Work Plan Implementation
(General Paper)

IPTP/87/GEN/12

REPORT OF THE 2ND MEETING OF TUNA RESEARCH GROUPS IN THE SOUTHEAST ASIAN REGION

Manila, Philippines
August 25 - 28, 1987

This document forms part of publications of the Investigation on Indian Ocean and Western Pacific Small Tuna Resources Project (GCP/RAS/099/JPN) which is sponsored and funded by the Government of Japan

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INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME

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REPORT OF THE 2ND MEETING OF TUNA RESEARCH GROUPS IN THE SOUTHEAST ASIAN REGION

1. OPENING OF THE SESSION

1.1 Opening Address (Appendix 1)

Mr. Juanito B. Malig, Director of the Bureau of Fisheries and Aquatic Resources (BFAR), welcomed participants and observers (Appendix 2) to the Second Annual Workshop of Tuna Research Groups of Southeast Asian Countries. He considered it an honour for the Philippines to host a workshop on tunas because of the importance of fisheries in this region: Of all fish groups, tuna ranked second in value.

1.2 Welcoming Address

Mr. Toshifumi Sakurai, Programme Leader of IPTP, welcomed the participants and observers and expressed his appreciation to BFAR for hosting the workshop.

He stressed the importance of tuna, seerfish, and billfish in Southeast Asia by pointing out that landings in 1985 totaled 685,000 metric tons, which exceeded the total of 547,000 metric tons for the entire Indian Ocean. He stated IPTP's role was to assist countries in the Indo-Pacific region in establishing and maintaining collection systems for tuna statistics. Basic and sound information was required for planning, developmen,t and management of fisheries resources.

Since its inception, IPTP has provided assistance to the Philippines and Indonesia, and beginning this year, assistance is being provided to Malaysia and Thailand. A new project, Regional Collaboration in Tuna Fisheries in Southeast Asia, will be approved shortly and provide funds for training courses and study tours in research, statistics, and gear technology.

Mr. Sakurai emphasized the informal nature of the workshop and called on participants for frank and open discussions to ensure a successful workshop.

1.3 Appointment of Chairman

Mr. Dhammasak Poreeyanond (Thailand) nominated Mr. Reuben A. Ganaden (Philippines) as Chairman: The nomination was seconded by Mr. Abdul Hamid Bin Yasin (Malaysia) and unanimously accepted by the participants.

1.4 Adoption of Agenda (Appendix 3)

The Chairman asked for any changed to the tentative agenda. The agenda was accepted after addition of a status report from Japan.

It was also noted that several summary and experience papers may be deleted due to the non-appearance of one participant. Appendix II list of participants.

2. STATUS REPORTS

2.1 Indonesia

The tuna fisheries in Indonesia were active in 1986, with an estimated total tuna landings of 240.8 thousand metric tons. The breakdown by species was:

Skipjack tuna	86.4 thousand metric tons
Yellowfin tuna	37.4 thousand metric tons
Tuna-like	117.0 thousand metric tons
Total	240.8 thousand metric tons

Tuna exports increased by 12%, principally due to the export of skipjack tuna for the canning industry.

In 1986-87 Indonesia issued fishing licenses to 150 Taiwanese longliners and 2 U.S.A. purse seiners.

The use of payaos (fish aggregating devices) apparently is becoming part of the basic fishing strategy in the pole-and-line fishery, especially the fishery based in Sorong, where presently there are 23 payaos. In the Sorong region, this adaptation reportedly is responsible for an increase in catch of 1,000-1,500 kg per day. Furthermore, fuel costs have been reduced by 40%.

The success of payaos in eastern Indonesia has encouraged the Government to place 8 payaos in western Sumatra to aid the artisanal tuna fishery in the region.

In 1986, a total of 1,300 skipjack tuna were tagged in the Bitung area. To date there have been 66 recoveries; 97% of the returns were from fish caught around the payaos. The longest time between tagging and recovery was 334 days.

Future plans for tuna research include a 6-month study of tuna baitfish, expected to start in October 1987, and a plan to develop cultured baitfish for the pole-and-line fishery. Tuna data are continuing to be collected from 13 sites in Indonesia.

2.2 Malaysia

There was little change in tuna fisheries from the previous year. Landing for 1985 was 19,631 mt, with production by regions as follows:

West coast peninsular Malaysia	4,551 mt
East coast peninsular Malaysia	14,600 mt
Sarawak	880 mt
Sabah	2,600 mt

Species composition for the east coast of peninsular Malaysia was estimated as 60% longtail, 30% kawakawa and 10% frigate.

The government is encouraging extension of fishing activities into offshore waters to more fully exploit the tuna resources off the east coast of Peninsular Malaysia and in waters of Sarawak and Sabah. Longtail, kawakawa and frigate are the principal tuna species caught off Peninsular Malaysia and Sarawak, whereas yellowfin and skipjack are the dominant species off Sabah. A tuna survey is currently (May-Sept. 1987) being conducted by the Government of Malaysia off the east coast of Peninsular Malaysia and future plans include surveying the area by purse seines. The Government is also encouraging the use of payaos for tunas; about 20 payaos were deployed in 1984 by the joint Malaysia-Philippine venture. Small-scale fishermen in Sabah operate handline for large yellowfin under payaos in the Sulu Sea. Troll line vessels of Trengganu used to fish off the oil rigs in the South Chine Sea, but fishing in the immediate vicinity of the rigs is prohibited.

2.3 Thailand

Tuna landings from the Gulf of Thailand during 1985 totalled 81,234 t, a 17% increase over the previous year. Of the total landings, longtail tuna accounted for 63%; kawakawa 23%; and frigate, 13%. The latter 2 species are grouped as "TUN" in the National Statistics, and the above breakdown was determined from the monthly biological sampling surveys conducted by the Marine Fisheries Division. Longtail landings were more seasonal than those of TUN, with high landings from January to May. TUN landings were slightly higher from July to October.

The most important fishing gear for tuna in the Gulf of Thailand is the purse-seine. The gear accounts for 75% of the total catch; drift gillnet (23%) and mackerel encircling net (2%) are other major types of fishing gear. Purse-seines operate primarily in the middle and southwestern part of the Gulf where water depth is generally deeper than in coastal waters. Gill-netters fish in shallower (20-40 m) depths around islands and capture a higher percentage of TUN.

2.4 Philippines

In 1986 the Philippine tuna landings totalled 266,211 mt - a 2% increase over the previous year. The municipal and commercial sectors contributed almost equal proportion to the total landings. Thirteen percent of the total was exported and was valued at 1.3 billion pesos. There were decreases of 3,000 mt in the export of chilled or frozen tuna and 1,000 mt of tuna for canning.

Landings of the various tuna categories and changes from the previous year were as follows:

Frigate	87,225 mt	9% decrease
Yellowfin	59,510 mt	6% decrease
Skipjack	77,031 mt	28% increase
Kawakawa	42,445 mt	3% increase

The increase in skipjack tuna landings reported in recent years has been due, in part, to the inclusion of capturtes outside Philippine waters. Several Philippine tuna companies are known to operate vessels in foreign waters; the exact number, however, is unknown. Approximately 30 Taiwanese longliners have been licensed to fish in Philippine waters; fishing occurs in the Celebes Sea.

The biological sampling program was continued at fish landings in Mindanao Island - Sta. Cruz, General Santos, Zamboanga and Opol. The principal gears monitored included ring-nets, purse-seines and handlines. Size composition of fish caught by the ring-net fishery has changed since early 1980; present catches show a higher percentage of fish above 30 cm in length.

2.5 Japan

There has been little change in the Japanese tuna landings during the past few years, remaining at about 750,000 mt. National production for sashimi fish cannot meet current demand so imports have increased: approximately 150,000 mt in 1986. Consequently, total supply greatly exceeds demand, resulting in depressed prices; thus, the tuna fishing industry is presently suffering some financial difficulties. About an 80% reduction occurred in both the longline and pole-and-line fleet during the past 10 years. The tuna purse-seine fleet has remained stable, at 39 vessels since 1982.

Catch and effort information is obtained from logbooks. Cooperation of industry has been good, with the logbook recovery rate of more than 90%. Recently, longline logbook returns have been mailed from port of calls for fuel and victuals. As a result of increased duration of fishing trips and greater mobility of vessels, recent emphasis has been given to having fishing crews measure fish on board for size composition data. Approximately several 100,000 measurements are obtained annually.

The Tohoku Fisheries Research Laboratory presently has a skipjack tuna tagging program in the Western Pacific Ocean, while Japan Marine Resources Research Center (JAMARC) vessels have tagged tuna in the Pacific and the Indian Ocean. Tag recoveries have been reported from the Indian Ocean, but particulars were not available.

2.6 Recent Development of Tuna Fisheries in the U. S. A.

Mr. Shomoura presented a brief review of the status of USA tuna fisheries in the Pacific and recent research activities, especially that of the Southwest Fisheries Center.

For the past several decades, the largest component of the tuna fisheries of the eastern Pacific Ocean has been the USA purse seine fleet. The growth of the tuna fishing fleet of Mexico has been phenomenal over the past several years and, today, the Mexican fleet is reported to be the largest in the eastern Pacific; its total capacity exceeds 100,000 tons. Currently there is a major initative to create a new international tuna body for the eastern Pacific Ocean.

In the mid-1980's several major tuna processors closed their tuna canning plants in California; only one small cannery presently operates in the region. The reasons given for the closures are primarily related to the inability of the domestic canning industry to compete economically with imports of canned tuna, especially from Thailand. The cannery in Hawaii was also closed in 1985, although the the USA canneries located in American Samoa and Puerto Rico continue to operate actively. For the canneries in American Samoa, the raw materials come from foreign longliners based in American Samoa and from the fleet of USA purse seiners operating in the central and western Pacific Ocean for the past several years. The purse seiners offloading their catches directly at Pago Pago, American Samoa, or have catches transshipped from Guam and Tinian Island in the Marianas Archipelago.

The USA government recently completed negotiations with Pacific island nations on a treaty which would provide access to USA purse seiners to fish for tunas within the Exclusive Economic Zone (EEZ) of these island nations. The treaty is expected to become effective this year.

The USA troll fishery for albacore tuna in the North Pacific Ocean continued to be active; some vessels fished in the north Pacific waters north and northwest of Hawaii. It was reported that, although the major part of the North Pacific catch of albacore was canned in California, a small part of the catch was exported to Japan. Additionally, there has been a major initiative to market albacore fillets in the USA.

In response to seeking a better economic climate, several USA trollers have begun operating in the high latitudes of central South Pacific. Catches were reported as outstanding in early 1986 for two albacore trollers operating in the waters south of French Polynesia. As a result, seven trollers operated in these waters in 1987, their reported catches equaled about 1,000 metric tons. Another increase in fishing activity is expected in this region in 1988: More than 40 USA trollers plan to fish in southern latitudes.

In a brief review of current research being conducted by the Southwest Fisheries Center, Mr. Shomura noted that the Honolulu Laboratory is continuing its acoustic tracking of tunas. Recent efforts focus on large tracking yellowfin tuna. In the field of culture, the Honolulu Laboratory directed some effort several years ago toward rearing skipjack tuna larvae from eggs fertilized in the laboratory. One single skipjack tuna larvae was kept alive for about 49 days. An additional research initiative in culture work involved the rearing of a stolephorus sp. from a fertilized egg to a stage just before the fish assumed adult colour characteristics.

The Southwest Fisheries Center continues working with the USA albacore industry in tagging albacore in the North and South Pacific. Presently, these data are being analyzed to give insight into the dynamics of the albacore resource in the North and South Pacific.

Other research activities noted included work on tuna age and growth validation, by using the daily growth increment technique, and development of plans to conduct some field work on yellowfin tuna in the Hawaiian Archipelago. Finally, scientists from Hawaii and Canada appear to be close to gaining a full understanding of the condition noted as "burnt" tuna. This condition, which has been reported in several areas (e.g. Hawaii and Japan) results in poor quality of large tuna for the sashimi market; low prices are given for the off-colour and peculiar taste of the flesh associated with this condition.

3. SUMMARY OF TUNA, SEERFISH AND BILLFISH LANDINGS

Mr. T. Sakurai introduced the subject by noting that the prime objective of IPTP was to establish a data centre for tuna and tuna-like species in the Indian Ocean and Southeast Asia. To date, summaries of tuna statistics for the region have been published by IPTP, commencing with statistics for 1970. The data are provided by liaison officers appointed by each country in the region.

Landings of tuna and tuna-like species for 1985 in the Indian Ocean and Southeast Asia have been estimated at 500,000 and 600,000 metric tons, respectively. Data reported by IPTP are listed by:

1. catch by species and gear
2. fishing craft by gear
3. catch and effort data by time-area strata
4. size frequency data by time-area strata

Countries in the region have been asked to provide IPTP with data for items 1 and 2 by the end of July and data for items 3 and 4 by the end of November. To date, only Indnesia has sent these data on schedule; other countries were urged to meet the deadlines.

In reviewing the data currently being provided by member countries to IPTP, several shortcomings were noted. These generally involved the lack of detailed data by species; tables provided often included combinations of species. It was stressed that maximum value of these data can be achieved if details are provided. Generally countries needed to provide information on the landings of billfishes.

4. MAPPING RESOURCES IN THE REGION

A brief description of the information to be presented in the tuna resource maps was given. Information to be included is as follows:

- total landings
- numbers of fishing vessels by gear type
- size class of vessels
- distribution of fishing grounds by gear type and fishing seasons
- landings by species and fishing gear
- length frequency distributions by species and gear type

Information in the country maps will be used for summary maps of the Indo-Pacific region. These summary maps will include fishing vessels, species landings and size composition, densities and potential yield of neritic tunas. The proposed atlas of tuna fisheries in the Indo-Pacific region may be published in colour if the information is adequate and a suitable printer can be found.

5. TAGGING PROPOSAL

Mr. Shomura thanked IPTP for the opportunity to participate in the present workshop. He thought meetings of this type were extremely useful in gathering together region's people, who are working on tunas, for exchange of views and experience. He suggested that it be expanded to include invited participants from other tuna fishing countries, such as Korea.

In his tagging proposal, he has briefly reviewed the various tuna tagging programs conducted over the past several decades. Tag recoveries from the various programs varied from 0.2 to 40.0 percent. However, tag recovery rates alone was not a good criterion for evaluating tagging experiments because size of the resources, tag mortality, and the intensity of fishing in the immediate vicinity must be considered. The most important factor in successful tagging tuna is to reduce tagging time to a minimum, preferably to less than 10 seconds.

The objectives of tagging programes are as follows:

1. to obtain growth estimates - not reliable especially for short times at liberty,
2. migrations
3. stock size
4. interactions

The movement of tunas as determined by tag recoveries in the Pacific Ocean was reviewed. Of all the tuna species, skipjack tuna appear to be the most sensitive to stress and, therefore, difficult to tag.

Philippines

Mr. Shomura proposed a tagging protocol using indigenous fishing crafts and gear to reduce costs and to ensure tagging experiments can be continued in the future. He proposed using a ringnet vessel and attempting the following options:

1. direct part of catch to holding pen for later tagging
2. pole and lining without and with live-bait for fish in the pursed net.

Mr. Yonemori suggested a further option of using troll vessels to capture fish around payaos. Trolling was used, with good results, to tag juvenile bluefin tuna in Japan.

The scientists from the Philippines were agreeable to the proposal for a long term program to evolve a tagging protocol to suit local conditions, thereby enabling them to continue tagging experiments on their own, in the future. The Programme Leader stated that IPTP will provide technical assistance and equipment to conduct a tagging program, but the country must provide vessels and personnel to conduct the tagging.

Thailand

Thailand's priority was a tagging program for skipjack tuna in the Andaman Sea, and the second priority is a tagging program for longtail tuna in the Gulf of Thailand. Thailand should consider a joint programme with Malaysia to assess the longtail tuna movements between the two countries and the status of the stocks.

Malaysia

Malaysia was interested in initiating a tagging program for longtail tuna off the east coast of Peninsular Malaysia. For tagging, commercial troll vessels could be used. These vessels average approximately 400 fish per 5-day trip so, assuming 75% tagging success, 300 fish can be released. Three troll vessels can tag 7,000 fish in a 2-month interval.

6. SOUTHEAST ASIAN TUNA CONFERENCE

A part of the Second Meeting of the Tuna Research Group in the Southeast Asian region was devoted to the presentation and discussion of current tuna research in the region. Current plans are to continue this practice at future meetings; thus, it seemed appropriate to formalize this workshop or conference. The Second Meeting of the Tuna Research Groups endorsed the idea of calling the formal presentation of research results as the "Southeast Asian Tuna Conference". Although focussing on tuna research in southeast Asian region, the meeting will be open to presentation of tuna research from other areas, especially from the western Pacific and the eastern Indian Oceans.

The papers or abstracts of papers presented at the First meeting of the Southeast Asian Tuna Conference are included in Appendix 5.

7. RECOMMENDATIONS

Based on discussions during the meeting, the following recommendations were made:

(1) The present tuna sampling programme in each country be continued as a fundamental basis to obtain precise information for stock analysis. The tuna research group in each country should closely monitor the program to ensure quality data, and IPTP assist the tuna research groups in maintaining the programs.

(2) A standard computer system for processing of data collected by the sampling program be introduced by IPTP to facilitate comparative studies in the region.

(3) The Philippines, with the assistance of IPTP, should pursue development of a tuna tagging protocol which can be integrated in the commercial ring-net fishing operation.

(4) Thailand and Malaysia, with the assistance of IPTP, should initiate a cooperative longtail tuna tagging program in the Gulf of Thailand. Initial efforts should be to tag longtail tuna using the existing Malaysian commercial troll vessels and possibly chartering small vessels from Thailand.

(5) Training course or study tours be held or provided by IPTP for data collection, data analysis, computer operation, tagging technique, fishing technique and tuna biology.

(6) The IPTP Tuna Biologist should collect available information on kawakawa with assistance from participating countries to update the species synopsis.

(7) Establish a Southeast Asian Tuna Conference as a routine component of the annual meeting of the Tuna Research Group in the Southeast Asian Region. The Conference is to provide region's scientists with the opportunity to present and discuss current tuna research findings.

Appendix 1

OPENING ADDRESS
by
Juanito B. Malig
Director
Bureau of Fisheries & Aquatic Resources

ORGANIZERS of this Tuna Meeting, PARTICIPANTS,
LADIES AND GENTLEMEN

It is with great pleasure that I welcome you today on the occasion of the Opening of the Second Meeting of Tuna Research Groups in the Southeast Asian Region.

The tuna resources, including the tuna-like species, comprise a very important fishery in the Philippines. Tuna has been a top dollar exchange earner for the country, ranging second among the Philippine fishery export commodities. With the establishment of the 200-mile Exclusive Economic Zone, the tuna resources have become even more important to Philippine fisheries.

Realizing the importance of this meeting of tuna research groups within this region and the benefits that can be reaped out of the meeting's objective, I did not hesitate to accept Mr. Sakurai's request to host this meeting. I know that there are still many questions on tuna biology and stock assessment yet unanswered. These questions and the conflicts that shall arise as a result of the EEZ regime can best be resolved through a cooperative tuna research programme among the ASEAN-member nations.

It is a very great honour for the Philippines to serve as host of this Meeting. I certainly hope that, with the experience of the participants, this Meeting will be a successful regional endeavour.

Once again, I welcome you all, and I hope you will enjoy your short stay here in Manila.

Appendix 2

LIST OF PARTICIPANTS

INDONESIA

Mr. Bachtiar Gafa Fishery Biologist	Research Institute for Marine Fisheries JL. Krapu No.12 Sunda Kelapa Jakarta 14430 Indonesia
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Appendix 3

AGENDA

Tuesday, August 25 1987

0900	-	Opening Ceremonies	
	-	Opening Address	- BFAR, Director
	-	Welcome Address	- IPTP/FAO
	-	Appointment of Chairman	
	-	Adoption of Agenda	
1015	-	Coffee Break/Free Time	
1215	-	Lunch Break	
1345	-	Status Report	- Indonesia
1530	-	Coffee Break	
1545	-	Status Report	- Malaysia

Wednesday, August 26 1987

0830	-	Status Report	- Thailand
1015	-	Coffee Break	
1030	-	Status Report	- Japan
1130	-	Status Report	- Philippines
1215	-	Lunch Break	
1345	-	Summary and experience papers	
*		Summary of tuna, sailfish, billfish landings	- Sakurai
*		Exploratory Fishing in Thailand	- Poreeyanond
*		Length frequency and tag returns	- Ganaden
1530	-	Coffee Break	
1545	-	Summary and experience papers	
*		Interactions in skipjack tuna fisheries	- Yesaki
*		Biology of skipjack	- Dalzell

Thursday, August 27 1987

0830	-	Summary and experience papers	
*		Fad's in the Philippines	- Aprieto
*		Studies of otoliths of yellowfin	- Yamanaka
1015	-	Coffee Break	
1030	-	Summary and experience papers	
*		Growth of skipjack from tag returns	- Uktolseja
*		Hook selectivity	- Dalzell
*		Stomach contents of yellowfin tuna	- Barut
1215	-	Lunch Break	
1345	-	Small Tunas	
*		Auxis fisheries in Batangas	- Arce
*		Tuna larvae in Sulu Sea	- Baguilat
*		Small tuna fisheries in the Philippines	- Yesaki
1530	-	Coffee Break	
1545	-	Mapping	
	-	Discussion for future activities	

Friday, August 28 1987

0830	-	Tagging	
*	Tagging proposal	-	Shomura
1015	-	Coffee Break	
1030	-	Review of tuna fisheries and research in US	- Shomura
1215	-	Lunch Break	
1530	-	Coffee Break	
1545	-	Adoption of final report	
	-	Closing Ceremonies	

Appendix 4

Status Reports:

4.1 Malaysia

(1) Status Report from Malaysia.

