area.

4.3 Dissolved oxygen

	1991		*1992*		*1993*	
	March	*May*	*March*	*April–May*	*April*	*May*
Av. surface dis. oxy. (ml/L)	5.40	5.39	5.41	5.47	5.56	5.43
Av. dis. oxy. at 200 m depth	1.58	1.83	1.46	1.60	1.56	1.57

Dissolved oxygen reading during the months were rather consistent for the surface but there were little variation trend at 200m depth on May of those three years. This was probably due to well mixing of water mass in the season which made a widely spreading out of dissolved oxygen, affected to the abudance and to be more tuna catch in this month.

4.4 pH

	1991		*1992*		*1993*	
	March	*May*	*March*	*April–May*	*April*	*May*
Av. surface pH	7.76	7.98	8.06	7.98	7.41	7.98
Av. pH at 200 m depth.	7.60	7.34	7.70	7.66	7.29	7.72

Generally, the pH values obtained from all observation were almost the same ranging from 7.34 to 8.06. It was found that the value at 200 m depth on March 1993 was obviously low down from normal level of 7.5 and it would affect to the distribution of tuna resources. However this difference had recovered to the normal condition on May.

4.5 Thermocline zone

	1991		*1992*		*1993*	
	March	*May*	*March*	*April–May*	*April*	*May*
Uper layer (m)	30	16	10–20	20–30	20–30	10–30
Lower layer (m)	170	160	180	150	160	160

From the result of the Andaman Sea survey (Fig. 3–5) the thermocline zone which mostly effected to fish behavion occurred at the average layer from 20 to 170 m depth with the temperature ranging 30.15° to 15.68° C. The top layer was rater shallow of 10–30 m in this pre-monsoon period, affected to the moving of tuna school close to the surface. Such condition made a high tuna catch of all fishing survey, particularly the sharp thermal gradient, occuring on April–May 1992 **(Fig. 6).**

Table 1: General hydrological conditions observed in the Andaman Sea EEZ of Thailand, March and May 1991

Data		*March*		*May*	
		Range	*Average*	*Range*	*Average*
Temperature	Surface	28.70–30.30 C	29.18 C	30.55–31.59 C	30.96 C
	200 m depth	11.69–14.12 C	12.39 C	13.24–14.54 C	13.73 C
Salinity	Surface	30.75–33.35 ppt.	32.68 ppt.	31.11–32.50 ppt.	32.31 ppt.
	200 m depth	34.84–34.96 ppt.	34.92 ppt.	34.88–34.91 ppt.	34.89 ppt.
Dis. oxygen	Surface	5.29–5.50 ml/L	5.40 ml/L	5.35–5.42 ml/L	5.39 ml/L
	200 m depth	1.42–1.99 ml/L	1.58 ml/L	1.78–1.91 ml/L	1.83 ml/L
pH	Surface	7.74–7.88	7.76	7.38–8.06	7.98
	200 m depth	7.74–7.88	7.60	7.29–7.38	7.34
Current	10 m	0.0–0.2 kts.	0.1 kts.	0.0–0.1 kts.	0.1 kts.
	50 m	0.5–0.8 kts.	0.5 kts.	0.2–0.5 kts.	0.2 kts.
	120 m	0.2–0.9 kts.	0.6 kts.	0.1–0.6 kts.	0.6 kts.
Thermocline	Top depth	10–90 m	40 m	10–70 m	50 m

Table 2: General hydrological conditions observed in the Andaman Sea EEZ of Thailand, March and April – May 1992

Data		*March*		*April – May*	
		Range	*Average*	*Range*	*Average*
Temperature	Surface 200 m depth	28.52–28.92 C 13.09–13.86 C	28.70 C 13.48 C	30.05–32.13 C 14.79–16.91 C	30.72 C 15.60 C
Salinity	Surface 200 m depth	32.47–32.66 ppt. 34.86–34.97 ppt.	32.57 ppt. 34.92 ppt.	34.40–33.44 ppt. 34.58–34.97 ppt.	33.01 ppt. 34.82 ppt.
Dis. oxygen	Surface 200 m depth	5.30–5.51 ml/L 1.44–1.48 ml/L	5.41 ml/L 1.46 ml/L	5.35–5.64 ml/L 1.46–1.89 ml/L	5.47 ml/L 1.60 ml/L
pH	Surface 200 m depth	7.92–8.20 7.58–7.81	8.06 7.70	7.82–8.07 7.53–7.75	7.98 7.66
Current	10 m 50 m 120 m	0.0–0.1 kts. 0.2–0.6 kts. 0.3–0.9 kts.	0.1 kts. 0.4 kts. 0.6 kts.	0.0–0.3 kts. 0.1–0.9 kts. 0.1–1.4 kts.	0.1 kts. 0.5 kts. 0.6 kts.
Thermocline	Top depth	10–20 m	15 m	20–30 m	30 m

Table 3: General hydrological conditions observed in the Andaman Sea EEZ of Thailand, April and May 1993

Data		*April*		*May*	
		Range	*Average*	*Range*	*Average*
Temperature	Surface 200 m depth	29.85–30.14 C 13.31–17.52 C	29.98 C 15.36 C	30.54–30.79 C 12.96–21.31 C	30.72 C 15.56 C
Salinity	Surface 200 m depth	32.39–33.05 ppt. 34.84–34.95 ppt.	32.66 ppt. 34.80 ppt.	32.10–33.22 ppt. 34.09–34.90 ppt.	33.88 ppt. 34.62 ppt.
Dis. oxygen	Surface 200 m depth	5.29–5.84 ml/L 1.43–1.81 ml/L	5.56 ml/L 1.56 ml/L	5.34–5.55 ml/L 1.36–2.44 ml/L	5.43 ml/L 1.57 ml/L
pH	Surface 200 m depth	7.04–7.61 7.25–7.38	7.41 7.29	7.90–8.04 7.62–7.93	7.98 7.72
Current	15 m 50 m 100 m	0.0–0.9 kts. 0.1–0.3 kts. 0.1–2.2 kts.	0.17 kts. 0.33 kts. 0.61 kts.	0.1–0.2 kts. 0.1–0.5 kts. 0.1–0.9 kts.	0.13 kts. 0.31 kts. 0.67 kts.
Thermocline	Top depth	10–30 m	27 m	10–30 m	17 m

ANNEXE 11

Annex 11

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / CR. 8

COUNTRY STATUS REPORT
THAILAND

(2) ANDAMAN SEA COAST OF THAILAND

STATUS OF PELAGIC FISHERIES ALONG THE ANDAMAN SEA COAST OF THAILAND

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STATUS OF PELAGIC FISHERIES ALONG THE ANDAMAN SEA COAST OF THAILAND

Introduction

According to the development of marine fisheries in the past two decades, Thailand is currently ranked among the top-ten fishing nations in the world. Marine fishery production are shared about 87% of the total fishery productions, which consist of 82% from the Gulf of Thailand and 18% from the Andaman Sea Coast. Due to the rapid development of marine fisheries and also the limitation of fishing area, the fishery resources have been heavily exploited especially demersal fish and crustacean as a consequence of the catch has already over its maximum sustainable yield. In the same time, the pelagic fishes shared in the catch of all marine species increase from the range of 24 – 28% during 1979 – 1982 to 38 – 40% during 1988 – 1991, especially in the Andaman Sea area of Thailand, the pelagic fish production increased from 11,278 tons in 1980 to 176,794 tons in 1991.

From those reasons as discuss earlier, and the developing of pelagic fishing technique as well as expanding fishing area to off shore in the Andaman Sea lead pelagic fishery in the Andaman Sea play more important role of Thailand's marine fisheries.

Pelagic Fisheries

The major type of fishing gears are purse seines, which accounting for approximately 85% of total pelagic catch by all gears during 1983 – 1991. The first purse seiner, Chinese purse seine (CPS) was introduced in 1930 and targetting on schoolfish such as Indian mackerel. The mesh size which currently used in CPS seine is 2.5 cm. while length and depth of the seine are within 300 – 450 m. and 50 – 80 m. respectively.

After the end of the Second World War, many CPS has been modified into Thai purse seine (TPS) using mesh size of 2.5 cm. which operated by using one main boat to set the net instead of setting net by 2 row boats as being used in CPS. In 1973 several kind of luring techniques were introduced such as payao with coconut leaves and kerosene lamp. Until 1982 the luring techniques (LPS) has been well developed by equipped electric generator on board and became the popular fishing gear for mixed species such as round scad, sardine, small tuna etc. The principle of LPS is to set the net after using light attraction, in addition, it can be operated as TPS method by searching the fish school and set the net while sailing to the destination of luring place. As a result, estimation of realistic effort values has become problematic. The common mesh sizes used in TPS and LPS are approximately 2.5 cm. while the length and depth of the seine range from 300 – 1100 m. and 50 – 130 m. respectively.

The other size of purse seine, green purse seine (GPS) which operated as same as TPS. The mesh size of the net is 3.8 cm. while the length and depth range from 450 – 1200 m. and 60 – 140 m. respectively. The fishermen used GPS to catch the medium and large size of Indo – Pacific mackerel which entered to the fishery from March to May.

For tuna purse seine, (TUNP) the size of the net range from 100 – 120 m. in depth, 800 – 1400 m. in length and 7.5 – 9.4 cm. mesh size.

Generally, purse seiner of size class 18 – 24 metres in lengths is the most popular in the Andaman Sea Coast, except TUNP which occupied more than 24 metres.

The registered number of purse seiners in the Andaman Sea area of Thailand divided into Chinese purse seine (CPS) and other purse seines (TPS, LPS, GPS and TUNP) are shown in **Table 1**.

Species Composition

The main pelagic fish in the Andaman Sea caught during 1979 – 1991 consists of Indo–Pacific mackerel, Indian mackerel, round scads, small tunas and sardines which shared about 60 – 86% of all pelagic species during 1979 – 1991 (**Table 2**).

Observation made by staff of Andaman Sea Fisheries Development Center (AFDEC) on species composition of mackerels, small tunas and round scads are shown in **Table 3**. The species composition of Mackerels are consist of Indo–Pacific mackerel (*Rastrelliger brachysoma*) and Indian mackerel (*R. Kanagurta*) about 76% and 24% respectively. Four main species of small tunas are kawakawa (*Euthynnus affinis*), frigate mackerel (*Auxis thazard*), Longtail tuna (*Thunnus tonggol*) and skipjack tuna (*Katsuwonus pelamis*) which shared about 35%, 41%, 18% and 6% respectively. For round scads, the production are consists of *Decapterus maruadsi* 58% and *D. macrosoma* 42%. Besides these species, yellow fin tuna (*Thunnus albacares*) and bullet tuna (*Auxis rochei*) were also caught occasionally in a less quantity by purse seines in the upper part of Phuket Island.

Fishing Gear

Production of Indo–Pacific mackerel, Indian mackerel round scads, small tunas and sardines are mainly caught by purse seines about 88%, 96%, 92%, 98% and 94% of catch from all gears respectively.

Observation made by staff of AFDEC during 1985 – 1990 on the production caught by types of purse seines are shown in **Table 4**. Indo-Pacific mackerel was mainly caught by GPS, while small tunas, round scads and Indian mackerel by LPS.

Fishing Ground

The fishing ground for purse seines have been expanded along the Coast, with in the range 3 – 45 km. from shore and the depth range 30 – 100 m. as shown in Figure 1. The main fishing ground of Indo–Pacific mackerel are located in the lower part of the coast, but for Indian mackerel small tunas and round scads are located in the upper part of the coast and the area around Raja Island in the lower part.

Fishing Season

Pelagic species, especially mackerel, round scads and small tunas on the west coast of Thailand were caught all year round. The peak of catch considered to be higher during the Northeast Monsoon (November to May) than the Southwest one. (**Figure 2**).

Size Composition

Mode in the catch of small tunas, kawakawa was 18 – 35 cm. (range 8 – 58 cm.), frigate mackerel 18 – 32 cm. (range 9 – 44 cm.) and longtail tuna 24 – 36 cm. and 42 – 50 cm. (range 11 – 51 cm.).

For round scads, mode in the catch for *D. maruadsi* were 9 – 19 cm. (7 – 24 cm.) and for *D. macrosoma* were 14 – 22 cm. (9 – 25 cm.).

During the period 1985 – 1994 mean length by year of kawakawa and frigate mackerel are fluctuated and slightly different by year, but the mean length of Longtail tuna in overall view shown increasing trend (**Figure 3**). For round scads, the mean length are fluctuated and shown gradually decreased in overall view (**Figure 4**).

Production and Catch Rate

The production of all pelagic species for overall view was increased during 1979 – 1991 but CPUE increased trend from 1437.6 kg./day in 1979 to high peak about 4280.3 kg./day in 1983 and then decreased until 1988 as shown in **Figure 5**. Production and catch rate of important economic species Indo–Pacific mackerel, round scads, small tunas and sardines are shown in **Figure 6**, **Figure 7**, **Figure 8** and **Figure 9** respectively.

Estimated Potential Yield and Optimum Fishing Effort

Fox's model was applied to estimate the Maximum Sustainable Yield and the optimum fishing effort, by using the CPUE of purse seines as standard gear. The result are presented in **Table 5**.

Biological Parameters

Some biological parameters of important economic pelagic species along the Andaman Sea Coast of Thailand are shown in **Table 6**.

Status of Pelagic Species

Consideration of all parameters combining with other information on fishery, the result can be stated as follow:–

— the signs of overfishing have been observed for Indo–Pacific mackerel and sardines but in the same time, the recovery of these stock seemed to be gradually improved.

— No definite sign of overfishing has been observed for round scads, small tunas and all other pelagic species.

Table 1: The Registered Number of Purse Seines in the Andaman Sea Coast of Thailand, 1979 – 1991

Year	*CPS*	*Other Purse Seines*	*Total*
1979	15	71	86
1980	12	102	114
1981	14	144	158
1982	13	140	153
1983	18	135	153
1984	16	162	178
1985	17	152	169
1986	17	153	170
1987	14	208	222
1988	16	257	273
1989	16	264	280
1990	12	260	272
1991	24	217	241

Source: Thai Fishing Vessels Statistics, 1979 – 1991,
Department of Fisheries (DOF), Thailand.

Table 2: **Total Catch and Species Composition of Pelagic Fish Along the Andaman Sea Coast of Thailand, 1979 – 1991**

Year	*Total Catch (Tons)*	*Species Composition (%)*					
		1	*2*	*3*	*4*	*5*	*6*
1979	30,997	14.5	9.3	3.4	6.8	35.5	30.5
1980	11,278	15.9	8.6	7.9	6.8	20.9	39.9
1981	14,062	15.8	5.9	8.4	14.7	14.6	40.6
1982	60,121	16.7	1.9	6.2	15.9	45.0	14.3
1983	64,109	20.5	3.0	14.9	6.0	38.3	17.3
1984	90,846	20.6	2.4	18.5	8.1	33.6	16.8
1985	67,952	20.2	1.3	8.8	6.2	30.3	33.2
1986	59,560	23.0	1.6	4.1	5.7	44.4	21.2
1987	20,563	12.5	1.9	11.8	5.2	34.5	34.1
1988	98,912	12.2	5.6	17.9	4.9	33.0	26.4
1989	121,646	14.4	5.9	18.4	3.9	24.0	33.4
1990	146,281	17.2	6.9	15.4	4.7	18.7	37.1
1991	176,794	21.8	8.3	13.6	8.1	13.7	34.5

Source: The Marine Fisheries Statistics, base on the sampling survey 1979 – 1991, DOF, THAILAND.

Note:
1. Indo–Pacific mackerel.
2. Indian mackerel.
3. Round scads.
4. Small tunas.
5. Sardines.
6. Others.

Table 3: Species Composition of Mackerels, Small Tunas and Round Scads Along the Andaman Sea Coast of Thailand, 1991 - 1994

Pelagic Groups	*Species*	*%*
Mackerels	R. brachysoma	76
	R. kanagurta	24
Small tunas	E. affinis	35
	A. thazard	41
	T. tonggol	18
	K. pelamis	6
Round scads	D. maruadsi	58
	D. macrosoma	42

Source: From the sampling survey conducted by Andaman Sea Fisheries Development Center (AFDEC) Phuket, Thailand.

Table 4: Percentage of Important Pelagic Species Caught by Type of Purse Seines Along the Andaman Sea Coast of Thailand, 1991 — 1994

Type of Purse Seines	*Production Caught by Type of Purse Seines (%)*				
	Indo–Pacific Mackerel	*Small Tunas*	*Round Scads*	*Indian Mackerel*	*Sardines*
CPS	—	—	—	2	1
TPS	18	15	5	6	24
LPS	16	63	95	90	75
GPS	66	3	—	2	—
TUNP	—	19	—	—	—

Source: From the sampling survey conducted by AFDEC, Phuket, Thailand.

Table 5: Maximum Sustainable Yield and Optimum Fishing Effort of Pelagic Species Along the Andaman Sea Coast of Thailand.

Species	*MSY (tons)*	*Fopt (day)*	*r*	*Remark*
R. brachysoma	24,100	69,200	– 0.62	Data 1982 – 1991
Small tunas	22,700	92,000	– 0.50	Data 1979 – 1991
Sardines	32,400	38,800	– 0.98	Data 1982 – 1991
Round scad	—	—	+ – – –	—
All Pelagic Species	190,000	161,200	– 0.68	Data 1982 – 1991

Table 6: Biological Parameter of Pelagic Species Along the Andaman Coast of Thailand

Species	$W = aL^a$		*Size at* $1^{st.}$ *mature*	*Spawning season*	*K and L*
	a	*b*			
R. brachysoma	0.01296	3.2104	178 mm.	Dec. – March, Aug. – Nov.	2.1 /year 21.0 cm.
E. affinis	0.00001731	2.9992	370 mm.	Jan. – March, June – July	
A. thazard	0.00002316	2.9617	340 mm.	Feb. – April, Sept.	
T. tonggol	0.00002493	2.9471	400 mm.	March – May, Aug. – Dec.	

Source: Boonraksa, V. 1993 (in Thai).
Pimoljinda, J. 1978 (in Thai).
Saranakomkul, K. 1985 (in Thai).
Sutthakorn, P. 1986 (in-Thai).

ANNEXE 12

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK
IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

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COUNTRY STATUS REPORT
VIETNAM

SOME BIOLOGICAL PARAMETERS AND FISHERIES STATUS OF SHARED STOCK *Decapterus, Rastrelliger* AND TUNAS IN COASTAL SEAWATERS OF VIETNAM

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SOME BIOLOGICAL PARAMETERS AND FISHERIES STATUS OF SHARED STOCK *DECAPTERUS, RASTRELLIGER* AND TUNAS IN COASTAL SEAWATERS OF VIETNAM

I. INTRODUCTION

Vietnam has a coast line of 3,260 km. spreading over 13 latitudes and an exclusive economic zone of about one million square kilometres.

The fisheries sector plays an important role in the national economy of Vietnam. In order to develop the fisheries sector successfully, it is necessary to master all characters of natural conditions and resources.

Both the pelagic and demersal fish resources have become very important for commercial fisheries in Vietnam. The shared stock like round scad (Decapterus), mackerel (Rastrelliger) and tunas belonging to the most important commercial fish of the country.

Fisheries research in seawaters of Vietnam was carried out since foundation in 1923 of the Indo – China Oceanographic Institute based in Nha Trang. Series of research cruises on board of the R/V De LANESSAN, Trawler, 1000 Hp were conducted continuously until the World War II taken place.

Due to the war situation the research works were interupted during 1940 – 1955 period. After 1955, the research works on fisheries resources and oceanography were being carried out by the Research Institute of Marine Products (RIMP) and other institutions independent or in cooperation with research institutions of other countries.

The major fisheries research activities in seawaters of Vietnam are summarized in **Table 1.**

Table 1: Fisheries Research Activities

Period	*Research Institutions*	*Research Vessels*	*Research Areas*
1959 – 1961	Station of Marine Research (now RIMP) (Vietnam – China Cooperation.	Trawler of 250 Hp	Tonkin Gulf
1960 – 1961	Station of Fisheries Research, (now RIMP) (Vietnam – USSR Cooperation)	Trawler PELAMIDA (1000 Hp) Purse Seiner ONDA Trawler, Long Line ORLIK	South China Sea and adjacent areas
1962 – 1977	Station Fisheries Research (now RIMP)	6 Trawler of 90–200 Hp	Coastal areas of the Tonkin Gulf

Period	*Research Institutions*	*Research Vessels*	*Research Areas*
1969 – 1971	Fisheries Research Institute Saigon (UNDP/FAO)	Trawler KYOSHIN MARU No. 52, (1000 Hp) HUU NGHI, Purse seiner (380 Hp)	Central and South Vietnam, Gulf of Thailand
1977 – 1980	Research Institute of Marine Products (RIMP)	R/V BIEN DONG Fishery Multipurpose (1500 Hp)	Coastal areas of Vietnam
1979 – 1988	RIMP (Vietnam – USSR)	21 Research Vessels of 800–3800 Hp 33 cruises	EEZ of Vietnam
1991 – 1993	RIMP	4 pair trawlers 500 Hp	Coastal areas of Tonkin Gulf

Data on biology and fishery of round scads, mackerels and neritic tunas were collected from above-mentioned research activities and from commercial fishery.

The data have been collected and analyzed in accordance with the FAO Manuels for fishery research purposes and others methods.

II. BIOLOGICAL PARAMETERS

A. Round Scads *Decapterus Maruadsi*

Round scads belonging to genus Decapterus in the Vietnamese seawaters are represented by 4 species namely: *Decapterus maruadsi* (White tip scad), *D. lajang* (Slender mackerel scad), *D. kurroides* (Redtail scad) and *D. russelli* (Russell's mackerel scad). Among these species *D. maruadsi* is the most common species. The biological features of *D. maruadsi* are given as follows:

DISTRIBUTION

D. maruadsi is distributed widely in seawaters of Vietnam, it was found through the coastal areas from the Tonkin Gulf to the Thailand Gulf, mainly at the depth range of 30 – 60 m.

LENGTH FREQUENCY DISTRIBUTIONS

D. maruadsi caught by traditional pelagic fishery have body length ranging from 60 to 239 mm, mainly from 120 – 189 mm. There are some differences in length frequency distributions of fishes caught during North–East Monsoon time and South–West Monsoon time. (**Figure 1**) Length frequency distributions of *D. maruadsi* caught by bottom trawl and pelagic trawl on board of R/V BIEN DONG during 1978 – 1980 in Central and South Vietnam seawaters areas are shown in **Figure 2**.

The length frequency distributions of *D. maruadsi* caught by trawl fishing and other fishing methods are relatively similar. It could be understood through the day night vertical migration of this species. The phenomen is described in this paper.

GROWTH

Length – Weight Relationship

Values of a and b in Length – Weight relationship equation $W = a L^b$ are shown in **Table 2**.

Figure 1 – Length Frequency Distribution D. Maruadsi in 1974 – 1975

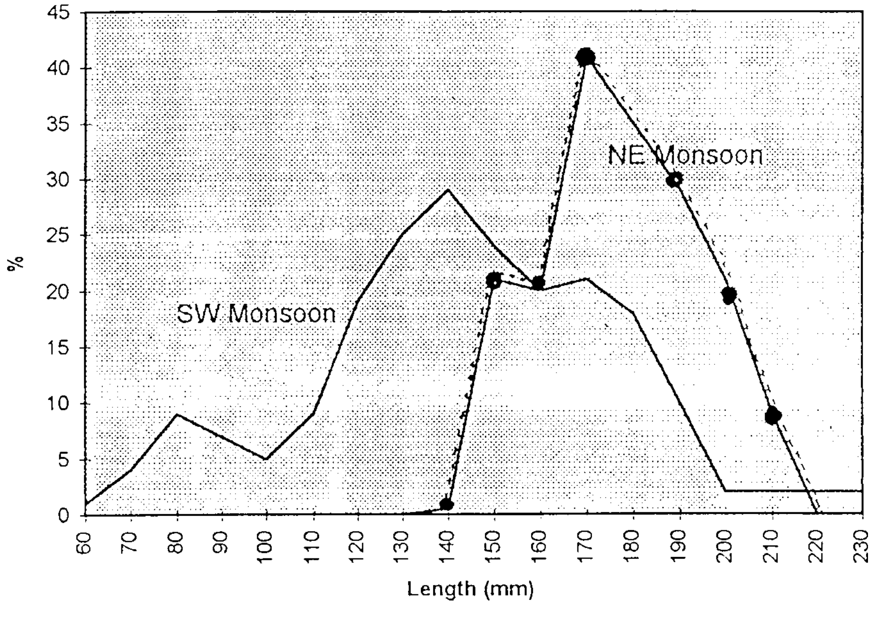


Fig.2 : Length frequency distributions of D.maruadsi caught by R/V BIENDONG during 1978-1980

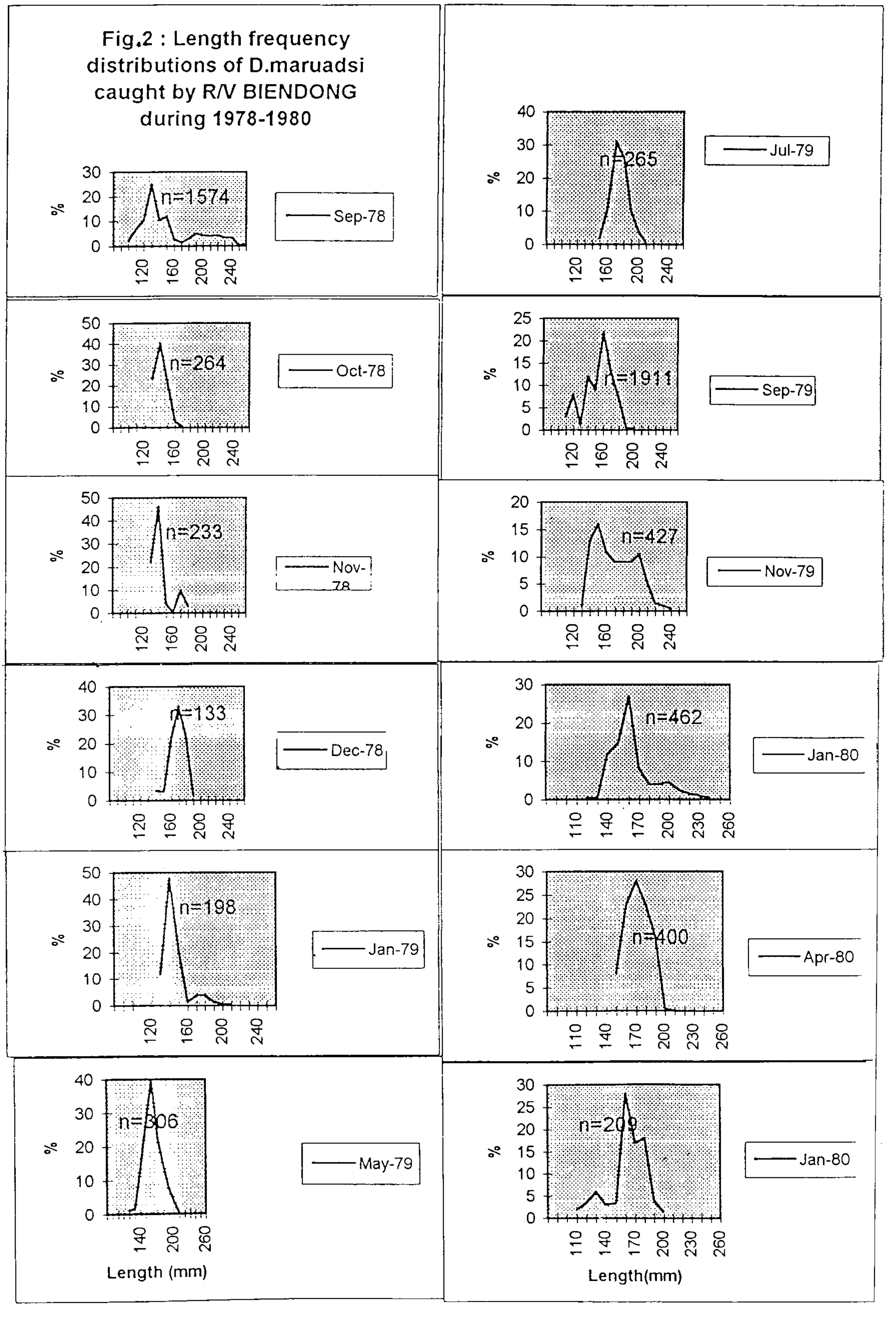


Table 2: Length – Weight Relationship of *D. maruadsi*

Areas	*a*	*b*
Central part of the Tonkin Gulf	0.00001340	2.5330
South–Eastern part of the Tonkin Gulf	0.00006839	2.6507
Southern part of Central Vietnam	0.0001005	2.6020

Von Bertalanffy Equation

The growth parameters of *D. maruadsi* are shown in **Table 3**.

Table 3: Growth Parameters of *D. maruadsi*

Areas	*Lo*	*K*	*to*
Central part of the Tonkin Gulf	243	0.32	0.89
South–Eastern part of the Tonkin Gulf	286	0.21	1.17
Southern part of Central Vietnam	258	0.22	0.79

The growth curves of *D. maruadsi* are shown in **Figures 3, 4** and **5**.

Growth Rate

D. maruadsi grew very fast in the first year. Growth in length–at–age is shown in **Table 4**.

Table 4: Growth Rate of *D. maruadsi*

Age (Year)	*Length (mm)*	
	Range	*Mean*
1	70 – 159	100 – 110
2	100 – 199	137 – 148
3	140 – 209	164 – 176
4	160 – 219	184 – 202

Fig 3 : Growth curve of D.maruadsi in central part of the Tonkin Gulf

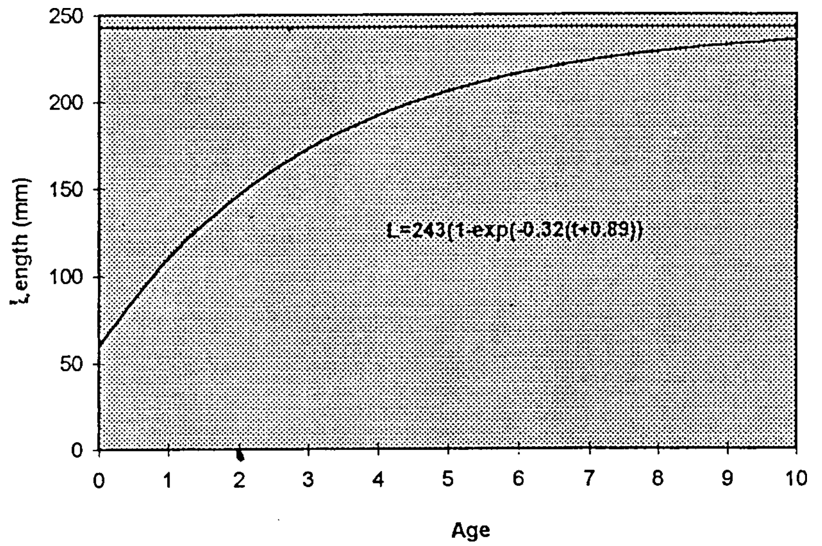
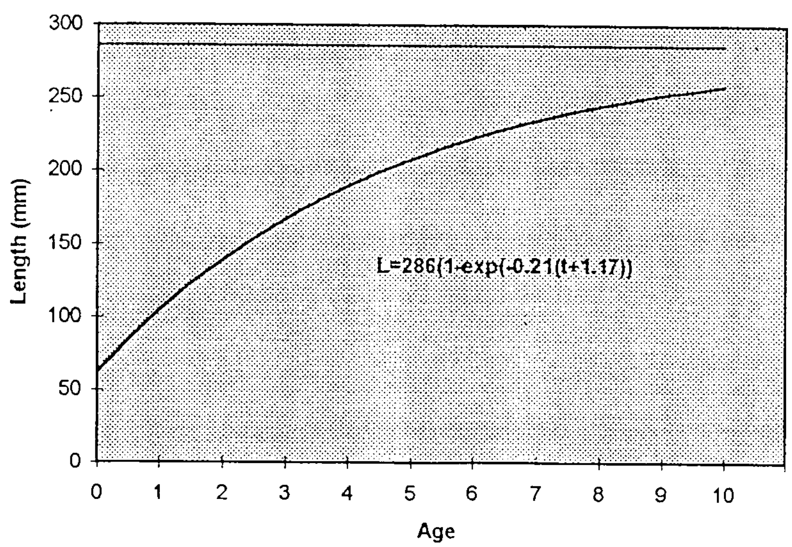


Fig 4 : Growth curve of D.maruadsi in South - Eastern part of the Tonkin Gulf



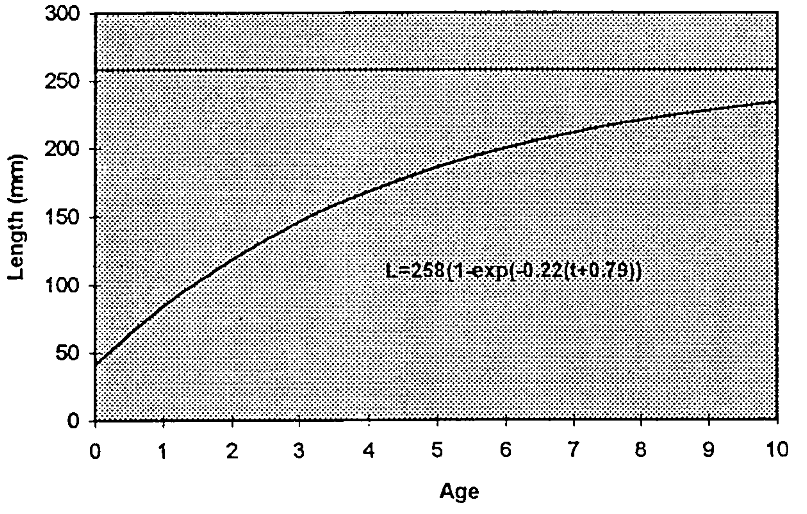


Fig.5: Growth curve of D.maruadsi in Southen part of the Central Vietnam

MORTALITY

The total mortality (Z) was estimated to be 1. 19, natural mortality (M) 0.87 and fishing mortality (F) 0.32.

SPAWNING

Spawning season of *D. maruadsi* lasts from January to August – September. In the Tonkin Gulf *D. maruadsi* spawns earlier (in January) than in other areas. *D. maruadsi* spawns 2 – 3 times during the spawning season. The size at first maturity of *D. maruadsi* is estimated at the smallest body length of 145 mm.

The spawning population consists mainly of fishes of length group 160 – 199 mm. (2 – 3 years old group).

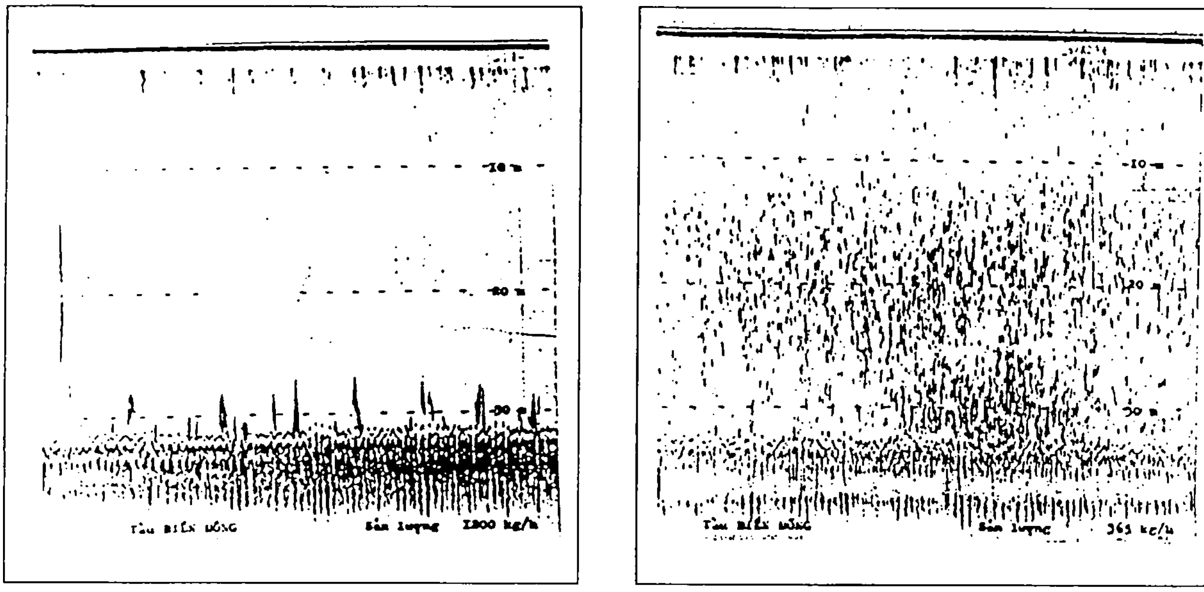
The fecundity of *D. maruadsi* ranges from 36.700 – 139.500 eggs. The relationship between fecundity and length and age are shown in **Table 5**.

Table 5: Fecundity of *D. maruadsi*

Length and Weight *(mm)* *(g)*		*Fecundity Range*	*Average*
	60 – 69	49,800 – 57,500	53,200
	70 – 79	39,500 – 112,400	73,100
Weight	80 – 89	58,700 – 115,900	78,200
	90 – 99	110,400 – 139,500	124,900
	100 – 109	51,900	51,900
	110 – 119	49,300	49,300
	160 – 169	46,000 – 46,900	46,500
	170 – 179	36,700 – 112,400	66,300
Length	180 – 189	49,800 – 115,900	68,900
	190 – 199	39,500 – 139,500	79,300
	200 – 209	51,900	51,900
	210 – 219	49,300	

MIGRATION

By Echodiagram recordings and catch composition of sample of test fishing by bottom and pelagic trawls, the day – night vertical migration of the *D. maruadsi* have been seen very clearly. It was found from the bottom during day time and to the upper layers at night time. **(Figure 6).**



Day time Night time

Figure 6: Day and Night Vertical Migration of *D. maruadsi* in South Vietnam (near CONSON Island)

From December to March, *D. maruadsi* migrates from central to the northern areas of the Tonkin Gulf for spawning and from April to August they approaches the coastal in the West. (**Figure 7**).

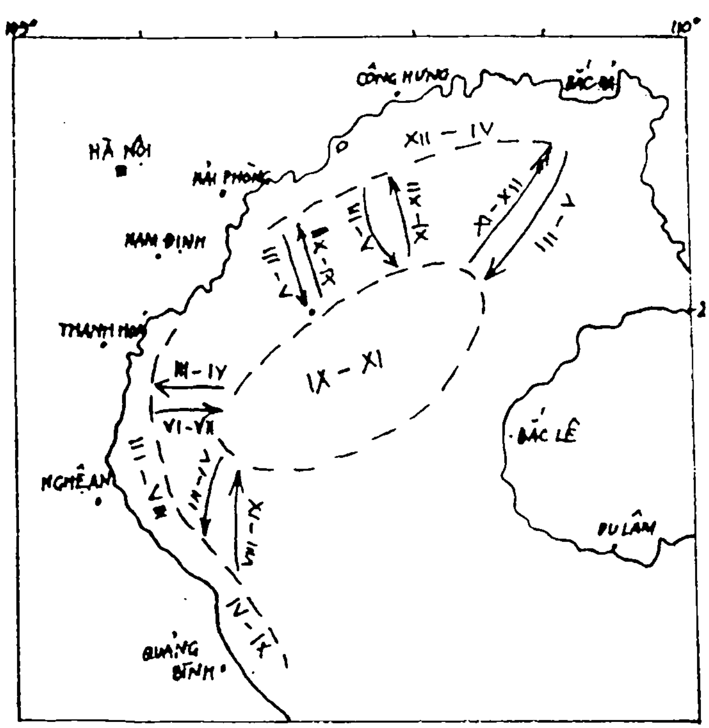


Figure 7: Migration of *D. maruadsi* in the Tonkin Gulf

In Phan thiet and Vung tau areas, South Vietnam *D. maruadsi* migrates from the northern to the southern areas and from off-shore areas to coastal ones.

STOCK ASSESSMENT

By Acoustic and Swept Area Methods, the total biomass and total allowable catch (TAC) of *D. maruadsi* were estimated for the Tonkin Gulf, Central Vietnam (12 – 16°N) and South Vietnam (8 – 12°N), the results of estimation are shown in **Table 6**.

Table 6: Biomass and Total Allowable Catch of *D. maruadsi*

Areas	*Biomass (MT)*	*TAC (MT)*
The Tonkin Gulf	59,000 – 75,000	26,000 – 33,000
Central Vietnam (12 – 16°N)	30,000 – 40,000	15,000 – 20,000
South Vietnam (8 – 12°N)	70,000 – 108,000	30,000 – 47,000
TOTAL	158,000 – 223,000	71,000 – 100,000

Comparing with the fishery it was only a priliminary rough estimation of biomass and total allowable catch of *D. maruadsi.* The more detail stock assessment of *D. maruadsi* is needed in the future.

B. Mackerels *Rastrelliger Kanagurta*

Mackerels (*Rastrelliger* spp.) are widely distributed in the Indian and Western Pacific Oceans. Two species of mackerels commonly found in the Vietnamese seawaters are:

Rastrelliger kanagurta (Indian Mackerel) and *R. brachysoma* (Short body mackerel). *R. kanagurta* are found through the whole seawaters of Vietnam while *R. brachysoma* are found only in the Gulf of Thailand.

Extensive studies on biology and ecology of mackerels have been carried out for *R. kanagurta* and *R. brachysoma* in many waters. In Vietnam, some studies on *R. kanagurta* have been done only.

The biological features of *Rastrelliger kanagurta* are given as follows:

DISTRIBUTION

R. kanagurta is distributed along the coast of Vietnam in water depth ranging from 15 to 10 m, but concentrated mainly in stratum of 25 – 70 m.

LENGTH DISTRIBUTION

R. kanagurta caught has length ranging from 72 to 280 mm with an average length of 209 mm. The length varies accordingly to areas, for example in Vungtau areas the length of *R. kanagurta* caught varies from 72 – 280 mm, in Conson Island areas from 62 – 260 mm and in Phanrang – Phanthiet areas from 135 to 295 mm.

LENGTH – WEIGHT RELATIONSHIP

The length – weight relationship equation of *R. kanagurta* is estimated to be:

$$W = 0.084\ L^{2.33}$$

AGE COMPOSITION

Indian mackerels caught in the Vietnamese water belonging to 4 age groups of which two years old fish group is predominant and accounting for average of 64.4%, one year old group accounting for 19.7%, three years old group – 12.0% and four years old group only 3.8%.

GROWTH

R. kanagurta grew very fast in the first year, at the end of the first year the length of newly hatched *R. kanagurta* reached in average of 113 mm. From second year, growth gradually decreased. The growth in length by age group of *R. kanagurta* is shown in **Table 7**.

Table 7: Growth in Length by Age Group

Age	*Length (cm)*	*Growth increments (cm)*
1	113	113
2	176	63
3	217	41
4	250	33

SPAWNING

Spawning season of R. kanagurta lasts from the end of dry season. (March) to the end of rainy season (October) with two peaks in March – June and September – October. The size at first maturity varies from 140 to 200 mm. The favourable temperature of seawater surface for spawning is 26 – 27.5°C and salinity 30 – 34%.

FOOD AND FEEDING HABIT

R. kanagurta feed mainly on zooplankton and partly on phytoplankton. Oncaea is dominant in food composition and accounting for 39.8%, Copepoda – 11.4%, Megapoda larva – 9.4%, Microtella – 5.6%, Temora discaudata – 4.6%, etc.

Food compositions of male, female and juveniles of *R. kanagurta* are relatively similar.

MIGRATION

Day and night migration by the vertical direction of *R. kanagurta* has been seen very clearly, especially by the echo diagram recordings received from the Echosounder SIMRAD – 38, 50 and 120 KHz. The results of trawling showed that, *R. kanagurta* being caught by bottom trawls only in the time from 2 am. to 6 pm.. With the pelagic trawl the highest catch was gained from 10 –12 pm.

C. Tunas

Tunas are widely distributed in Coastal and seawaters and off-shore areas of Vietnam. Among 14 species belonged to 8 genera distributing in the South China Sea and adjacent waters, 8 species belonged to 5 genera have been identified in seawaters of Vietnam, namely: *Auxis thazard* (Frigate tuna), *A. rochei* (Bullet tuna), *Euthynnus affinis* (Eastern little tuna), *Sarda orientalis* (Oriental bonito), *Katsuwonus pelamis* (Skipjack tuna), *Thunnus tonggol* (Longtail tuna), *T. albacares* (Yellowfin tuna) and *T. obesus* (Bigeye tuna).

The first 6 species are considered as neritic tunas, they are objects of traditional tunas fishing in Vietnam, and the last two species are objects of longline fishing which was introduced into Vietnam only for some years ago:

The data and information on the important biological features of neritic tunas in seawaters of Vietnam are given as follows:

LENGTH COMPOSITION

Among the neritic tunas caught in seawaters of Vietnam, *Auxis rochei* (Bullet tuna) has the smallest body size, the size of Bullet tuna ranges from 24 – 29 cm. The size compositions of tunas are shown in **Table 8**.

Table 8: Length Composition of Tunas

Species	*Body Size (Lf) Captured (cm)*	*Dominant Size Group*
Auxis rochei	24 – 29	26 – 27
A. thazard	20 – 59	29 – 33
Euthynnus affinis	20 – 64	36 – 60
Sarda orientalis	41 – 71	44 – 57
Thunnus tonggol	26 – 68	48 – 56
Katsuwonus pelamis	41 – 65	50 – 56

Length frequency distribution are shown in **Figures 8 – 12**.

LENGTH – WEIGHT RELATIONSHIP

Length – Weight relationship of tunas caught in seawaters of Vietnam are shown in **Table 9**.

Fig. 8 : Length frequency distribution of Auxis rochei

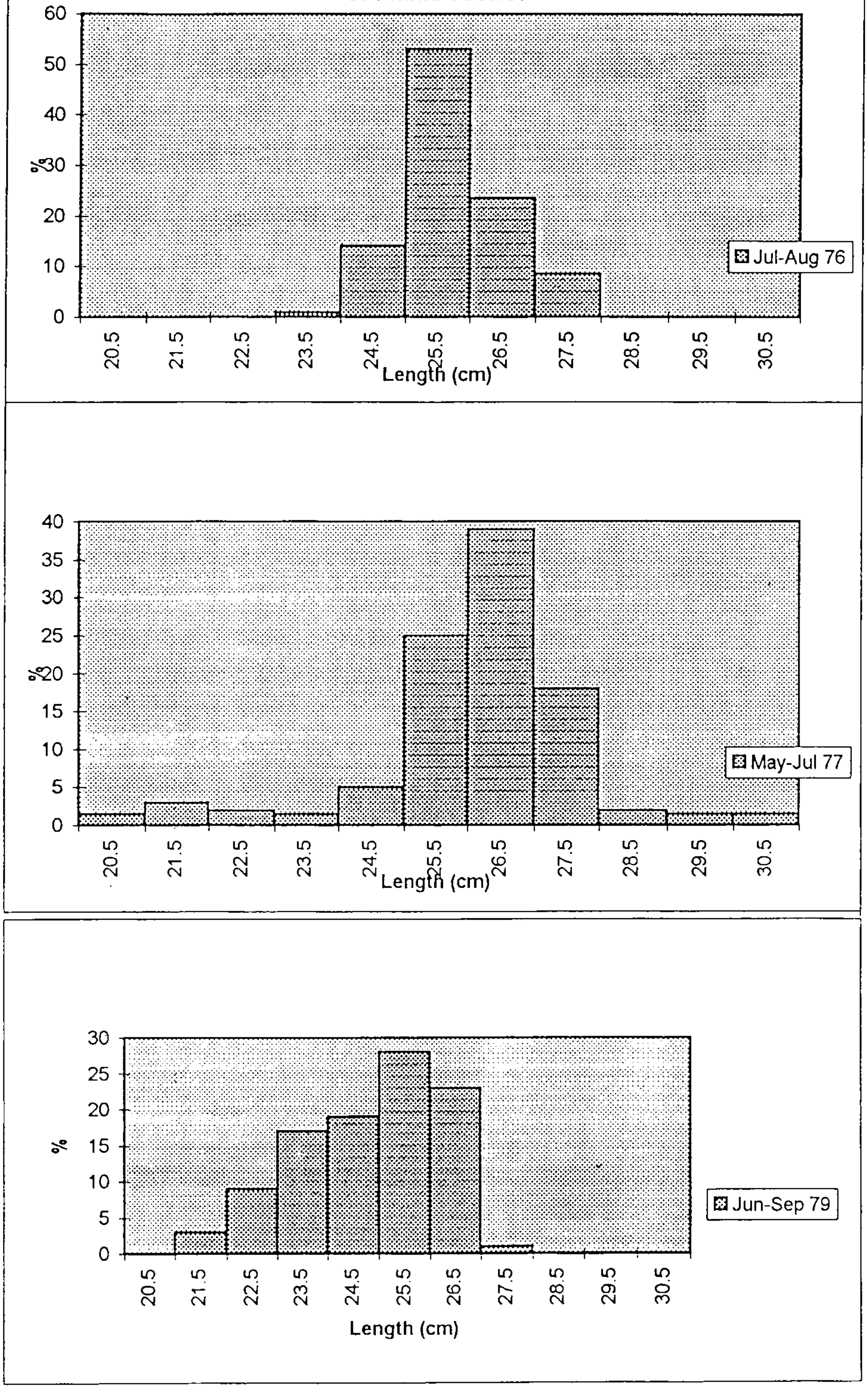
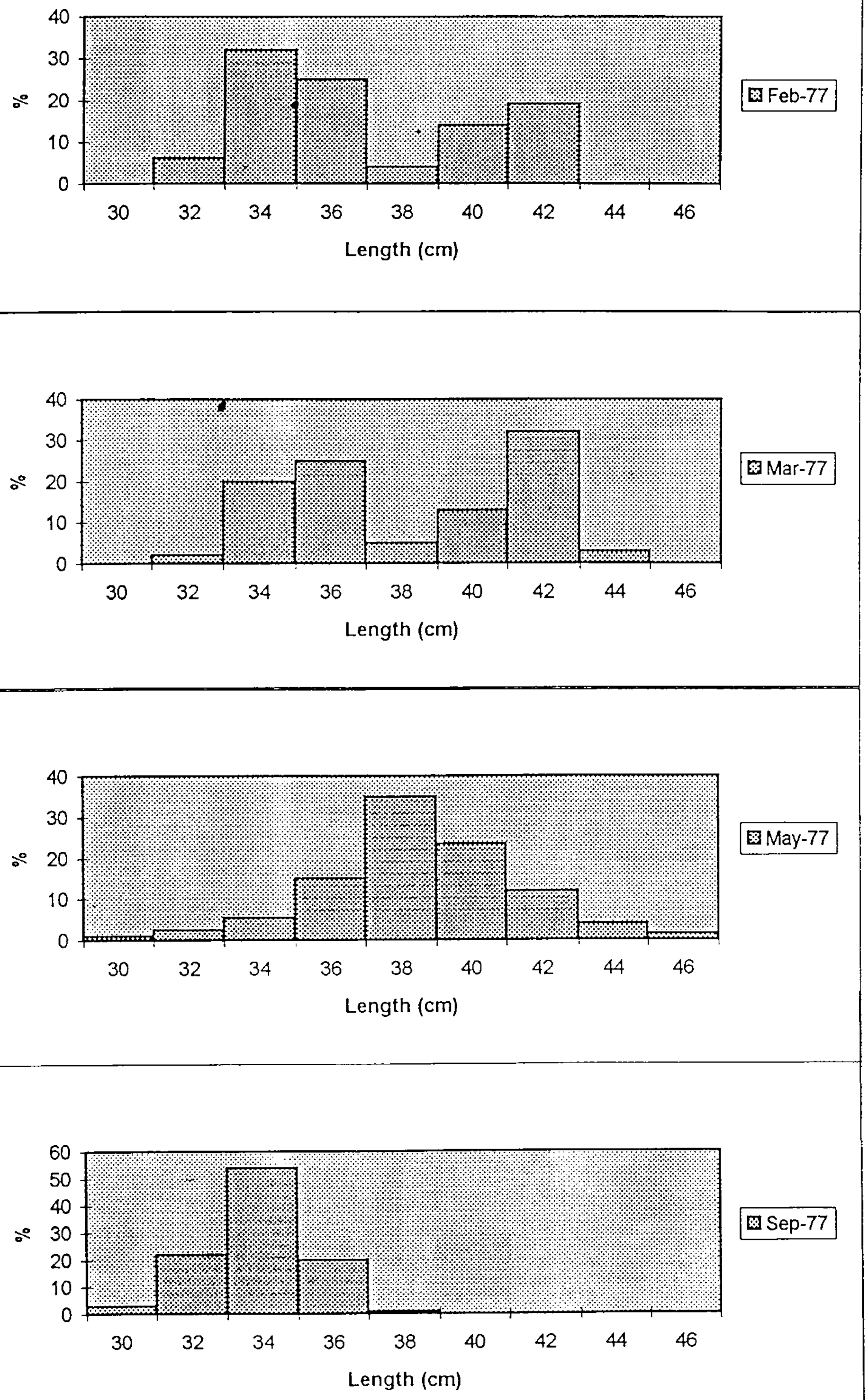