(2) Tuna Fisheries in Sarawak and Sabah

4.2 Thailand

(1) Tuna Fisheries/Resources in the Gulf of Thailand.

4.3 Philippines

(1) Status of the Philippines Fisheries for Tuna.

(2) Tuna Stock Assessment Research Project.

I.P.T.P. SECOND MEETING OF TUNA RESEARCH GROUPS

IN

THE SOUTHEAST ASIAN REGION

25 - 28 AUGUST 1987

MANILA, PHILIPPINES

STATUS REPORT FROM MALAYSIA

BY

ABDUL HAMID YASIN

&

CHEE PHAIK EAN

STATUS REPORT - MALAYSIA

1. Review of fisheries during the past year

With the increasing fishing intensity in coastal waters off Malaysia, offshore fishing in the Malaysian EEZ is strongly encouraged. Over the last few years, there has been an increasing number of fishermen and private entrepreneurs applying for licences to fish in the offshore waters of the Malaysian EEZ. Prior to this, fishing in offshore waters around 80 nautical miles offshore was only by fishermen using traps for bottom living species like snappers and groupers. Some troll liners do operate in these areas for tunas and spanish mackerels but it is seen that fishing activity using this gear has increased.

The success of fishing for tunas with the aid of 'payaos' in Philippine waters has prompted the use of these fish aggregating devices in Malaysian waters. Some units of payaos were used in waters off Sabah under a joint venture project for a limited period. This showed very promising catches.

'Payaos' using stainless steel floats are being experimented in the offshore waters off the East Coast of Peninsular Malaysia and Sabah.

2. Progress and/or difficulties in collection of statistics during the past year

2.1. Progress

1. The number of boats sampled were more than the past year. Landings from gill nets were also sampled at the landing

site and the catch composition of tunas by gill nets is available. However the majority of the boats landing tunas use troll lines.

2. The number of fish measured per species increased and number of fish by gear type is also recorded. The length frequency data is expected to cover all the 12 months of a year.

3. The estimation on the tuna landings for a sampling site is done by direct observation at P. Kambing.

4. Sampling of tunas landed by purse seiners has been initiated.

5. With the availability of a computer, data analysis can be done quickly and the processed data can be reported easily. While waiting for the software the data however have to be analysed manually.

2.2. Difficulties

1. The unloading of tunas by the trolling boats is fast. Sometimes many boats come back at the same time, thus observation of landings by some boats cannot be made. Therefore the landings of some boats are obtained from boat owners.

2. To measure a large number of tunas at one time to meet the target is difficult. Some species landed are few in number. Weighing fish on boats to obtain the length weight relationship of tunas of any species has to be done quickly. The handling time is fast, therefore only few fish can be measured and weighed.

3. It is difficult to trace the boats that unload the fish on the jetty. Fish landed are put in piles on the jetty, most probably there are more than one boat per pile, so it is also difficult to tell from where the fish were caught.

4. Tunas caught by fish purse seiners are usually smaller in size and less in number. The sample to be measured is limited. Tunas form the by-catch of fish purse seiners. There are no tuna purse seine boats that land their catch in Pulau Kambing jetty. The number of tuna purse seine boats are small and the boats are small, usually less than 70 GRT. These land at private landing sites along the coast.

5. The data for tunas in the Annual Fisheries Statistics of Malaysia is not broken down into species. All species are recorded under "tunas". Thus to provide information on tuna landings by species is not possible. Species composition was only obtained by the Fisheries Research Institute at Pulau Kambing very recently. A generalised

species composition for the whole east coast of Peninsular Malaysia and West Coast was made from the limited sampling information obtained by the Fisheries Research Institute.

6. Very little data on fishing effort on tunas is available.

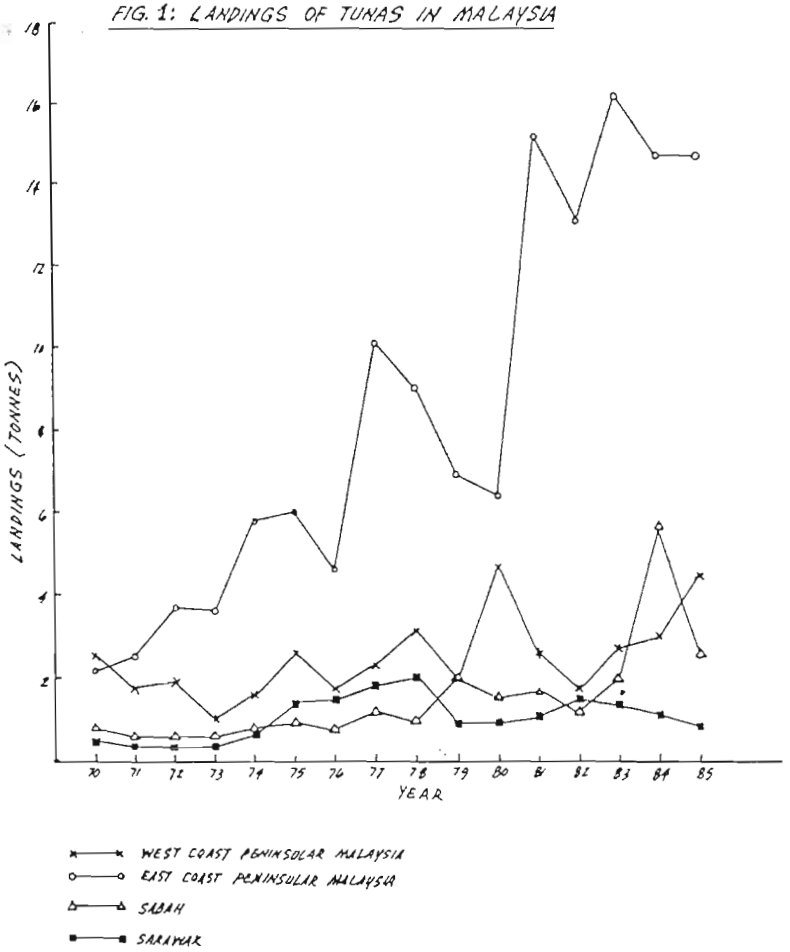
3. Catch and effort trends

3.1. Catch trends

Fig. 1 shows the annual landings of tunas in Malaysia from 1970 to 1985. It is clear that the bulk of the tuna landings come from the East Coast of Peninsular Malaysia. In 1985, 14,600 tonnes of tunas (or 65% of the total tuna landings) were recorded for the East Coast of Peninsular Malaysia, while 4,551 tonnes (or 20% of the total tuna landings) were recorded for the West Coast. In Sabah, 2,600 tonnes (11%) of tunas were landed while Sarawak recorded only 880 tonnes (4%).

Generally, an increase in tuna landings has been observed from 1970 on the East Coast of Peninsular Malaysia. This could be due to a few reasons. Firstly there could be possible increase in the number of trolling vessels used for catching tunas. Trolling lines form the dominant gear group that catch tunas on the East Coast. Fig. 2 shows that from 1980 to 1982, the percentage landings of tunas by 'hooks and lines' (the gear classification in the Annual Fisheries Statistics of Malaysia that includes troll lines) increased. The reported landings of tunas by 'hooks and lines' increased from 44% in 1980 to 65% in 1982.

FIG. 1: LANDINGS OF TUNAS IN MALAYSIA

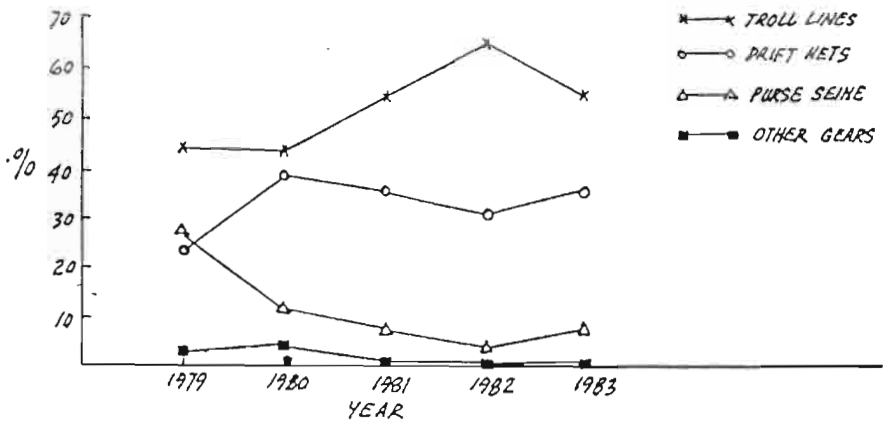


Another reason that could possibly explain the increase in tuna landings is the exploitation of new fishing areas further offshore. In the last couple of years, as a measure to lessen the fishing intensity in coastal areas, the government has encouraged offshore fishing. Fishermen now venture further offshore to fish and tunas are known to be found far out at sea. This could have contributed to the increase in landings of tunas on the East Coast.

On the West Coast of Peninsular Malaysia, relatively high tuna landings were recorded in 1980 and 1985 only when 4,700 tonnes and 4,551 tonnes were landed respectively. For the other years the landings fluctuated between 1,000 tonnes and 3,000 tonnes (Fig. 1). The main fishing gear that catches tunas on the West Coast is the purse seine. Some of these are used in conjunction with coconut leaf lures while some actively chase fish schools that are seen through the phosphorescence in the sea surface as the schools break surface.

In Sabah, the years before 1983 only recorded less than 2,000 tonnes of tunas. In 1984 and 1985, 5,700 tonnes and 2,600 tones were landed respectively. The increase in tuna landings could be attributed to the use of a more efficient fishing method i.e. the use of fish aggregating devices (FADs) in conjunction with purse seining to fish for tunas. It is strongly believed that the deep waters off Sabah has the potential for the development of a deep sea tuna fishery.

FIG.2: PERCENTAGE LANDING OF TUNAS ON THE EAST COAST OF PENINSULAR MALAYSIA BY VARIOUS GEARS



Tuna landings in Sarawak have always been below 2,000 tonnes since 1970 (Fig. 1).

3.2. Effort

While it is easier to estimate landings of fish, the estimation of fishing effort remains a difficult task.

Although it is known that the troll lines predominate as a fishing gear for tunas, the actual number of this particular gear type is difficult to estimate. The gear classification that covers all hand lines, long lines and troll lines as used in the licensing system as well as in the Annual Fisheries Statistics of Malaysia, is 'hooks and lines'. Since not all 'hooks and lines' catch tunas and tuna-like fishes the proportion of the effort exerted on tunas cannot be allocated. Also the number of hooks used on each troll line varies. Sometimes only 4 hooks are used on each line while at other times as many as 25 hooks are used. It is hoped that the study on tunas on the East Coast of Peninsular Malaysia will attempt to estimate the number of troll lines fishing for tunas at selected important landing sites on the East Coast.

Gill nets, the next most important fishing gear on the East Coast, is also varied in length as well as mesh size. Although gill nets used for tunas and tuna-like fishes have 3 inch meshes, the length of the net varies greatly. Also in the Annual Fisheries Statistics, all drift/gill nets are licensed under one category of fishing gear with no break-down by mesh sizes or lengths of nets.

For the purse seines used in conjunction with coconut leaf lures, fishing is not selective as nearly all the fish aggregated around the lures will be caught. In this case the number of lures set and fished should be taken into account to estimate fishing effort. Purse seining without lures is more selective in the sense that the captain of the vessel can tell the type of fish and its approximate size. It is easier to estimate the number of purse seines actually operating or licensed as compared to the estimation for troll lines and gill nets.

Although the number of gears licensed as well as the estimated number of gears in operation are available, these units do not actually reflect the fishing effort exerted on tunas.

4. Distribution

4.1. Geographic distribution of resources

Fig. 3 shows the distribution of tuna species off the East Coast of Peninsular Malaysia. There are three major species found off the East Coast of Peninsular Malaysia, namely, Thunnus tonggol, Euthynnus affinis and Auxis thazard. These three species are found together but skipjack tuna is also found in areas further out. Further south these three major species are also found together. Besides these species another species occasionally caught by the trolling lines is the Oriental bonito, Sarda orientalis.

Fig. 4 shows the distribution of tuna species off Sarawak and Sabah. There are a number of species found in the Sarawak and Sabah waters. Thunnus tonggol, Euthynnus affinis and Auxis thazard that are more coastal are dominant. The more oceanic Skipjack and Yellow fin tuna are also found in the waters off Sarawak. In Sabah the Yellow fin and Big Eye are found near the coast because the deep water runs closely to the coast in north and west Sabah and in the Sulu Sea.

4.2. Seasonal distribution of tunas

From Fig. 5 it can be seen that tunas are landed throughout the year both on the East and West Coasts of Peninsular Malaysia. There does not appear to be any fixed seasonality observed except that the landings decrease from October to December yearly on the East Coast. This is possibly due to the bad weather conditions that prevail during the north-east monsoon that limits fishing.

5. Current research

The existence of sizeable quantities of tuna off the East Coast of Peninsular Malaysia, is indicated by the high landings and increasing fishing activities in the Gulf of Thailand as well as by the rapid expansion of the Thai tuna fisheries in general. Before any further development to be undertaken to expand the tuna fisheries in Malaysia, a resource survey is being carried out to determine the distribution and abundance of tunas inside the Malaysian EEZ, off the East Coast of Peninsular Malaysia, Sabah and Sarawak.

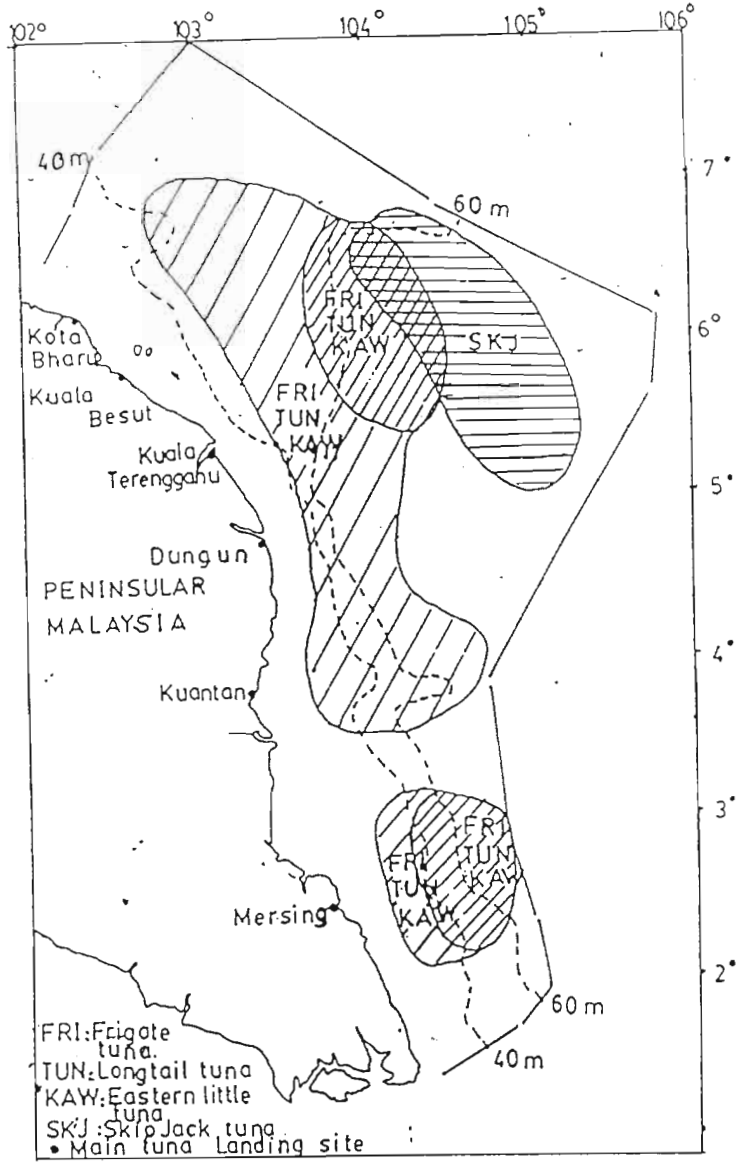


FIG. 3 Distribution Map of Tuna Spp. and Main Landing sites of the East Coast of Peninsular Malaysia.