Fig. 9 : Length frequency distribution of Auxis thazard in Central Vietnam



Length frequency distribution of Auxis thazard in South-Eastern seawaters and the Tonkin Gulf

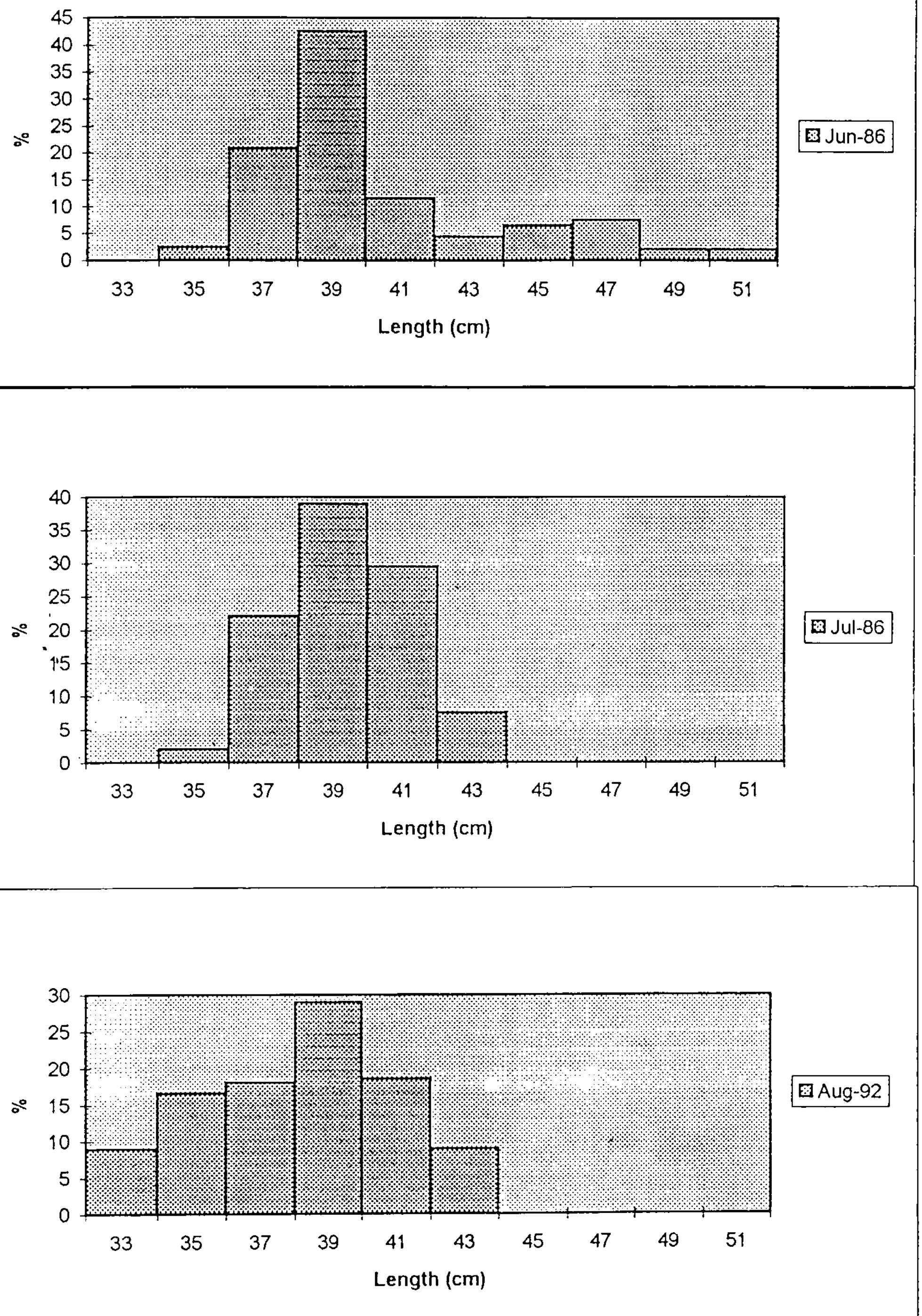
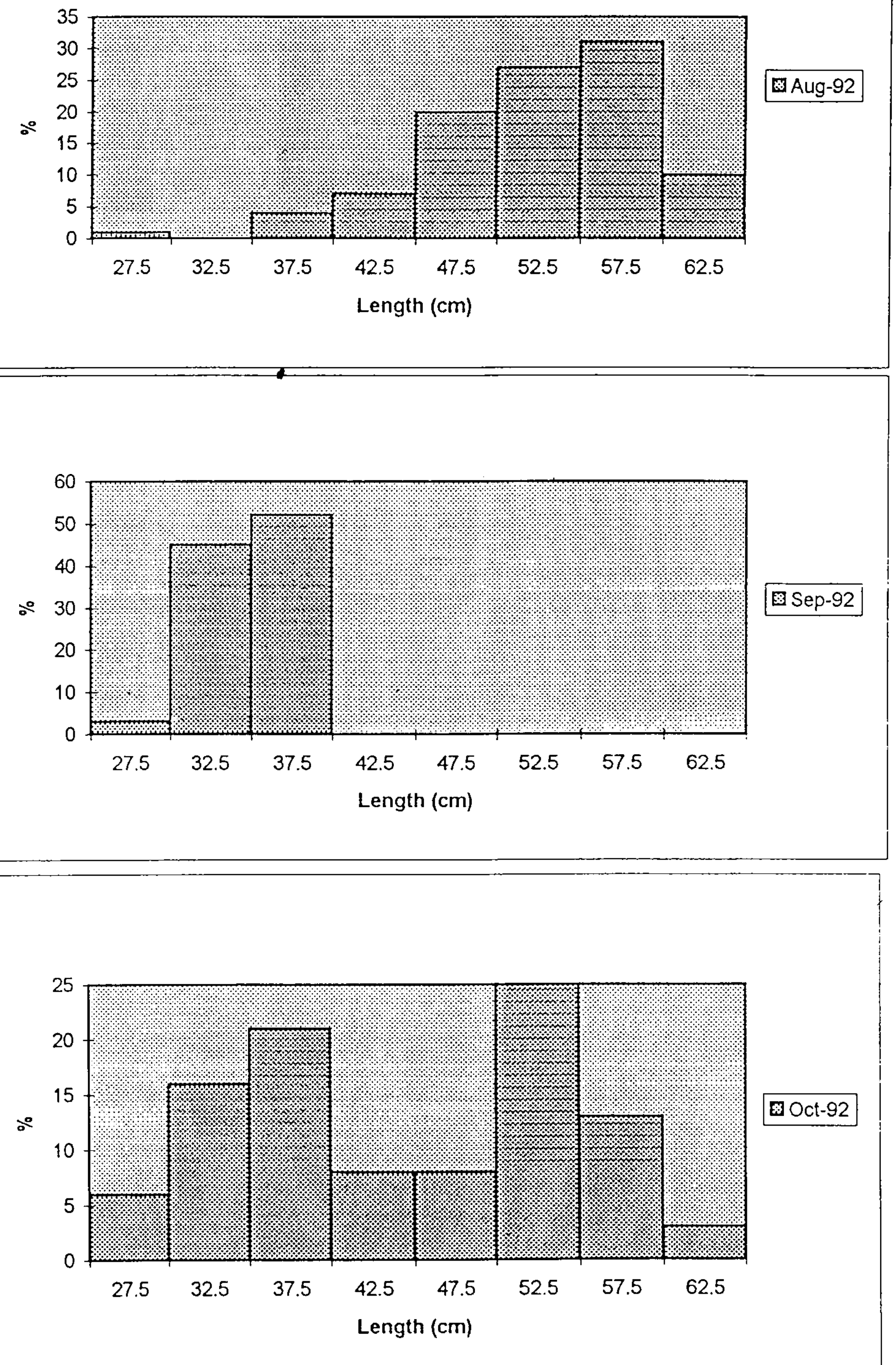
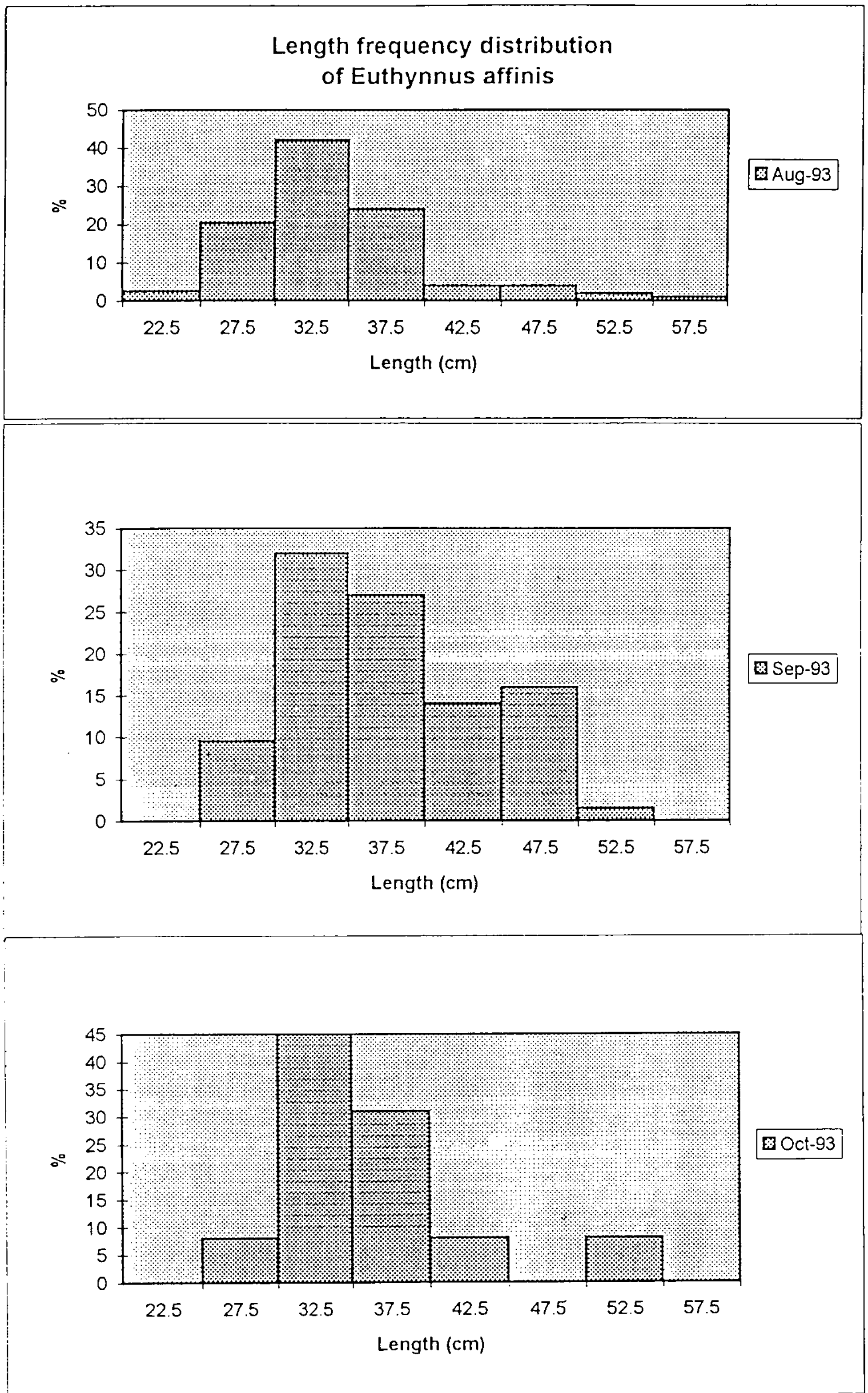


Fig. 10 : Length frequency distribution of Euthynnus affinis




Length frequency distribution
of Euthynnus affinis
50
40
30
20
10
0
%
22.5
27.5
32.5
37.5
42.5
47.5
52.5
57.5
Length (cm)
Aug-93
35
30
25
20
15
10
5
0
%
22.5
27.5
32.5
37.5
42.5
47.5
52.5
57.5
Length (cm)
Sep-93
45
40
35
30
25
20
15
10
5
0
%
22.5
27.5
32.5
37.5
42.5
47.5
52.5
57.5
Length (cm)
Oct-93

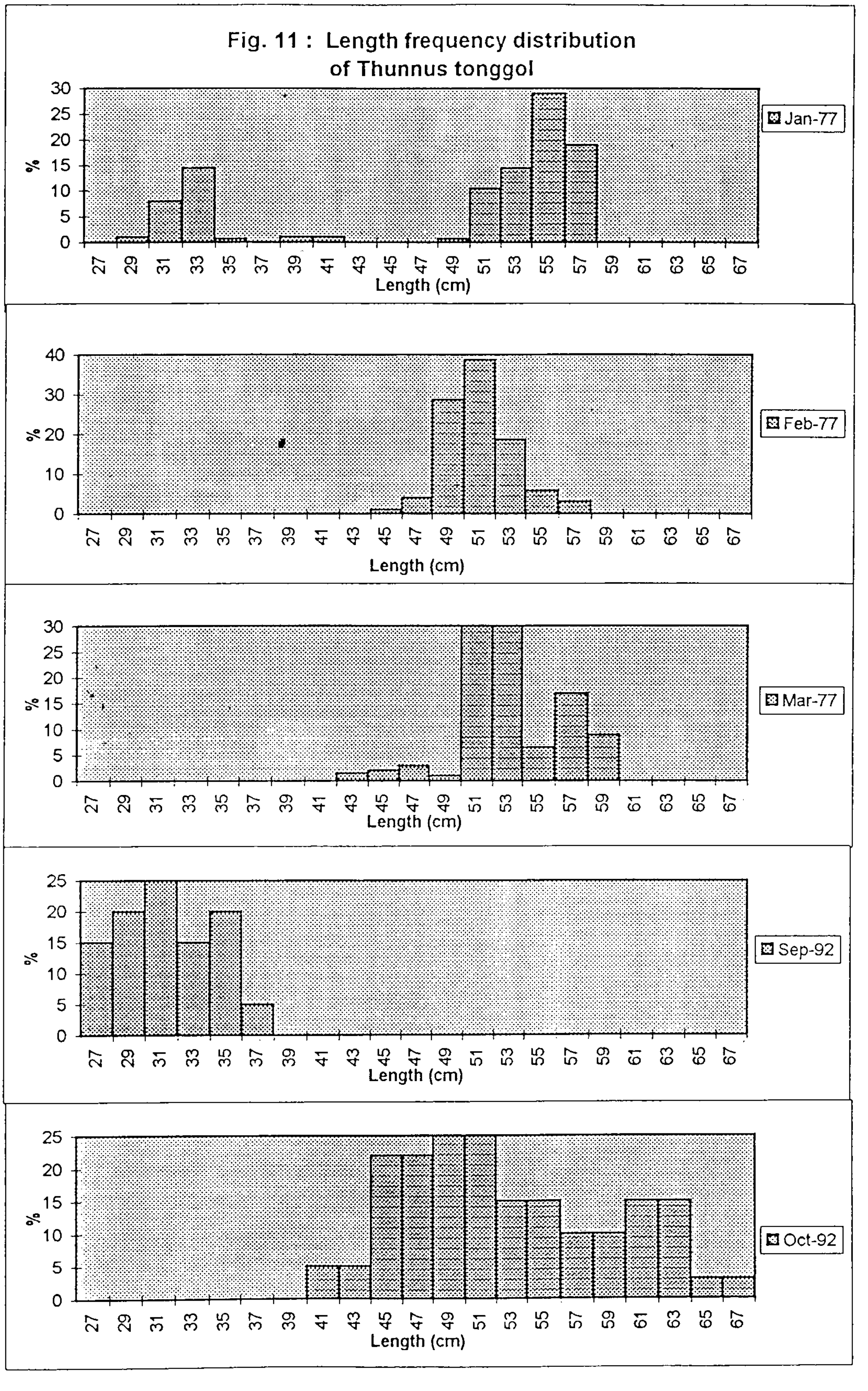


Fig. 11 : Length frequency distribution
of Thunnus tonggol
%
Length (cm)
Jan-77
Feb-77
Mar-77
Sep-92
Oct-92

Fig. 12 : Length frequency distribution of Katsuwonus pelamis

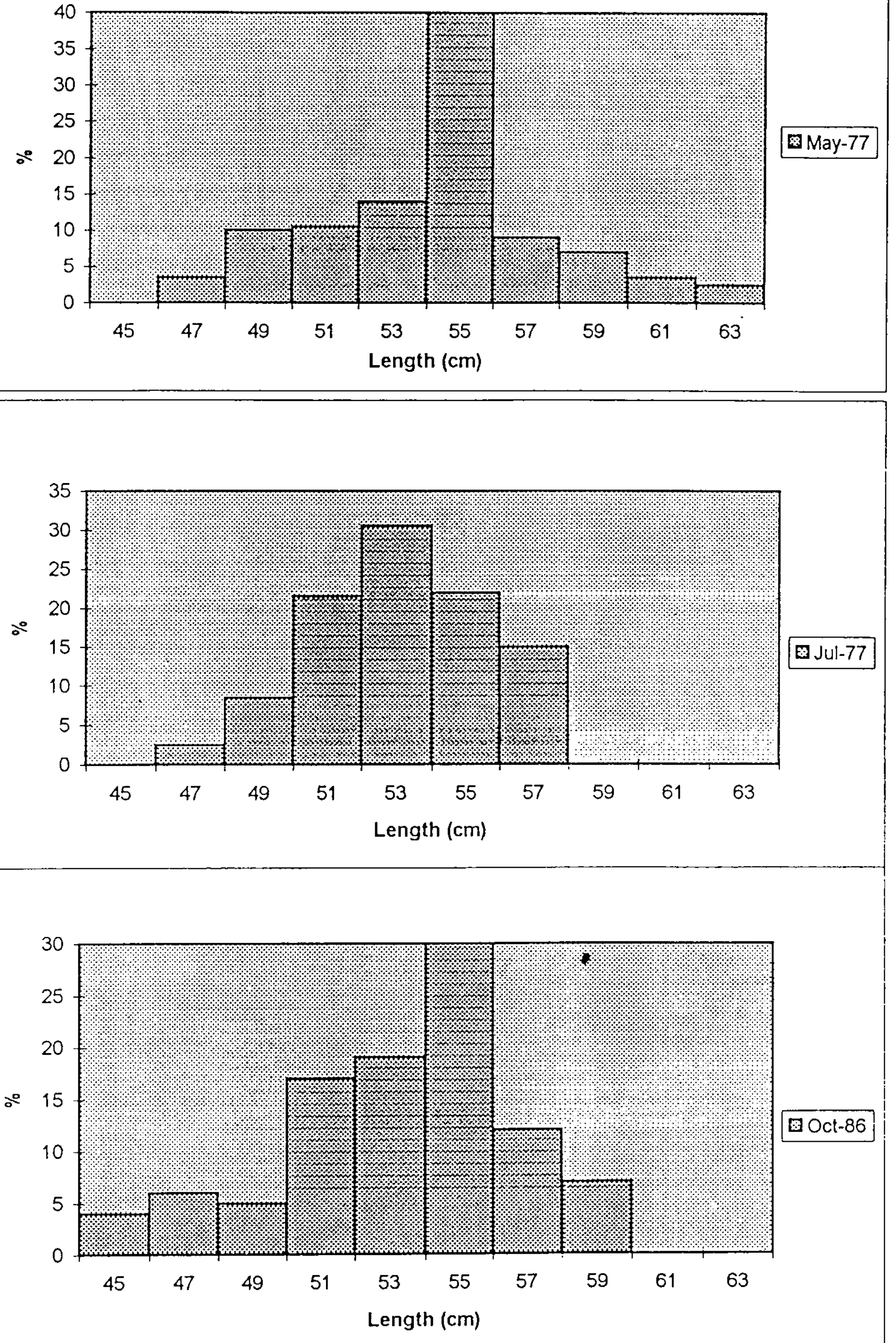


Table 9: Length – Weight Relationship ($W = aL^b$)

Species	*a*	*b*
Auxis thazard	0.00164	2.210
Euthynnus affinis	0.00058	2.698
Thunnus tonggol	0.000731	2.644
Katsuwonus pelamis	0.000114	2.710

VON BERTALANFFY EQUATION

Growth parameters were estimated by Bhattacharya method (used program FiSAT – FAO/ICLARM. Stock assessment Tools). The results of estimation are shown in **Table 10**.

Table 10: Growth Parameters

Species	*Loo*	*K*	*to*
Auxis thazard	60.58	0.982	0.111
Katsuwonus pelamis	72.08	1.099	0.08
Thunus tonggol	72.22	0.899	0.128

The Growth curves of some species are shown in **Figures 13, 13a, 14, 14a**.

MORTALITY

Mortality rate was estimated by using program FiSAT. The total mortality (F), Fishing mortality (F) and natural mortality (M) Coefficents are shown in **Table 11**.

Table 11: Z, F and M Coefficents

Species	*Z*	*M*	*F*
Auxis thazard	1.94	0.38	1.56
Euthynnus affinis	1.0	0.52	0.48
Thunnus tonggol	1.3	0.27	1.03
Katsuwonus pelamis	0.54	0.28	0.26

Figure 13 : Growth curve of Thunnus tonggol

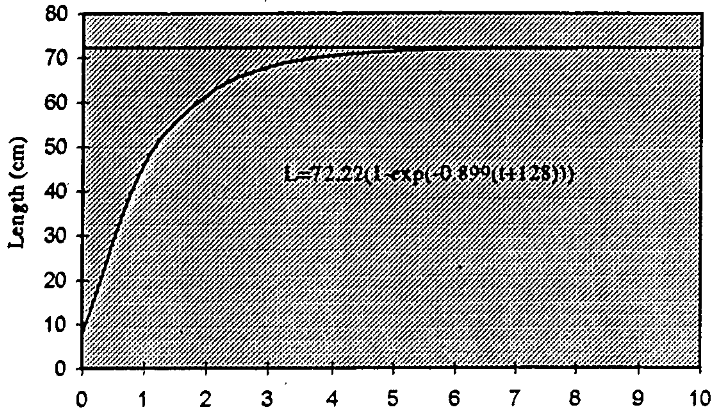


Figure 14 : Growth curve of Katsuowonus pelamis

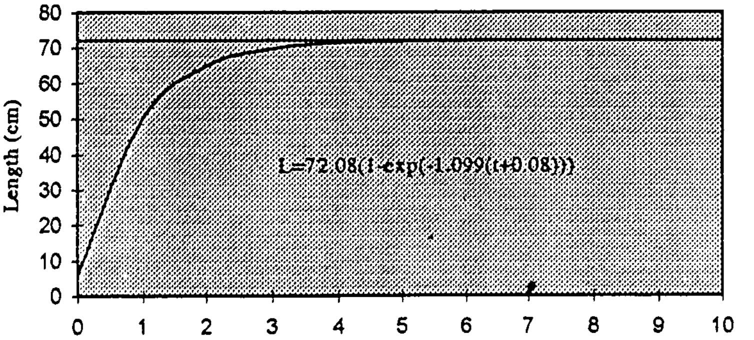


Figure 13a. Growth curve of Auxis thazard

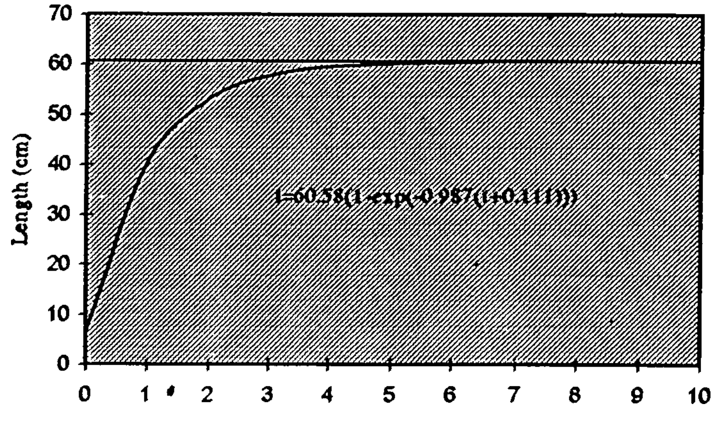
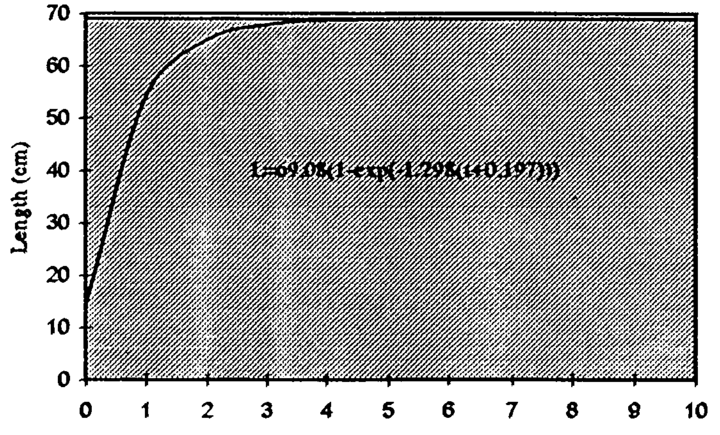


Figure 14a : Growth curve of Euthynnus affinis



FOOD AND FEEDING HABIT

All species of neritic tunas feed essentially on Carangids (Decapterus spp.), Squid (Loligo spp.), Sardines (Sardinella spp.) and Anchovies (Stolephorus spp.) as well as Zooplankton such as Amphipoda, Copepoda, Cephalopoda, Crustacean and Squilla larvae.

SPAWNING

Spawning seasons, fecundity of two neritic tunas as shown in **Table 12**.

Table 12: Spawning Season and Fecundity

Species	*Spawning Season (month)*	*Fecundity (x 1000)*	*Spawning Areas*
Auxis thazard	5 – 8 4 – 8 2 – 7	200 – 1060	Tonkin Gulf Central Vietnam Gulf of Thailand
Euthynnus affinis	4 – 8 3 – 9	1400	Tonkin Gulf Gulf of Thailand
Thunnus tonggol	3 – 9	1400	Gulf of Thailand
Katsuwonus pelamis	5 – 8 4 – 8		Tonkin Gulf Central Vietnam

MIGRATION

According to the results of drift gillnet catch of tunas, it was assumed that neritic tunas are migrating from off-shore areas of the South China Sea to seawaters of Central areas of Vietnam in January – February. They accure for sometime there and one part of stock migrates northward to the Tonkin Gulf in March – April and stays there until August – September. Other part of stock migrates southward to the Eastern seawaters. The major part of the stock stays in the Central seawaters areas.

Another stock migrates from southern off-shore areas to the Thailand Gulf.

III. STATUS OF FISHERIES

D. maruadsi in Vietnamese seawaters are caught mainly by bottom trawls, liftnet and purse seiners. The catch distributions of *D. maruadsi, D. kurroides* and *D. lajang* (kg./h of vessel of 2300 Hp, bottom trawl) in general and in dry (November – April) and rainy seasons (May – October) are shown in Figures of *D. kuroides* 15 – 17 of *D. maruadsi* in **Figures 18 – 20** of *D. lajang* in **Figures 21 – 23**.

The total catch production of *D. Maruadsi* was estimated at about 30,000 MT/year.

Mackerels (*R. kanagurta*) are objects of bottom trawl, liftnet, purse seiners and drift gillnet fishing.

No statistical data on catch and production are available from commercial fisheries. The catch distributions of *R. kanagurta* from research data are shown in **Figures 24 – 26**.

Fishing on neritic tunas is becoming one of the important commercial fisheries in Vietnam. Although the tunas resources are believed to be abundant over the entire areas, fishing on tunas has not been developed accordingly to resources potential yet.

The traditional methods of fishing for neritic tunas are chinese purse seiners and drift gillnet. Due to the lack of fisheries statistical system in Vietnam, the data on catch and production by species of tunas are not available. Roughly, the total production of all species of tunas in seawaters of Vietnam was estimated to be about 30,000 MT/year. The main fishing season for tunas in Vietnam is from April to August.

The catch dinamics of 3 species of *Decapturus* and *R. kanagurta* are given in **Table 13**. The results showed that, catch productivity of *D. maruadsi* in some years reached very high values (in 1977, 1979, 1980). It's tendency is to decrease in recent years.

In coastal areas of the Gulf of Thailand, date collected are limited, the similar tendency has been seen for *D. maruadsi* and *R. kanagurta* (**Table 14**).

Catch rate dinamics of shared stock in the Tonkin Gulf, Central sea waters and Eastern sea waters of South are shown in **Tables 15 – 17**.

FIG. 15 : CATCH DISTRIBUTION OF *DECAPTERUS MARUADSI*
During rainy season (May - October) 1977 - 1988
Converted Hp : 2300

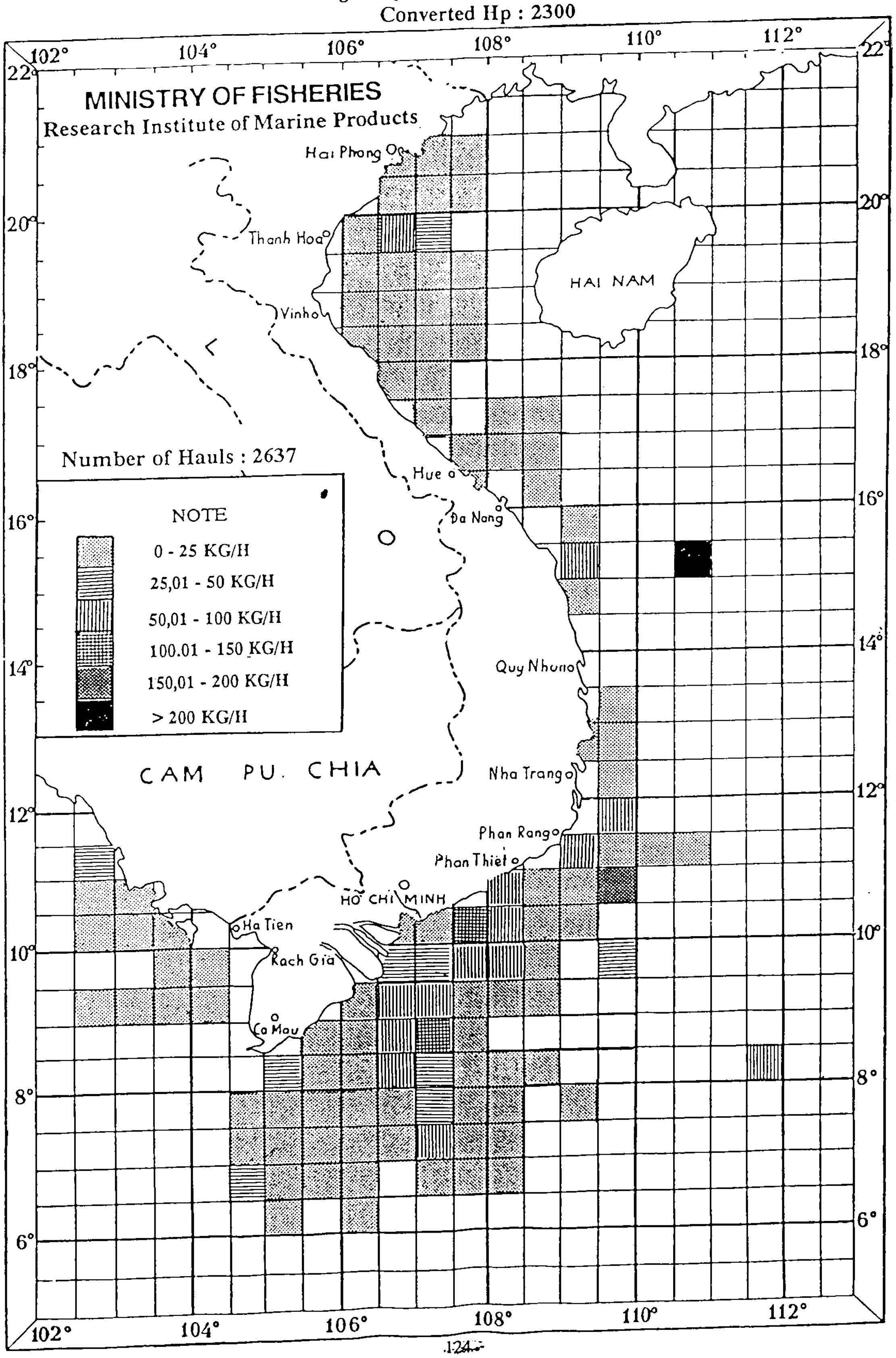


Table 13: Catch Productivity (Kg/h) of Shared Stock in Vietnamese Seawaters During 1977 – 1988

Year	*1977**	*1978**	*1979**	*1980**	*1981**	*1983*	*1985*	*1986*	*1987*	*1988*
N° of Hauls	*64*	*80*	*564*	*410*	*314*	*26*	*63*	*84*	*64*	*173*
Hp	*1.500*	*1.500*	*1.000*	*1.000*	*1.000*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*
Converted Hp	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*	*2.300*
1	2	3	4	5	6	7	8	9	10	11
Decapterus maruadsi	42.41	14.92	30.52	40.59	—	4.69	1.57	—	6.14	2.44
D. lajang	—	—	—	0.14	—	—	1.19	—	2.08	0.70
Decapterus kurroides	—	—	—	—	0.35	—	—	1.98	—	—
Rastrelliger kanagurta	2.89	—	—	1.78	—	0.14	—	—	0.97	0.38

Table 14: Catch Rate (%) of Shared Stock in the Gulf of Thailand During 1977 – 1978

Year	*1977*	*1979*	*1980*	*1981*	*1985*	*1986*	*1988*
N° of Hauls	*2*	*6*	*133*	*64*	*23*	*15*	*7*
Hp	*1500*	*1000*	*1000*	*1000*	*2300*	*2300*	*2300*
D. maruadsi	—	—	0.03	—	0.80	—	—
R. kanagurta	0.23	5.19	0.69	5.18	3.36	3.17	0.54

Table 15: Catch Rate (%) of Shared Stock in Central Seawaters During 1977 – 1988

Year	*1977*	*1978*	*1979*	*1980*	*1981*	*1983*	*1985*	*1987*	*1988*
N° of Hauls	*5*	*9*	*88*	*6*	*23*	*14*	*9*	*36*	*66*
Hp	*1500*	*1500*	*1000*	*1350*	*1000*	*2300*	*2300*	*2300*	*2300*
Decapterus	3.59	0.08	0.07	—	—	0.33	—	2.22	0.26
D. lajang	—	—	—	—	—	—	—	1.31	0.34
Rastrelliger kanagurta	—	—	—	0.65	0.08	0.56	—	6.67	1.57

Table 16: Catch Rate (%) of Shared Stock in the Gulf of Thailand During 1977 – 1978

Year *N° of Hauls* *Hp*	*1977* *44* *1.500*	*1978* *62* *1.500*	*1983* *12* *2.300*	*1985* *7* *2.300*	*1987* *22* *2.300*	*1988* *35* *2.300*
Decapterus maruadsi	5.21	10.95	16.24	1.43	7.38	2.31
D. lajang	—	—	—	0.9	1.71	—
Rastrelliger kanagurta	1.49	—	0.51	1.65	1.52	

Table 17: Catch Rate (%) of Shared Stock in Eastern Seawaters of South Vietnam During 1977 – 1988

Year *N° of Hauls* *Hp*	*1977* *13* *1500*	*1978* *19* *1500*	*1979* *470* *1000*	*1980* *275* *1000*	*1981* *227* *1000*	*1985* *24* *2300*	*1986* *69* *2300*	*1987* *6* *2300*	*1988* *65* *2300*
Decapterus maruadsi	34.67	4.40	9.48	19.37	—	0.43	—	1.05	3.12
D. lajang	—	—	1.38	0.06	—	1.10	—	0.10	0.96
Decapterus kurroides	—	—	3.76	—	0.13	4.72	0.33	0.60	19.79
Rastreliger kanagurta	3.09	—	0.26	0.31	—	—	—	0.58	0.08

IV. CONCLUSIONS AND RECOMMENDATIONS

1. Resources of shared stock in seawaters of Vietnam have been studied mostly in coastal areas, while in off-shore areas there were still few studies have been done.

2. In Vietnamese coastal areas, studies on *D. maruadsi* have been done relatively regularly and detaily, while on others round scads species, *R. kanagurta* and others mackerels and tunas, especially oceanic tunas very few studies have been conducted. Studies focused mainly on biological features of these species rather than on behaviour, migration or stock assessment.

3. Statistical systems on catch and effort for all species in general and for above shared stock should be established and made accurate as soon as possible.

4. Fishing technology for shared stock must be improved in order to reach higher productivity, catch and at the same time to conserve the resources.

5. Cooperative research works on shared stock of Round Scads, Mackerels and Tuna (stock assessment, biology, behaviour, migration, exchange of date, etc. ...) should be organized and conducted among the countries bordering the South China Sea.

6. Species compositions and catch dynamics of shared stock in the Vietnamese Waters as well as in some countries in the region showed that: It is time to strietly enforce measures to protect and converse above shared stock.

Only with common will and unified management of all countries bordering the South China Sea – these measures could be come in to forces.

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ANNEXE 13

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / WP. 1

STATUS ON FISHERIES EXPLOITATION AND POTENTIAL YIELD OF ROUND SCADS AND MACKERELS IN THE REGION

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STATUS ON FISHERIES EXPLOITATION AND POTENTIAL YIELD OF ROUND SCADS AND MACKERELS IN THE REGION

INTRODUCTION

The South China Sea Area is one of the most important areas for marine capture fisheries in the world, and the marine catches of the region accounted for around 10% of the world grand total. This paper describes the facts and figures on fisheries of three major species groups, round scads (*Decapterus* spp.), Indian mackerels *(Rastrelliger kanagurta* and *R. faughni)* and Indo-Pacific mackerel *(Rastrelliger brachysoma)* in the region.

The combined catch quantity of these three species groups was 1,155.000 MT in 1992 and accounted for 12% of the grand total in the region. The references of data examined were Fishery Statistical Bulletin and Catch-effort Statistics for the South China Sea Area which have been published annualy by SEAFDEC.

1. MARINE PRODUCTION OF ROUND SCADS AND MACKERELS IN THE REGION

This section describe the catch quantity (Metric ton), catch value (US$) and unit price (US$/kg) of three species groups of round scads, Indian mackerels and Indo-Pacific mackerel from 1976 to 1992 in the region.

1-1 Catch Trend

Catch by three species groups from 1976 to 1992 in the region is shown in **Table 1** and **Figure 1.**

The sub-total of three species groups in the region recorded at 646,000 MT (accounted for 11.2% of the grand total) in 1976 and it decreased to 480,000 MT in 1979. After 1979, combined catch showed steady increase to 1,155 MT (12.1%) in 1992 with an exception of a slight decreasing of 1988.

Round scads catch in the region recorded at 405,000 MT (accounted for 7.0% of the grand total) in 1976 and remained constant in 1977. The catch decreased drastically from 1978 and then recorded at 193,00 MT in 1980, but it increased to 446,000 MT in 1987. In 1988, the catch decreased slightly, but it increased again steadily and reached at 596,000 MT in 1991 and remained constant in 1992.

Indian mackerel catch in the region recorded at 84,000 MT (accounted for 1.5% of the grand total) in 1976. The catch increased to 279,000 MT in 1983, then remained constant until 1989 and it increased again and reached at 357,000 MT (3.8%) in 1992.

Indo-Pacific mackerel catch in the region recorded at 156,000 MT (accounted for 2.7% of the grand total) in 1976, but it recorded at 164,000 MT (1.9%) in 1991 as similar as the quantity of 1976. During the period from 1976 to 1992, the catch showed no big variations with a minimum of 92,000 MT in 1981 and a maximum of 206,000 MT in 1992.

1-2 Catch Value

Catch value by three species groups from 1976 to 1992 in the region is shown in **Table 2** and **Figure 2.** Data from 1976 to 1985 were obtained from all countries, but data from 1986 to 1992 were excluded the data of Indonesia.

The sub-total catch value trend of three species groups in the region from 1976 to 1985 was divided into two periods, i.e., from 1976 to 1980 which showed US$ 300 million level, and from 1981 to 1985 which showed US$ 400 million level. After 1985, the combined sub-total catch value of 1986 showed US$ 312 million and showed a steady increase to US$ 556 million in 1992.

Round scads catch value in the region from 1976 to 1985 varied in general from US$ 155 million to US$ 198 million with exceptions of US$ 142 million in 1980 and over US$ 200 million in 1981 and 1982. After 1985, the catch value of 1986 showed US$ 156 million and increased steadily to US$ 270 million in 1992.

Indian mackerels catch value trend in the region from 1976 to 1985 was divided into two, i.e., from 1976 to 1980 which showed less than US$ 100 million, and from 1981 to 1985 which showed around US$150 million. After 1985, the catch value of 1986 showed US$83 million and increased steadily to US$157 million in 1992.

Indo-Pacific mackerel catch value in the region from 1976 to 1985 showed less variations from US$67 million to US$ 92 million with exceptions of around US$ 55 million in 1981 and 1982. After 1985, the catch value showed a increase trend generally to US$129 million in 1992.

1-3 Unit Price

Estimated unit price (catch value/catch quantity) of three species groups in the region from 1976 to 1992 is shown in **Table 3** and **Figure 3.** The price shows the producer price at the landing center.

On round scads unit price in the region from 1976 to 1992, the price increased from US$0.47 per kilogram in 1977 to US$0.76/Kg. in 1979, then it remained constant until 1981. The price decreased to US$ 0.49/kg in 1984, but it recorded at US$ 0.69/kg. in 1986, then it showed less variations until 1992.

On Indian mackerels unit price in the region from 1976 to 1992, the price increased dramatically from US$ 0.48/kg. in 1977 to US$ 0.74/kg. in 1978, but it showed general decreasing trend to US$ 0.55/kg. in 1985. After 1985, the price remained constant around US$ 0.63/kg. for five years, then increased to US$ 0.91 in 1991.

On Indo-Pacific mackerel unit price in the region from 1976 to 1992, the price showed less variations through this period with a minimum of US$ 0.44/kn. in 1976 and a maximum of US$ 0.66/kg. in 1992.

2. CATCHES OF ROUND SCADS AND MACKERELS BY TYPE OF FISHING GEAR

This section describes the catch quantity and its percentage by type of fishing gear for round scads, Indian mackerels and Indo-Pacific mackerel in 1976, 1981, 1986 and 1992.

2-1 Round Scads

Round scads catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 4**. Percentage of type of fishing gear for round scads is shown in **Figure 4.**

The purse seine catch, the most dominant for the round scads, was 253,000 MT (accounted for 77.3 % of the total round scad catch) in 1976. In 1981, the purse seine catch decreased to 126,000 MT (59.4%), and the other fishing gear catches were increased, especially lift net catch for round scads showed dramatic increase to 39,000 MT (18.5%). In 1986, the purse seine catch for round scads increased to 150,000 MT (68.1%), and lift net catch showed a decrease. The trawl catch in 1986 showed still 23,000 MT and accounted for 10% of the round scads catch, and gill net catch accounted for 4.9% and hook-and-line showed 3.5%. In 1992, the purse seine catch increased steadily to 332,000 MT (84.5%), followed by lift net (31,000 MT; 7.9%) and trawl (12,000 MT; 3.0%).

2-2 Indian Mackerels

Indian mackerel catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 5.** Percentage of type of fishing gear for Indian mackerels is shown in **Figure 5.**

The purse seine catch, the most dominant for the Indian mackerels catch, was 44,000 MT (accounted for 53.0% of the total Indian mackerels catch), trawl catch showed 13,000 MT (15.2%) and gill net catch showed 3,600 MT (4.3%) in 1976. In 1981, purse seine catch showed 80,000 MT (61.5%), followed by gill net (24,000 MT; 18.5%) instead of trawl (increased to 21,000 MT, but accounted for 15.8%). In 1986, the purse seine catch was still accounted for over 60 % of Indian mackerel catch and quantity of 80,000 MT. The gill net and trawl catches in 1986 were almost the same of 16,000 MT (13%), and hook-and-line showed 6,300 MT (5.0%). In 1992, the purse seine catch showed 94,000 MT, still the most dominant, but it accounted for 52.4%. On the other hand, gill net catch in 1992 increased to 45,000 MT and accounted for 24.9%, followed by trawl catch (25,000 MT; 13.9%).

2-3 Indo-Pacific Mackerel

Indo-Pacific mackerel catch by type of fishing gear from 1976, 1981, 1986 and 1992 is shown in **Table 6.** Percentage of type of fishing gear for Indo-Pacific mackerel is shown in **Figure 6.**

The purse seine catch, the most dominant for the Indo-Pacific mackerel, was 45,000 MT (accounted for 55.5% of the total Indo-Pacific mackerel catch), followed by trawl (12,000 MT; 14.5%) and gill net (8,600 MT; 4.3%) in 1976. In 1981, the purse seine catch remained 44,000 MT but it accounted for less than 50%, on the other hand, gill net catch increased to 28,000 MT and accounted for 31.0% with a dramatic increase. The trawl catch in 1981 was still 12,000 MT (13.3%). In 1986, the purse seine catch increased both quantity (75,000 MT) and percentage (52.0%), followed by the gill net catch (42,000 MT; 29.3%) and the trawl catch (15,000 MT; 10.2%). In 1992, the purse seine catch increased to 101,000 MT (65.9%) instead of decreasing of gill net at 26,000 MT (17.1%). The trawl catch in 1992 increased a bit to 18,000 MT and accounted for 11.6%.

3. CATCH-EFFORT DATA ON ROUND SCADS AND MACKERELS

This section describes the CPUE value of round scads, Indian mackerels and Indo- Pacific mackerel from 1978 to 1991 in the region. Operating days were used as the effort for estimation of CPUE value for purse seine, trawl (instead of trawling hours because of data availability) and drift gill net.

3-1 Round Scads

The CPUE value (MT/day) for round scads by purse seine from 1978 to 1991 in the region is shown in **Table 7** and **Figure 7.**

The CPUE value of round scads by purse seine in 1978 showed 0.624 MT per day, it was very high value, but then it ranged from 0.095 MT/day (1990) to 0.323 MT/day (1987) with some variations. After 1985, the CPUE value varied up and down repeatedly by year until 1991 with more variations than the previous years.

3-2 Indian Mackerels

The CPUE value (MT/day) for Indian mackerels by purse seine from 1978 to 1991 in the region is shown in **Table 8** and **Figure 8.**

The CPUE value of Indian mackerel by purse seine showed 0.124 MT/day in 1978 and decreased to 0.081 MT/day in 1981. Then, the CPUE value increased dramatically to 0.434 MT/day in 1983. After 1983, the CPUE value showed a clear decreasing trend to 0.120 MT/day in 1990 with variations of up and down repeatedly by year.

The CPUE value (MT/day) for Indian mackerels by trawl from 1978 to 1991 in the region is shown in **Table 9** and **Figure 9**, and that by drift gill net is shown in **Table 10** and **Figure 10.**

The CPUE value of Indian mackerels by trawl ranged from 0.003 MT/day (1978,1979 and 1980) to 0.008 MT/day (1982) with an average of 0.005 MT/day. The CPUE value of Indian mackerels by drift gill net showed less tahn 0.003 MT/day with exceptions of 0.009 MT/day in 1979 and 0.005 MT/day in 1982.

3-3 Indo-Pacific Mackerel

The CPUE value (MT/day) for Indo-Pacific mackerel by purse seine from 1978 to 1991 in the region is shown in **Table 11** and **Figure 11.**

The CPUE value of Indo-Pacific mackerel by purse seine showed 0.078 MT/day in 1978 and showed a general increase trend to 0.337 MT/day in 1985 with some up and down variations. After 1985, the CPUE value showed generel decrease trend to 0.191 MT/day in 1990 before increasing again to 0.258 MT/day in 1991.

The CPUE value (MT/day) for Indo- Pacific mackerel by trawl from 1978 to 1991 in the region is shown in **Table 12** and **Figure 12**, and that by drift gill net is shown in **Table 13** and **Figure 13.**

The CPUE value of Indo-Pacific mackerel by trawl showed decrease trend from 0.008 MT/day in 1981 to 0.003 MT/day in 1983, and then it increased a bit to 0.006 MT/day in 1988 and remained constant until 1990. The CPUE value of Indo-Pacific mackerel by drift gill net showed less than 0.003 MT/day during the period from 1978 to 1991 with an exception of 0.007 MT/day in 1981.

4. POTENTIAL YIELD

Provisional estimation of the potential yield for the South China Sea Area was done by Yanagawa and Wongsanga (1993). In the report, the potential yield was estimated provisionally on the bisis of the relationship between catch data and their percentages from 1976 to 1989. Therefore, estimated potential yield in the report means that the estimated maximum possible catch based on the actual catch trend and the species composition (percentage) by fisheries during the examined period.

Estimated potential yield, the latest three-year mean (1990-1992) and catch in 1992 for round scads, Indian mackerels and Indo-Pacific mackerel are shown in **Table 14.**

On round scads, the catch increased steadily from 1981 to 1992 **(Fig.14)** and the CPUE value by the purse seine can be considered as no big fluctuations from 1979 to 1991 **(see Fig. 7).** Therefore, it can be considered that there are certain possibilities of more increase of round scad catch in the region instead of the catches in 1990, 1991 and 1992 which were included in the potential yield zone.

On Indian mackerels, the catches from 1983 to 1988 remained constant at the potential yield zone and then it showed increasing trend until 1992 **(Fig. 15),** on the other hand the CPUE values by purse seine from 1984 to 1990 showed a clear decreasing trend **(see Fig. 8).** Therefore, it can be considered that there are certain possibilities of over exploitation of Indian mackerels in the region.

On Indo-Pacific mackerel, the catches from 1982 to 1992 showed an increasing trend with some fluctuations under the potential yield zone **(Fig.16),** on the other hand the CPUE values by purse seine from 1986 to 1990 showed a decreasing trend **(see Fig. 11).** Therefore, it can be considered that there are certain possibilities of over exploitation of Indo-Pacific mackerel even the catches were under the potential yield zone.

As the general consideration for the status of round scads, Indian mackerels and Indo-Pacific mackerel was described above on the basis of general fisheries statistics, more detailed examinations for the major species (group) should be done in the near future. For the purpose of doing the detailed analysis, good quality data on various fishery biology items for important species, more reliable catch and effort statistics and so on are necessary to collect and exchange the information among the researchers and the organizations concerns.

5. BIOLOGICAL INFORMATION

Regarding biological information of round scads, Indian mackerels and Indo-Pacific mackerel, information obtained from the report, **"Distribution and important biological features of coastal fish resources in Southeast Asia by Chullasorn and Martosubroto, 1986; FAO Fisheries Technical Paper No. 278"**, are shown in the following pages.

For fish in general, the information on length-weight relationship of 26 fish species belonging to 17 families from the Gulf of Thailand is obtained from the report, **"Length-weight relationship of Gulf of Thailand fishes by Yanagawa, 1994; Naga, ICLARM Quarterly 17 (4)"** is shown also the following page.