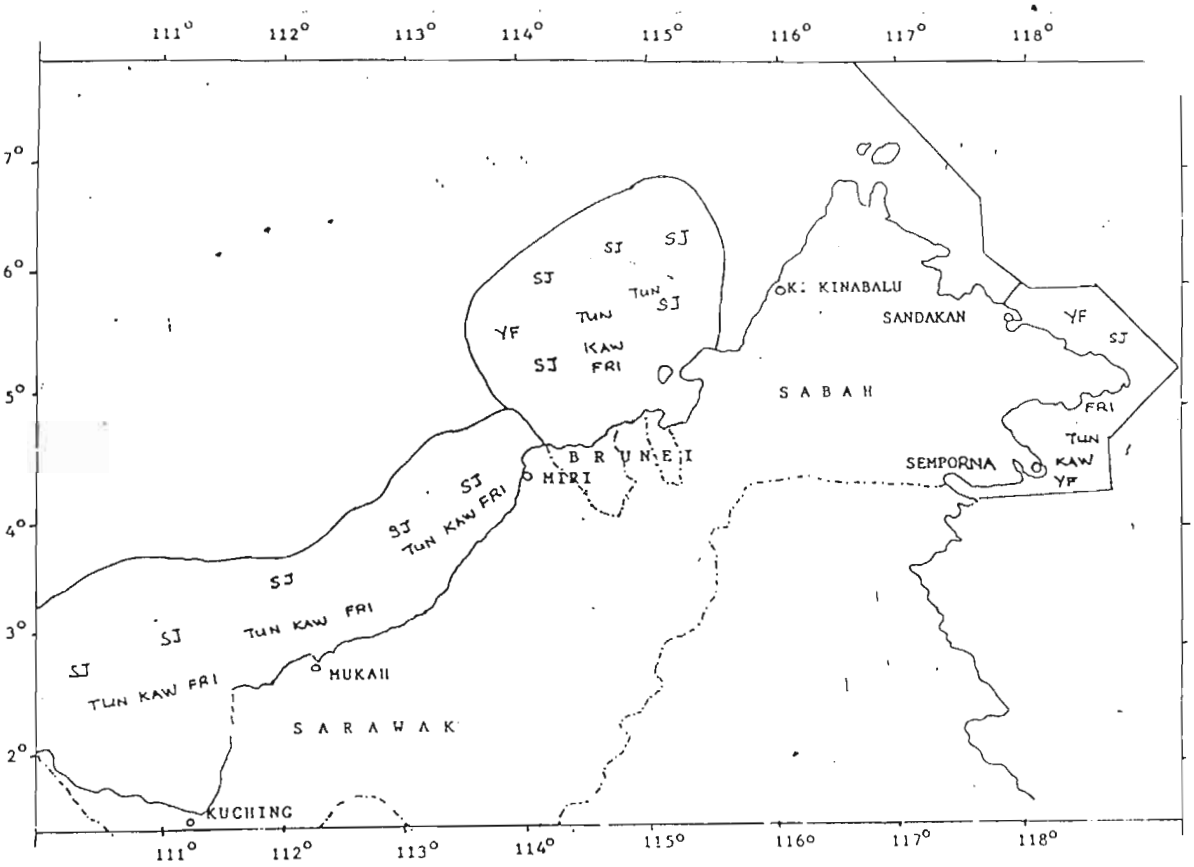


Fig. 4 :- DISTRIBUTION MAP OF MAJOR TUNA SPP. AND MAIN LANDING SITES OF SARAWAK AND SABAH

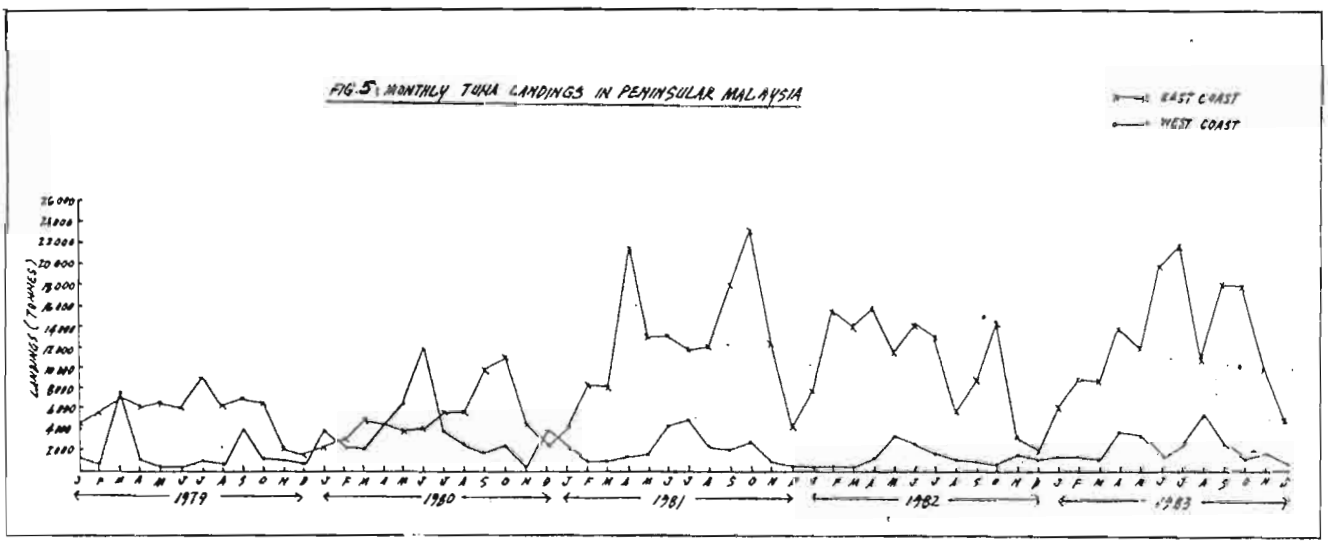
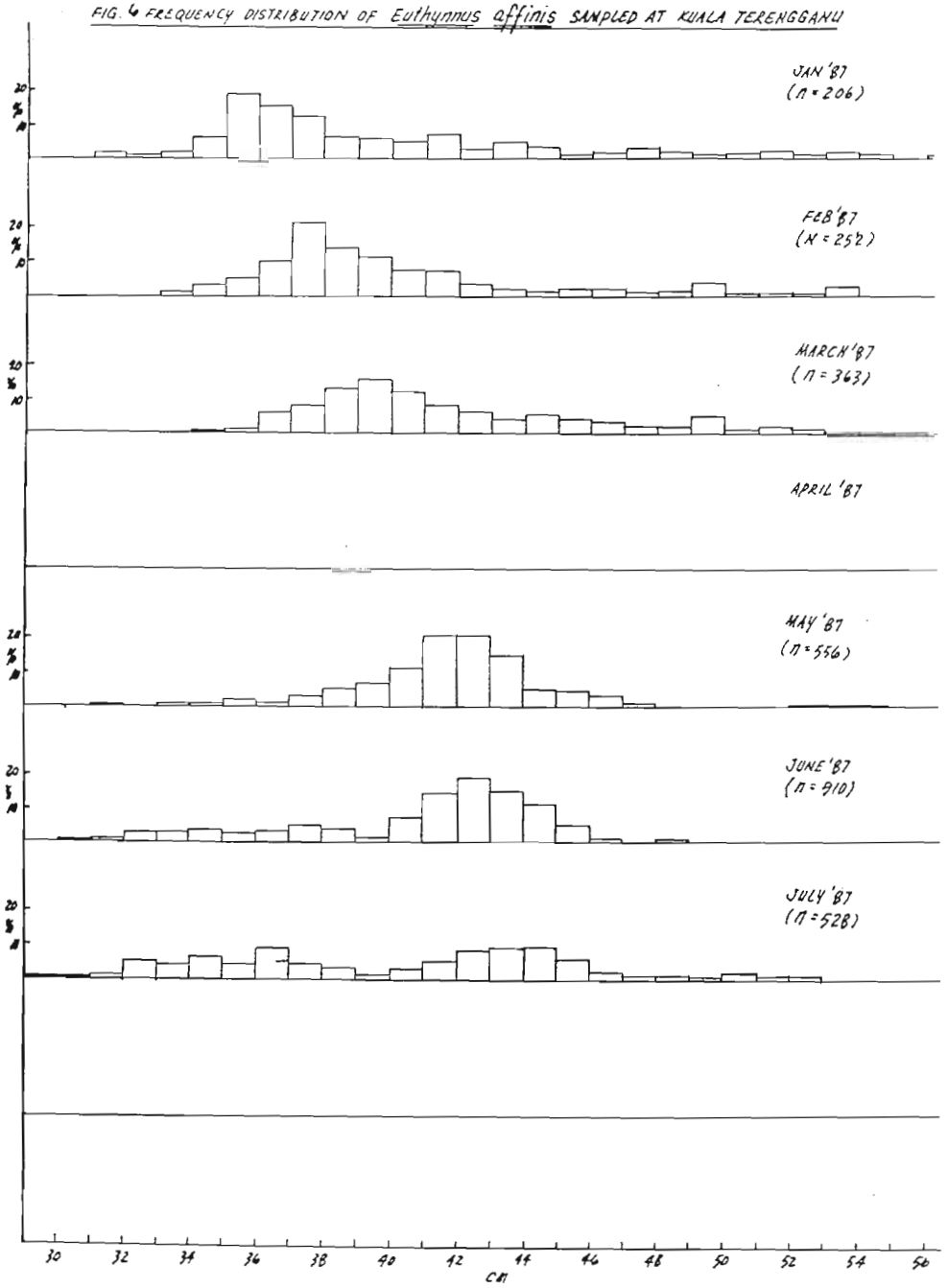


FIG. 6 FREQUENCY DISTRIBUTION OF Euthynnus affinis SAMPLED AT KUALA TERENGGANU



Currently, the Fisheries Research Institute is conducting the survey deploying fisheries research vessel K.K. "MERSUJI" fitted with sonar and other navigational equipment. The primary objective of the survey off the East Coast of Peninsular Malaysia is to determine the distribution of tunas species. It will also provide information on the distribution and density for tunas off the East Coast of Peninsular Malaysia. This survey also aims to provide information on the biomass and areas of concentration of tunas.

Besides the resource survey, other studies carried out on a routine scale are the biological studies that include gonad studies and length distribution studies. The estimation of catch and effort by the observation of boats operating at certain selected landing sites are also conducted by the I.P.T.P. samplers. The use of 'payaos' as fish aggregating devices for tunas and small pelagics has been launched to determine the effectiveness of 'payaos' as luring devices.

6. Biological studies

Since January 1987 with the funding from I.P.T.P., two samplers were employed to observe landings of tunas as well as to take length and weight measurements of tunas landed.

The monthly length frequency distribution of Euthynnus affinis, Auxis thazard and Thunnus tonggol since January 1987 are shown in Fig. 6 to 8. It can be quite clearly seen that there is one mode monthly for each species studies. However the difficulty of sampling from the purse seiners has been earlier mentioned.

FIG. 7 FREQUENCY DISTRIBUTION OF *Auxis thazard* SAMPLED AT KUALA TERENGGANU

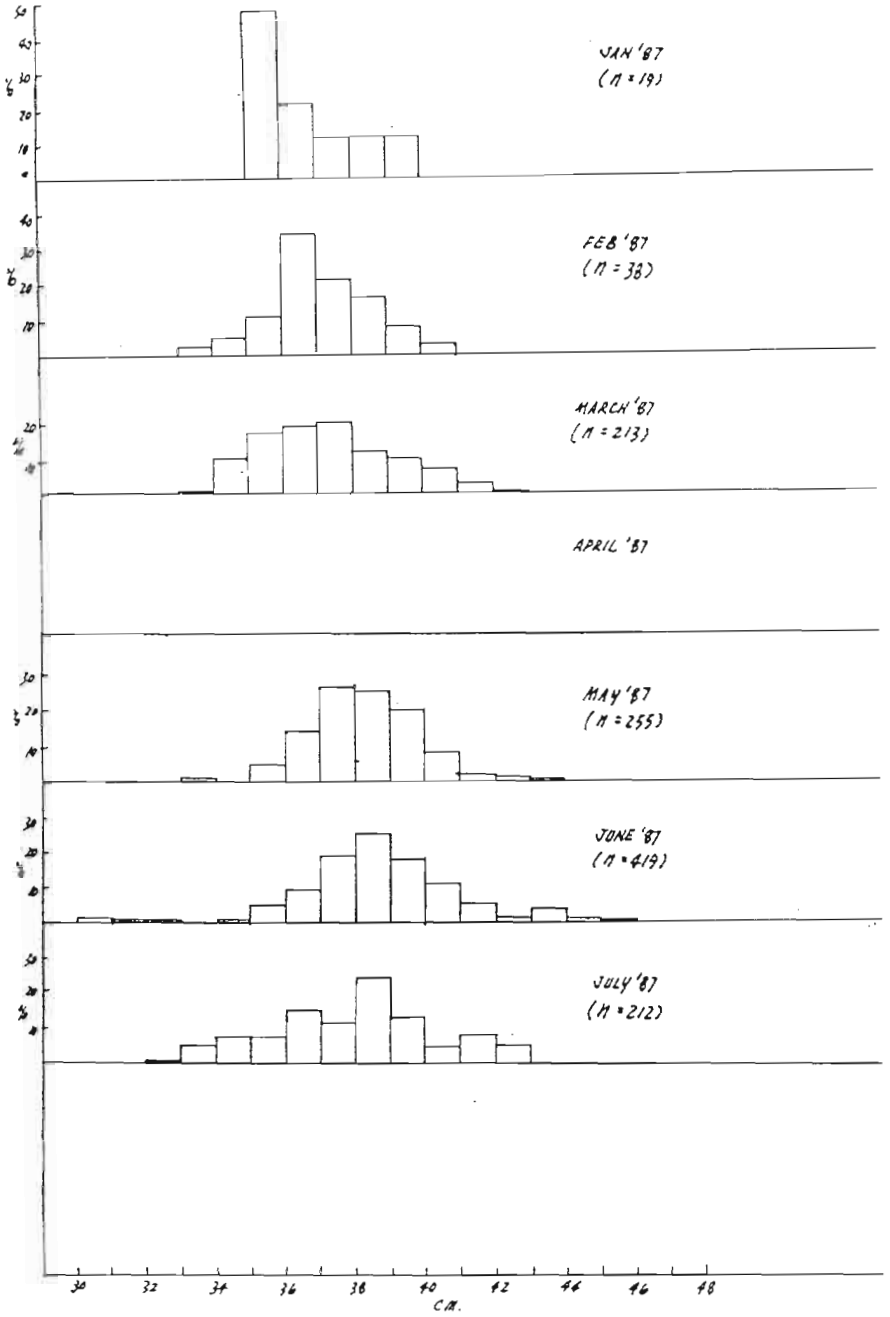
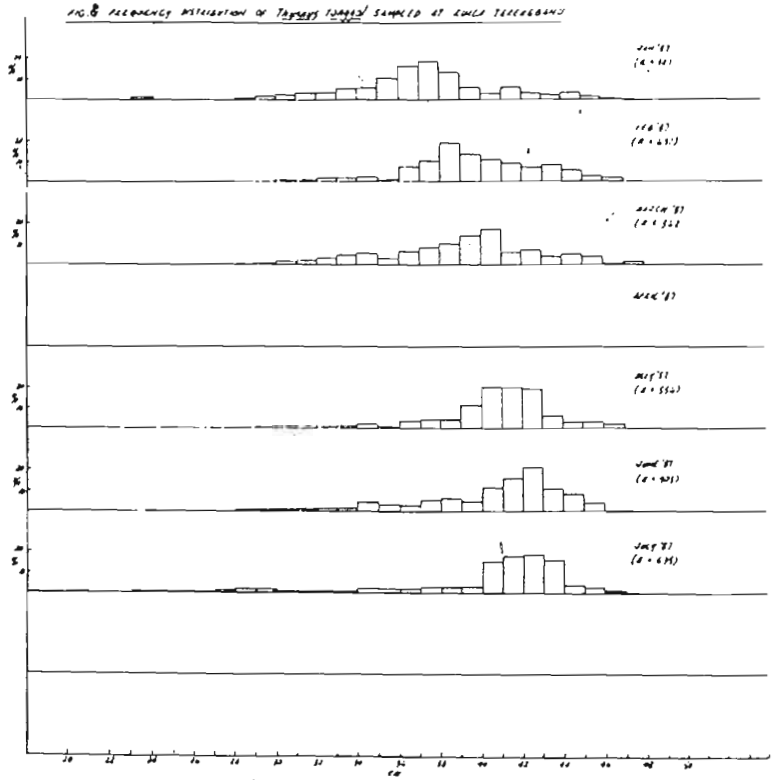


FIG. 8 FREQUENCY DISTRIBUTION OF *Rastrelliger kanagurta* SAMPLED AT KUALA TERENGGANU



These purse seiners generally land smaller-sized tunas. Also the area of operation of troll liners and purse seiners are not known but is expected to be quite distantly spaced. It is hoped that length frequency measurements can be continued for at least a year in order to make a meaningful analysis.

Length weight measurements have also been recorded monthly. At the moment it is seen that the size ranges of tunas species caught are quite limited because of the difficulties of getting fish of smaller sizes that are caught by purse seiners. More fish specimens are hoped to be collected.

Observation of gonads of tunas is being done as well. However the number of specimens obtained is very small. This is due to the high price of tunas that have to be purchased. This is still being continued.

I.P.T.P. 2nd Meeting of Tuna research groups in Southeast Asia
Manila, Philippines
25-28 August 1987.

TUNA FISHERIES IN SARAWAK AND SABAH MALAYSIA

by

Abdul Hamid Yasin

1. Introduction

Tuna fisheries in Sabah is more important as compared to the tuna fisheries in Sarawak. The existence of bigger tuna species in Sabah waters implies that there is potiential for developing the tuna fisheries. The distribution of tunas is frequently correlated with oceanographic conditions. Off the coast of Sabah, deep water runs close to the shore. Deep water is the niche of the Yellowfin, Bigeye and other bigger tuna species.

2. Species found

In Sarawak the species landed vary along the coast Generally the smaller tunas (longtail, kawa kawa and frigate tunas) are caught by local fishermen using gill nets, hand-lines and purse seines. Some oceanic tuna species are landed further east ie. nearer to Sabah. Significant quantitites of Skipjack are landed in Miri and Bintulu. In Sabah a number of species are normally landed. This includes Bigeye, Yellowfin, Albacore, Skipjack and other small species of Longtail, Kawa kawa and Frigate.

3. Landing trends

Fig: 1 shows the trend of tuna landings in Sarawak. The tuna landings in Sarawak is fairly contant from 1975 to 1985 with little fluctuation. In the early 70s the landings were less then 1000 m.t. per annum but increased to 1474 m.t. in 1975. This could probbaly be due to the increase in the number of boats catching tunas. The landings dropped in 1979

to 914 m.t. and remained rather constant until 1985 when an annual catch of 674 m.t. were recorded. The major gear that catches tunas and tuna-like fishes are gill nets and handlines.

Fig: 2 shows the landings of tunas in Sabah. The landings of tunas in Sabah were constant in the early 80s and ranged between 610 m.t. to 2000 m.t. In 1984 there was a major increase in the landings and this probbaly could be due to the joint venture project between the Phillippines and Malaysia. The landings decreased again in 1985 which could be attributed to the termination of the joint venture contract. The main fishing gears that contribute to the landings in Sabah are purse seines, handlines and gill nets.

4. Distribution

Fig: 3 shows the distribution of tunas at the major landing sites. In Sarawak there are a few species being landed in Kuching, Mukah and Miri. These species include Longtail tuna, kawa kawa (Eastern little tuna). Frigate tuna and Skipjack tuna. Skipjacks and Longtail tunas contribute to 50% of the total tuna landings in Sarawak. Yellowfin tunas have been spotted in areas well beyond the continental shelf.

5. Species composition in West Sabah (Sulu Sea)

Table 2 shows the Catch Composition of tunas and seerfishes in West Sabah (Sulu Sea). The data was obtained from the Tawau Market place and the catches came from Semporna by road. The main gears that operate in the Sulu Sea are the purse seine and the hook and line. From the table it can be observed

that the kawa kawa contributed to 39.6% to the total tuna landings in Semporna in 1985. Frigate tuna contributed 39.1%. Yellowfin contributed 21.3%. Skipjack tuna was not observed in the landings. Personal communication with the fisherman however indicated the existence of skipjack tuna in their catches. Seerfishes were also caught by the fishermen with S. commersoni forming more than 50% of the seerfish landings in Semporna.

Table 3 shows the catch composition of tunas and seerfishes in Sandakan market for the month of July 1986. A number of species were landed in Sandakan and comprised of 29.3% of Eastern Little tuna (kawa kawa) 27.4% of Longtail tuna, 22.7% of Oriental tuna and 20.6% of Dogtooth tuna. Other species like Yellowfin, Skipjack and Big eye not recorded in the July 1986 landings, however normally contribute to a good proportion to the yearly landings.

6. Marketing

In Sarawak tunas are either consumed locally or exported to neighbouring countries. Most of the tunas caught by the Miri fishermen are landed in Brunei or transported by land from Miri to Brunei.

In Sabah most of the tuna landings are exported to the Phillippines. Only a small proportion of the smaller species are consumed locally. Yellowfin tuna is the target species of the big purse seiners. Yellowfin tunas are exported to the Japanese sashimi market via the Phillippines.

7. Future development

The availability of tunas off Sarawak and Sabah indicates the possibility of developing the tuna fisheries for export possibly for the sashimi and katsuoboshi markets. The techniques of making sashimi and katsuoboshi should be taught to the local fishermen so that they can handle the tunas properly.

8. Recommendations

The needs to conduct proper research on tunas in Sarawak and Sabah should be emphasied. Currently there is little research work undertaken to monitor the catch and effort of tunas very little biological studies is being undertaken this should be stepped up.