[From Hiroyuki Yanagawa, 1993]

Table: Summarized length-weight relationships of fish obtained from the Gulf of Thailand

Species	*N*	*Range of* *Total length*	*Adjusted* r^2	*b*	*a*	*Survey*
Holocentridae						
Sargocentron rubrum	8	124.4 — 184.5	0.871	2.658	0.05710	R-2
Myripristis hexagonus	11	142.2 — 189.4	0.872	3.040	0.01869	R-1
Serranidae						
Epinephelus bleekeri	11	142.4 — 269.0	0.976	3.126	0.00889	R-3 dan P-2
Epinephelus tauvina	9	126.6 — 377.9	0.996	2.957	0.01563	P-2
Cephalopholis pachycentron	3	109.0 — 174.5	0.991	3.207	0.00990	P-2
Cephalopholis boenack	8	156.0 — 238.2	0.982	3.002	0.01554	R-1, 3
Apogonidae						
Archamia lineolata	63	70.0 — 102.8	0.907	3.207	0.01066	R-3
Sillaginidae						
Sillago sihama	8	170.5 — 207.8	0.905	3.362	0.00285	P-1
Carangidae						
Selaroides leptolepis	25	99.2 — 163.6	0.983	3.101	0.00745	R-2
Lutjanidae						
Lutjanus russelli	31	114.1 — 337.8	0.991	3.234*	0.00708	P-1, 2
Lutjanus vitta	95	83.7 — 209.2	0.970	3.110	0.00999	R-1, 3
L. vitta	41	131.6 — 218.7	0.946	2.913	0.01871	R-2
L. vitta	30	102.2 _ 160.8	0.919	3.103	0.01142	P-1, 2
Lutjanus lineolatus	90	102.4 — 163.8	0.892	2.807	0.02351	R-2, 3
Nemipteridae						
Nemipterus hexodon	11	131.4 — 217.0	0.990	3.277*	0.00576	R-2, 3
Scolopsis ciliatus	9	159.8 — 261.2	0.964	2.480*	0.06405	R-1
Scolopsis dubiosus	4	219.2 — 248.0	0.995	3.280	0.00542	R-3
Scolopsis temporalis	5	153.0 — 231.4	0.967	3.090	0.01129	R-2
Pentapodidae						
Pentapodus setosus	20	119.5 — 213.5	0.984	3.073	0.01062	R-2, 3
Pomadasyidae						
Plectorhynchus pictus	11	155.4 — 566.2	0.983	3.019	0.01302	R-3, P-2
Theraponidae						
Therapon jarbua	6	96.4 — 267.8	0.999	2.884	0.02215	R-3

Table 2

Important biological features and parameters; coastal small pelagic fish in the region
(1) Mackerels. See Sections 5 and 6.1.1 for annotations and broader references

(Body size refers to total length unless specified as FL: fork length or SL: standard length; sexes are combined unless specified as M: male or F: female)

Species	*Area (country) surveyed*	*Vertical distribution range (m)*	*Body size captured*		*Spawning*		*Fecundity*	*Recruitment*		*Size at first maturity (cm)*	*Sex ratio (M:F)*	*Growth (rate or coefficient)*	*Mortality (coefficient)*	*Life span (year)*	*Food organisms*	*Length-weight relationship*
			Mean (cm)	*Maximum (cm)*	*Area*	*Season (month)*		*Size (cm)*	*Season (month)*							
FAMILY SCOMBRIDAE *Rastrelliger brachysoma*	Gulf of Thailand[a]	20-40	15.0	20.95	10-40 mi off Pran-chuat Surat-tani	2-4, 6-8	egg= $9 \times 10^{-8} L^{4.8356}$ 200 000 500 000, 20 000-30 000/ batch	10.25	1-3, 7-9	17.5	1:1	k=0.33	Z=1.06	2-3	Phyto-planktons, zoo-planktons	$W = 0.006138L^{3.215}$ M: $W = 0.000005732L^{3.1235}$ F: $W = 0.000006578L^{3.1235}$
	Andaman Sea[b] (Thailand)	—	17.5	—	Koh Yao, Krabi	2-3, 8-9	30 000/ batch 97 250-241 832	9.5-12.5	4, 8-10	17.5	1:1.3	--	—	—	Phyto-planktons, zoo-planktons, diatoms, copepods	Log W = 1.8874 + 3.214 Log L
	North of Java[c]	—	—	22.92	—	6-10	—	—	—	17.3	1.3:1	k=0.19	Z=0.88	3-4	—	—
	Malacca Strait[d] (Malaysia)	—	—	19.6-20.1	—	10-12	20 000-30 000/ batch	10.0	1-3	18.5	—	k=0.36-0.44	M=0.38 Z=0.82	—	—	—
	Manila Bay[e]	—	—	34.0	—	6-2	11 300-119 300	—	—	15.0-16.0	—	k=1.1	M=1184 Z= 4.27	—	—	—
	Samar Sea[f]	—	—	25.0	—	—	—	—	—	—	—	k=1.60	M=2.56 Z=4.49	—	—	—

a Boonprakob (1965, 1967, 1972); Tabtimtai (1968); Suchondhamarn *et al.* (1970); Somjaiwong *et al.* (1970); Suvapepun and Suwanrumpha (1970).
b Boonragsa *et al.* (1984); Bussarawitch (1984, 1984a, 1984b).
c Sujastani (1974).
d Pathansali (1961, 1967); Chong and Chua (1974).
e Ingles and Pauly (1984); Tan (1970).
f Ingles and Pauly (1984).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (1) Mackerels (continued)

Species	*Area (country) surveyed*	*Vertical distribution range (m)*	*Body size captured*		*Spawning*		*Fecundity*	*Recruitment*		*Size at first maturity (cm)*	*Sex ratio (M:F)*	*Growth (rate or coefficient)*	*Mortality (coefficient)*	*Life span (year)*	*Food organisms*	*Length-weight relationship*
			Mean (cm)	*Maximum (cm)*	*Area*	*Season (month)*		*Size (cm)*	*Season (month)*							
FAMILY SCOMBRIDAE *Rastrelliger brachysoma* (continued)	Andaman Sea[a] (Burma)	—	19.3FL	23.0FL	—	10-5	20 000-30 000/ batch	13.7FL	2, 5-6	—	1:1.7	—	—	—	—	—
R. kanagurta	Gulf of Thailand[b]	30-60	16.0	22.9	—	2-4, 7-8	200 000	11.0	5-6	18.6	1:1	—	—	2-3	Phyto-planktons, zoo-planktons, diatoms, copepods	M:W = $0.0000001958L^{3.7653}$ F:W = $0.000009454L^{3.0375}$
	Andaman Sea[c] (Thailand)	—	—	19.2	—	12.2	25 000/ batch 94 495 263 178	13.0-14.0	5-12	18.67	1:0.93	—	—	—	Phyto-planktons, diatoms, zoo-planktons, crustaceans, dinofla-gellates	—
	North of Java[d]	—	11.9-12.4	23.89	—	10-2, 6-9	200 000 500 000	18.8	—	19.0	1:1.1	k=2.78 k=1.63	Z=1.2 Z=0.58	3-4	Fila-mentous algae, zolina, ceratium	M:W = $1.35 \times 10^{-5}L^{2.9927}$ F:W = $2.16 \times 10^{-5}L^{2.9281}$
	Malacca Strait[e] (Malaysia)	—	16.75	—	—	All around 5-1, 11-4,	20 000-30 000-batch	—	—	18.75	—	—	—	—	Phyto-planktons, crustaceans, copepods, decapods, dinofla-gellates	—

a Druzhinin (1968).

b Vanichkul and Hongskul (1965); Boonprakob (1967); Tantiswetratana (1979).

c Boonragsa *et al.* (1984); Bussarawitch (1984).

d Sujastani (1974); Gafa (1982): Dwiponggo and Pauly (in press).

e Pathansali (1961, 1967); Chee; (1980).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE *R. kanagurta* (continued)	Palawan waters[a]	—	—	28.0	—	—	—	—	—	—	—	k=1.55	Z=8.27 M=2.43	—	—	—
	Andaman Sea[b] (Burma)	—	20.47FL	—	—	9-5	—	14.0FL	6-7	—	1:1.39	—	—	—	—	—

a Ingles and Pauly (1984).

b. Druzhinin (1968).

Table 2 (continued)

(2) Round scads. See Sections 5 and 6.1.2 for annotations and broder references

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE *Decapterus macrosoma*	Manila Bay and Palawan waters[a]	50-90	M:17.7 F:17.6	25.0	Manila Bay to Palawan	11-3	67 000-106 200	7.0-8.0	2-3	—	1:0.99	0.56 cm/ month	—	3-6	Crustaceans, zoo-planktons, fish, molluscs	$W = 0.005639L^{3.167}$
	Java Sea[b]	—	—	25.4	—	—	—	17.6	—	—	—	k=0.98	Z=6.22	—	—	—
	Gulf of Thailand[c]	30-60	—	—	—	12-5	—	—	—	16.5	1:0.9	—	—	—	—	—

a Magnusson (1970); Tiews, Ronquillo and Caces-Borja (1970); Ronquillo (1974).

b. Dwiponggo and Pauly (in press).

c Chullasorn and Yusukswad (1977).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (2) Round scads (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE *Decapterus maruadsi*	Gulf of Thailand[a]	30-70	13.2	23.1	Central Gulf	2-3, 7-8	38 000-515 000	5.5-6.5	1-2, 6-8	16.1	1:1.2	k=0.11 1-2 cm/ month	—	2-3	crustaceans, copepods	$W = 0.00005L^{2.811}$
	Java Sea[b]	—	—	26.8	—	—	—	9-14.2	—	18.3	—	k=0.95-1.04	Z=3.5-4.79 M=1.3	—	—	—
	Malacca Strait[c] (Malaysia)	—	—	—	—	—	—	7.5	7	—	—	—	—	—	—	—
Decapterus russelli	Palawan waters[d]	36-180	M:16.72 F:16.5	33.0	Palawan to Manila	11-3 1-4	29 000-49 000	8.0-9.0	2-3	16.6	1:1.04	k=0.2 0.6 cm/ month	Z=2.62	3-6	Zoo-planktons, crustaceans, fish	$W = 0.0098L^{3.0152}$
	Java Sea[e]	—	—	26.8	—	—	20 000-84 000	14.6	—	—	—	k=1.09	Z=4.09	—	—	—

a Chullasorn and Yusukswad (1977); Chantarasri (1980); Cheunpan (1981).

b. Sadhotomo *et al.* (1983); Atmadja (1982).

c Southeast-Asian Fisheries Development Centre (1982).

d Tiews, Ronquillo and Caces-Borja (1970); Magnusson (1970); Ronquillo (1974); Ingles and Pauly (1984).

e Dwiponggo and Pauly (in press).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Species	*N*	*Range of Total length*	*Adjusted* r^2	*b*	*a*	*Survey*
Sciaenidae						
Johnius belengerii	13	150.8 — 194.2	0.918	3.388	0.00385	P-1
Lethrinidae						
Lethrinus lentjan	60	143.4 — 227.4	0.984	2.938	0.01894	R-1, 2, 3
Mullidae						
Upeneus tragula	8	153.4 — 216.8	0.976	2.845	0.01438	R-1
Chaetodontidae						
Chelmo rostratus	10	136.3 — 170.4	0.811	2.289*	0.12803	R-1
Siganidae						
Siganus oramin	4	66.5 — 250.7	0.991	3.011	0.01201	R-3
Siganus javus	35	89.0 — 163.1	0.984	3.208*	0.00912	R-2
Scombridae						
Rastrelliger kanagurta	18	106.7 — 137.6	0.867	2.755	0.01634	R-2
Aluteridae						
Monacanthus chinensis	4	68.8 — 199.8	0.999	2.447*	0.07038	R-3
M. chinensis	7	152.4 — 245.2	0.900	2.506*	0.07978	P-2

* Significant difference from b = 3 at the 5% level.

6. REFERENCES OF DATA EXAMINED

Fishery Statistical Bulletins for the South China Sea Area from 1976 to 1992 issued by SEAFDEC annually.

Catch-effort Statistics for the South China Sea Area from 1978 to 1991 issued by SEAFDEC annually.

Review of Fishery Production, Provisional Estimation of Potential Yield and the Situation of Fisheries in the Southeast Asian Region — 1976 to 1989. Yanagawa, H. and Pouchamarn Wongsanga, SEAFDEC TD/SP/18: 114 PP. 1993.

Table 1: **Catch by three species groups and the grand total from 1976 to 1992 in the region. On data in 1979, Indonesian data was estimated as same as the actual results of the previous year**

(MT)

Year	*Grand total*	*Sub-total*	*Round scads*	*Indian mackerels*	*Indo-Pacific mackerel*
1976	5,769,755	645,508	405,339	83,824	156,345
1977	6,601,423	640,112	419,743	83,035	137,334
1978	6,714,387	559,769	283,006	123,976	152,787
1979	6,198,419	479,942	203,526	88,664	187,752
1980	6,119,952	492,208	192,565	138,476	161,167
1981	6,386,088	594,352	285,981	216,739	91,632
1982	6,644,305	649,022	326,359	210,833	111,830
1983	7,163,755	713,710	321,435	278,913	113,362
1984	6,663,749	779,188	344,189	268,438	166,561
1985	6,835,037	808,669	365,923	282,846	159,900
1986	7,296,718	815,645	414,686	257,197	143,762
1987	8,017,748	876,083	445,607	275,589	154,887
1988	8,008,984	841,747	403,275	262,679	175,793
1989	8,290,739	934,163	464,285	289,693	180,185
1990	8,511,397	989,511	509,909	313,006	166,596
1991	8,784,641	1,060,273	595,692	301,071	163,510
1992	9,514,250	1,155,026	591,816	356,971	206,239

Table 2: **Value of catch by three species groups and the grand total from 1976 to 1992 in the region. On data in 1979 and 1982, Indonesian data were estimated as same as the actual results of the previous years. On data from 1986 to 1992, Indonesian data were excluded**

(US$1000)

Year	*Grand total*	*Sub-total*	*Round scads*	*Indian mackerels*	*Indo-Pacific mackerel*
1976	2,315,758	307,201	194,303	44,430	68,468
1977	2,821,188	309,181	197,766	39,905	71,510
1978	3,581,855	346,187	167,967	91,626	86,594
1979	3,912,661	307,300	154,505	63,769	89,026
1980	4,037,649	312,756	142,342	78,769	91,645
1981	4,498,282	411,197	212,932	144,712	53,553
1982	4,482,420	420,013	223,802	138,051	58,160
1983	4,234,580	401,648	173,333	161,289	67,026
1984	4,171,953	404,622	169,323	147,727	87,572
1985	4,172,318	414,370	186,145	154,368	73,857
1986	3,912,775	312,107	155,874	83,350	72,883
1987	4,316,862	341,681	181,974	88,075	71,632
1988	3,500,643	355,937	179,756	82,101	94,080
1989	4,034,149	409,595	213,030	93,952	102,613
1990	3,822,715	406,588	199,215	107,389	99,984
1991	4,210,336	495,912	262,122	142,807	90,983
1992	4,743,290	555,939	269,698	156,932	129,309

Table 3: **Estimated unit price of three species groups from 1976 to 1992 in the region. Price is the producer one at the landing center (wholesale price). On data from 1986 to 1992, Indonesian data were excluded.**

(US$/Kg.)

Year	*Grand total*	*Sub-total*	*Round scads*	*Indian mackerels*	*Indo-Pacific mackerel*
1976	0.48	0.48	0.48	0.53	0.44
1977	0.50	0.48	0.47	0.48	0.52
1978	0.61	0.62	0.59	0.74	0.57
1979	0.68	0.64	0.76	0.72	0.47
1980	0.71	0.64	0.74	0.57	0.57
1981	0.76	0.69	0.74	0.67	0.58
1982	0.72	0.65	0.69	0.65	0.52
1983	0.64	0.56	0.54	0.58	0.59
1984	0.64	0.52	0.49	0.55	0.53
1985	0.62	0.51	0.51	0.55	0.46
1986	0.67	0.63	0.69	0.67	0.51
1987	0.65	0.57	0.61	0.57	0.49
1988	0.60	0.61	0.65	0.61	0.54
1989	0.67	0.64	0.67	0.65	0.57
1990	0.62	0.60	0.59	0.64	0.60
1991	0.67	0.71	0.69	0.91	0.56
1992	0.70	0.72	0.68	0.87	0.66

Table 4: **Catch by type of fishing gear for round scads from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)

Gear/Year	*1976*	*1981*	*1986*	*1992*
Total	326,789	212,684	220,086	392,583
Purse seine	252,667	126,279	149,858	331,744
Trawl	14,546	21,181	22,873	11,862
Gill net	1,103	13,569	10,778	6,658
Lift net	7,129	39,258	27,229	30,832
Hook and line	29	8,716	7,774	5,136
Trap	10,803	1,009	325	176
Others	40,512	2,672	1,249	6,175

Table 5: **Catch by type of fishing gear for Indian mackerels from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)

Gear/Year	*1976*	*1981*	*1986*	*1992*
Total	83,753	130,798	124,826	179,769
Purse seine	44,386	80,471	79,661	94,231
Trawl	12,759	20,725	15,695	24,989
Gill net	3,568	24,171	16,775	44,822
Lift net	933	1,372	3,412	3,278
Hook and line	253	2,663	6,276	6,318
Trap	678	662	1,702	1,017
Others	21,176	734	1,305	5,114

Table 6: **Catch by type of fishing gear for Indo-Pacific mackerel from 1976, 1981, 1986 and 1992 in the region. Data were obtained from Malaysia, Philippines and Thailand.**

(MT)

Gear/Year	*1976*	*1981*	*1986*	*1992*
Total	80,991	91,632	143,762	153,254
Purse seine	44,941	43,547	74,774	101,043
Trawl	11,735	12,182	14,617	17,844
Gill net	8,646	28,418	42,093	26,214
Lift net	2,535	800	770	217
Hook and line	10	1,487	4,859	2,415
Trap	1,333	3,186	5,460	1,997
Others	11,791	2,012	1,189	3,524

Table 7: CPUE value of round scads by purse seine from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sabah, Visayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).

Year	*Purse Seine*		
	Effort (Days)	*Catch (MT)*	*CPUE M(T/Day)*
1978	169,352	105,675	0.624
1979	127,681	22,430	0.176
1980	126,494	32,239	0.255
1981	143,485	36,397	0.254
1982	288,465	55,939	0.194
1983	247,912	44,529	0.180
1984	331,958	51,928	0.156
1985	311,647	46,769	0.150
1986	319,841	40,894	0.128
1987	332,606	107,402	0.323
1988	281,628	32,057	0.114
1989	362,020	77,820	0.215
1990	357,982	33,945	0.095
1991	390,354	92,937	0.238

Table 8: CPUE value of Indian mackerels by purse seine from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sarawak, Sabah, Visayas, Gulf of Thailand and Andaman Sea (available data were not always same by year).

Year	*Purse Seine*		
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	169,352	21,050	0.124
1979	127,681	15,411	0.121
1980	177,110	18,216	0.103
1981	194,123	15,660	0.081
1982	310,124	60,925	0.196
1983	253,716	110,006	0.434
1984	331,958	95,230	0.287
1985	311,647	91,716	0.294
1986	319,841	61,745	0.193
1987	332,606	77,738	0.234
1988	381,218	48,811	0.128
1989	362,020	52,628	0.145
1990	459,822	55,299	0.120
1991	390,354	56,656	0.145

Table 9: **CPUE value of Indian mackerels by trawl from 1978 to 1991 in the region. Data were obtained from Hong Kong, west and east coast of Peninsular Malaysia, Sarawak, Sabah, Visayas, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

Year	*Trawl*		
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	1,436,181	4,135	0.003
1979	1,340,590	4,004	0.003
1980	3,099,825	9,466	0.003
1981	3,266,860	16,868	0.005
1982	3,076,809	25,109	0.008
1983	3,046,472	21,021	0.007
1984	3,058,556	16,090	0.005
1985	2,717,905	13,929	0.005
1986	3,059,537	12,388	0.004
1987	2,918,059	19,419	0.007
1988	3,022,672	17,960	0.006
1989	2,840,876	20,115	0.007
1990	3,349,605	21,142	0.006
1991	3,488,685	15,119	0.004

Table 10: **CPUE value of Indian mackerels by drift gill net from 1978 to 1991 in the region. Data were obtained from west and east coasts of Peninsular Malaysia, Sarawak, Sabah, Gulf of Thailand and Andaman Sea (available data were not always same by year).**

Year	*Drift*	*Gill*	*Net*
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	33,941	36	0.001
1979	48,530	432	0.009
1980	1,180,830	299	0.000
1981	—	—	—
1982	40,302	214	0.005
1983	47,253	16	0.000
1984	2,351,343	3,981	0.002
1985	44,862	25	0.001
1986	63,192	81	0.001
1987	67,036	94	0.001
1988	76,915	37	0.000
1989	51,498	26	0.001
1990	750,848	38	0.000
1991	799,093	1,921	0.002

Table 11: CPUE value of Indo-Pacific mackerel by purse seine from 1978 to 1991 in the region. Data were obtained from Sabah, Viasayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).

Year	*Purse Seine*		
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	169,352	13,269	0.078
1979	127,681	29,603	0.232
1980	124,694	18,080	0.145
1981	141,707	38,327	0.270
1982	180,710	50,982	0.282
1983	157,180	36,530	0.232
1984	203,271	62,968	0.310
1985	183,258	61,683	0.337
1986	224,926	65,693	0.292
1987	236,670	61,979	0.262
1988	281,628	60,226	0.214
1989	266,561	67,948	0.255
1990	357,982	68,209	0.191
1991	282,112	72,895	0.258

Table 12: CPUE value of Indo-Pacific mackerel by trawl from 1978 to 1991 in the region. Data were obtained from Sabah, Visayas, Mindanao, Gulf of Thailand and Andaman Sea (available data were not always same by year).

Year	*Trawl*		
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	1,609,332	11,643	0.007
1979	1,522,551	11,840	0.008
1980	1,324,450	10,139	0.008
1981	1,139,621	8,599	0.008
1982	1,432,124	9,380	0.007
1983	1,502,230	4,675	0.003
1984	1,450,520	6,494	0.004
1985	1,277,720	6,099	0.005
1986	1,895,219	9,903	0.005
1987	1,853,233	9,534	0.005
1988	1,886,182	11,943	0.006
1989	1,896,830	12,206	0.006
1990	1,911,625	11,549	0.006
1991	1,824,463	8,378	0.005

Table 13: CPUE value of Indo-Pacific mackerel by drift gill net from 1978 to 1991 in the region. Data were obtained from Sabah, Gulf of Thailand and Andaman Sea (available data were not always same by year).

Year	*Drift*	*Gill*	*Net*
	Effort (Days)	*Catch (MT)*	*CPUE (MT/Day)*
1978	26,857	4	0.000
1979	48,357	48	0.001
1980	—	—	—
1981	41,478	306	0.007
1982	3,872	7	0.002
1983	48,463	23	0.000
1984	43,318	21	0.000
1985	44,862	19	0.000
1986	732,583	22	0.000
1987	743,885	56	0.000
1988	789,655	12	0.000
1989	791,411	77	0.000
1990	750,848	557	0.001
1991	785,178	26	0.000

Table 14: Estimated potential yield (Yanagawa and Wongsanga, 1993), 3-year mean catch from 1990 to 1992 and catch quantity in 1992 for three species groups in the region.

(MT)

Species group	*Estimate potential yield*	*3-year mean*	*Catch in 1992*
Round scads	486,000 — 607,000	565,806	591,816
Indian mackerels	253,000 — 316,000	323,683	356,971
Indo-Pacific mackerel	205,000 — 257,000	178,782	206,239

Table 2

Important biological features and parameters; coastal small pelagic fish in the region
(1) Mackerels. See Sections 5 and 6.1.1 for annotations and broader references

(Body size refers to total length unless specified as FL: fork length or SL: standard length; sexes are combined unless specified as M: male or F: female)

Species	*Area (country) surveyed*	*Vertical distribution range (m)*	*Body size captured*		*Spawning*		*Fecundity*	*Recruitment*		*Size at first maturity (cm)*	*Sex ratio (M:F)*	*Growth (rate or coefficient)*	*Mortality (coefficient)*	*Life span (year)*	*Food organisms*	*Length-weight relationship*
			Mean (cm)	*Maximum (cm)*	*Area*	*Season (month)*		*Size (cm)*	*Season (month)*							
FAMILY SCOMBRIDAE *Rastrelliger brachysoma*	Gulf of Thailand[a]	20-40	15.0	20.95	10-40 mi off Pran-chuat Surat-tani	2-4, 6-8	egg= $9x10^{-8}$ $L^{4.8356}$ 200 000 500 000, 20 000-30 000/ batch	10.25	1-3, 7-9	17.5	1:1	k=0.33	Z=1.06	2-3	Phyto-planktons, zoo-planktons	W = $0.006138L^{3.215}$ M:W = $0.000005732L^{3.1235}$ F:W = $0.000006578L^{3.1235}$
	Andaman Sea[b] (Thailand)	—	17.5	—	Koh Yao, Krabi	2-3, 8-9	30 000/ batch 97 250-241 832	9.5-12.5	4, 8-10	17.5	1:1.3	—	—	—	Phyto-planktons, zoo-planktons, diatoms, copepods	Log W = 1.8874 + 3.214 Log L
	North of Java[c]	—	—	22.92	—	6-10	—	—	—	17.3	1.3:1	k=0.19	Z=0.88	3-4	—	—
	Malacca Strait[d] (Malaysia)	—	—	19.6-20.1	—	10-12	20 000-30 000/ batch	10.0	1-3	18.5	—	k=0.36-0.44	M=0.38 Z=0.82	—	—	—
	Manila Bay[e]	—	—	34.0	—	6-2	11 300-119 300	—	—	15.0-16.0	—	k=1.1	M=1184 Z= 4.27	—	—	—
	Samar Sea[f]	—	—	25.0	—	—	—	—	—	—	—	k=1.60	M=2.56 Z=4.49	—	—	—

a Boonprakob (1965, 1967, 1972); Tabtimtai (1968); Suchondhamarn *et al.* (1970); Somjaiwong *et al.* (1970); Suvapepun and Suwanrumpha (1970).

b Boonragsa *et al.* (1984); Bussarawitch (1984, 1984a, 1984b).

c Sujastani (1974).

d Pathansali (1961, 1967); Chong and Chua (1974).

e Ingles and Pauly (1984); Tan (1970).

f Ingles and Pauly (1984).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY SCOMBRIDAE *Rastrelliger brachysoma* (continued)	Andaman Sea[a] (Burma)	—	19.3FL	23.0FL	—	10-5	20 000-30 000/ batch	13.7FL	2, 5-6	—	1:1.7	—	—	—	—	—
R. kanagurta	Gulf of Thailand[b]	30-60	16.0	22.9	—	2-4, 7-8	200 000	11.0	5-6	18.6	1:1	—	—	2-3	Phyto-planktons, zoo-planktons, diatoms, copepods	M:W = $0.0000001958L^{3.7653}$ F:W = $0.000009454L^{3.0375}$
	Andaman Sea[c] (Thailand)	—	—	19.2	—	12.2	25 000/ batch 94 495 263 178	13.0-14.0	5-12	18.67	1:0.93	—	—	—	Phyto-planktons, diatoms, zoo-planktons, crustaceans, dinofla-gellates	—
	North of Java[d]	—	11.9-12.4	23.89	—	10-2, 6-9	200 000 500 000	18.8	—	19.0	1:1.1	k=2.78 k=1.63	Z=1.2 Z=0.58	3-4	Fila-mentous algae, zolina, ceratium	M:W = $1.35 \times 10^{-5}L^{2.9927}$ F:W = $2.16 \times 10^{-5}L^{2.9281}$
	Malacca Strait[e] (Malaysia)	—	16.75	—	—	All around 5-1, 11-4,	20 000-30 000-batch	—	—	18.75	—	—	—	—	Phyto-planktons, crustaceans, copepods, decapods, dinofla-gellates	—

a Druzhinin (1968).

b Vanichkul and Hongskul (1965); Boonprakob (1967); Tantiswetratana (1979).

c Boonragsa *et al.* (1984); Bussarawitch (1984).

d Sujastani (1974); Gafa (1982): Dwiponggo and Pauly (in press).

e Pathansali (1961, 1967); Chee; (1980).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (1) Mackerels (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured: Mean (cm)	Body size captured: Maximum (cm)	Spawning: Area	Spawning: Season (month)	Fecundity	Recruitment: Size (cm)	Recruitment: Season (month)	Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
FAMILY SCOMBRIDAE *R. kanagurta* (continued)	Palawan waters[a]	—	—	28.0	—	—	—	—	—	—	—	k=1.55	Z=8.27 M=2.43	—	—	—
	Andaman Sea[b] (Burma)	—	20.47FL	—	—	9-5	—	14.0FL	6-7	—	1:1.39	—	—	—	—	—

a Ingles and Pauly (1984).

b. Druzhinin (1968).