FIG: 1 TUNA LANDINGS IN SARAWAK

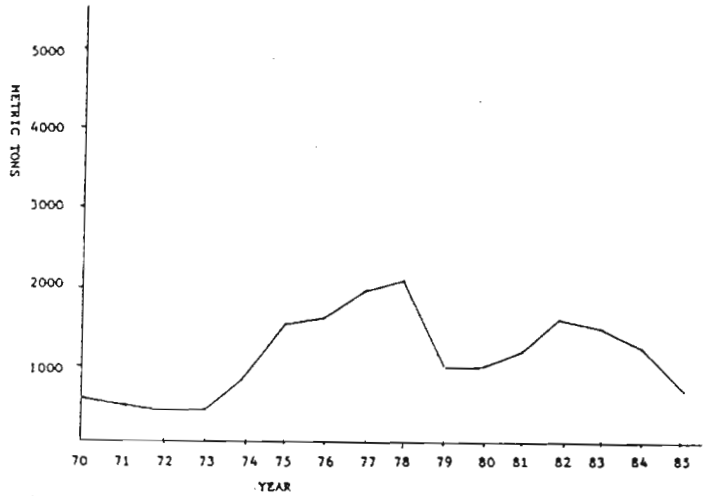


FIG: 2 TUNA LANDINGS IN SABAH

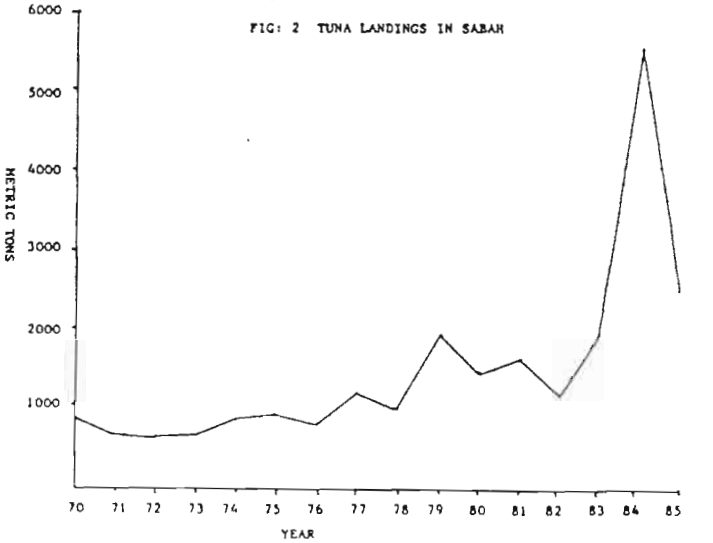


Table 1 : CATCH COMPOSITION OF TUNAS AND BEERFISHES IN WEST SABAH

YEAR: 1985 WEIGHT UNIT: Kg

SAMPLING LOCATIONS: FISH MARKET TAWAU
catches from Semporna

TYPE OF GEAR: PURSE SEINE

SPECIES	MONTH													
	JAN.	FEB.	MARCH	APRIL	MEI	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL	% COMPOSITION
(1) Tunas and Bonitos														
Eastern Little Tuna	4,010	3,341	4,528	3,887	4,242	3,343	2,900	2,233	3,301	3,148	4,239	3,069	42,241	39.6%
Frigate/Bullet Tuna	2,824	3,779	3,315	4,967	4,368	3,480	3,920	2,385	2,119	3,050	3,338	4,406	41,751	39.1%
Yellowfin Tuna	1,020	1,709	1,762	2,106	2,148	933	7,515	2,424	1,999	2,223	3,338	1,599	22,776	21.3%
Skijack Tuna	0	0	0	0	0	0	0	0	0	0	0	0	0	
(2) Beerfishes														
S. commersion	2,478	2,249	2,648	2,112	1,995	1,054	550	691	2,341	1,057	2,012	1,200	20,467	55.5%
S. guttatus	1,394	1,486	1,505	2,207	1,564	362	1,249	221	1,306	1,302	1,501	2,112	16,309	44.5%

TABLE 2: CATCH COMPOSITION OF TUNAS AND NEAR RELATED IN SANDAKAN (EAST SABAH)

YEAR: 1986

MONTH: JULY

SAMPLING LOCATION: SANDAKAN MARKET

Weight: kg

Species	Date																													Total	%
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
Dogtooth tuna	100	-	100	-	-	100	100	-	100	150	150	-	-	-	100	100	-	150	-	-	-	200	-	-	-	100	-	100	-	-	-	1,550	20.6
Oriental tuna	100	-	100	-	-	100	100	-	100	150	150	-	-	-	100	100	-	150	-	-	150	100	100	-	-	100	-	-	-	100	-	1,700	22.7
Bullet tuna																																	
Frigate Tuna																																	
Eastern Little Tuna	100	150	200	-	-	150	100	-	100	-	100	-	-	150	-	100	-	100	-	200	150	100	100	-	-	100	200	-	-	100	-	2,200	29.3
Skijack Tuna																																	
Yellowfin tuna																																	
Bigeye Tuna																												1					
Longtail Tuna	100	150	200	-	-	150	100	-	100	-	200	-	-	150	-	100	-	100	-	200	-	-	200	-	-	100	100	100	-	-	-	2,050	27.4
S. commersoni	150	100	-	200	-	200	-	100	200	200	150	250	-	-	200	200	200	-	200	-	200	230	-	200	150	190	250	-	200	150	100	4,000	50.6
S. guttatus	150	100	-	200	-	200	-	200	200	-	200	200	-	-	200	180	250	-	200	-	250	250	-	200	150	100	250	-	200	100	100	3,930	49.4
Total:	700	500	600	400	-	900	400	300	800	500	950	450	-	300	600	780	450	500	400	400	750	880	400	400	300	690	300	200	400	500	200	15,450	-

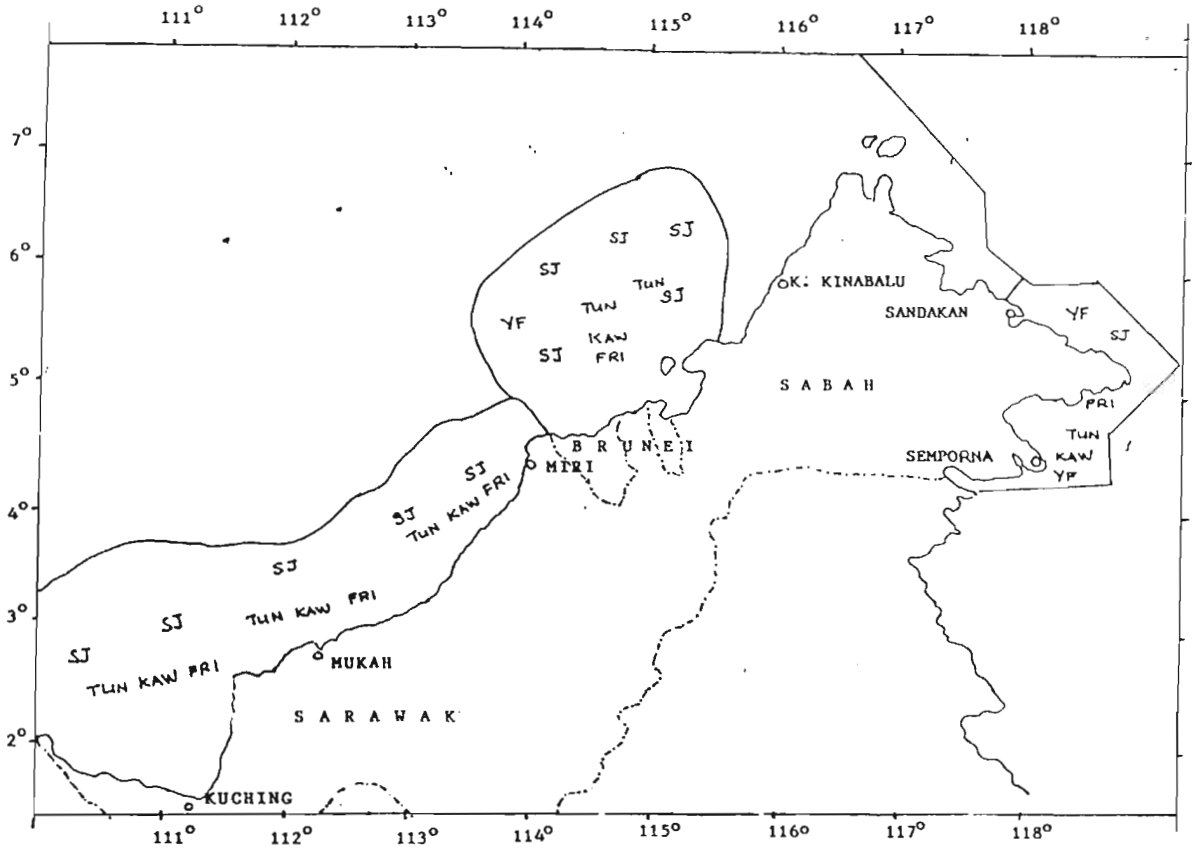


Fig. 3: DISTRIBUTION MAP OF MAJOR TUNA SPP. AND MAIN LANDING SITES OF SARAWAK AND SABAH

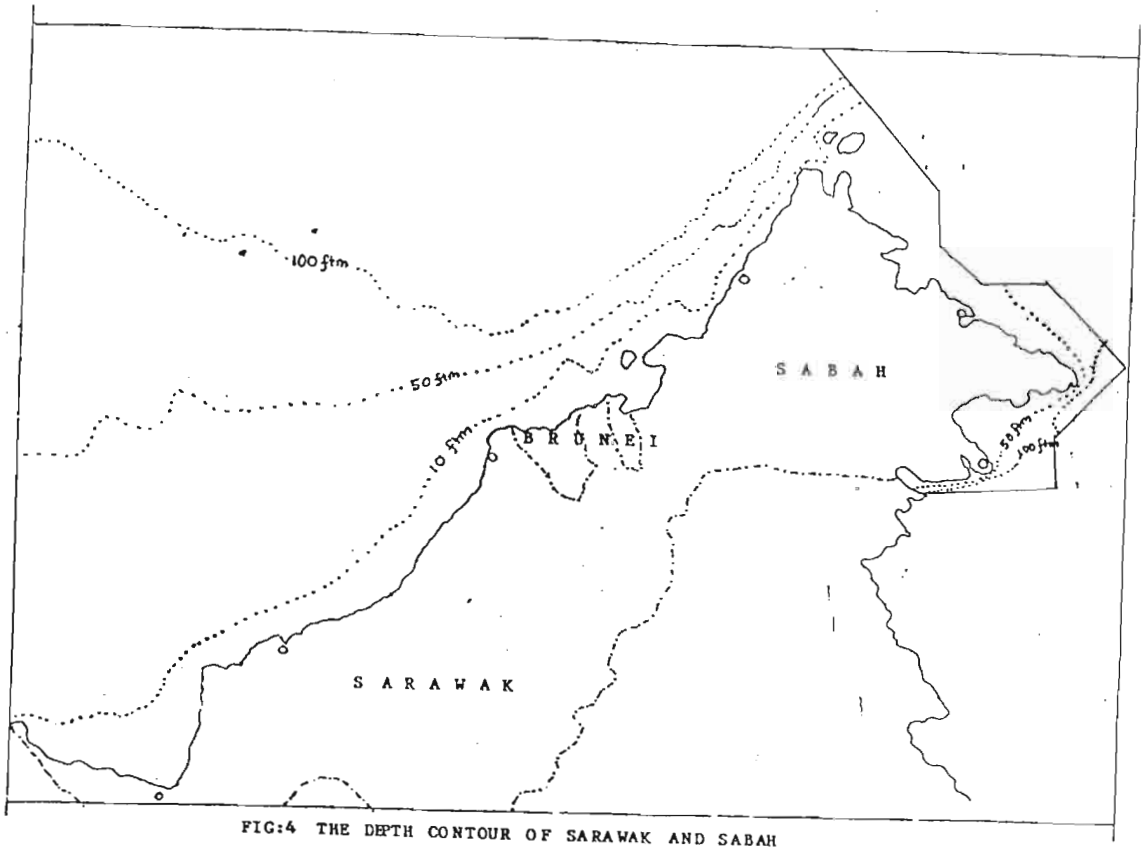


FIG:4 THE DEPTH CONTOUR OF SARAWAK AND SABAH

TUNA FISHERIES/RESOURCES IN THE GULF OF THAILAND

by

Amara Cheunpan

Marine Fisheries Division

Department of Fisheries, Thailand

Meeting of Tuna Research Groups in the Southeast Asian region
PCED Hostel, University of the Philippines
Manila, Philippines 25 - 28 August 1987

Introduction

Doubtlessly, the development of tuna in Thailand is not subject to the need for additional protein of population but to the increasing demand for canning industries, which are now 13 tuna canning plants in this country. Formerly, tuna were caught incidentally by gillnetters and purse seiners until 1981 these resources became the main target species for some fishermen, who try to improve the fishing technique as well as expand the fishing area further offshore. Recently sophisticated electronic equipments, as radar, depth sounder, sonar and satellite navigation instrument are well equipped on the fishing vessels especially purse seiners. Among them, sonar plays the most important role with high efficiency of school detection. Thus, the total yield of tuna seem to be increased year by year. This production sector can be categorized into two groups, the Andaman fisheries and the Gulf of Thailand fisheries; of which productions, almost 90 % come from the Gulf of Thailand which show the tendency of overexploitation. In order to improve the productivity, it need attempt to study more informations for resource management in this area while the new fishing area must be explored, but it would require careful planning.

The fisheries

There are several types of fishing gear used in tuna fisheries, but those are multi-purpose gears using for catching pelagic fishes according to any chance. Among those gears,

the major types are drift gill net, luring purse seine and thai purse seine, while other commercial fishing gears and traditional gears are considered the minor gears as referred to the percentage of tuna caught. (Table 1)

According to the development of tuna fisheries, there is tendency of change in registered fishing gears as shown in Table 2. Previously, the drift gill net, using the vessel with the net of 3000 - 5000 m. long and 30 - 50 m. deep, targetted on king mackerel (Scomberomorus spp). From 1979 the object change to tuna species when the catch of king mackerels tended to decrease but the demand for tuna of canning industries increased. Then the number of registered boats had been risen to 301 boats in 1981 but dropped down a little in the subsequent year. This was due to changeability of the target species. However the number of vessels in 1984 and 1985 indicated that the drilt gill net fisheries had been recovered.

Regarding the thai purse seine and luring purse seine, which are the most important gear. The luring purse seine were modified from thai purse seine by using coconut leaves as fish attraction devices in 1973. Since then the number of thai purse seine had declined while the number of luring purse seine had increased considerably. (Fig. 1). Actually, those two gears are operated homogenously, particularly the luring purse seine which are commonly operated in forms of thai purse seine searching for fish school during the sailing to the destination of luring places. Therefore, the annual production by those two gears are combined from 1984. Being arouse by

the price of tuna, the fishermen have reinforced the gear efficiency by installation of electronic equipments such as echo-sounder, sonar and recently the satellite navigation devices are introduced into the Gulf of Thailand.

The production

Tuna fishing of Thailand has been developed for years, it has been surmise to be effected by the increase in demand of target species. The tuna exploitation in the Gulf of Thailand is about 90 % of total tuna landings which composes of longtail tuna (Thunnus tonggol), kawa kawa (Euthynnus affinis) and frigate tuna (Auxis thazard); of these total, longtail tuna accounts for 63 %, the rest being kawa kawa and frigate tuna about 23 % and 13 % respectively. The production of these three species in this area over 13 years period (1973 - 1985) have increased tremendously in the last five years, from 20,198 MT in 1981 to 81,234 MT in 1985. Around this period the productions fluctuated with an estimated annual average of 28,828 MT. Annual yield showed an increasing trend to the peak about 82,000 MT in 1983 with an increasing rate of 106.8 % (Fig. 2), then dropped down to 69,182 MT in 1984 and reach up the peak again in 1985. It is notable that the rapid rise of catch in the last three years were produced by purse seine (see Table 1).

Taking into consideration of tuna production, the available catch statistics for tuna from 1979 to 1985 were separated into two groups, kawa kawa and frigate tuna have been combined together as TUN and the rest is LOT, which are classified by IPTP. The yield by mojor fishing gear of

1985 as compared to 1984 (Table 3) was increased about 11,876 MT. The increase came mainly from LOT fishing in the first half of the year (65 % higher than the previous year), which showed the boom production of LOT during February to May.

The data collection

From 1973 to 1986 the data collection have been conducted mainly by the Statistics Section of the Department of Fisheries on weekly and monthly basis. The informations on catch data by species and groups of species, by fishing area as well as the fishing effort for each types of gear are collected through simple random sampling technique.

On the other hand, the data have been conducted by the team biologists from Marine Fisheries Division who have surveyed along the coast of the Gulf intended to visit the fish landing places once a month. These surveys are assigned on the purpose of data gathering for some important pelagic fishes, such as mackerels, scads, trevallies, sardines and anchovies as well as tunas. Due to budget allotment, any activities must be carried out following the priority of important scheme according to the National Economic Development Programme. Unfortunately the budget obtained for surveying are limited to support all activities. Another problem encountered is lack of manpower and instrument to deal with tuna collection particularly. Therefore, some detailed informations are insufficient to evaluated the state of stock precisely.

Nevertheless, some problems have been revised for the year 1987. Regarding the assistance from IPTP, the project of data collection system for tuna and its related species in Thai water has been appointed.

Catch and effort

In purse seine fishery, the fishing effort can be measured by day of fishing included searching time. The variation in effort has effected to variance in catch, which can be explained by investigation that the fishermen fish almost anytime and the mobility of this gear is high. Thus, the individual skill is the dominant factor in various amount of catch. Table 4 shows the monthly distributions of catch and effort in 1985. Fishing was good in the first half of the year with the total production about 39,407 MT, of which, LOT was about three times higher than TUN. The amount of LOT was lower than TUN in the second period of the year. Unless, taking into account of the annual catch, it can be stated that the fishing of LOT was better than TUN. This may be due to the fact that LOT distributes more abundantly in the deeper water which is the main fishing grounds for tuna purse seine.

The drift gill net was monitored around the islands in water about 20 - 40 m. deep. These gears were set against the track of fish school. Table 4 shows the drift gill net fishery during 1985 period, it was observed that July was the most productive month (1958 MT). The monthly distributions of catch shows that TUN fishing was better than LOT. On the other hand it was noticeable that TUN would distribute more abundantly around an island. Considering the monthly catch and the trend of fishing effort, the similar pattern of TUN production to effort was seen.

Fishing ground

As mentioned before, the drift gill net was operated around islands in the deep of 20 - 40 m. Table 5 shows that the drift gill net are operated within area I, II and III, (Fig. 3) while some purse seines were extended further into area IV. Compared to previous year, the geographical distribution of the catches in 1985 had been changed notably with large catch by purse seine increase in area III and IV.

Seasonal distribution

Tuna were caught all year round. Seasonal distributions varied according to natural function and the objective by mean of target species. It was observed that there were two peaks by monthly landings, one peak between January to May and another peak between July to September. Fig 4 indicated that the peaks of yield by each gear coincided with those of total production. Anyhow, it can be stated that the catch of tuna was higher during the Northeast monsoon period (November - April).

Research activities

To study about tuna, sampling programmes are assigned in 1987, Three sampling sites located in Songkla, Pattani and Trang have been selected. At each landing place the informations on tuna and tuna like species caught by any gear will be collected daily. The details of each vessel will be gathered about the amount of catch by species, size of fish, size of vessel by each type of gear, number of days per trip as well as fishing area. Except this programme,

the biological information based on planktonic stage have been monitored.

It is noted that the particular attention have to be taken on the study of the state of tuna stock and spawning ground.

In addition, some biological aspects had been studied and summarized in Table 6.

Table 1 Percentage of Tuna catch by major fishing gears in the Gulf of Thailand, 1973 - 1985

year	Total catch		Drift gill net	Thai Purse seine	Luring Purse seine	Mackerel encircling gill net	others
	MT	%					
1973	6,519	100	44.2	33.6	7.8	3.7	10.7
1974	8,715	100	20.4	44.9	4.6	7.2	22.9
1975	11,172	100	23.6	36.9	8.8	2.0	28.7
1976	8,890	100	26.8	37.4	10.9	7.9	17.0
1977	11,296	100	41.5	21.4	31.2	4.9	1.0
1978	8,258	100	34.8	28.5	17.5	5.1	14.1
1979	14,713	100	29.4	4.2	47.1	9.8	9.5
1980	12,395	100	44.4	16.7	31.6	4.4	2.9
1981	20,198	100	55.5	5.1	37.9	0.1	1.4
1982	39,661	100	48.9	3.1	42.6	4.7	0.7
1983	82,001	100	16.0	0.3	81.8	1.7	0.2
1984	69,213	100	26.4	70.3*		3.1	0.2
1985	81,234	100	23.0	74.8*		2.1	0.1

* Combinded percentage of catch by LPS and TPS.

Table 2 Number of fishing vessels registered by types of gear and sizes of boat in the Gulf of Thailand. 1977 - 1985.

Size of boat (m)	1977	1978	1979	1980	1981	1982	1983	1984	1985
Drift gill net	206	115	203	272	301	250	234	243	256
- 14	111	34	62	86	53	47	40	50	45
14 - 18	77	62	112	142	166	148	134	116	135
18 - 25	18	19	29	44	82	55	60	76	75
25 -	-	-	-	-	-	-	-	-	-
Thai purse seine	138	82	64	103	40	42	40	363	448
- 14	105	66	36	40	9	21	20	26	27
14 - 18	33	15	28	51	28	19	17	116	144
18 - 25	-	1	-	12	3	2	3	218	270
25 -	-	-	-	-	-	-	-	3	7
Luring purse seine	410	510	480	506	603	589	556	265	218
- 14	2	40	67	59	75	59	42	25	18
14 - 18	153	158	138	150	189	154	124	34	33
18 - 25	254	311	275	294	331	369	377	200	162
25 -	1	1		3	8	7	13	6	5
Mackerel encircling gill net	314	358	355	305	257	227	141	167	210
- 14	239	285	217	174	125	103	36	87	113
14 - 18	65	60	101	73	76	70	57	40	48
18 - 25	10	13	37	58	56	54	48	40	49
25 -	-	-	-	-	-	-	-	-	-

Source : Fisheries record of Thailand, 1977 - 1985, Department of Fisheries.

Table 3 Monthly landing of tuna by major fishing gears from the Gulf of Thailand, 1984-85.