Table 2 (continued)

(2) Round scads. See Sections 5 and 6.1.2 for annotations and broder references

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured: Mean (cm)	Body size captured: Maximum (cm)	Spawning: Area	Spawning: Season (month)	Fecundity	Recruitment: Size (cm)	Recruitment: Season (month)	Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
FAMILY CARANGIDAE *Decapterus macrosoma*	Manila Bay and Palawan waters[a]	50-90	M:17.7 F:17.6	25.0	Manila Bay to Palawan	11-3	67 000-106 200	7.0-8.0	2-3	—	1:0.99	0.56 cm/month	—	3-6	Crustaceans, zoo-planktons, fish, molluscs	$W = 0.005639L^{3.167}$
	Java Sea[b]	—	—	25.4	—	—	—	17.6	—	—	—	k=0.98	Z=6.22	—	—	—
	Gulf of Thailand[c]	30-60	—	—	—	12-5	—	—	—	16.5	1:0.9	—	—	—	—	—

a Magnusson (1970); Tiews, Ronquillo and Caces-Borja (1970); Ronquillo (1974).

b. Dwiponggo and Pauly (in press).

c Chullasorn and Yusukswad (1977).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

Table 2 (2) Round scads (continued)

Species	Area (country) surveyed	Vertical distribution range (m)	Body size captured		Spawning		Fecundity	Recruitment		Size at first maturity (cm)	Sex ratio (M:F)	Growth (rate or coefficient)	Mortality (coefficient)	Life span (year)	Food organisms	Length-weight relationship
			Mean (cm)	Maximum (cm)	Area	Season (month)		Size (cm)	Season (month)							
FAMILY CARANGIDAE *Decapterus maruadsi*	Gulf of Thailand[a]	30-70	13.2	23.1	Central Gulf	2-3, 7-8	38 000-515 000	5.5-6.5	1-2, 6-8	16.1	1:1.2	k=0.11 1-2 cm/ month	—	2-3	crustaceans, copepods	$W = 0.00005L^{2.811}$
	Java Sea[b]	—	—	26.8	—	—	—	9-14.2	—	18.3	—	k=0.95-1.04	Z =3.5-4.79 M=1.3	—	—	—
	Malacca Strait[c] (Malaysia)	—	—	—	—	—	—	7.5	7	—	—	—	—	—	—	—
Decapterus russelli	Palawan waters[d]	36-180	M:16.72 F:16.5	33.0	Palawan to Manila	11-3 1-4	29 000-49 000	8.0-9.0	2-3	16.6	1:1.04	k=0.2 0.6 cm/ month	Z=2.62	3-6	Zoo-planktons, crustaceans, fish	$W = 0.0098L^{3.0152}$
	Java Sea[e]	—	—	26.8	—	—	20 000-84 000	14.6	—	—	—	k=1.09	Z=4.09	—	—	—

a Chullasorn and Yusukswad (1977); Chantarasri (1980); Cheunpan (1981).

b. Sadhotomo *et al.* (1983); Atmadja (1982).

c Southeast-Asian Fisheries Development Centre (1982).

d Tiews, Ronquillo and Caces-Borja (1970); Magnusson (1970); Ronquillo (1974); Ingles and Pauly (1984).

e Dwiponggo and Pauly (in press).

[From Somsak Chullasorn and Purwito Martosubroto, 1986]

[From Hiroyuki Yanagawa, 1993]

Table: Summarized length-weight relationships of fish obtained from the Gulf of Thailand

Species	*N*	*Range of Total length*	*Adjusted r^2*	*b*	*a*	*Survey*
Holocentridae						
Sargocentron rubrum	8	124.4 — 184.5	0.871	2.658	0.05710	R-2
Myripristis hexagonus	11	142.2 — 189.4	0.872	3.040	0.01869	R-1
Serranidae						
Epinephelus bleekeri	11	142.4 — 269.0	0.976	3.126	0.00889	R-3 dan P-2
Epinephelus tauvina	9	126.6 — 377.9	0.996	2.957	0.01563	P-2
Cephalopholis pachycentron	3	109.0 — 174.5	0.991	3.207	0.00990	P-2
Cephalopholis boenack	8	156.0 — 238.2	0.982	3.002	0.01554	R-1, 3
Apogonidae						
Archamia lineolata	63	70.0 — 102.8	0.907	3.207	0.01066	R-3
Sillaginidae						
Sillago sihama	8	170.5 — 207.8	0.905	3.362	0.00285	P-1
Carangidae						
Selaroides leptolepis	25	99.2 — 163.6	0.983	3.101	0.00745	R-2
Lutjanidae						
Lutjanus russelli	31	114.1 — 337.8	0.991	3.234*	0.00708	P-1, 2
Lutjanus vitta	95	83.7 — 209.2	0.970	3.110	0.00999	R-1, 3
L. vitta	41	131.6 — 218.7	0.946	2.913	0.01871	R-2
L. vitta	30	102.2 _ 160.8	0.919	3.103	0.01142	P-1, 2
Lutjanus lineolatus	90	102.4 — 163.8	0.892	2.807	0.02351	R-2, 3
Nemipteridae						
Nemipterus hexodon	11	131.4 — 217.0	0.990	3.277*	0.00576	R-2, 3
Scolopsis ciliatus	9	159.8 — 261.2	0.964	2.480*	0.06405	R-1
Scolopsis dubiosus	4	219.2 — 248.0	0.995	3.280	0.00542	R-3
Scolopsis temporalis	5	153.0 — 231.4	0.967	3.090	0.01129	R-2
Pentapodidae						
Pentapodus setosus	20	119.5 — 213.5	0.984	3.073	0.01062	R-2, 3
Pomadasyidae						
Plectorhynchus pictus	11	155.4 — 566.2	0.983	3.019	0.01302	R-3, P-2
Theraponidae						
Therapon jarbua	6	96.4 — 267.8	0.999	2.884	0.02215	R-3

Species	*N*	*Range of Total length*	*Adjusted r^2*	*b*	*a*	*Survey*
Sciaenidae						
Johnius belengerii	13	150.8 — 194.2	0.918	3.388	0.00385	P-1
Lethrinidae						
Lethrinus lentjan	60	143.4 — 227.4	0.984	2.938	0.01894	R-1, 2, 3
Mullidae						
Upeneus tragula	8	153.4 — 216.8	0.976	2.845	0.01438	R-1
Chaetodontidae						
Chelmo rostratus	10	136.3 — 170.4	0.811	2.289*	0.12803	R-1
Siganidae						
Siganus oramin	4	66.5 — 250.7	0.991	3.011	0.01201	R-3
Siganus javus	35	89.0 — 163.1	0.984	3.208*	0.00912	R-2
Scombridae						
Rastrelliger kanagurta	18	106.7 — 137.6	0.867	2.755	0.01634	R-2
Aluteridae						
Monacanthus chinensis	4	68.8 — 199.8	0.999	2.447*	0.07038	R-3
M. chinensis	7	152.4 — 245.2	0.900	2.506*	0.07978	P-2

* Significant difference from b = 3 at the 5% level.

ANNEXE 14

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 – 20 July , 1995

SEAFDEC / MFRDMD / WS / 95 / WP. 2

STATUS ON FISHERIES EXPLOITATION AND POTENTIAL YIELD OF NERITIC TUNAS IN THE REGION

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STATUS ON FISHERIES EXPLOITATION AND POTENTIAL YIELD OF NERITIC TUNAS IN THE REGION OF THE SOUTH CHINA SEA

1. INTRODUCTION

The South China Sea comprised the waters of Vietnam, Thailand, east coast of Peninsular Malaysia, Sabah and Sarawak (East Malaysia), the west coast of the Philippines, and some parts of Indonesia (**Figure 1**). FAO categories this area, which is on the western part of the Western Pacific Ocean, as FAO Statistical Area Number 71. This paper described in general the status of the tuna fishery in this region with emphasis, however, given on the tuna fishery on the east coast of Peninsular Malaysia.

Tuna catching on the east coast of Peninsular Malaysia is still predominantly a traditional activity (since some 70% of total catch comes from trolling) with some inputs coming from commercial gears. Emphasis at present is given to the development of tuna fisheries both in the coastal waters as well as in the offshore waters within the Exclusive Economic Zone (EEZ) of Malaysia (Rumpet and Raja Bidin 1992). A new fishing technique may be introduced soon for the exploitation of skipjack and yellowfin tuna resources, especially off Sarawak and Sabah. However, on neritic tuna, not much development regarding their fishing gears might be expected for perhaps the next ten years.

Fishing for neritic tunas such as *Euthynnus affinis, Thunnus tonggol* and *Auxis thazard* are confined to the east and west coast of Peninsular Malaysia, with only slight activities in Sabah and Sarawak waters. This is due to the continental shelf areas being quite limited in both of these states, which however comprised of vast areas of deep waters housing oceanic tunas such as *Katsuwonus pelamis* and *Thunnus albacares.*

A fishery resource survey, conducted by R.V. Rastrelliger in 1986, has estimated the annual potential yield of tuna in waters of the east cost at around 50,000 tonnes. The highest tuna landing for the whole of Malaysia recorded in 1993, however, was only at around 36,000 tonnes. Since landing of tuna at present is still below the expected potential yield, expansion of this fishery, especially on the east costs, is still possible and should be seriously considered.

Tuna fishing in Thailand in the early 1970s was mostly obtained as by-catches caught incidentally from purse seines and gill nets. However, due to a rapid development in the fish canning industry, tuna became more important than other groups of pelagics like mackerels, scads and sardines. As a result, tuna production increased drastically (by about 47 times) during a 20 year period from 1971 to 1990.

2. TUNA RESEARCH PROGRAMME

Research into tuna carried out in Malaysia may be divided into a number of project activities, which can be categorised as national and regional.

2.1 National Projects

2.1.1 Tuna Tagging Programme

A tuna tagging programme was implemented during May-October 1994, in waters off Terengganu, which is on the east Coast of Peninsular Malaysia. Five trips were undertaken to obtain live samples. A total of 10,000 coastal tunas were tagged during this period. Results showed that for a time of liberty of 106 days, tagged *Euthynnus affinis* can obtain a growth increment of up to 10 cm. They were generally shown to migrate towards the coastal waters after being tagged and released out on the open sea some distance away (**Figure 2**). The bulk of recaptures were however obtained within the first week after released, and this was probably due to a local purse seiner operating in the vicinity of the releasing area. Results also showed that the routes taken by migrated tuna gave some kind of semblance to the pattern shown by surface water currents in the South China Sea. In the middle of the year, tagged tuna moved towards the south, but turned north towards the end of the year. Some movement of tuna towards inshore areas were also observed during the monsoon season, and this could perhaps be related to the availability of food supply from upwelling and movement of massive water bodies during this period.

2.1.2 *Tuna sighting*

In 1994, a small aircraft was employed to help in an air surveillance of tuna fishing grounds on the east cost of peninsular Malaysia. A total of 11 hours of flight time was recorded covering a stretch of coastal waters up to 40 nautical miles from shore. The survey managed to spot a tuna school near one of the island. However, it was difficult to identify the school's swimming direction.

2.2 Regional Projects

2.2.1 *Application of the Satellite Technology*

In 1994, MFRDMD was installed with a High Resolution Picture Transfer (HRPT) satellite receiving system which has the ability to determine sea surface temperature (SST) through the Stars routine programs. The information obtained can then be compared to actual fishing grounds (ground truth) for pelagic species such as tuna. Information on productive fishing areas can then be directly relayed to local fishermen via facsimile or other electronic devices. In a number of major fishing countries, sea surface temperature maps, determined directly from satellite derived data, have been used by tuna fishing fleets to locate tuna since it is now well known that some tuna species feed on the warm seaward side of the thermal fronts (Laurs, 1984).

Fiuza (1990) concluded that application of remote sensing methods to fisheries may be considered under two aspects: as a tool for fisheries research, and through the operational support to fishing activities. The general aim in fisheries research is to understand the response of fish to their environment and to ensure the maintenance of sustainable fish and marine stocks, while obtaining high yields. The operational support to fisheries can be defined as the provision of services to minimize search time and to direct fishing vessels to the fishing grounds under different environmental conditions.

2.2.2 *Stock Identification*

Another important research activity planned to be carried out is to establish the origin of tuna stock shared by neighboring countries, as for example between Thailand and Malaysia or Brunei and Malaysia. Morphometric studies and DNA analyses on particular species will be conducted in the countries concerned. Comparison of results derived from the above analyses would help to clarify the tuna stock as either a common or separated one.

3. TUNA FISHERIES IN THE REGION

3.1 The Fishing Season

In Sarawak, neritic tunas were caught from March of June and the highest catches were recorded in May, while for seerfish and oceanic tuna, in September to November annually. The fishing season throughout the year was dependent and controlled by two monsoons: South-West Monsoon (March to July) and North-East Monsoon (August to February). Catches are poor and efforts are at a minimun from November to February (the North-East Monsoon) each year when strong winds and rains prevented fishermen from going out to sea.

3.2 Fishing Gears

The type of fishing gear used to catch tuna varies from one geographical area to another (Mahyam and Kamarrudin, 1990). Purse seine and troll-line are the major fishing gears used on the east coast of Peninsular Malaysia, while gillnet is dominant in Sarawak. Purse seine fishing using lures will mainly catch small pelagics such as mackerels or scads and some tuna, and is quite common on the west coast of Peninsular Malaysia.

In Thailand, the major type of tuna fishing gear are purse seine and Spanish Mackerel drift gill net, while other type of commercial fishing gears and traditional gears are considered minor in reference to the quantities of tuna caught. Purse seiners operating in the Gulf of Thailand can be divided into two types: Thai purse seine and luring purse seine. No tuna was caught by luring purse seiners after 1983 (Somsak, 1995) and this could be due to the preference by local fishermen on using the former gear.

3.3 Species Composition

In the early 1980s, catches of tuna on the east coast of Peninsular Malaysia would normally show *Thunnus tonggol* as being most dominant. This, however, changed in 1992 when *Euthynnus affinis* showed the greater abundant and led in the species composition. *Auxis thazard*, on the other hand, was only found occasionally and showed some form of association to oceanic species such as *Katsuwonus pelamis* and *Thunnus albacares*. This change in the species composition was probably related to the change in the major fishing gears employed for catching tuna. Purse seine was more widely used than trolling after 1987, and differences in the selectivity of this gear as well as changes in the overall number of fishing efforts probably led to this change (in species composition).

Thunnus tonggol, in 1990, was the dominant species among small tunas caught by local fishermen in Sarawak and may account up to 75% of the catch. Its composition, however, decreased to around 55% in 1991. *Euthynnus affinis* was the second most dominant species.

In the Philippines, the dominant tuna species were the frigate and bullet tuna, which may normally account up to 45% of the catch (Barut, 1995). This is followed by skipjack tuna (28%), Yellowfin and Bigeye (16%) and the Eastern little Tuna (10%).

In Thailand, the dominant tuna species was *Thunnus tonggol* and followed by *Euthynnus affinis* and lastly *Auxis thazard.* In 1991, the percentage of *Thunnus tonggol* in purse seine catches was 58.5% and only 39.8% in gillnet catches (Somsak, 1995).

3.4. Biological Parameters

Length frequency analyses using the Compleat ELEFAN showed L_∞ and K for *Euthynnus affinis* as 87.0 cm and 0.48, respectively. Similar analyses carried out on *Thunnus tonggol* put its L_∞ at 73.5 cm, and K at 0.44.

The growth *increment of Euthynnus affinis* under the tuna tagging programme was estimated at around 2.2 cm per month. Growth is normally faster at the begining of the animal's life cycle and may even exceed 3 cm per month.

The instantaneous natural mortality coefficient M, and total mortality Z, estimated for *Euthynnus affinis* were 0.852 and 2.228 per year, respectively. *Thunnus tonggol* showed a comparatively higher value of Z (2.278) but lower value of M (0.839) (Raja Bidin and Richard, 1992).

4. STATUS OF TUNA STOCK AND ITS EXPLOITATION

A preliminary analysis using the surplus production model on the historical data of tuna collected from the east cost of Peninsular Malaysia showed its maximum sustainable yield (MYS) as ranging from 14,000 – 16,000 tonnes. A similar analysis on tuna caught in Sarawak waters provided the estimated MSY values of 15,000 to 28,000 tonnes (Raja Bidin and Taupek, 1995).

Prior to 1987, exploitation of tuna on the east coast of Peninsular Malaysia was mainly from trolling and gill nets. In 1987, however, there was change in tuna fishing when offshore purse-seine boats were introduced. These boats were able to carry out fishing in the waters of the Malaysian Exclusive Economic Zone. Each boat was equipped with purse-seine nets of around 1.6 km in length (Raja Bidin, 1993).

The trend of tuna landings in Malaysia is given in **Figure 3**. Annual landings within the period 1984 to 1993 showed an increase from 24,611 to 35,980 tonnes, but decreased to 25,000 tonnes in 1994 (Annual Fisheries Statistics, 1993). The bulk of this landing, in recent years, was actually obtained from the state of Sabah (**Figure 4**). Tuna landing in Sabah for the year 1994 was estimated at 11,564 tonnes, decreasing due to a lesser fishing effort by about 32% when compared to the landing of 17,136 tonnes of the previous year. Tuna fishing off Sabah and Sarawak became more important, especially in the last two years, after foreign fisherman introduced tuna longline fishing around the Luconia Shoals and the Sprately Islands.

Exploitation rate (E) of *Euthynnus affinis* on the east coast of Peninsular Malaysia was calculated at 0.641, suggesting the species as being exploited near to (or slighty exceeding) the maximum level. In Sarawak, rate of exploitation was very much lower (0.15) which showed the possibility of expanding the fishery. This is hardly surprising considering only traditional gears (such as drift gillnets and trollers) are currently deployed to exploit the tuna resources (Hadil and Richard, 1991).

Tuna landings in the Philippines was estimated at around 9.054 tonnes in 1970, but rose significantly to 124,984 tonnes in 1976 after payao was introduced in 1975 (Barut, 1995). Landing continued to increase and reached a peak of around 339,074 tonnes in 1991, after which it began to decline. The landings for 1992 and 1993 were estimated at 285,803 and 243,306 tonnes, respectively. Reason for this decline is not yet known.

In Thailand, the rapid development of tuna fishing has resulted in the marked increase of tuna catches from 3,300 tonnes in 1971 to 156,206 tonnes in 1990. Up to 1982, tuna was one of the main target species of the Thai fishermen because of the great demand within the canning industry which offered good prices for tunas. This encouraged the Thai fishermen to improve their fishing gears and expand their fishing ground, in search for tuna, further offshore.

5. RECOMMENDATION

Preliminary results have indicated the existence of a relationship between good fishing grounds and oceanographic factors such as sea surface temperatures. An indepth study to accurately determine oceanographic and catch data within the South China Sea should next be undertaken so as to be able to forecast the potential distributions of commercially important pelagic species (such as tuna) for the benefits of all fishermen working in this region.

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FIGURE 1 : FAO STATISTICAL AREA – 71