Month	1984			1985		
	LOT	TUN	Total	LOT	TUN	Total
Jan.	2513	1990	4503	4589	2610	7199
Feb.	2513	2805	5318	7203	2435	9638
Mar.	3394	2634	6028	7725	2939	10664
Apr.	2681	2092	4773	7296	2752	10048
May.	2005	1926	3931	5543	3575	9118
Jun.	3907	2225	6132	2309	1674	3983
Jul.	2479	2317	4796	1806	4227	6033
Aug.	3748	2550	6298	2894	3239	6133
Sep.	3538	4022	7560	1760	4038	5798
Oct.	3780	3338	7118	1405	3465	4870
Nov.	2168	2396	4564	1361	2302	3663
Dec.	5459	2577	8036	1422	2364	3786

Table 4 Distribution in catch (MT), fishing effort (day) and catch rate (kg/day) by month and gear from the Gulf of Thailand, 1985.

Catch \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Purse seine													
LOT	3913	6573	7056	6580	4849	1569	1266	2332	1072	946	707	1110	37973
TUN	3565	1213	1682	1805	2156	446	2575	2273	3154	2543	1396	1977	22785
Days	11451	8925	8750	10025	11534	10539	12010	12571	11628	9978	7660	6969	122040
CPUE LOT	341.72	736.47	806.40	656.30	420.41	148.88	105.41	185.51	92.19	94.81	92.30	159.28	311.15
CPUE TUN	136.67	135.91	192.23	180.05	186.93	42.32	214.40	180.81	271.24	254.86	182.25	283.68	186.70
CPUE Total	478.39	872.38	998.63	836.41	607.33	191.19	319.82	366.32	363.43	349.67	274.54	442.96	497.85
drift gill net													
LOT	642	630	669	716	694	723	540	556	584	607	654	312	7327
TUN	981	1100	1104	867	1014	1131	1418	788	850	848	906	360	11367
Days	4172	3703	4085	2740	3383	3398	3989	3790	2689	3834	4510	3581	43874
CPUE LOT	153.88	170.13	163.77	261.31	205.14	212.37	135.37	146.70	217.18	158.32	145.01	87.13	167.00
CPUE TUN	235.14	297.06	270.26	316.42	299.73	332.84	355.48	207.92	316.10	221.18	200.89	100.53	259.08
CPUE Total	389.02	467.19	434.03	577.74	504.88	545.62	450.85	354.62	533.28	379.50	345.90	187.66	426.08

Table 5 Totel catch of tuna by area and gear from the Gulf of Thailand, 1984-85.

year	1984				1985			
area / Gear	I	II	III	IV	I	II	III	IV
purse seine								
catch (MT)	9833	15976	8086	14763	10097	10497	17735	22429
effort (day)	18911	96227	17194	15234	14610	78547	19916	8049
CPUE (kg/day)	519.96	166.02	470.28	969.08	689.25	133.64	890.49	2736.56
drift gill net								
catch (MT)	2484	4501	11276	-	2001	5822	10371	-
effort (day)	13501	17582	16374	-	11367	18558	14643	-
CPUE (kg/day)	183.99	256.00	688.65	-	176.64	313.72	742.40	-

Table 6 Summary of biological information studies of coastal tunas in the Gulf of Thailand

Species	Distribution	Size composition	Recruitment	Spawning	Length at maturity	Fecundity sex ratio	Growth rate	Life span	Lt - Wt Relation	Parasite
Gulf of Thailand										
Thunnus tonkkol	Adults Throughout Thai water of > 20 m depth Larvae off Chumporn-Nakorn-Srithammarat 15-30 m. depth (Not abundance)	22-25 cm LF Modes in the catch : East 35.0-47.0, 51.0 cm. West (upper): 31.0, 35.0, 47.0 cm. West (lower): 26.0, 37.0, 47.0, 50.0 cm.	East : all year round peak : Jan-Feb., Sept.-Dec. Length 22.0 cm. West (upper) Jan.-Feb. Apr.-June Sept.-Dec. Length: 23.0 cm West (lower) Apr.-May Sept.-Dec.	Area: edge of the basin of the Gulf Season: Mar.-May Jul.-Dec.	♀ 39.6 cm (LF.)	Average 1,400,000 (Lt. 43.8-89.7 cm.), sex ratio 1 : 1	1.4 cm/Mo	4 year	W=0.000021L 2.979	External and Internal inhibited : such as Copepod, Acanthocephale Nematode and Trematode:

Table 6 (Cont'd)

Species	Distribution	Size composition	Recruitment	Spawning	Length at maturity	Fecundity, sex ratio	Growth rate	Life span	Lt - Wt Relation	Parasite
Euthynnus affinis	same as T.tonggol	21-60 cm LF Modes : East : 21.0,35.0 31.0 cm. West (Upper): 26.0,47.0 cm. West (lower): 25.0,32.0,34.0, 42.0 cm.	East : 11-21 cm. Feb.-Mar. Aug.-Dec. West (upper): length : 26.0 cm Mar.-Apr. Jun.-Aug. West (lower) Length-25 cm. Mar.-Apr. Aug.-Sept.	Season : Jan.-Mar. Jun.-Aug. Ground : Not clear	♀ 37.5 cm. (LF)	Average : 1,730,000 (Length 39.5 -51.0 cm LF) Sex ratio: 1 : 1	1.2 cm/Mo K=0.63	-	$W=0.000015L^{3.0223}$	same as T. tonggol specific species : Aphanurus sp and Unidentified cestode

Table 6 (Cont'd)

Species	Distribution	Size composition	Recruitment	Spawning	Length at maturity	Fecundity sex ratio	Growth rate	Life span	Lt-Wt Relation	Parasite
Auxis thazard	same as T. tonggol	19-49 cm.LF Modes: East: 27.0,45.0 cm. West (upper): 35.0 cm. West (lower) 35.0 cm.	East Length 21.0 cm. Feb.and Sept. West (upper) All year round length; 19-27cm. Apr.-May. Aug.-Dec. West (lower) Length: 19-27cm. Apr.-May Oct.-Nov.	Area Not clear Season Apr.-Jun. Aug.-Sept.	♀ 34.1 cm (LF)	Sex ratio 1 : 1	-	3 - 4 year	$W= 0.00002L^{2.990}$	same as T. tonggol

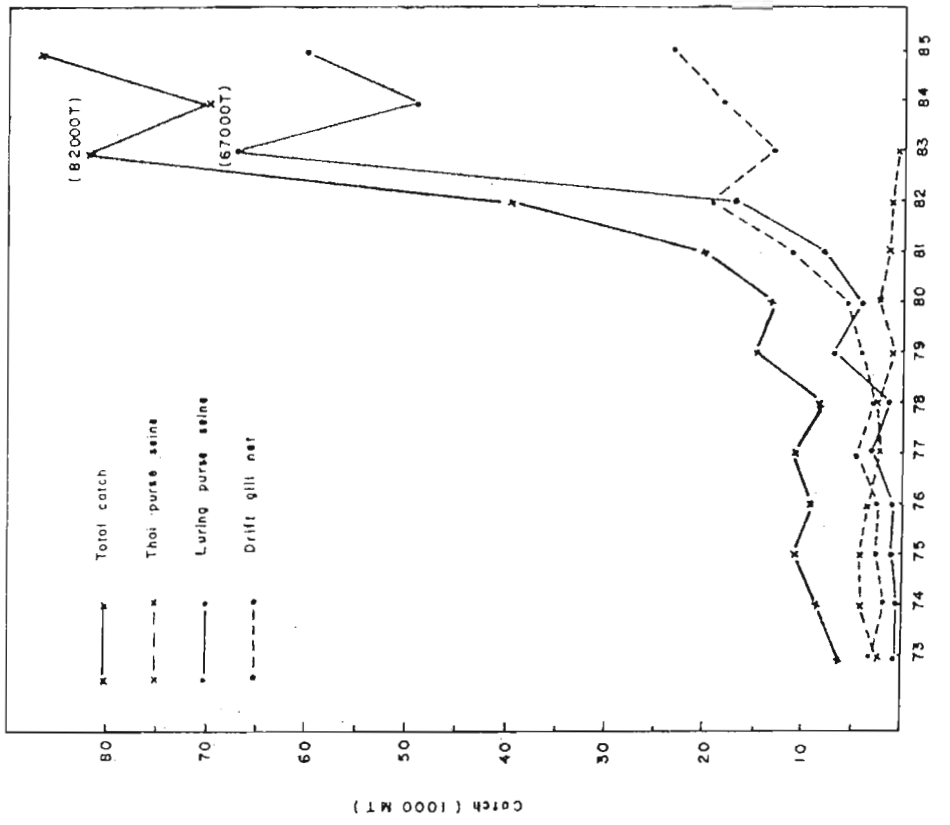


Fig. 2 Annual catch of tunas by major type of fishing gears in the Gulf of Thailand, 1973-1984

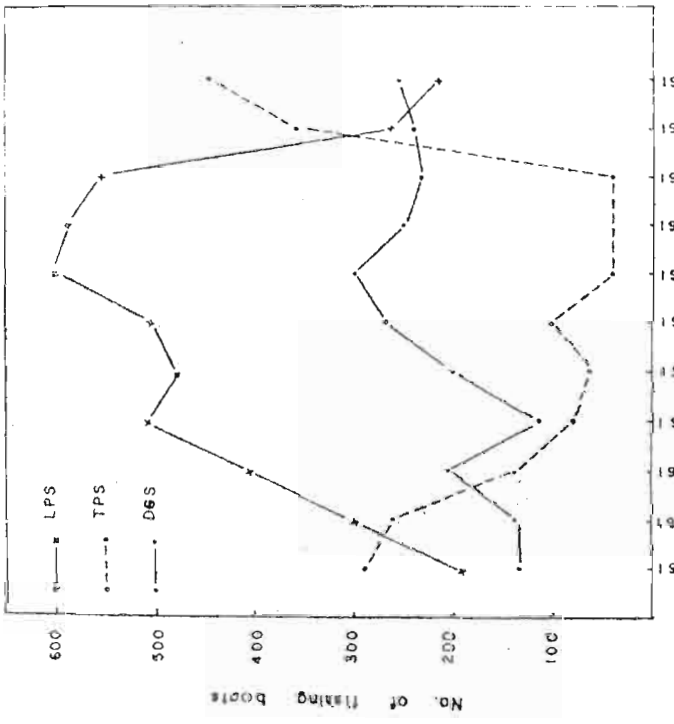


Fig. 1 Variations of fishing boats registered in the Gulf of Thailand, 1975 - 1985

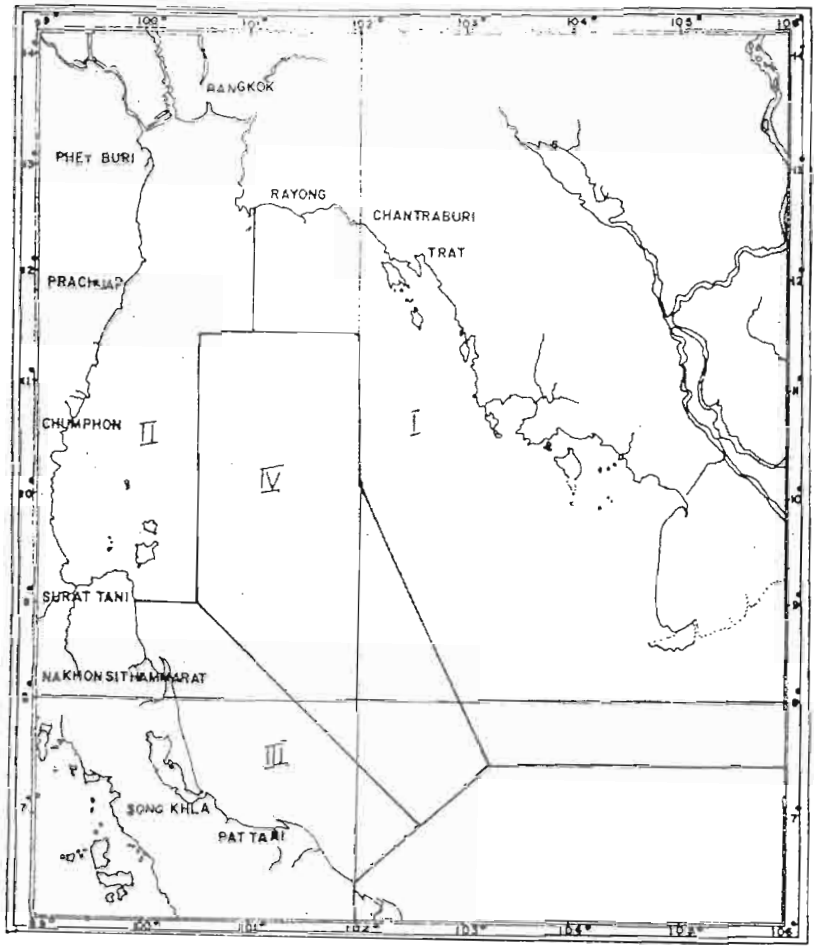


Fig. 3 Map showing fishing area in the Gulf of Thailand

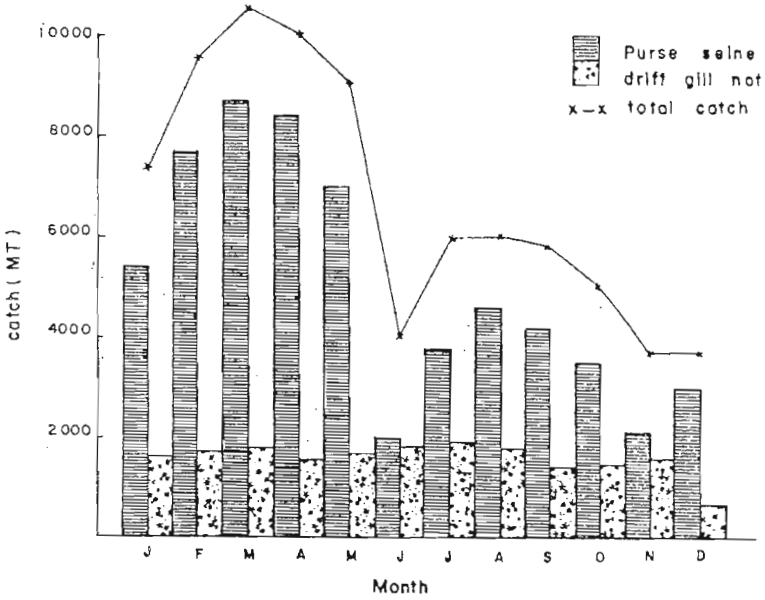


Fig. 4 Seasonal variations in catch (MT) by gear from January – December 1985

STATUS OF THE PHILIPPINE FISHERIES FOR TUNA

1. INTRODUCTION

The fisheries for tuna in the Philippines remains to be the most important fishery in the country in view of the fact that it satisfies the demand of the domestic consumers and contributes to the foreign exchange earnings. In 1986, tuna production increased by about 5,000 mt from 1985.

1.1 Tuna Landings

Annual total tuna landings by species group and fishery sector for 1976-1986 is shown in Tables 1-3. Production of tuna represents 20% or 266,211 mt of the marine fisheries landings of 1,323,802 mt in 1986.

The commercial and municipal fishery sector contributed to the total tuna landings in almost equal proportion, 49.9% and 50.1%, respectively. This compares with the landings in 1985 which is 47.7% (municipal) and 52.3% (commercial).

The increase in tuna landings of about 5,000 mt from the 1985 production is mainly due to the increase in the municipal landings of tuna which accounted for about 8,000 mt. This may be attributed to the program of the government of developing the countryside by providing the needed inputs towards this end.

1.2 Catch by species groups

In 1986, the landings of tuna by species show that the catches of frigate/bullet and yellowfin/big-eye declined while that of skipjack and eastern little show an increased. As in previous years, however, frigate tuna remains as the major tuna species landed but it showed a decline from that of last year. On the other hand, skipjack have shown a substantial increase of about 8,000 mt.

In the commercial landings, a similar picture as that of the annual total landings. Frigate tuna and yellowfin tuna landings showed a decline but that of skipjack and eastern little tuna it showed an increase. Landings in the municipal sector show that all the tuna species groups have increased landings but the more significant are the landings of skipjack and eastern little tuna.

1.3 Catch by fishing gear

The main gear capturing tunas in 1986 are the purse seine, ringnet and bagnet which contributes, 58%, 32% and 9%, respectively. This compares to 49%, 35% and 13% in 1985. (Table 4).

A great variety of gear are employed by the municipal sector in capturing tuna. The main gear catching tuna in this sector is hook and line which would account for about 64 % of the total municipal catch of tunas. Gill net contributes about 19 % or 25,156 mt and followed by ringnet with 13,877 mt or 10 %. This 3 gear accounts for about 93 %. (Table 5)

1.4 Tuna Landings by fishing ground and by region

In the fisheries statistics, tuna landings are published by statistical fishing area and political region. The landings of tuna by statistical fishing area is shown in Table 6. There is a general decline of tuna catches in most of the fishing area with the exception of West Sulu Sea, South Sulu Sea and East Sulu Sea which showed a significant increase. Moro Gulf which is the main fishing ground for tuna in 1985 showed a decrease of about 13,000 mt. One factor which would have affected this, is the reported rampant piracy in Moro Gulf last year and would also explain the increase in catches in the Sulu Sea area.

In the regional landings in the commercial sector, Region 9 the Zamboanga area is the most productive followed by Region XI and NCR. The high landings at NCR is not reflective of the tuna landings in the area but due to the fact that carrier boats of purse seine vessels in the area of Mindanao are landing their catch at NCR.

In the municipal sector, regional landings show that Region 9 is the top producer. Next is Region 4 followed by Region 6 and 11 is almost equal in volume.

The above would indicate that the bulk of landings are from the waters around Mindanao and Palawan.

1.5 Tuna catch disposition

The major proportion of the tuna landings of 266,211 mt in the Philippines are consumed locally.

Tuna export in 1986 represents about 13% of the total tuna landings valued at about P1.3 B pesos. Frozen tuna export decreased by about 3,000 mt and canned tuna export increased by 1,000 mt. On the whole, there was a dropped of export by 2,000 mt.

The factors which might have caused the decline in export of frozen tuna is overfishing, resource depletion and one capitalist of the industry. These and other factors such as increased operating costs and the economic problem facing the country as well as the external factors such as higher import duties of Philippine canned tuna and increased competion from other tuna-processing countries, particulatly Thailand are playing the tuna fishing industry.

Table 9 and 10 show the destination of canned and frozen tuna in 1980-1986. Canned tunas was exported in 1986 mainly to the US, Germany, and Canada. However, only exports to Germany

showed a substantial increased of about 4,000 mt. Frozen tuna exports have shown a general decline. Most of the frozen tuna are the large yellowfin and big-eyed which is defined for the "sashimi" market in Japan.

Table 1. Annual total landings (MT) of tunas in the Philippines from 1976-1986.

SPECIES \ YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	$\bar{X}$	
FRIGATE/ BULLET	28328	43007	50899	79909	96874	78248	67363	74219	80305	95718	87225	71100	
YELLOWFIN	44478	63059	47029	49224	48023	56176	51922	62036	58924	64293	59510	54970	
SKIPJACK	29174	55090	49730	45084	31178	38439	50795	57151	44671	60536	77031	48989	
EASTERN LITTLE	23004	54744	36341	23094	24730	30891	46524	48880	41899	41060	42445	37601	
TOTAL	124984	215900	183999	197311	200805	203754	216604	242286	225799	261607	266211	212660	

Table 2. Annual commercial landings (MT) of tunas in the Philippines from 1976-1986.

SPECIES \ YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	$\bar{X}$	
FRIGATE/ BULLET	6101	11318	20897	39694	53310	47141	39862	34097	47360	53478	44196	36132	
YELLOWFIN/ BIG-EYE	12845	12260	5519	11407	11496	20073	19787	20507	22254	22185	16758	15917	
SKIPJACK	9816	22519	14816	19834	12486	17706	31188	39613	28871	42433	51778	26460	
EASTERN LITTLE TUNA	4098	14289	9468	7269	9958	13071	14442	12359	18832	18673	20348	12982	
TOTAL	32860	60386	50700	78204	87250	97991	105279	106676	117317	136769	133080	91491	

Table 3. Annual municipal landings (MT) of tunas in the Philippines from 1976-1986.