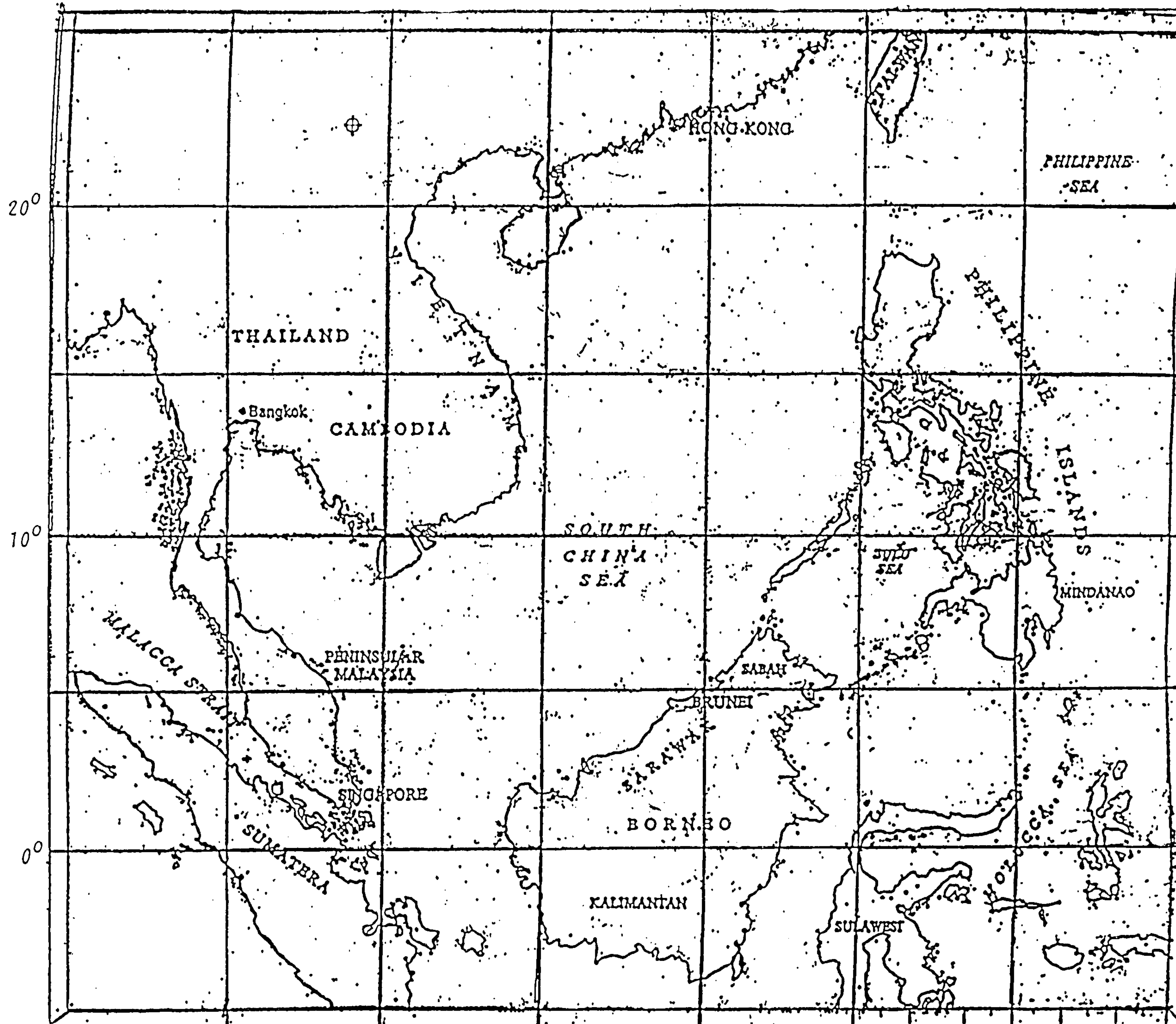


FIGURE 2: TUNA MIGRATION IN THE SOUTH CHINA SEA

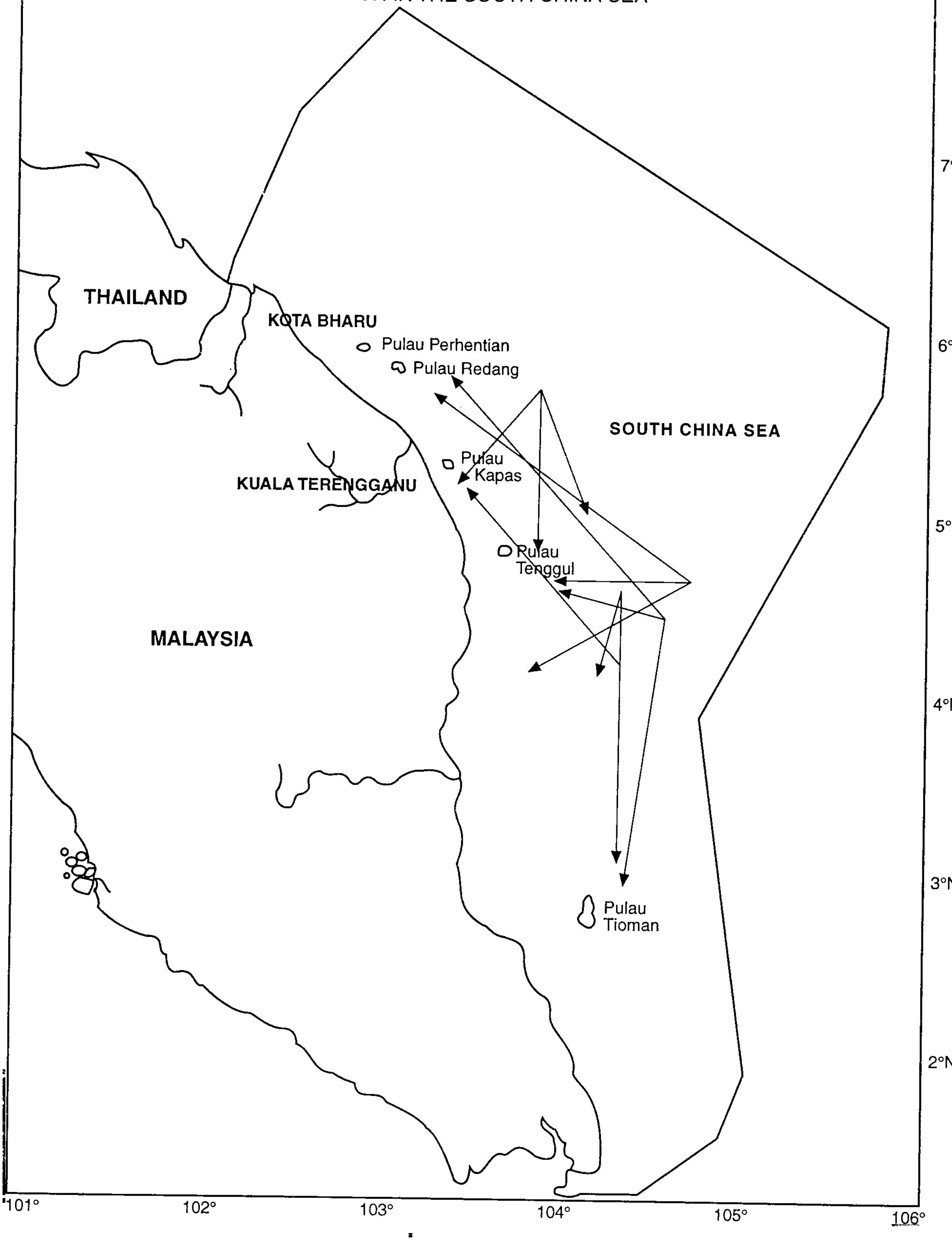


Figure 3: Trend Of Tuna Landings In Malaysia

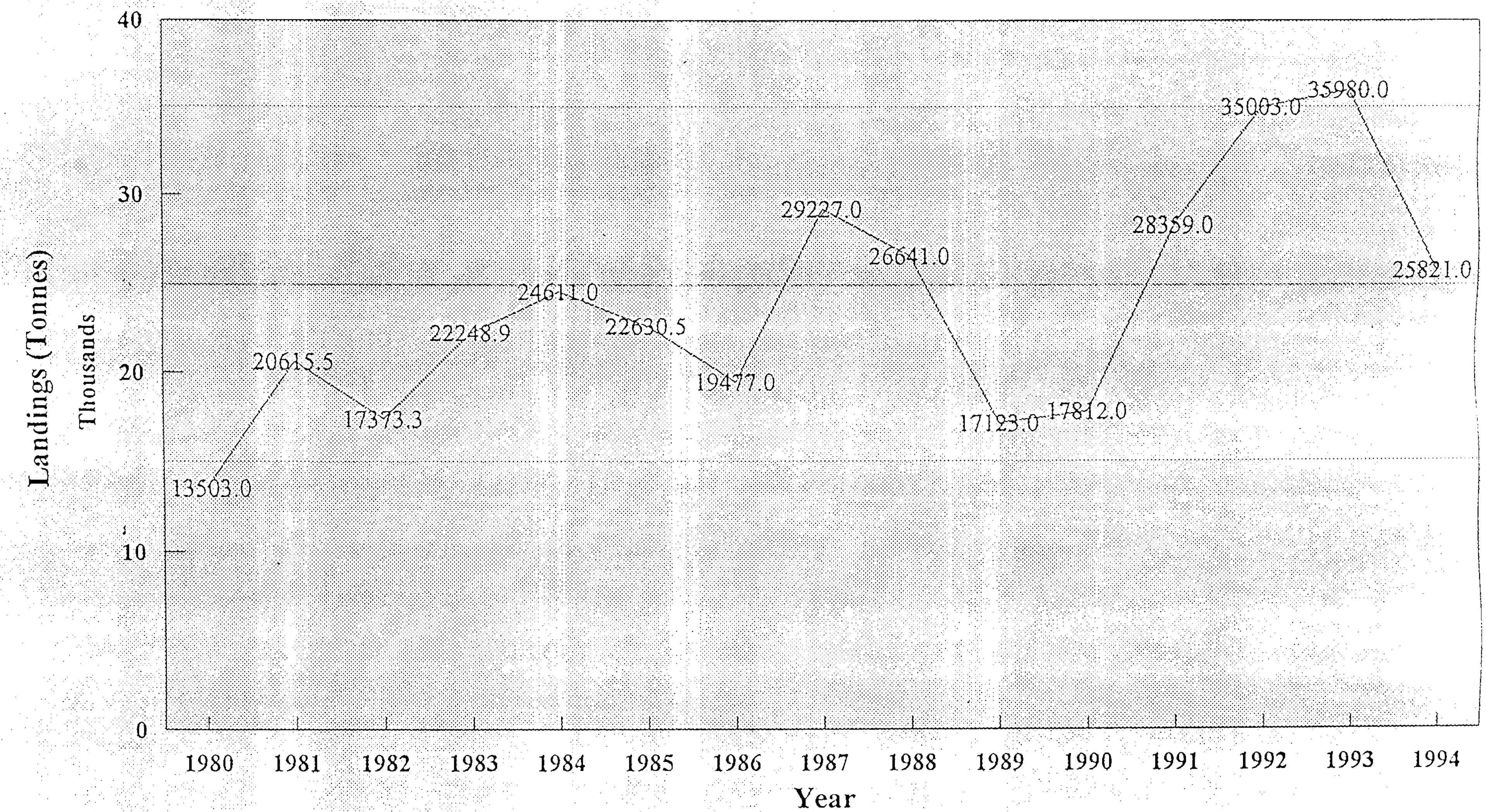
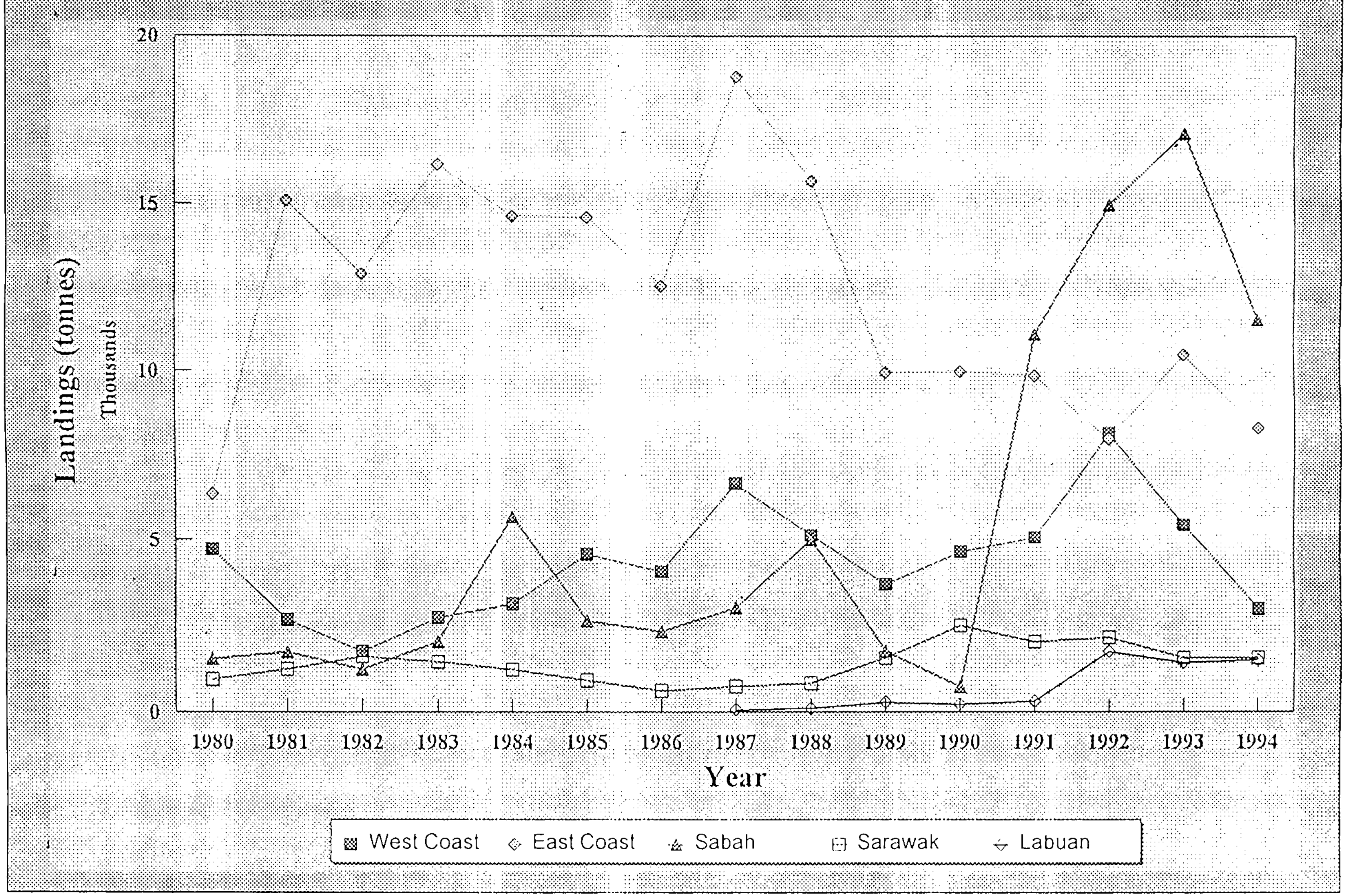


Figure 4 : Tuna Landings By Area In Malaysia



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ANNEXE 15

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK IN THE SOUTH CHINA SEA AREA

Kuala Terengganu, Malaysia, 18 — 20 July 1995

SEAFDEC / MFRDMD / WS / 95 / WP. 3

SITUATION OF THE STOCKS IN THE REGION (TOPICS AND ANALYSED DATA)

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SITUATION OF THE STOCKS IN THE REGION (TOPICS AND ANALYSED DATA)

THE STOCK STATUS OF *DECAPTERUS RUSSELLI*

1. Spawning Season

Investigating the relationship between the gonad stage and total length by month, *Decapterus russelli* was ripe over 160 – 170 mm in total length. As ripe individuals appeared in every month, it seemed that *D. russelli* spawned throughout the year. The main spawning season was not clearly, but the spawning group around September seemed to be especially large-scale. The spawning season as a parameter in the stock analysis was September.

2. Growth

The total length-weight relationship was determined by method of least squares using measured data of total length (mm) and weight (gr.). The results were as follows:

$$W = 6.87376 \times 10^{6} \times L^{3.07668}$$

$$W = 1.03236 \times 10^{5} \times L^{3}$$

Noticing the histograms of total length by month, polymodal distribution was decomposed into monomodal distribution by eyes. And, each mode of the monomodal distributions was read **(Figure 1)**. Considering the approximate growth with the results, the following data were got. The starting month of age was September which stated the above.

age 0.917	140 mm	(August)
age 1.917	230 mm	(August)
age 1.0	160 mm	(September)
age 2.0	240 mm	(September)
age 1.083	175 mm	(October)
age 2.083	230 mm	(October)
age 1.167	180 mm	(November)
age 2.167	235 mm	(November)
age 1.25	195 mm	(December)
age 1.417	185 mm	(February)
age 1.583	200 mm	(April)
age 1.75	215 mm	(June)

The following growth formula was got using a method of non-linear least squares (if the starting month of age is change, the parameter "t0" only change. The parameters "Loo" and "K" don't change).

$$Lt = 270.1\ [1 - \exp\{-1.0244\ (t - 0.13661)\}]$$

3. Maturity Rate

Since age 1 grew about 160 mm in total length and over 160 mm ripened, the changes of the maturity index of female as to over 160 mm were examined. The maturity index was different according as month, but all the individuals at October were ripened, Therefore, over age 1 seemed to ripen already. The maturity rate of over age 1 were hypothesized as 100%.

4. Longevity

The calculated total length at interval of a year by the growth formula were as follows:

age 1.0	158.6 mm
age 2.0	230.1 mm
age 3.0	255.7 mm
age 4.0	264.9 mm
age 5.0	268.3 mm

Investigating appeared ratio of individuals about over 260 mm from the size composition in catch, the ratio was 1.7% in 1993 and 0.1% in 1994. From this fact, it was able to consider that *D. russelli* between age 4 – 5 would die almost. Therefore the longevity was hypothesized as age 4.

A mode of the minimum size group on the size composition in catch had the range of 90 – 130 mm in total length. This group was below age 1. If the ratio of this group is high, the population analysis must be included this age group. Therefore, the ratio of below 130 mm was examined. The ratio accounted for 12% throughout from 1993 to 1994. Calculating the average total length as to below 130 mm and over 130 mm, it were 116 mm and 172 respectively. These weights were 16 gr. and 53 gr. respectively. The ratio of below age 1 in weight could calculate easily by the above ratio and weight. The result was only 4%. Therefore, the group below age 1 accounted for about 12% in number, but this group was only 4% in weight. From this results, the analysed unit was used a year excluding the group below age 1. The annual catch included the weight of below age 1, but the weight (4%) was ignored as tolerance.

5. Natural Mortality Coefficient M

The natural mortality coefficient M per year was estimated at 1.273 (survival ratio S = 0.28) by Biomass analysis. Therefore, 1.3 as M was used in the stock analysis.

6. Total Mortality Coefficient Z

Two normal distribution which are side by side usually differ with one years old for species which spawn at a specific month in a year. But, for species such as *D. russelli* which spawn throughout the year, the above distribution do not always differ with one years old. Therefore, if the modes between distribution of the oretical total length and normal distribution accord comparatively, these distribution can regard as spawning group at the same time. In case of the opposite, these distribution mean complex groups of different spawning time. Accordingly, the modes between the theoretical total length by the above growth formula and each monomodal distribution by normal distribution analyses were compared. From the results, modes accorded comparatively from May to November 1993. If two modes which are side by side have a gap of a year, the total number with the each distribution of these two modes can use calculation of total mortality coefficient (Z). Therefore, the gaps between each mode from May to November were examined, And, it became clear that the gaps at June and September accorded with a year. The other gaps showed below a year, and these distribution were interpreted as complex spawning groups.

From the above, Z was estimated using the data of June and September. Z of each month were 1.394 and 2.551 respectively. The average was 1.97. Accordingly, 2 as Z was used in the stock analysis.

7. Catch

The fisheries form on the east coast of Peninsular Malaysia had changed as a boundary at 1987. The catch trend of CPUE which was calculated by standardized effort was examined using the catch after 1987. The CPUE fluctuated on a large scale in the results. It seems that the CPUE was affected by the annual recruitment, the migration and the distribution. But, the cause was unknown. It was able to guess that the fluctuation of the stock was far larger than *Selar crumenophthalmus* and *Rastrelliger kanagurta*. However, the coefficient of variation which was calculated with the average and the standard error of the catch was about 20%. As the value was not regard extreme fluctuation, the catch of *D. russelli* in the stock analysis was used 28,720 ton of the annual average catch.

8. Full Available Age

As *D. russelli* also was caught by the same gears for *R. kanagurta*, the recruited information of *R. kanagurta* was used. As the full available age of *R. kanagurta* was about 125 mm (age 0.71), it seemed that *D. russelli* which is almost the same body type against *R. kanagurta* also recruited full about the same size. Therefore, the full available age in the stock analysis was used age 1.

9. Present Analysis

The following input parameters for the stock analysis were made from the above results.

Age	*TL (mm)*	*Weight (gr)*	*Maturity (%)*	*Age Composition*
1	158.57	41.16	100	1000
2	230.06	125.70	100	135.34
3	255.72	172.64	100	18.310
4	264.94	191.99	100	2.4788

M = 1.3, Catch = 28,720 ton, Full available age = 1

Using the above input data, the steady analysis model (Doi, 1982) was carried out. The results were as follows:

Age	*Total Stock* *Number* x 10^4	*Total Stock* *Weight* *ton*	*Available Stock* *Number* x 10^4	*Available Stock* *Weight* *ton*	*Catch* *Number* x 10^4	*Catch* *Weight* *ton*	*Adult* *Number* x 10^4
1	153526.0	63197.30	153526.0	63197.30	46461.7	19125.40	153526.0
2	20777.5	26118.40	20777.5	26118.40	6287.9	7904.27	20777.5
3	2811.9	4854.60	2811.9	4854.60	851.0	1469.16	2811.9
4	380.6	730.61	380.6	730.61	115.2	221.11	380.6
TOTAL	177496	94900.9	177496	94900.9	53716	28720.0	177496

It was clear that the main available age were age 1 and 2. The both are groups were occupied 67% and 28% in catch in weight respectively. As the exploitation rate was 30%, the nearly one thirds part of total stock in the sea was caught.

10. Reproduction and Sustainable Yield

Estimation of reproduction mechanism of *D. russelli* was used the same way which expressed on *R. kanagurta*. Hypothesizing the four relationships of Ricker type (**Figure 2**), the most suitable relationship (Case A) was estimated according to the examined method on *S. crumenophthalmus* and *R. kanagurta*. And, the following formula was hypothesized as the reproductive mechanism.

$$R = 1.02541A\exp(-9.39147 \times 10^7 A)$$

The answers which were estimated sustainable yield (SY) by the above formulas and KAFS model (Kinetic Analysis of Fisheries; Kimoto *et. al.*, 1988) were as follows:

F	*Catch* $x\ 10^6$	*Weight* *ton*
0.2	30341	18890
0.4	46218	26873
0.6	53361	29271
0.8	55351	28907
1.0	54417	27272
1.2	51934	25148
1.4	48742	22938
1.6	45344	20840
1.8	42028	18942
2.0	38952	17274

The fishing mortality coefficient (F) and the catch in weight at present were 0.7 and 28720 ton respectively. These values were not on the reproductive curve, but it was due to the reason which conformity between the present status and the used data on the above formula was imperfection. Judging the present status by the sustainable yield (SY), the stock status of *D. russelli* was nearby the maximum sustainable yield (MSY). And, possibility of overfishing was very low. As stated above, the stock flúctuation of *D. russelli* was quite large. Therefore, the above reproductive mechanism should be considered with influence of the fluctuation. It was possibility that the potential productivity of *D. russelli* was far higher than *R. kanagurta* and *S. crumenophthalmus.*

1. Spawning Season

Investigating the relationship between the gonad stage and total length by month, *Rastrelliger kanargurta* was ripe over 190 mm in total length. As ripe individuals appeared in every month, it seemed that *R. kanagurta* spawned throughout the year. The main spawning season was from July to December with September as the center. And, there was also a peak in about April. However, it was not clear because of shortage of data. The spawning season as a parameter in the stock analysis was September.

2. Growth

The total length-weight relationship was determined by method of least squares using measured data of total length (mm) and weight (gr.). The results were as follows:

$$W = 4.79906 \times 10^{6} \times L^{3.15526}$$

$$W = 1.11765 \times 10^{5} \times L^{3}$$

Noticing the histograms of total length from May to September in 1993, it seemed that the mode of the smallest group in May, July and August and the mode of the second group in September were the same spawning group. Therefore, the rough total length of those mode was read by eye. But, as the histogram in May was decomposed into normal distribution, the average total length was calculated using the results. On the other hand, since the group which had the mode of 11 cm. in May was felt to be September – born group of last year, the absolute age of the group was hypothesized as age 0.667 (=8/12). The absolute age of the other month groups were also calculated in a similar way. The following growth data were got from the results.

age 0.667	108 mm	(May)
age 0.833	165 mm	(July)
age 0.917	190 mm	(August)
age 1	205 mm	(September)

The following growth formula was got using a method of non-linear least squares.

$$LT = 287.1 \, [1 - \exp \{ -2.375 \, (t - 0.4687) \}]$$

3. Maturity Rate

Since age 1 grow 200 mm in total length, age 1 was already adult. However, as *R. kanagurta* was ripe from about 190 mm, the gonad stage was examined by age 0.25. And, as the individual of age 0.75 was about 140 mm in total length, it was clear that this age group was not ripe yet (maturity rate = 0). Therefore, it was hypothesized that all the individuals was ripe over age 1.

4. Longevity

The calculated total length at interval of age 0.25 by the growth formula were as follows:

age 0.75	139.9 mm
age 1.00	205.8 mm
age 1.25	242.2 mm
age 1.50	262.3 mm
age 1.75	273.4 mm
age 2.00	279.5 mm
age 2.25	282.9 mm

Investigating the maximum size from the size composition in catch, a individual in 280 – 289 mm range at September 1993 was the maximum size. But, all the individuals of the other months were below 270 mm. From this fact, it was able to consider that *R. kanagurta* over age 2 would die almost. Therefore, the longevity was hypothesized as age 2.

R. kanagurta spawned throughout the year, but had the spawning peak. Accordingly, the group of the peak was expected to reflect in catch composition. As previously stated, the size compositions by month substantiated the expectation clearly, and it seemed that the compositions consisted of groups of some spawning peaks. Comparing each mode in the above histograms of total length to the calculated total length at interval of one month by the growth formula, spawning month of each mode was counted backward. From this results, it was ascertained that each group was the group which was born on the two spawning peaks. Therefore, as the analysis by a unit of year was rough, the stock analysis was carried out using the six age groups form age 0.75 as the minimum age to age 2 as the maximum age by interval of age 0.25.

5. Natural Mortality Coefficient M

The natural mortality coefficient M per 0.25 year was estimated at 0.916 (survival ratio S = 0.40) by Biomass analysis. This value is 3.665 (S = 0.0256) per annum. The value was used in the stock analysis.

6. Total Mortality Coefficient Z

The following groups were extracted from the previously stated histograms by month. And, reading the mode of each group, frequency of each group was calculated by separating each group at middle point in total length:

(*a*) to be side by side and to have a decreasing trend;

(*b*) furthermore, to seems that the groups are the same spawning season-born.

The groups of April, May, July and August 1993 could utilize for calculation of Z from the results. The results of age difference and survival ratio (S) of each month were as follows:

age difference and S at April ; age 0.17, S = 0.474;

age difference and S at May ; age 0.12, S = 0.288;

age difference and S at July ; age 0.21, S = 0.282;

age difference and S at August ; age 0.21, S = 0.316.

Explaining the interpretation of the above results as an example for April, 0.474 means survival ratio (S) of time for age 0.17. S per annum was 0.01238, Z per annum was 4.39. Z of the other month were 10.37, 6.03, and 3.65 respectively. As there were very widely, it seemed that Z (or S) fluctuated considerably. Since the information about Z was nothing in Malaysia, 1.5 as Z by quarter was used in the stock analysis.

7. Catch

The fisheries form on the east coast of Peninsular Malaysia had changed as a boundary at 1987. The catch trend of CPUE which was calculated by standardized effort was examined using the catch after 1987. As the CPUE after 1987 was steady relatively, it seemed that the stock status was steady condition. Accordingly, the catch of *R. kanagurta* was used 2,300 ton which was a quarter of the annual average catch from 1987 to 1993 in the stock analysis.

8. Full Available Age

The full available age of *R. kanagurta* was about age 0.71 from the above mentioned Z. Therefore, the full available age in the stock analysis was used age 0.75 as the minimum age in the analysis.

9. Present Analysis

The following input parameters for the stock analysis were made from the above results.

Age	*TL (mm)*	*Weight (gr)*	*Maturity (%)*	*Age Composition*
0.75	139.91	30.61	0	1000
1.00	205.81	97.44	100	223.13
1.25	242.21	158.81	100	47.78
1.50	262.31	201.72	100	11.11
1.75	273.41	228.43	100	2.479
2.00	279.54	244.14	100	0.533
M = 0.916,		Catch = 2,300 ton,		Full available age = 0.75

Using the above input data, the steady analysis model (Doi, 1982) was carried out. The results were as follows:

Age	*Total Stock* *Number* x 10^4	*Total Stock* *Weight* *ton*	*Available Stock* *Number* x 10^4	*Available Stock* *Weight* *ton*	*Catch* *Number* x 10^4	*Catch* *Weight* *ton*	*Adult* *Number* x 10^4
0.75	12038.3	3684.82	12038.3	3684.82	3639.3	1113.97	0
1.00	2686.1	2617.23	2686.1	2617.23	812.0	791.22	2686.1
1.25	599.4	951.82	599.4	951.82	181.2	287.75	599.4
1.50	133.7	269.77	133.7	269.77	40.4	81.55	133.7
1.75	29.8	68.16	29.8	68.16	9.0	20.61	29.8
2.00	6.7	16.26	6.7	16.26	2.0	4.91	6.7
TOTAL	15494	7608.1	15494	7608.1	4684	2300.0	3459

It is clear that the catch were occupied around age 1 from the results. This status has to understand as a average result in quarter.

10. Reproduction and Sustainable Yield

The reproduction of *R. kanagurta* was studied with the relationship between recruitment stock and adult stock. Adult stock and recruitment stock mean number of adult and number of age 0.75 respectively. When X–axis and Y–axis are adult stock and recruitment stock respectively, one point can plot from the present status. If analysis of the past is carried out, the information of reproduction will increase, and reproductive mechanism can guess. However, as the past information was nothing, the analysia of the past could not carry out. Therefore, reproductive mechanism was studied with the point of the present results. The relationship between recruit and adult in nature never increase monotonously or exponentially. It is natural that the relationship will be saturated with density effect. Therefore, the four relationships of Ricker type which spawning quantity will decide mortality or recruit were hypothesized (**Figure 1**). Reading some values of adult and recruit on these the hypothesized curves, the following data were made. The eight data is the present value.

No.	*Case A* Adult	*Recruit* x 10^4	*Case B* Adult	*Recruit* x 10^4	*Case C* Adult	*Recruit* x 10^4	*Case D* Adult	*Recruit* x 10^4
1	500	6600	500	14000	2000	8100	2000	8100
2	1000	10200	1000	22200	4000	16200	2500	10150
3	1500	13200	1500	26600	6000	23500	4000	16000
4	2000	14900	2000	27600	8000	28200	6000	19900
5	2500	15300	2500	26000	9000	29000	6500	20000
6	3000	14900	3000	21000	10000	27800	7000	19700
7	4000	12400	4000	2000	12000	26700	7500	18900
8	3456	12038	3456	12038	3456	12038	3456	12038

Using the above data, the following formulas were got.

Case A : $R = 16.3639A\exp(-4.1665 \times 10^4 A)$

Case B : $R = 71.9675A\exp(-9.7097 \times 10^4 A)$

Case C : $R = 4.75282A\exp(-5.1548 \times 10^5 A)$

Case D : $R = 4.91269A\exp(-7.7487 \times 10^5 A)$

The answers which were estimated sustainable yield (SY) by the above formulas and KAFS model (Kinetic Analysis of Fisheries; Kimoto *etal.*, 1988) were as follows:

F	*Case A* Catch x 10^4	Weight ton	*Case B* Catch x 10^4	Weight ton	*Case C* Catch x 10^4	Weight ton	*Case D* Catch x 10^4	Weight ton
0.2	1750	1063	1350	820	5978	3630	3158	1918
0.4	3447	1856	2797	1506	8911	4799	4879	2628
0.6	5063	2467	4359	2125	7912	3856	5585	2722
0.8	6537	2934	6043	2712	1667	748	5469	2454
1.0	7773	3259	7847	3289	−11644	−4881	4604	1930
1.2	8629	3420	9756	3866			2986	1183
1.4	8904	3370	11739	4442			558	211
1.6	8324	3032	13746	5008			−2787	−1015
1.8	6515	2300	15696	5542				
2.0	2978	1025	17470	6012				

The responses to fishing mortality coefficient (F) of Case C and D were sensitive. And, if the present is the saturated point, the maximum sustainable yield (MSY) in D is very small. Considering the catch and effort trend, the response to F was dull clearly. Therefore, it was hard to think the relationships such as Case C and D. On the other hand, the responses to F of Case A and B were dull. In especially Case B, the more catch effort increase, the more catch increase. But, it is too extremely. It seemed that Case A was the most properness. As this was the limits of speculation because any information was nothing at present, Case A was hypothesized as the reproductive mechanism.

From the above, MSY of *R. kanagurta* was 3,400 ton (around 13,000 ton per annum). Diagnosis at the present status was under exploitation.

1. Spawning Season

Investigating the relationship between the gonad stage and total length by month, *Selar crumenophthalmus* was ripe over 180 – 190 mm in total length. As ripe individuals appeared in every month, it seemed that *S. crumenophthalmus* spawned throughout the year. The main spawning seasons were April – May and September – October. It seems that the former a bigger spawning recruitment and larger scale than the latter. The spawning season as a parameter in the stock analysis was April.

2. Growth

The total length-weight relationship was determined by method of least squares using measured data of total length (mm) and weight (gr.). The results were as follows:

$$W = 4.13369 \times 10^{6} \times L^{3.20569}$$

$$W = 1.27294 \times 10^{5} \times L^{3}$$

S. crumenophthalmus grows to about 20 cm a year after birth according to the reports from Manila Bay and Java Sea (Chullasorn, S. & P. Martosubroto, 1986). The information and the histograms of total length from every month were used as examined materials. And the following hypotheses were set.

(*a*) The growth of all the spawning month is the same.

(*b*) Polymodal distribution which overlaps too some monomodal distribution shows existence of different spawning groups of near spawning month.

From the above, finding out cases which each momomodal distribution separate clearly respectively, June 1993, April and October 1994 corresponded to such case. The mode of the smallest distribution at April could be read about 105 mm in total length. Considering the above information, the distribution was estimated at the birth in September – October of the last year. The mode at June was about 155 mm. From the estimation of April, the distribution of June was estimated at the birth in April – May of the last year. The distribution of October was also estimated at the birth in the same month of the last year. The following data were made from these estimation.

age 1.167	155 mm	(June)
age 2.167	235 mm	(June)
age 0.583	105 mm	(April)
age 1.583	215 mm	(April)
age 1.50	195 mm	(October)
age 2.50	255 mm	(October)

The following growth formula was got using a method of non-linear least squares.

$$LT = 338.9 \, [1 - \exp \{ - 0.5427 \, (t + 0.08076) \}]$$

3. Maturity Rate

Since age 1 grew over 200 mm and age 2 grew 229 mm in total length, age 1 started to recruit the adult group, and age 2 became adult. Calculating the maturity rate about over III from the maturity index of female between 150 – 229 mm in total length at April – May and September – October as the spawning peak, the maturity rate was 45%. The maturity rate of age 1 and over age 2 were hypothesized as 50% and 100% respectively.

4. Longevity

The calculated total length at interval of age 0.5 by the growth formula were as follows:

age 1.0	150.4 mm
age 1.5	195.2 mm
age 2.0	229.3 mm
age 2.5	255.4 mm
age 3.0	275.2 mm
age 3.5	290.4 mm
age 4.0	301.9 mm

Investigating the maximum size from the size composition in catch, three individuals at April 1993 and a individual at July 1993 in 300 – 309 mm range were the maximum size. But, all the individuals of the other months were below 300 mm. From this fact, it was able to consider that *S. crumenophthalmus* between age 4 – 5 would die almost. Therefore, the longevity was hypothesized as age 4.

The minimum size group on the size composition in catch was about 100 mm in total length. This group was below age 1. If the ratio of this group is high, the population analysis must be included this age group. Therefore, the ratio of below 150 mm was examined. The ratio accounted for about 20% in the result. The central total length in catch was between 150 – 200 mm from the size composition. And many individuals over 200 mm also appeared. Accordingly, if the average total length over 150 mm in catch hypothesize as 200 mm, the weight will be about 100 grams. If the average length below 150 mm in catch also hypothesize as 125 mm, the weight will be about 25 grams. Therefore, the group below age 1 accounted for about 20% in number, but this group was only 4% in weight. From this results, the analyzed unit was used a year excluding the group below age 1.

5. Natural Mortality Coefficient M

The natural mortality coefficient M per year was estimated at 1.470 (survival ratio S = 0.23 by Biomass analysis. The value was used in the stock analysis.

6. Total Mortality Coefficient Z

The following groups were extracted from the previously stated histograms by month:

(*a*) to be side by side, and to have a decreasing trend;

(*b*) furthermore, to seems that the groups are the same spawning season–born.

The groups of June 1993, August, September and October 1994 could utilize for calculation of Z from the results. The histograms of these months were decomposed into normal distribution. From the results, total mortality coefficient (Z) were gained the values as 1.16, 2.41, 2.59 and 0.84. As there were very widely, it seems that fluctuation of natural mortality coefficient (M) or fishing mortality coefficient (F) contributed considerably. The sample number of these months were 282, 205, 1080 and 467 respectively. The number of August 1994 was the largest. Considering to grasp most the population, Z of August was used in the stock analysis.

7. Catch

The fisheries form on the east coast of Peninsular Malaysia had changed as a boundary at 1987. The catch trend of CPUE which was calculated by standardized effort was examined using the catch after 1987. As the CPUE after 1989 was steady relatively in the results, it seemed that the stock status was steady condition after 1989. Accordingly, the catch of *S. crumenophthalmus* was used in 18,451 ton which was the annual average catch from 1989 to 1993 in the stock analysis.

8. Full Available Age

As *S. crumenophthalmus* also was caught by the same gears for *R. kanagurta*, the recruited information of *R. kanagurta* was used. As the full available age of *R. kanagurta* was about 125 mm (age 0.71), it seemed that *S. crumenophthalmus* which is almost the same body type against *R. kanagurta* also recruited full about the same size. Therefore, the full available age in the stock analysia was used age 1.

9. Present Analysis

The following input parameters for the stock analysis were made from the above results.

Age	*TL (mm)*	*Weight (gr)*	*Maturity (%)*	*Age Composition*
1	150.39	43.29	50	10000
2	229.34	153.55	100	750.2
3	275.23	265.39	100	56.28
4	301.89	350.25	100	4.222
M = 1.5,		Catch = 18,451 ton,		Full available age = 1

Using the above input data, the steady analysis model (Doi, 1982) was carried out. The results were as follows:

Age	*Total Stock*		*Available Stock*		*Catch*		*Adult*
	Number x 10^4	*Weight* *ton*	*Number* x 10^4	*Weight* *ton*	*Number* x 10^4	*Weight* *ton*	*Number* x 10^4
1	84296.0	36499.20	84296.0	36499.20	32577.8	14405.80	421148.0
2	6398.5	9825.22	6398.5	9825.22	2472.8	3797.15	6398.5
3	485.7	1288.92	485.7	1299.92	187.7	498.13	485.7
4	36.9	129.12	36.9	129.12	14.3	49.90	36.9
TOTAL	91217	47742.5	91217	47742.5	35253	18451.0	49069

It was clear that the 78% in catch in weight were occupied age 1 from the results. Therefore, the main available stock was age 1. As the exploitation rate was 39%, the nearly half part of total stock in the sea was caught.

10. Reproduction and Sustainable Yield

Estimation of reproduction mechanism of *S. crumenophthalmus* was used the same way which expressed on *R. kanagurta*. Firstly, the five relationships of Ricker type which spawning quantity will decide mortality or recruit were hypothesized (**Figure 1**). Reading some values of adult and recruit on these the hypothesized curves, the following data were made. The seventh data is the present value.

No.	*Case A* A. x 10^6	*Case A* R.	*Case B* A. x 10^6	*Case B* R.	*Case C* A. x 10^6	*Case C* R.	*Case D* A. x 10^6	*Case D* R.	*Case E* A. x 10^6	*Case E* R.
1	100	540	50	970	150	320	200	350	200	350
2	200	820	100	1600	300	580	400	695	400	695
3	300	950	150	1950	400	730	600	1030	700	1215
4	350	960	250	2260	600	910	800	1280	1400	2360
5	400	940	350	2040	700	900	1000	1450	1600	2550
6	600	640	400	1740	800	810	1200	1520	1800	2670
7	491	843	491	843	491	843	491	843	491	843

Note: A : Adult, R : Recruit.

Using the above data, the following formulas were got.

Case A : $R = 7.89981A\exp(-3.17482 \times 10^5 A)$

Case B : $R = 27.9748A\exp(-5.04867 \times 10^5 A)$

Case C : $R = 2.92806A\exp(-1.0867 \times 10^5 A)$

Case D : $R = 1.99741A\exp(-3.23167 \times 10^6 A)$

Case E : $R = 1.80518A\exp(-8.30683 \times 10^7 A)$

The answers which were estimated sustainable yield (SY) by the above formulas and KAFS model (Kinetic Analysis of Fisheries; Kimoto *etal.*, 1988) were as follows:

F	*Case A* Catch x 10^6	*Case A* Weight ton	*Case B* Catch x 10^6	*Case B* Weight ton	*Case C* Catch x 10^6	*Case C* Weight ton	*Case D* Catch x 10^6	*Case D* Weight ton	*Case E* Catch x 10^6	*Case E* Weight ton
0.2	89	6013	97	6528	112	7555	194	13074	519	34995
0.4	164	10259	181	11324	195	12204	304	18948	743	46379
0.6	228	13349	255	14949	258	15098	356	20823	771	45132
0.8	282	15670	320	17767	305	16926	370	20539	675	37472
1.0	329	17471	377	20018	341	18107	360	19152	506	26902
1.2	369	18911	427	21861	369	18893	337	17269	300	15377
1.4	404	20095	471	23405	391	19439	306	15233	80	3961
1.6	435	21093	510	24722	409	19843	273	13232	–140	–6793
1.8	462	21954	544	25866	424	20161	239	11364		
2.0	486	22711	575	26874	437	20431	207	9675		

The present status in Case E was overfishing. A temporary history which had appeared bigger catch effort and larger catch than the present was necessary to go through the process of overfishing. But, as such trend was not recognized in the transition of both factors after 1980, it was not reasonable that Case E counted as the reproductive mechanism.

The present status in Case A, B and C were under exploitation. And moreover, there are not shown in the table, but even if the fishing mortality coefficient (F) at present (about F = 1) was done twenty times, the catch did not reach MSY, and even if F became infinite, the stock was not extinction because adult survived. Therefore, it was hard to think the relationships such as Case A, B and C.

The last Case D was also overfishing as Case E, but the degree was barely. And, considering with accuracy of input data in the model, it did not declare that the present was overfishing clearly. The MSY was 20,823 ton against 18,451 ton at the present catch. Accordingly, it should regard as tolerance because the gap between the both values was only about 10% to the present catch.

From the above, it seems that the reproduction mechanism of *S. crumenophthalmus* approximated Case D. The extinction of the stock in Case D did not occur until about F = 6. As stated above, the fisheries form on the east coast of Peninsular Malaysia changed as a boundary at 1987. The change was the increase of F. However, as a drastic increased trend did not recognize, it seems that the present status was under exploitation near to MSY.

ANNEXE 16

THE SECOND REGIONAL WORKSHOP ON SHARED STOCK
IN THE SOUTH CHINA SEA AREA

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FRAMEWORK OF THE COLLABORATIVE RESEARCH WORKS ON ENVIRONMENTAL STUDY AND RESOURCES SURVEY

By

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FRAMEWORK OF THE COLLABORATIVE RESEARCH ON MARINE ENVIRONMENTAL STUDY AND RESOURCES SURVEY BY M.V. SEAFDEC

1. INTRODUCTION

Southeast Asian Countries face today a grave situation of environmental damage and misuse. The rapid development in marine fisheries sector has been satisfactory judging from the considerably increase in fish catches. Much of this development has, however, taken place with negligible consideration for its impact on the very environment which sustains it. SEAFDEC was established to address itself to just such issues. Since its establishment, SEAFDEC has been working to move towards a sustainable future. With the newly acquired of the modern training and research vessel, M.V. SEAFDEC, the Center will concentrate on consolidating its collaborative research programs among the Center's departments and its member countries.

The oceanographic data in the Southeast Asian region is rather scanty. Besides, most of the oceanographic information were not available from the Asian countries in the form of publications.

The acoustic survey technique for resource assessment has been widely used by developed countries as a mean of quick estimation of abundance. Though this technique has been introduced in this region in the 1980, very little work has been done in this area.

The increasing global concern in the environmental issues requires a close monitoring on the quality of water and other pollutants that might be harmful to aquatic resources and to human beings. However, this information are very limited for proper management.

At its twenty sixth Council Meeting, the meeting had approved the proposal to fully utilize M.V. SEAFDEC in the collaborative research programs among the Center's departments and with member countries.

2. OBJECTIVES

The prime objectives of the collaborative research survey area:

1. To collect and analyse data and information necessary for the management of fishery resources and the protection of the environment through collaborative research among Member Countries and Organisations concerned, and
2. To train researchers from Member Countries on modern research techniques throught the collaborative research project.

3. RESEARCH VESSEL AND EQUIPMENT TO BE USED

M.V. SEAFDEC with a displacement 1178 GRT and a cruising speed of 15 knots will be deployed for the survey. She is well equipped with the latest oceanographic equipment e.g. Rosette water sampler with ICED and NOAA (APT) Receiver. The vessel is also equipped with the Furuno FQ 70 scientific echosounder and relevant data processing software suitable for acoustic survey. In addition, the national research vessels of member Countries are also deployed, and/or if necessary to charter commercial vessels to carry out some scientific/fishing trials.

4. SURVEY AREA AND DURATION

The proposed survey area are shown in **Fig. 1**. The survey track is composed of parallel track of 20 nautical mile. 45 oceanographic stations will be in the "Gulf of Thailand, 45 stations in the east coast of Peninsular Malaysia and 97 stations in the Sarawak and Sabah. Bunkering will be in Songkhla, Kuala Terengganu and Labuan. The acoustic survey will follow the same track as the oceanographic survey. Sampling of fish species will be carried out to obtain the species composition for the biomass estimation by deploying M.V. Pramong from Thailand and K.K. Manchong from Malaysia.

Table 1, **2** and **3** shows the survey duration:

Table 1: The first and second survey cruise in 1995

Gulf of Thailand (45 Stations)

Survey distance	1,780 nautical mile
Survey activities	16 days

East Coast of Peninsular Malaysia (45 Stations)

Survey distance	1,530 nautical mile
Survey activities	14 days
– Hydroacoustic calibration	1 day
– Bunkering at Songkhla	1 day
– Bunkering at Kuala Terengganu	1 day
– Spare time	2 day
Total =	35 days

Table 2: The third and fourth survey cruise in 1996

West coast of Sabah and Sarawak (97 Stations)

Survey distance	2,970 nautical mile
Survey activities	25 days
– Hydroacoustic calibration	1 day
– Sailing Bangkok – Kuching	3 days
– Bunkering at Labuan	2 days
– Sailing Kota Kinabalu – Bangkok	3 days
– Spare time	2 days
Total =	36 days

Table 3: The proposed survey area and duration in 1995 and 1996

	April–May	*August–September*
1995	The Gulf of Thailand & East Coast of Peninsular Malaysia (–35 days)	The Gulf of Thailand & East Coast of Peninsular Malaysia (–35 days)
1996	West Coast of Sabah and Sarawak (–36 days)	West Coast of Sabah and Sarawak (–36 days)

PROPOSE RESEARCH PROJECT AREAS

1. Physical Oceanography Study

Water Circulation Pattern in Southeast Asian Waters.

Parameter	*Equipment/Methods*
Temperature profile	ICTD
Salinity profile	ICTD
pH profile	ICTD
Dissolve oxygen profile	ICTD
Sea surface tempreature	NOAA (APT)

2. Chemical Oceanography Study

Nitrate, Nitrite, Ammonia	Autoanalyser
Phosphate, Silicate	Autoanalyser

3. Biological Oceanography Study

Distribution, Abundance and Composition of Marine organisms in Southeast Asian Waters.

Phytoplankton	Phytoplankton net (56 um)
Zooplankton	Plankton net (330 um)
Chlorophylll	ICTD (fluorometers)
Benthos	Smith Me Intre Grab
Fish larvae	Bongo net/Egg and Larva net
Fish	Trawl net

4. Resource Survey

: Biomass Estimation in Southeast Asian Waters.

Acoustic survey	FQ – 70 Scientific Echo Sounder

5. Marine Environmental Study

: Marine Pollution in Southeast Asian Waters.

Heavy metal	Rosette water sampler
Oil pollution	Crab
Red tide	Core sampler

5.3 *Biological Oceanography*

Phytoplankton	Plankton net (56 um)
Zooplankton	Plankton net (300 um)
Chlorophyll	ICTD (flurometer)
Benthos	Smith Me Intre Grab
Fish larvae	Net
5.4 Resource Survey	FQ – 70 Scientific
Acoustic Survey	Echosounder

Detail research title are shown in appendix **1, 2 & 3.**

6. Participants

The participants for the research survey are member countries scientists who are currently involved in the oceanography studies and resources assessment surveys. The allocation participating scientists is as follows:

MFRDMD (Malaysia)	6
FRI (Malaysia)	4
Thailand	7
TD / SEAFDEC	5
Japanese Expert	3
Total	24

7. · Budget Requirement

The budget necessary to conduct this collaborative survey will be decided in early next year taking into account the result of budgetary acquisition of Japan.

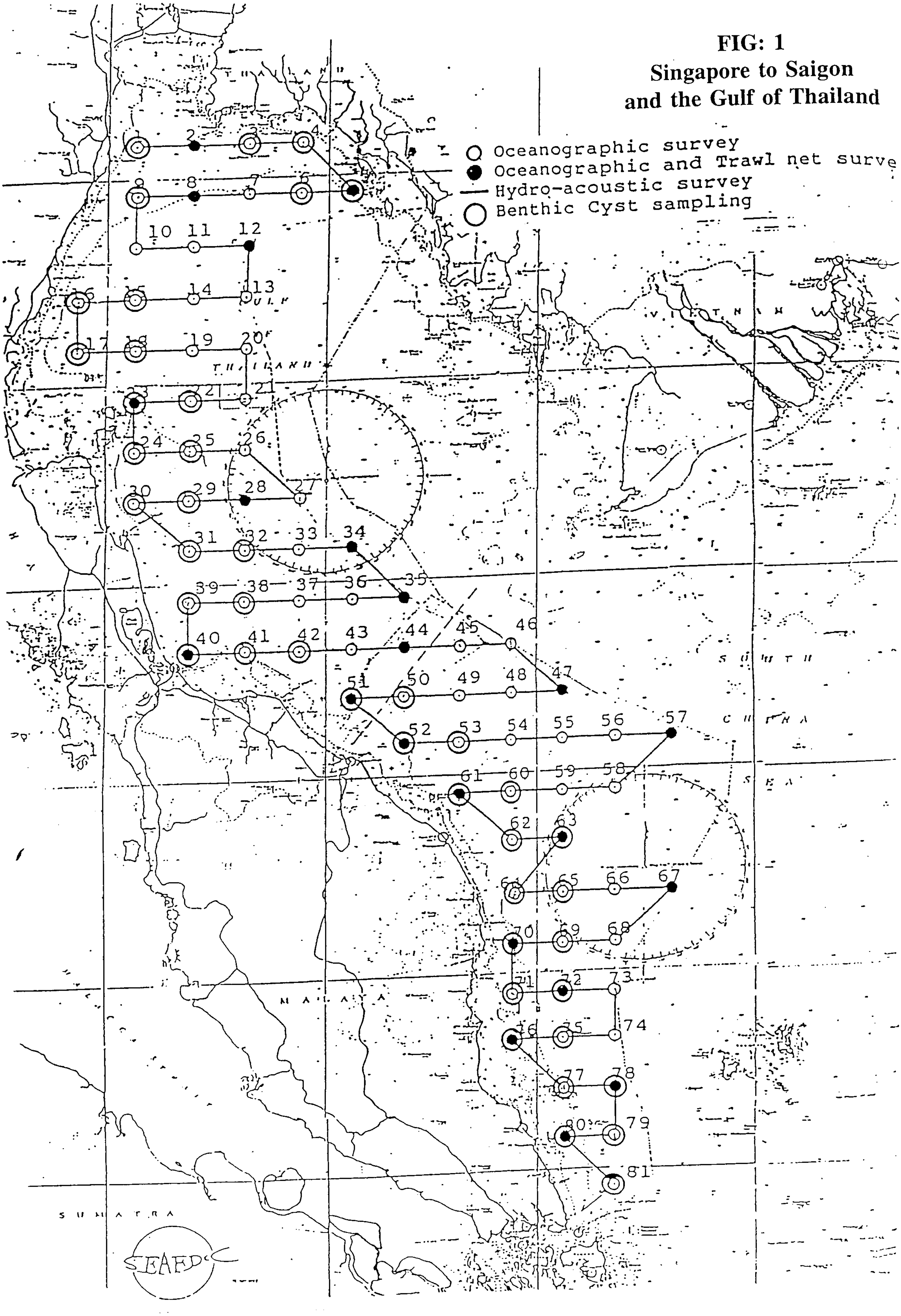
8. Data analysis/Report

Data analysis and report writing will be undertaken by the scientists from MFRDMD, TD and DOF Malaysia and Thailand. Other participation scientists may participate in the data analysis or report writing. For this purpose an allocation of fund to cover travelling and other expenses is required.

9. Conclusions

At present the environment is one of the most pressing issues facing most countries in the Southeast Asia region. Therefore, there is a need for both catalysts and facilitators to help bridge the efforts to maximize the natural resources utilization and to achieve the sustainable development. To this regard, SEAFDEC can play a vital role. This collaborative research between TD and MFRDMD would generate up to date scientific information on the marine resources status and to train the participated national scientists on board M.V. SEAFDEC.

FIG: 1
Singapore to Saigon and the Gulf of Thailand



Appendix 1

PROJECT TITLE (MALAYSIA)

Title 1 Longitudinal Variability of Physical Parameters on the Western Side of South China Sea.

Researcher: Dr. Mohd. Nasir Saadon,
Fisheries and Marine Science Center,
Universiti Pertanian Malaysia,
Mengabang Telipot, 21030 Kuala Terengganu.

Title 2 Trace Metals and Mineral Composition of Sediments of the Gulf of Thailand and South China Sea.

Researcher:
1. Dr. Noor Azhar Mohd Shazili (Universiti Pertanian).
2. Dr. Mohd Lokman Husain (Universiti Pertanian).
3. Dr. Mohd Kamil Abdul Rashid (Universiti Pertanian).

Title 3 The Chlorophyll's A Content of the South China Sea and the Gulf of Thailand.

Researcher: Dr. Lokman Shamsudin.

Title 4 Photosynthetic Values, Light Intensity and other Related Parameters of South China Sea and the Gulf of Thailand.

Researcher: Dr. Lokman Shamsudin.

Title 5 The Microplankton of the South China Sea and the Gulf of Thailand.

Researcher: Dr. Lokman Shamsudin.

Title 6 The Microzooplankton (Include Dinoflagellate and Foraminifera) of the South China Sea and the Gulf of Thailand.

Researcher: Dr. Lokman Shamsudin.

Title 7 Nutrients Distribution in the South China Sea.

Researcher:
1. Abdul Hamid Yasin.
2. Solahudin Abdul Razak.

Title 8 The Distribution, Abundance and Species Composition of Phytoplankton in the South China Sea and the Gulf of Thailand.

Researcher: Abdul Hamid Yasin.

Title 9 The Distribution, Abundance and Species Composition of Benthos in the Gulf of Thailand and South China Sea.

Researcher:
1. Abdul Hamid Yasin.
2. Solahudin Abd. Razak.

Title 10 Bottom Sediment Sedimentological characteristics of the South China Sea.

Researcher: Dr. Mohd Lokman Husin.

Title 11 Density, Biomass, Species Composition and Distribution of Pelagic Fish Species.

Researcher:
1. Albert Chuan Gambang (IPPMS).
2. Edward Rooney Buising (PPP, Sabah).
3. Hadil bin Rajali (IPPMS).
4. Raja Bidin bin Raja Hassan (MFRDMD).
5. Shamsudin bin Basir (IPP, Penang).

Title 12 Distribution, Abundance, Species Composition and Biological Studies of Economically Important Pelagic Fishes in the East Cost of Peninsular Malaysia.

Researcher:
1. Mansor Mat Isa.
2. H. Yanagawa.
3. Che Omar Mat Hussin.

Appendix 2

PROJECT TITLE (THAILAND)

Title 1 Distribution, Abundance and Species composition of Macrobenthos.

Researcher: Miss Montira Piumtipmanus,
Aquatic Natural Resource Museum,
Department of Fisheries, Bangkok.

Title 2 Distribution, abundance and Species Composition of Phytoplankton:

(i) In the Gulf of Thailand and East Coast of Malaysia Peninsular.
(ii) In the West Coast of Sabah, Sarawak and Brunei.

Researcher: Miss Sopana Boonyapiwat,
Oceanic Fisheries Division,
Department of Fisheries,
Samutprakarn 10270, Thailand.

Title 3 Distribution, Abundance and composition of Zooplankton in the Gulf of Thailand and Malaysia.

Researcher: Jutamas Jivaluk,
Fisheries Environment Division,
Department of Fisheries, Thailand.

Title 4 Species Composition, Diversity and Biology of Economic Fishes.

Researcher: Dr. Chavalit Vidthayanon,
Aquatic Natural Resource Museum,
Department of Fisheries, Bangkok.

Title 5 Kinds Abundance and distribution of the Fish Larvae in Thai – Malaysian Water.

Researcher: Dr. Apichart Termvidchakorn,
Fishery Planning Sub-division Policy and Planning,
Division Department of Fisheries, Bangkok.

Title 6 Distribution of Dinoflagellate Cysts in the Surface Sediments of ASIAN Waters:

(i) The Gulf of Thailand and the East Coast of Peninsular Malaysia.
(ii) The West Coast of Sabah, Sarawak and Brunei Darussalam.

Researcher: Dr. Thaithaworn Lirdwitayaprasit,
Fisheries Division,
Department of Fisheries, Bangkok.

Title 7 Fishery Oceanography of Southeast Asian Continental Shelf Waters.

Sub – 1. Numeric Modeling of Shelf Circulation.
Sub – 2. Pelagic Food-chain Analysis.
Sub – 3. Marine Pollution Studies.
Sun – 4. Remote Sensing and GIS Applications.

Researcher: 1. Dr. Anond Sanidwong.
2. Dr. Manuwadi Hungspreugs.
3. Dr. Supichai Tangjaitrong.
4. Dr. Pramot Sojisuporn.
5. Dr. Ajcharaporn Piumsomboon,

Department of Marine Science,
Faculty of Science,
Chulalongkorn University,
Bangkok.

Title 8 Biomass Estimation in Southeast Asian Waters.

Researcher: Dr. Yuttana Theparoonrat,
SEAFDEC/TD. Samutprakarn,
Thailand.

Appendix 3

SURVEY ITEMS ON THE FIELD OF THE MARINE RESOURCES

1. Fisheries Resource Survey

To estimate the abundance of fisheries resources and their structures in the region based on the acoustic surveys.

Use the scientific echo sounder equipped by M.V. SEAFDEC and fishing survey in order to obtain the following items:

(1) Stock density of the resources.

(2) Resource volume in the region; and

(3) Information on the species composition.

2. Fishery Biology Survey

To classify the species at the survey area and to obtain the various biological information of the major fish species.

Use M.V. SEAFDEC and/or research vessels (fishing vessels) belonging to the Department of Fisheries or to charter commercial vessels to obtain the following items:

(1) Species composition; and

(2) Various biological information on major fish species.

The survey should be carried out at the same time as acoustic survey at selected some stations.

PNMB
DICETAK OLEH
PERCETAKAN NASIONAL MALAYSIA BERHAD
CAWANGAN KUALA TERENGGANU
1996