YEAR / SPECIES	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	$\bar{X}$	
FRIGATE/ BULLET	22227	31689	30002	40215	43564	31107	27501	40122	32945	42240	43029	34967	
YELLOWFIN	31633	50799	41510	37817	36527	36103	32135	41529	36670	42108	42752	36326	
SKIPJACK	19358	32571	34914	25250	18692	20733	19612	17820	15800	18103	22097	22243	
EASTERN LITTLE TUNA	18906	40455	26873	15825	14772	17820	32082	36421	23067	22387	25253	24892	
TOTAL	92124	155514	133299	119107	113555	105763	111330	135610	108482	124838	133131	118428	

TABLE 4. COMMERCIAL FISHERY PRODUCTION BY SPECIES & GEAR 1986

	BAGNET	TRAWL	MURO-AMI	PURSE SEINE	RINGNET	BEACH SEINE	R H S	PUSHNET	HOOK LINE	LONGLINE	T O T A L :
FRIGATE TUNA	7270	301		14296	22139	10	144		31	5	44196
YELLOWFIN, BIG-EYE TUNA	218	110		12640	3573				163	54	16758
EASTERN LITTLE TUNA	3529	800		11224	4768				27		20348
SKIPJACK TUNA	681			38929	12108				60		51778
T O T A L :	11,698	1,211		77,089	42,588	10	144		281	59	133,080

TABLE 5.

REPORTING COUNTRY : Philippines
FLAG COUNTRY : Philippines
YEAR : 1986

GEAR	CATCH OF SPECIES			
	Frigate Tuna	Yellowfin/Big-Eyed Tuna	Eastern little Tuna	Skipjack
Bagnet	244	132	68	359
Gillnet	11,132	2,389	3,725	2,850
Baby Trawl	32	1	54	1
Fish Corral	351	34	55	251
Beach Seine	2,253	9	161	72
Ringnet	2,910	1,347	2,912	6,225
Hook and Line	20,781	37,431	13,668	13,623
Longline	1,382	2,357	154	591
Troll Line	2,264	512	496	542
Purse seine/Ringnet	1,577	32	97	63
Spear	52	55	5	59
Drive-in-net	15		11	4
Filter net				
Round Haul Seine	2			3
Lift net			1	
Push net				9
Danish line				
Purse seine				
Pole and Line		107	88	594
Fish Pot	34	3		7
TOTAL	43,029	44,409	21,990	25,253

TABLE 6. Tuna Landing by Statistical Fishing Area (m.t.)

Statistical Fishing Area	1984	1985	1986
1. Lingayen Gulf	7185	7771	3466
2. Manila Bay	6797	8560	7558
3. Batangas Coast	6546	8675	12486
4. Tayabas Bay	4153	9483	7279
5. West Palawan Waters	994	414	215
6. Cuyo Pass	17887	12240	11213
7. West Sulu Sea	6031	6009	21256
8. South Sulu Sea	26443	24690	34468
9. East Sulu Sea	14560	14900	20834
10. Moro Gulf	59769	84429	71328
11. Davao Gulf	6603	4790	4923
12. Bohol Sea	18117	21483	16281
13. Leyte Gulf	2898	2491	2835
14. Camotes Sea	3720	2302	3361
15. Visayas Sea	9648	12081	12661
16. Guiuerros Strait	8943	11188	10118
17. Sibuyan Sea	3907	3142	3269
18. [illegible] Gulf	10837	6041	5481
19. Samar Sea	3078	6908	5350
20. Lagonoy Gulf	2393	3513	2323
21. Lamon Bay	3670	4752	4239
22. Casiguran Sound	982	1954	606
23. North Eastern Mindanao	-	2078	3013
24. Babuyan Channel	638	813	1376
25. South Eastern Mindanao	-	-	182
Total	225799	261607	266,221

TABLE 7. ANNUAL COMMERCIAL LANDING BY REGION (M.T.)

	I	II	III	NCR	IV	V	VI	VII	VIII	IX-A	IX-B	X	XI	XII	TOTAL
FRIGATE TUNA (TULINGAN)	138	953	241	8277	8147	24	2145	3485	2251	915	1191	4933	11477	19	44196
YELLOWFIN, BIG-EYE TUNA (ALBACORA) (TAMBAKOL)	217	3	519	1120	1070	—	517	196	1	36	9470	104	3495	10	16758
EASTERN LITTLE TUNA (OCEANIC)	38		670	602		3600	10,115	1379	37		3179		670	58	20348
SKIPJACK TUNA (GULYASAN)	643	207	1238	14981	907			64	155	402	18597	233	14350	1	51,778
T O T A L :	1036	1163	2668	24980	10,124	3,624	12,777	5,124	2,444	1,353	32,437	5,270	29,992	88	133,080

ANNUAL MUNICIPAL LANDING BY REGION (M.T.)

	I	II	III	NCR	IV	V	VI	VII	VIII	IX-A	IX-B	X	XI	XII	TOTAL
FRIGATE TUNA (TULINGAN)	359	125	83		11657	6660	2105	2453	1960	2377	10021	2020	2001	1208	43029
YELLOWFIN, BIG-EYE TUNA (ALBACORA) (TAMBAKOL)	818	62	3114		5695	306	492	305	734	1436	16901	754	8940	3195	42752
EASTERN LITTLE TUNA (OCEANIC)	1	1	55		1706	2770	9906	224	197	338	5119	811	276	693	22097
SKIPJACK TUNA (GULYASAN)	523	25	944		3279	352	2144	341	381	1406	3651	1514	3162	7531	25253
T O T A L :	1701	213	4196		22337	10,088	14,647	3,323	3272	5,557	35,692	5,099	14,379	12,627	133,131

Table 8. Export of tuna by kind, 1980-1985
(in MT)

	1980	1981	1982	1983	1984	1985	1986
	Volume	Volume	Volume	Volume	Volume	Volume	Volume
Frozen/chilled tuna	47,290	35,830	17,731	18,533	13,387	11,899	9,168
Smoked	551	341	193	88			
Canned	71	18,033	19,411	23,537	22,599	25,312	26,402
Dried					44		
TOTAL	47,912	54,204	37,335	42,158	36,030	37,211	35,570

Table 9. Export of canned tuna by destination, 1985
(in MT)

	1980	1981	1982	1983	1984	1985	1986
Greece							15
Australia		294	14	385	585	137	
Austria					46	24	61
Belgium		95	51	78	69	136	29
Canada		1,687	1,268	1,791	2,056	2,526	1,099
Denmark		145	40	15	56		114
Finland		243	67	165	43	46	31
France		141	42	143	140	103	135
Federal Rep. of Germany	71	2,990	2,717	3,312	4,763	3,936	7,998
Israel		88	122	13	28		512
Japan				151		19	
Kuwait				29		19	14
Lebanon			72	14	257	71	
Malta-Gozo					173	101	200
Mozambique						106	993
Netherlands		45	79	64	198	192	399
Puerto Rico				15		45	76
Sweden		69	164	463	553	327	456
South Africa						27	
Switzerland		140	126	168	214	99	216
Saudi Arabia				29			
United Kingdom		1,327	1,368	3,049	3,050	2,348	1,981
U.S.A.		10,699	13,252	13,610	10,224	15,046	12,003
Others		70	29	43	139	4	
Norway							15
Italy							34
Singapore							18
T O T A L	71	18,033	19,411	23,537	22,599	25,312	26,402

Table 10. Export of canned tuna by destination, 1985
(in MT)

	1980	1981	1982	1983	1984	1985	1986
Canada							11
Denmark		24	63	22		45	20
Hawaii	1,115	325	1,018		3	1	5
Israel	66	73	85		45	111	219
Italy	9,480	5,651	4,545	8,310	6,238	1,669	
Japan	1,923	3,710	5,128	4,812	6,998	6,191	3,999
Hongkong							3
Korea	2,067						1
Panama	100						
Puerto Rico	1,280						
Singapore	4,139	1,696		593		29	5
Spain		200					
Switzerland	350	533					
Taiwan						40	
Thailand			360			3,746	2,878
United Kingdom			20				
U.S.A.	26,770	23,616	6,509	4,796	103	58	190
Others		2	3			6	2
T O T A L	47,290	35,830	17,731	18,533	13,387	11,899	9,168

CANNED

TABLE 11. TUNA EXPORT 1986

DESTINATION	QUANTITY (kgs.)	VALUE (₱)
Canada	1,099,306	54,758,074
U.S.A.	12,002,970	412,028,261
Puerto Rico	76,354	2, 719,290
Sweden	456,116	18,747,247
Norway	14,652	609,475
Finland	30,603	1,158,138
Denmark	113,809	5,156,831
United Kingdom	1,981,399	87,235,519
Netherlands	399,124	16,097,677
Belgium	29,395	1,325,615
France	135,265	5,789,295
West Germany	7,998,026	308,168,929
Austria	61,431	1,799,830
Switzerland	216,054	8,248,214
Malta and Gozo	199,818	9,001,226
Italy	33,928	1,438,137
Greece	14,901	635,900
Israel	512,226	22,004,423
Kuwait	14,288	615,048
Singapore	18,383	782,760
Guam	397	30,662
Mozambique	993,359	46,695,506
T O T A L	26,401,804	1,005,046,057

FROZEN

TABLE 12. EXPORT OF TUNA 1986

DESTINATION	QUANTITY (kgs)	VALUE (₱)
Canada	11,113	473,806
U.S.A.	190,354	4,708,048
Denmark	20,000	438,132
Italy	1,835,122	36,942,769
Israel	219,000	4,644,005
Thailand	2,877,817	30,267,001
Singapore	5,000	457,798
Korea	500	47,147
Hongkong	3,027	266,647
Japan	3,998,852	194,559,306
Okinawa	800	48,842
Guam	1,412	85,110
Hawaii	4,775	264,498
T O T A L	9,167,772 kgs.	273,203,709.00

Tuna Stock Assessment Research Project

Introduction

The Tuna Stock Assessment Research Project is the continuation of the Tuna Sampling Project initiated by the South China Sea Fisheries Development and Coordinating Programme in November 1979. The purpose was to obtain basic information in catch, effort and species and size composition of landings in the tuna fishery. After its termination in December 1980, the project became an on-going research project of the Fisheries Research Division, Bureau of Fisheries and Aquatic Resources and have the following as its objectives:

a. To determine the spatial and seasonal distribution of tunas.

b. To determine the size and species composition of the catch attained by the type of gear.

c. To obtain biological information on length/weight relationship, sex and maturity, feeding habit of tuna.

d. To determine the unit of fishing effort for the tuna fisheries.

e. To identify stocks and migration path of tuna in the Western Pacific to provide input in the International Tagging Programme of skipjack and other tunas.

Methodology

The Tuna Research Project is being implemented in the four (4) sampling centers in Mindanao located in the following provinces:

1. Davao del Sur (1 sampling site)

   1.1 Sta. Cruz (1 sampler)

2. General Santos City (3 sampling sites)

   2.1 Calumpang (1 sampler)

   2.2 City Public landing (1 sampler)

   2.3 Bula (1 sampler)

3. Zamboanga City (3 sampling sites)

   3.1 Labuan (1 sampler)

   3.2 Recodo
   (1 sampler)
   3.3 Baliwasan

4. Misamis Oriental (2 sampling sites)

   4.1 Opol
   (1 sampler)
   4.2 Initao

Major gear types in each sampling sites are being sampled such as ringnet and handline in Sta. Cruz and Opol and handline in Initao. Ring net, Purse seine and Handline are the gears selected in Gen. Santos City.

In Labuan, ring net, handline, troll line and multiple handline are selected while in Recodo, Purse seine, handline and fish corral are being sampled and only bagnet is selected in Baliwasan.

Skipjack, yellowfin, big eye tuna, frigate tuna, bullet tuna and eastern little tuna are the species being studied in the four sampling centers whenever they are available in the landed catch of the different boat/gears.

A. Sampling for purse seine/ringnet

1. Sampling of ringnet and purse seine is done every other 2 days regardless of Saturdays, Sundays and Holidays making a total of 10 sampline days per month.

2. On each sampling days up to 5 carrier boats are sampled. The catch of all other vessels unloading that day is also recorded.

3. For each vessel sampled, the following information is taken and recorded in form A.

   - boat name
   - gear type
   - fishing ground
   - catch composition by species
   - total weight of catch
   - no. of days fishing/net sets

4. For each vessel sampled, at least 1 box/basket by each category of tuna, i.e., piret, skipjack, yellowfin is sampled.

5. For each box sampled the following is done:

   a. Species is sorted out and all unidentified samll tuna is placed in separate category.

b. Each species is weighed to obtain composition by weight.

c. Twenty fish randomly selected for each tuna species is measured and recorded in form B.

d. All measurements is taken to the nearest cm (0.5 cm above taken to the next highest cm).

B. Sampling for handline

1. Sampling for handline is done every other day in Gen. Santos City, Labuan and Recodo; every other 2 days in Sta. Cruz and once a week in Opol and Initao.

2. For each sampling day the following data are collected

a. total landings of yellofin and big eye tuna from handline boat

b. no. of pumpboat landed

c. average number of fish landed per catch

3. For one landing center, length and weight (as recorded by buyer) from 20 yellowfin and all big eye are taken.

Information collected at each sampling site is summarized at the end of the month by fishing gear and species. These summaries include the number of total and monitored vessels, weight of total species composition of monitored landings. Samples of frequency distribution obtained during the month for a particular fishing gear and species in each area are also summarized to give weighted length frequency percentage distribution of the total landings for the month.

Type of information collected for 1986

A. Distribution of monitored effort by sampling site and fishing gear.

Ringnet, handline and purse seine were still the most important gears at the sampling site both in terms of the number of vessel landing and total landed weight.

Ringnet and handline were still the gears monitored at Sta. Cruz with a total landings of 29,010 kg and 57,576 kg respectively.

In Gen. Santos, 3 gears were monitored namely, purse seine, ringnet and handline. In terms of landed weight, ringnet was the most important followed by handline and purse seine.

In the three sampling sites in Zamboanga City, purse seine has a total landed catch of 14,002,470 kg followed by ringnet 1,114,264 kg handline 102,066. Other gears monitored were troll line, bagnet and multiple hand line.

B. Species Composition by sampling site and fishing gear.

A total of 31,155,954 kg tuna was recorded at the four sampling centers in Mindanao. This total comprised 59% skipjack, 28% yellowfin, 6% bullet tuna, 5% frigate tuna and 1% each of big eye and eastern little tuna.

Five species of tuna were captured by ringnetnamely, skipjack, yellowfin, big eye tuna, frigate tuna, bullet tuna and eastern little tuna. Hanline was catching yellowfin, big eye and minimal quantity of skipjack. Purse seine was also catching all five species of tuna under study while bagnet was only catching frigate, bullet and eastern little tuna. Troll line was likewise catching the bigger tunas such as yellowfin, big eye and skipjack.

In Sta. Cruz, skipjack comprised 78% of the catch landed by ringnet while 98% of the catch of handline was yellofin.

Skipjack was also the dominant catch of ringnet and purse seine in Gen. Santos City which comprise 48% and 62% of the catch landed respectively. Yellowfin was also the dominant catch of handline in General Santos City.

In Opol, frgate tuna comprised 56% while bullet comprised 20% of the catch landed followed by yellowfin, 14% and skipjack, 10%.

Skipjack was also the dominant catch of ringnet in Labuan but it was frigate that dominated the catch of ringnet in Baliwasan. Purse seine catch in Recodo was also observed to be dominated by skipjack (78%).

The dominant catch of bagnet in Baliwasan was eastern little tuna (48%) followed by frigate tuna (46%) and bullet tuna (6%). Multiple handline has 34% eastern little tuna in the catch followed by bullet tuna 30%, yellowfin tuna 25% and frigate tuna 12%.

C. Catch and catch rate

Ringnet

Ringnet landings of tuna was highest in Gen. Santos City as observed in the four sampling centers. October was the most productive month with a high catch of 2,523,056 kg followed by the month of September (2,212,499 kg) and June (1,148,572 kg). The rest of the months has a catch landed lower than 1,000 metric tons. The average landing of tuna for the period of was 7,025 kg/boat.

May was the most productive month in Labuan with a toal landings of 267,430 kg and a catch rate of 4,052 kg/boat. June, July, November and December registered a total catch of more than 100,000 kg. The average landing of tuna for this period was 2,256 kg/boat.

The month of February was observed to be the most productive month with a total landed catch of 117,056 kg. For the rest of the months, a total catch of less than 40,000 kg was observed. The average landing of tuna for this period was 751 kg/boat.

The total landed catch recorded in Sta. Cruz was 29,010 kg and June was observed to be the highest month with a landed catch of 13,812 kg. The average landing for this period was 99 kg/boat.

Purse seine

Purse seine landings of tuna was highest in Zamboanga City reaching 14,002,470 kg and a catch rate of 106,079 kg/boat. August registered a total landings of 2,341,532 kg and a catch rate of 292,692 kg/boat. An almost the same

landings of tuna was observed for the rest of the months.

May was observed to be the most productive months in Gen. Santos City with a landed catch of 487,143 kg then followed by December, 406,874 kg and July, 304,835 kg. Catch rate for the monitored period was 4,149 kg/boat.

Handline

Handline landings of tuna was highest in Gen. Santos City (2,722,200 kg) followed in Labuan (102,066 kg) and Sta. Cruz (57,576 kg).

March had the higest landings of tuna in Gen. Santos City,786,420 kg followed by April 723,210 kg and with a catch rate of 397 kg/boat and 338 kg/boat respectively.

In Labuan, Zamboanga City, December has a recorded catch of 19,868 kg then October, 17,750 kg and with a catch rate of 584 kg/boat and 591 kg/boat respectively. The average landing of tuna for the monitored period was 472 kg/boat.

Multiple handline

Multiple handline was only monitored in Labuan and has a total landed catch of 7,802 kg and a catch rate of 34 kg/boat. May, October and December were the months observed with a recorded landings of more than 1,000 kg.

Troll line

Troll line was also monitored only in Labuan. It has a total landed catch of 38,296 kg and a catch rate of 139 kg/boat. December was also the month observed with the highest landings (7,854 kg). The rest of the months have almost the same amount of tuna landings.

Bagnet

This gear is likewise monitored only in Zamboanga City. The total landed catch was 35,171 kg having a catch rate of 176 kg/boat for the

period monitored. A very high catch was observed in June (27,555 kg) with a catch rate of 810 kg/boat. The observed low catch was registered in December (66 kg) and with a catch rate of only 5 kg/boat.

D. Size distribution of Tuna

The size distribution of the different tuna species by the different fishing gear is presented in Table 4.

TABLE 1 NO. OF VESSELS MONITORED & TOTAL NO. OF TUNA LANDED & SAMPLED (1985)

SAMPLING CENTER	FISHING GEAR	VESSELS			LANDINGS (KG)		
		TOTAL NUMBER	NO. MONITORED	% MONITORED	TOTAL NO.	NO. SAMPLED	% SAMPLED
DAVAO DEL SUR							
STA. CRUZ	RINGNET	294	294	100	29,010	2,651	11.83
	HANDLINE	630	630	100	57,576	57,576	100.00
GEN. SANTOS CITY	RINGNET	1,535	255	17	10,781,044	4,963	0.05
	PURSE SEINE	463	147	32	1,921,015	3,695	0.19
	HANDLINE	8,291	1,940	23	2,722,200	446,621	16.41
MISAMIS ORIENTAL							
OPOL	RINGNET	363	236	65	272,585	1,722	0.63
	HANDLINE						
INITAO	HANDLINE						
ZAMBOANGA CITY							
LABUAN	RINGNET	494	320	65	1,114,264	16,958	1.52
	HANDLINE	216	202	94	102,066	11,500	11.27
	TROLL LINE	276	276	100	38,296	11,256	29.39
	MULTIPLE HANDLINE	228	191	84	7,802	1,018	13.05
RECODO	PURSE SEINE	132	132	100	14,002,470	360,331	2.57
BALIWASAN	BAGNET	200	138	69	35,171	2,824	8.03
	RINGNET	250	134	54	72,455	5,796	8.00

TABLE 2. PERCENTAGE SPECIES COMPOSITION BY SITE AND FISHING GEAR (1986)

SAMPLING CENTER	FISHING GEAR	SPECIES					
		SJ	YF	BET	FT	BT	ELT
DAVAO DEL SUR STA. CRUZ	RINGNET	78.04	11.65	–	9.45	0.86	–
	HANDLINE	0.49	98.05	1.46	–	–	–
GEN. SANTOS CITY	RINGNET	47.65	25.14	2.29	11.19	11.66	2.08
	PURSE SEINE	61.55	21.12	1.30	5.93	8.95	1.14
	HANDLINE	0.05	99.46	0.50	–	–	–
MISAMIS ORIENTAL							
OPOL	RINGNET	10.99	13.76	–	55.67	19.98	–
	HANDLINE						
INITAO	HANDLINE						
ZAMBOANGA CITY							
LABUAN	RINGNET	75.79	1.49	–	3.48	7.21	12.03
	HANDLINE	40.34	57.79	1.87	–	–	–
	TROLL LINE	53.97	45.96	0.07	–	–	–
	MOTHER HANDLINE	–	24.74	–	11.58	29.61	34.07
RECODO	PURSE SEINE	78.0	19.0	1.0	2.0	–	–
BALIWASAN	BAGNET	–	–	–	46.07	5.80	48.13
	RINGNET	–	1.64	–	51.94	33.72	12.70

TABLE 3. CATCH AND CATCH RATE OF TUNAS CAUGHT BY DIFFERENT FISHING GEAR PER AREA (1986)

SAMPLING CENTER	FISHING GEAR	TOTAL NO. OF VESSELS	TOTAL CATCH	CATCH RATE
DAVAO DEL SUR				
STA. CRUZ	RINGNET	294	29,010	99
	HANDLINE	630	57,576	91
GEN. SANTOS CITY	RINGNET	1,535	10,781,044	7,023
	PURSE SEINE	463	1,921,015	4,149
	HANDLINE	8,291	2,722,200	328
MISAMIS ORIENTAL				
OPOL	RINGNET	363	272,585	751
	HANDLINE			
INITAO	HANDLINE			
ZAMBOANGA CITY				
LABUAN	RINGNET	494	1,114,264	2,256
	HANDLINE	216	102,066	473
	TROLL LINE	276	38,296	139
	MARINE HANDLINE	228	7,802	34
RECODO	PURSE SEINE	132	14,002,470	106,079
BALIWASAN	BAGNET	200	35,171	176
	RINGNET	250	72,455	290

Table 4. Total tuna catch landed in Gen. Santos City by species, gear and by month (1986).

UNIT: METRIC TONS

FISHING GEAR	MONTH	NO. OF VESSEL	SPECIES							TOTAL
			SJ	YF	BET	FT	BT	ELT	OB	
RINGNET	JAN									
	FEB		NO SAMPLING ACTIVITY							
	MAR									
	APR	128	459	374	6	-	-	-	-	839
	MAY	147	253	238	-	41	8	-	-	540
	JUN	153	577	396	-	22	154	-	-	1,149
	JULY	159	330	363	18	4	35	2	-	752
	AUG	162	278	177	19	101	70	42	-	687
	SEPT	183	1,236	254	113	424	73	113	-	2,213
	OCT	252	620	591	76	420	759	55	-	2,521
	NOV	177	437	306	15	56	53	12	-	879
	DEC	174	947	11	-	138	105	-	-	1,201
TOTAL		1,535	5,137	2,710	247	1,206	1,257	224		10,781
PURSE SEINE	JAN									
	FEB		NO SAMPLING ACTIVITY							
	MAR									
	APR									
	MAY	45	316	129	1	25	16	1	-	488
	JUN	42	95	53	1	6	5	2		162
	JULY	54	204	65	3	18	9	6		305
	AUG	60	140	2	-	20	3	-	-	165
	SEPT	48	-	-	-	-	-	-	-	-
	OCT	63	30	14		23	126	5		198
	NOV	51	70	87	20	5	8	6		196
	DEC	60	328	56		17	5	1		407
TOTAL		463	1,183	106	25	114	172	21		1,921

CONTINUATION;

UNIT: Kg

FISHING GEAR	MONTH	NO. OF VESSEL	SPECIES							TOTAL
			SJ	YF	BET	FT	BT	ELT	OB	
	JAN									
	FEB									
	MAR	1,980	-	785,858	562	-	-	-	-	786,420
	APR	2,140	-	723,042	168	-	-	-	-	723,210
	MAY	604	-	200,350	-	-	-	-	-	200,350
	JUN	708	1,296	278,675	3,060	-	-	-	-	283,031
	JULY	843	-	193,458	7,743	-	-	-	-	201,201
	AUG	420	-	80,556	669	-	-	-	-	81,225
	SEPT	480	-	65,613	555	-	-	-	-	66,168
	OCT	873	-	175,695	744	-	-	-	-	176,439
	NOV	869	-	88,425	-	-	-	-	-	88,425
	DEC	474	-	115,731	-	-	-	-	-	115,731
TOTAL		8,291	1,296	2,707,403	13,501	-	-	-	-	2,722,200

TABLE 4. TOTAL TUNA CATCH LANDED IN OPOL MIS. OR. BY SPECIES, GEAR AND BY MONTH (1986)

FISHING GEAR	MONTH	TOTAL NO. OF BOATS	SPECIES				TOTAL CATCH (KG)
			SV	YF	FT	BT	
HANDLINE	JANUARY	60	1,632		14,206	10,656	26,494
	FEBRUARY	54			117,056		117,056
	MARCH	-					-
	APRIL	3				7,164	7,164
	MAY	12				33,852	33,852
	JUNE	21	100		201		301
	JULY	33	6,499	6,274	9,468		22,241
	AUGUST	57	9,019	11,388	5,426		25,832
	SEPTEMBER	39	4,090	14,671	-	817	19,578
	OCTOBER	27	2,721	2,369	1,814	1,962	8,867
	NOVEMBER	27	4,808	2,804	1,029		8,641
	DECEMBER	30	-	-	2559		2,559
	TOTAL	363	28,869	37,506	151,759	54,451	272,585

TABLE 4. TOTAL TUNA CATCH LANDED IN RECODO, Z. C. BY SPECIES, GEAR AND BY MONTH (1986)

FISHING GEAR	MONTH	TOTAL NO. OF BOATS	SPECIES				TOTAL CAT (KG)
			SV	YF	BET	BT	
PURSE SEINE	JANUARY						
	FEBRUARY						
	MARCH						
	APRIL	10	1,058,630	152,910		11,694	1,223,234
	MAY	20	1,558,880	300,518	8,742	21,434	1,898,574
	JUNE	20	1,166,176	158,208		114,790	1,439,174
	JULY	12	783,196	187,088		35,544	1,005,828
	AUGUST	8	1,594,112	616,484	113,360	17,596	2,341,532
	SEPTEMBER	12	1,099,802	415,680	11,732	7,676	1,534,890
	OCTOBER	14	972,906	285,908	3,360	9,270	1,271,444
	NOVEMBER	18	1,175,790	202,496		10,724	1,389,010
	DECEMBER	18	1,515,254	370,482		13,048	1,898,784
	TOTAL	132	10,924,746	2,689,754	146,194	241,776	14,002,470

TOTAL TUNA CATCH (KG) LANDED IN LABUAN, Z. C.
BY RINGNET (1986)

MONTH	TOTAL NO. OF BOATS	SPECIES							TOTAL CATCH (KG)
		SV	YF	FT	BT	ELT			
JANUARY									
FEBRUARY									
MARCH									
APRIL	26	31,496		3,632	2,934	7,276			45,338
MAY	66	234,310	544	5,168	6,736	20,672			267,430
JUNE	54	133,852	1,972	2,516	6,452	11,912			156,704
JULY	52	95,010	1,904	3,604	8,976	10,344			119,836
AUGUST	58	56,454	2,108	5,236	9,248	13,124			86,170
SEPTEMBER	58	62,162	1,088	4,352	11,560	11,604			90,766
OCTOBER	60	45,402	2,584	6,740	7,414	23,984			86,124
NOVEMBER	54	77,094	2,380	4,352	7,276	19,720			110,822
DECEMBER	66	103,720	4,012	3,138	19,788	15,424			151,082
TOTAL	494	844,500	16,592	38,738	80,374	134,060			1,114,264

TOTAL TUNA CATCH (KG) LANDED IN LABUAN, Z. C.
BY HANDLINE (1986)

MONTH	TOTAL NO. OF BOATS	SPECIES							TOTAL CATCH (KG)
		SV	YF	BET					
JAN									
FEB									
MAR									
APR	8	684	1,084						1,768
MAY	38	4,302	6,894	374					11,570
JUN	16	3,218	4,724	160					8,102
JUL	20	5,730	3,966	208					9,904
AUG	24	3,348	6,202	32					9,582
SEP	24	3,296	6,218	186					9,700
OCT	30	7,324	9,764	232					17,720
NOV	32	7,052	6,450	350					13,852
DEC	34	5,824	13,676	368					19,868
TOTAL	216	41,134	58,982	1,910					102,066

TOTAL TUNA CATCH (KG) LANDED IN LABUAN
ZAMB. C. BY MULTIPLE HANDLINE (1986)

MONTH	TOTAL # OF BOATS	SPECIES							TOTAL CATCH (KG)
		SJ		BET	FT	BT	ELT	YF	
JANUARY									
FEBRUARY									
MARCH									
APRIL	10					58	48	46	152
MAY	32					600	740	156	1,496
JUNE	20					198	340	158	696
JULY	20				52	304	226	92	674
AUGUST	24				132	298	212	174	816
SEPTEMBER	26				80	238	88	188	594
OCTOBER	30				242	380	210	324	1,156
NOVEMBER	30				132	-	238	420	790
DECEMBER	36				266	234	356	372	1,428
TOTAL	228				904	2,310	2,658	1,930	7,802

TOTAL TUNA CATCH (KG) LANDED IN LABUAN
ZAMB. C. BY TROLL LINE (1986)

MONTH	TOTAL # OF BOATS								TOTAL CATCH (KG)
		SJ	YF	BET	FT	BT	ELT	OB	
JANUARY									
FEBRUARY									
MARCH									
APRIL	18	1,524	314						1,838
MAY	26	2,914	636						3,550
JUNE	30	2,992	830						3,822
JULY	30	2,992	978						3,970
AUGUST	26	1,826	2,006						3,832
SEPTEMBER	28	1,444	3,498						4,942
OCTOBER	32	1,290	2,254	26					3,550
NOVEMBER	34	2,756	2,382						5,138
DECEMBER	52	3,152	4,702						7,854
TOTAL	276	29,670	17,600	26					38,296

TABLE 5. SIZE DISTRIBUTION OF TUNAS CAUGHT BY DIFFERENT FISHING GEAR (1986)

SAMPLING CENTER	FISHING GEAR	SIZE RANGES (cm)					
		SJ	YF	BET	PT	BT	ELT
DAVAO DEL SUR							
STA. CRUZ	RINGNET	10-68	21-70	–	13-28	10-20	–
	HANDLINE	31-67	31-167	–	–	–	–
GEN. SANTOS CITY	RINGNET	18-48	20-61	19-39	20-31	19-27	20-25
	PURSE SEINE	19-48	21-46	18-20	16-32	15-26	20-23
	HANDLINE	–	64-162	31-167	–	–	–
MISAMIS ORIENTAL							
OPOL	RINGNET	16-61	17-60	–	20-33	16-29	–
	HANDLINE	–	–	–	–	–	–
INITAO	HANDLINE						
ZAMBOANGA CITY							
LABUAN	RINGNET	39-64	–	–	21-38	21-30	21-48
	HANDLINE	37-62	36-149	39-128	–	–	–
	TROLL LINE	28-67	38-161	49-54	–	–	–
	MULTIPLE HANDLINE	–	–	–	21-38	20-31	22-38
RECODO	PURSE SEINE	22-75	21-164	72-165	–	22-49	–
BALIWASAN	BAGNET	–	19-26	–	12-49	15-48	12-48
	RINGNET	–	23-38	–	14-49	21-46	12-36

TUNA TAGGING IN THE PHILIPPINES, THAILAND, AND MALAYSIAN WATERS

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INTRODUCTION

During the past decade, world tuna landings increased markedly; especially active have been the fisheries in the western Pacific Ocean. In 1985, the total world tuna and billfish landings were reported in FAO statistics (FAO 1985) as 3.15 million metric tons (mt), an increase of 63% over landings for 1975. Landings in the Pacific Ocean for 1985 were 2.05 million mt, representing 65% of the world landings. The importance of the western Pacific Ocean is exemplified by the FAO statistical area 71 (Figure 1), in which 29 of the 48 world-recognized scombrid species occur (Collette and Nauen 1983) and catch represents 49% of the Pacific landings for 1985 (FAO 1985).

In an effort to understand more about the tuna resources in the western Pacific Ocean, the Indo-Pacific Tuna Development and Management Programme (IPTP) in 1983-84 cooperatively undertook a tuna tagging study with the Government of Indonesia. The study's results are summarized in Phuket tuna meeting report (FAO 1986). To broaden the tagging program, the IPTP engaged the author of the present report to formulate a plan to conduct tuna tagging in Philippines and Thailand-Malaysian waters.

The terms of reference of this consultancy were as follows:

(1) detail major objectives of tuna tagging in the region,
(2) list target species and number of fish expected to be tagged,
(3) describe the fishing vessel and gear to be used,
(4) develop a time schedule,
(5) calculate budget estimates, and
(6) detail the arrangements to implement the project.

Prior to preparing this report, the author visited the Philippines (Manila and General Santos City), Thailand (Bangkok), and Malaysia (Penang) to consult with fishery officials, tuna scientists, and industry representatives (Appendix Table A). The tour was to include Indonesia; however, time constraints prevented this portion of the consultation to be completed.

REVIEW OF TUNA TAGGING

In developing the strategies for tuna tagging in the Philippines and the Thailand-Malaysia regions, considerable value was gained in reviewing previous tuna tagging efforts. The following sections briefly summarize the results of this review.

Tags

The Atlantic bluefin tuna (Thunnus thynnus) was the first tuna species for which movement was described by tagging information. In 1961, a bluefin tuna landed off Bergen, Norway (Mather 1962) was determined to have originated in the Mediterranean Sea, based on the type of hook found embedded in the tuna's mouth. Although the tagging was inadvertent, the results demonstrated the value of tag placement on pelagic fishes.

Not until the 1950's was a concerted effort made by directed tagging programs to describe the movement of tunas in the eastern Pacific. The California Division of Fish and Game began using plastic loop tags on tunas in 1953 (Wilson 1953). The tag information (tag number and where the tag should be returned) was written directly on the plastic tubing. The tubing was inserted through the upper portion of the fish (posterior of the second dorsal fin) with the aid of a stainless steel tubing. The tag was secured by tying both ends together.

The loop tag was not very satisfactory because it was time consuming to affix the tag and, especially, to secure the ends. Although the latter was resolved by using a "figure eight" knot, tagging time remained a problem until the subsequent development of the dart tag. The dart tag consisted of a length of plastic tubing onto which a solid head with a single barb was affixed at one end. The standard procedure adapted was to secure the tag near the base of the second dorsal fin with the aid of a short length of stainless steel tubing. The tubing was sharpened at one end to permit ease in penetrating the tuna's skin.

The dart tag as described above has been used by research agencies in tagging various species of tunas, including the yellowfin (T. albacares), skipjack (Katsuwonus pelamis), bigeye (T. obesus), albacore (T. alalunga), northern bluefin (T. thynnus), and southern bluefin (T. maccoyi). Additional details of tuna and billfish tagging are reported by Bayliff and Holland (1986). The most extensive use of the dart tag to date has been the skipjack tagging program conducted by the South Pacific Commission (Kearney 1982).

Presently, there are several commercial manufacturers of dart tags: Floy Tag Co. (U.S.A.), Fuyo Sangyo Co. (Japan), and Hallprint, Pty, Co. (Australia). Based on limited interviews with scientists involved in recent tuna tagging experiments, the tags produced by Hallprint are highly recommended. Instead of dart heads that are secured to the tubing by glue, the Hallprint tag heads are molded onto the polyethylene tubing. An additional feature is that the tag consists of two pieces of tubing: An outer tubing protects the writing placed on the inner tubing from abrasion.

Method of Fish Capture for Tagging

Although tuna are taken by a wide range of fishing gear, the suitability of tuna for tagging purposes is limited to a few. The attributes of a good method of capture for tagging purposes include 1) the ability to release tuna in an "undamaged" and unstressed condition, 2) accessibility to a large number of fish, and 3) accessibility to the desired size of fish.

Table 1 provides a rough indication of the suitability of tuna for tagging, based on method of capture. The evaluation is generalized and subjective because some gear types are excellent for some tuna species but not for others; e.g., based on tag recoveries of 5-6% trolling apparently is a satisfactory method of capture for albacore tagging (Laurs and Wetherall 1981). Although not fully tested, it is unlikely that skipjack tuna caught by troll gear can be considered good candidates for tagging because their jaws are easily damaged by the gear. Furthermore, shoreside experiments conducted in Hawaii demonstrated that of the three tuna species (yellowfin, kawakawa, and skipjack) routinely maintained in captivity, skipjack tuna are by far the most susceptible to stress from handling, thus, leading to mortality (Queenth and Brill 1983).

Of the several methods of capture evaluated for tuna tagging, the pole-and-line gear has been the most successfully used to date. Large numbers of small to medium sized tunas can be tagged over a short period, and time from capture to release is generally less than 10 seconds. Marr 1963 reported that skipjack tuna were tagged in less than 4 seconds in one tagging experiment; however, the fish were not measured.

The success of fish caught by purse seine for tagging has not been rated high; the problem probably rests with the long period it takes from the time the gear is set until tagging takes place. The tuna probably becomes highly stressed as the "pocket" becomes small enough for the taggers to retrieve the fish. The stress apparently causes physiological changes in the animal that result in delayed mortality. After extensive trials, the Inter-American Tropical Tuna Commission (IATTC) abandoned tagging of tunas caught by purse seine; the recovery rate of yellowfin tuna was judged to be lower than achieved by pole-and-line tagged fish. Also, of 1,363 skipjack tuna caught by purse seine and tagged only 15 (1.1%) were recovered (Bayliff 1973). If fish can be tagged from the early phases of the purse seine operation, the method could result in large numbers of good quality fish being tagged.

With the exception of gill nets, other methods of capture (troll, longline, and handline) can be used for tagging tunas; however, a major shortcoming of these methods is that substantially fewer fish are caught than by the pole-and-line or the purse seine methods. Also, there are some fish size limitations with these gears. The fish caught by gill net generally are landed dead or too badly damaged for tagging.

Recovery Rates

The time between capture and release of the tagged fish is crucial for successful recovery. Data verifying this factor are not abundant; however, it should be noted that the recovery rate in Hawaii of skipjack tuna tagged by loop tags was considerably lower than that of skipjack tuna tagged by dart tags (0.6 vs 9.28%); the dart tag can be applied substantially faster than the loop tag (Marr 1963).

Recovery rates of tagged fish should not be used as the sole criterion to measure success of a tagging project. Low recovery rates may simply reflect a large population base or that the fish migrated from the area and were not available to subsequent fishing effort. Nonbiological factors possibly contributing to low recovery rates include high tagging mortality, tag loss and the nonreturn of tags after capture.

Table 2 provides some tag release and recovery data from previous tagging experiments. As noted above, the tag recovery rates should be viewed with caution.

Tag Rewards

Rewards have been used as a means to encourage the return of tags along with the necessary recovery data. These rewards range from gifts of printed T-shirts and caps to monetary gifts. Table 3 provides some examples of the types of rewards issued by previous tuna tagging programs. To emphasize the need for return of tags, most tagging programs have incorporated a system of annual lotteries, whereby monetary gifts are given to the selection of tag numbers representing tag returns from the previous year.

TUNA TAGGING IN THE PHILIPPINES

The tuna fisheries in the Philippines have shown a remarkable growth since 1971, when the total tuna catch for the Philippines was reported at 9.0 thousand metric tons. By 1985, the catch had risen to 261.6 thousand metric tons, and tuna landings represented 20% of the marine fish production of the Philippines. The principal fishing grounds are the waters off Mindanao Island; about 58% of the total tuna catch for the Philippines comes from this region although tuna are taken throughout the Philippine Archipelago. All tuna species are taken throughout the year; however, there appears to be a peak in August-September for the southern waters of Mindanao Island.

Of the 48 scombroid species recognized by tuna systematists (Collette and Nauen 1983) 29 species are in FAO statistical area 71, which encompasses the Philippines. The major part of the Philippines tuna catch, however, consists of five species: frigate and bullet tunas (36.6%), yellowfin tuna (24.6%), skipjack tuna (23.0%), and kawakawa (16.0%).

The types of gear used to capture tuna vary and include the purse seine (49%), ring net (35%), and bag net (13%). The remaining catch is made by drift gill nets, lift nets, seine nets, longline, handline, and troll gear. It should be noted that several of the gear types use the payaos as part of their fishing operations; e.g., ring-net gear and handline fishing by bancas.

Objectives of Tuna Tagging Program

Development of the tuna fisheries as a major industry in the marine production sector of the Philippine economy has given rise to a number of pertinent questions by the fishing industry and government agencies: 1) Can this catch be sustained? 2) What is the size of the resource base of the several tuna species being harvested? 3) What is the impact on the resource base of the large catches of small sized tunas associated with payaos? 4) Are the small sized tunas present around the payaos products of spawning in Philippine waters? 5) Not all size classes of tunas are present in the fishing grounds; what are their migratory pathways into and out of the region? 6) What are the interactions between gear? Although solutions to some these questions require information beyond that provided by tagging (e.g., detailed catch and effort data for stock assessment studies), a well-designed tagging program can provide a wealth of information regarding the dynamics of the tuna resources and the fisheries.

The objective of the present effort is to develop a tuna tagging technique that can form the basis for later tagging studies designed to address specific questions.

Method of Tagging

At the tuna meeting held in Phuket, Thailand, in August 1986, a recommendation was made to undertake tuna tagging in the southern Mindanao Island region (FAO 1986). A review of the fisheries based in General Santos revealed that ring-netting, handlining from bancas, and longlining were the principal methods used in the region. Reportedly, several bancas used a pole-and-line fishing operation with live bait to catch tunas in the region; this has not been confirmed to date.

Two of these three methods--handlining from bancas and longlining--were eliminated as potential sources for capturing tunas for the tagging project, because of the expected small catch and relatively large size of tunas. There are, however, several viable options as sources of tunas for tagging:

(1) If a pole-and-line banca fishery exists, charter one bancas and conduct tagging via surface schools or by fishing around payaos; the latter would require prior arrangements with the payao owner.

(2) Tag tuna caught by the ring-net fishery; tagging should take place after the "pocket" is small enough to catch fish for tagging.

(3) Tag tuna caught by the ring-net fishery; modify tagging operations to reduce stress of tagged fish; several modifications could be included:

   (a) operate in conjunction with pole-and-line fishing banca using live bait,

   (b) pole-and-line fishing with lures only from a skiff immediately after the ring net has been set, and

   (c) divert part of the commercial catch into a small net impoundment placed adjacent to the ring net; tagging can be done after commercial fishing has been completed.

(4) Convert existing fishing vessel (e.g., trawler) to conduct pole-and-line fishing operations.

(5) Charter a pole-and-line vessel from outside the region; e.g., a commercial pole-and-line vessel from Indonesia fishery.

Evaluation of Methods of Capture

The following provides some comments regarding each of the options listed above:

Option 1 is advantageous because the viability of fish caught for tagging by a pole-and-line operation is good. The disadvantages include the possible difficulty in obtaining adequate supplies of baitfish and the expected difficulty of tagging from a banca; e.g., limited space and the presence of two outriggers.

Option 2 would provide a very large supply of tuna, but the bulk of the catch probably would not be suitable for tagging. The latter could be tested by retaining tagged fish for 4-5 days in a small holding pen adjacent to the payao.

Option 3 also would provide a very large supply of tuna. The modifications (Options 3a-c), if successful, should lead to accessibility of good quality fish.

Option 4 has the advantage of a pole-and-line operation; thus, it has the potential of tagging large numbers of viable tuna. The disadvantages include the apparent lack of a steady supply of baitfish and the relative high cost of converting and operating a pole-and-line vessel over a short tagging period. During the South China Sea Programme, the Bureau of Fisheries vessel, Paeneus Monodon was converted into a pole-and-line vessel

at a reported cost of about $(US)20-25 thousand (Lee 1978). Operational costs could conceivably amount to $(US)20 thousand per month.

Option 5 has the same advantage as Option 4. The disadvantages include the possible lack of a steady baitfish supply and charter costs could equal about $(US)25 thousand per month.

Projection of Fish to be Tagged

A mission report (FAO 1986) proposed a tagging goal of 20,000 tunas over a 1- to 2-month tagging program in the Philippines. At this time, projecting a meaningful number of fish to be tagged would be difficult because a proven tagging protocol has not been developed for this region. Furthermore, it is unlikely that the conventional pole-and-line method of tagging fish will be the eventual mode of operation for the Philippines; thus, experiences from other areas that use this tagging technique are not applicable to tagged fish projections in the Philippines. It should be noted that the IATTC and the SPC, two research oranizations with extensive experience in tuna tagging, averaged about 250 fish tagged per fishing day. Individual highs exceeded 1,000 tagged fish by the SPC (Kearney 1970).

Rather than focus on a specific number of fish to be tagged, the present project proposed for the Philippines should be directed toward the development of a tagging protocol that could serve future tagging efforts in the region. Future tagging objectives will dictate the number of fish to be tagged and the time and space distribution of tagged fish.

Budget and Projected Time Schedules

Table 4 provides rough budget estimates for the several options noted in this section. Figure 2 gives some indication of the time schedules for these options. Generally, the options involving vessel conversion or charter or both (Options 4 and 5) will involve considerable lead time before field work can be conducted.

TUNA TAGGING IN THAILAND WATERS

During the past decade, Thailand has become the major canned tuna exporting nation in the world. In 1985, the production of canned tuna by Thailand was 10.9 million standard cases; 57% of the canned tuna was shipped to markets in the U.S.A. (Herrick 1986). Although the production sector of the Thailand tuna fishery has shown some growth, the major part of the supply for the canning industry has been through purchases from outside sources. The tuna fishery in Thailand increased steadily from 6.5 thousand mt landed in 1973 to 82.0 thousand mt in 1983; the 1984 landings showed a decline to 69.2 thousand mt (FAO 1986).

Tunas are caught in the Gulf of Thailand and along the west coast of Thailand by several types of gear; the principal gear types include drift gill nets and purse seines (Thai purse seine and the luring purse seine). Catches in 1984 were 26.4% and 70.3% for the two gear types, respectively (FAO 1986). About 85.8% of the Thailand tuna catch was taken from the Gulf of Thailand.

Longtail tuna, kawakawa, and frigate tuna are the principal tuna species taken by the various gear types; all three species are taken throughout the year. In 1979-81, exploratory cruises conducted by an FAO/UNDP project revealed the presence of skipjack tuna in commercial abundance off the west coast of Thailand (Lee 1982). A fishery for this species, however, is yet to be developed.

Objectives of a Tagging Program

A need exists for determining the dynamics of the longtail tuna resource in the Gulf of Thailand; however, tagging as a means to define the migratory pathways of the longtail tuna was not considered as a high priority research objective by Thailand. Instead, high priority was given to identifying the size of the skipjack tuna resource in the waters off the west coast of Thailand. Reference was drawn to the tagging study undertaken in 1977-1980 by the South Pacific Commission, which concluded that a large skipjack tuna resource existed in the central and western Pacific Ocean. The skipjack tuna resource in the SPC region was estimated to exceed 3.0 million metric tons (Kleiber 1983); the tagging data revealed a complex pattern of movement. Conceivably, the skipjack tuna resource in the eastern Indian Ocean is large and undergoes movement through waters of Indonesia, Malaysia, Thailand, and the Nicobar-Andaman Island regions. Although a well-designed, large-scale tagging program could aid materially in understanding this resource, a major drawback in initiating such an extensive tagging program at this time is the lack of wide-ranging fisheries for skipjack tuna in the eastern Indian Ocean. With the exception of coastal fisheries for skipjack tuna in western Indonesia, the only catches of skipjack tuna currently made in the region are from artisanal fisheries operating in near-coastal waters. The lack of extensive surface fisheries for tuna reduces the probability of successful recapture of tagged fish.

Although not covered under the terms of reference for this report, it would seem that some exploratory fishing would be more appropriate for the western Thailand region at this time.

Method of Tagging

The occurrence of adequate supplies of baitfish species suggests that a pole-and-line fishery, although not presently in existence in Thailand, would be the best method for a tagging program in the region for skipjack tuna or longtail tuna. In 1979, an FAO/UNDP project converted a commercial trawler to operate as a pole-and-line vessel (Lee 1982).

If this vessel is still available, the cost of implementing a tagging program will be reduced accordingly.

An alternative source of a fishing platform would be to charter one of the commercial tuna pole-and-line vessels operating in Indonesia. An earlier feasibility study of tuna tagging in the region (Gillett 1981) reported that the cost of chartering a 100-ton, commercial, pole-and-line vessel from the commercial fishery in Indonesia was about $(US)25 thousand per month.

Should a decision be reached to undertake a tagging program restricted to the longtail tuna, an alternative to the pole-and-line method would be to tag fish from a trolling operation.

Number of Fish Expected to be Tagged

It would not be unreasonable to expect to tag 200-400 fish per fishing day if a suitable pole-and-line vessel is used for the tagging program. These estimates are based on the extensive tagging conducted in the eastern Pacific Ocean by IATTC and in the central and western Pacific by the SPC and various Japanese research agencies. Assuming 30 days of pole-and-line fishing during a 2-month tagging program, one can expect about 9,000 fish to be tagged.

If troll vessels are used to tag longtail tuna, the expected number of tuna tagged per day could range up to 100 fish per day. Assuming conditions of 1) 40 fishing days, 2) a daily catch of 75 viable fish for tagging, and 3) engaging three commercial troll vessels for the tagging program, the total number of fish projected for the proposed program is 9,000 longtail tuna.

Budget and Time Table

Table 5 provides an estimated cost of the several options described above, to implement a tagging program in the Thailand region. It should be noted that a tagging program for skipjack tuna or longtail tuna should include Malaysia and Indonesia.

A time table is provided in Figure 3, covering the several options described above.

TUNA TAGGING IN MALAYSIAN WATERS

Presently tuna represents only a small proportion of the total marine fish landings of Malaysia. In 1983, the total tuna landings were reported as about 19,000 mt: 16,000 mt from the fisheries based along the east coast of Peninsular Malaysia and about 3,000 mt from the fisheries based on the west coast (FAO 1986).

The principal methods used in tuna fishing include the drift gill nets and trolling gear; both gear types account for about 90% of the total tuna catch in Malaysia.

Similar to the tuna landings in Thailand, the principal species taken by the tuna fisheries of Malaysia are the longtail tuna and kawakawa. The two species make up about 99% of the tuna landings. Small amounts of frigate, skipjack, bullet, and oriental tunas also are landed.

Objectives of a Tagging Program

A high priority has been placed by Malaysia to define the migratory pathways of the longtail tuna in Malaysian waters and to determine the size of the resource. There is a need to determine whether this species moves into other areas of the Gulf or even into waters outside of the Gulf of Thailand; e.g., Indonesian waters.

Another area identified for a tagging experiment is the region around Sabah and Serawak, where skipjack and yellowfin tuna are taken by commercial fisheries. Until recently, a ring-net fishery using payaos operated off Sabah; however, the present status of this fishery is unknown.

Method of Tagging

Among the existing methods of tuna fishing currently used in Malaysia, trolling appears to be suitable for tagging the longtail tuna. Troll vessels are common along the east coast of Peninsular Malaysia, especially at Terengganu, which is one of the principal tuna landing ports. Troll vessels are reported to average about 500 kg of longtail tuna per trip during the peak season (June-August), each trip lasting about 5 days.

Because pole-and-line fishing is not used in Malaysia, an implementation of this technique for a tagging program will entail converting an existing fishing vessel into pole-and-line fishing or chartering a vessel from outside the region; e.g., Indonesia.

Number of Fish Expected to be Tagged

During a 2-month tagging period, a single tagging operation on a commercial troll vessel should tag about 2,500 fish. This assumes 1) an average catch of 500 kg longtail tuna, 2) an average size of longtail tuna of 1.2 kg, 3) about 75% of the catch being viable for tagging, and 4) making eight fishing trips during the 2-month period. It would not be unreasonable to project a three-vessel tagging operation based in Terengganu, thus, tagging about 7,500 longtail tuna.

Budget and Timetable

Table 6 provides budget estimates for the several options discussed above; Figure 4 provides a general time table for these options. As expected, the time needed to prepare for a tagging program involving a pole-and-line vessel will be considerably longer than making arrangements with commercial troll vessels.

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Figure 1. FAO statistical areas for the Pacific Ocean

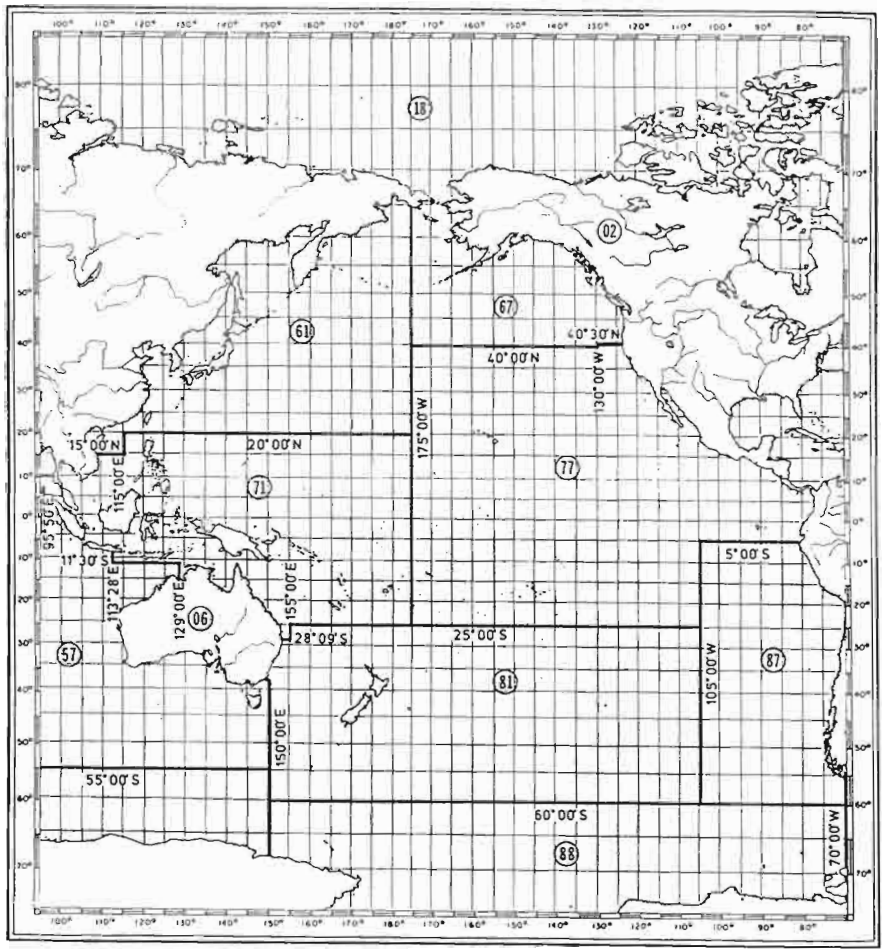

Table 1.--General evaluation of method of capture for tagging purposes.

Method	Potential large catch	Quality of fish	Size of fish
Pole-and-line	High	Good	Small-medium
Purse seine	Very high	Poor-medium	Small-large
Troll	Low-medium	Medium-good	Small-large
Gill net	Low-medium	Poor	Small-large
Longline	Low	Poor-Medium	Medium-large
Handline	Low	Good	Small-large

Table 2.—Recovery rates of tuna tagging experiments.

Area	Date	Agency	Type of tag	Method capture	Number tagged	Number recaptured	Recovery (%)
			SKIPJACK TUNA				
HAWAII	1954-56	POFI	LOOP	P&L	742		0.6
HAWAII	1957	POFI	DART	P&L	8,161		9.2
PALAU	1968	POFI	DART	P&L	265	5	1.9
E.PAC.	1969(?)	IATTC	DART	PS	1,363	15	1.1
E.PAC.	1952-64	IATTC	DART	P&L	90,412	4,381	4.8
PNG		PNG	DART	P&L			14.0
FR.POL.	?	IATTC(?)	DART	P&L			0.3
CWPAC	19__-82	SPC	DART	P&L	ca.140,000		4.3
INDON	1983/84	I/IPTP	DART	P&L	378	1	0.3
INDO	1984	I/IPTP	DART	P&L	5,361	18	0.3
WPAC		JAPAN	DART	P&L			
ATLAN	1987	ICCAT	DART	?	2,264	125	5.5
			YELLOWFIN TUNA				
E.PAC.	1969	IATTC	DART	PS	8,000		ca. 6.0
E.PAC.	1952-64	IATTC	DART	P&L	59,547	8,397	14.1
CWPAC	19__-82	SPC	DART	P&L			
INDO	1983	I/IPTP	DART	P&L	134	1	0.7
INDO	1984	I/IPTP	DART	P&L	575	1	0.2
WPAC	?	JAPAN	DART	P&L			
			SOUTHERN BLUEFIN TUNA				
AUST	1983-84	AUST	DART	P&L(?)	ca.10,000	4,000	40.0
			ALBACORE TUNA				
NPAC		NMFS	DART	TROLL			
NPAC		JAPAN	DART	P&L(?)			
SPAC		NMFS	DART	TROLL		2	
SPAC		ORSTOM	DART	TROLL			
SPAC		NZ	DART	TROLL			

Table 3.--Rewards for return of tuna tags.

South Pacific Commission

Tag return--- $2.00 (local currency) or one T-shirt with tagging logo paid for each tag returned to SPC

Lottery------ annual lottery held with monetary prizes given for top 3 tag numbers randomly selected; prizes totaled $2.0 thousand dollars (US)

AUSTRALIA

Tag return-- $5.00 (A) paid for each tag returned

Lottery------ annual lottery held; prizes of $400, $600 and $1,000 given to first three numbers randomly selected

ATLANTIC

Tag return--- $5.00 (US) paid for each tag returned

Lottery------ annual lottery held; $500 (US) for tropical tunas (yellowfin, bigeye and skipjack); $500 (US) for temperate tunas (albacore and bluefin) and billfishes

U.S.A. (ALBACORE TUNA)

Tag return--- baseball cap with logo and $2.00 (US) paid for each "standard"tag recovery; $50.00 (US) paid for tag and fish (tetracycline injected fish); additionally, cannery price paid for fish

Lottery------ 3-5 drawings; cash awards ($150-$300 US) for first two winners; cases of tuna given to other winners

Table 4.--Budget estimate for tuna tagging in Philippine waters.

Object class	Estimated cost (thousand US dollars)	Options 1	2	3A	3B	3C	4	5
PERSONNEL								
Project Leader (8months)	1.0	X	X	X	X	X	X	X
Bio-tech (4mo)	0.8	X	X	X	X	X	X	X
Bio-tech (4mo)	0.8	X	X	X	X	X	X	X
Consultant (3 weeks)	4.2	X	X	X	X	X	X	X
Admin. support (host country)		X	X	X	X	X	X	X
Sea Duty stipend	3.2	X	X	X	X	X	X	X
TRAVEL								
Consultant	4.0	X	X	X	X	X	X	X
PL(domestic travel)	1.0	X	X	X	X	X	X	X
TAGGING PLATFORM								
Banca charter	?	X	0	X	0	0	0	0
P&L								
conversion	25.0	0	0	0	0	0	X	0
operating (3 mo)	45.0	0	0	0	0	0	X	0
charter	75.0	0	0	0	0	0	0	X
Ring-net owner	?	0	X	X	X	X	0	0
EQUIPMENT/SUPPLIES								
Tags (10,000)	5.0	X	X	X	X	X	X	X
Tagging needles (600)	1.2	X	X	X	X	X	X	X
Cradles (3)	0.3	X	X	X	X	X	X	X
Tape recorders(3)	0.3	X	X	X	X	X	X	X
Calipers(3)	0.3	X	X	X	X	X	X	X
Micro-computer	5.0	X	X	X	X	X	X	X
Holding pen	1.0	0	X	X	X	X	0	0
OTHERS								
Posters	0.2	X	X	X	X	X	X	X
Printed T-shirts	2.0	X	X	X	X	X	X	X
Lottery awards (3 yrs)	3.0	X	X	X	X	X	X	X
Data mgt	1.0	X	X	X	X	X	X	X
MISCELLANEOUS	4.0	X	X	X	X	X	X	X
TOTAL	-							

1/ X denotes item to be included in the option
O denotes item not to be included in the option

Figure 2.—Projected timetable for tuna tagging program in Philippine waters.

Activity	1	2	3	4	5	6	7	8	9	10	11	12
	(months)											
1. Selection/appointment of Consultant and Project Leader (1 mo)	/—/											
2.Work out arrangements/ agreement with government (2 mo)		/——/										
3. Project preparation (includes arrangement for tagging platform, purchase equipment/supplies,posters, logbooks,develop data mgt system) (2 mo)		/——/										
4. Implementation of field work (2 mo)			/——/									
5. Analysis/write up of report (2 mo)				/——/								
6. Present results to Government and fishing industry (2 wks)					/—/							

Table 5.—Budget estimate for tuna tagging in Thailand waters.

Object class	Estimated cost (US dollars)	Pole-and-line convert	Pole-and-line charter	Troll	Purse seine
PERSONNEL					
Project Leader (8 mo)	2.9	X	X	X	X
Bio-tech (4mo)	1.0	X	X	X	X
Bio-tech (4mo)	1.0	X	X	X	X
Consultant	4.2	X	X	X	X
Admin. support	Host Country	X	X	X	X
Sea duty stipend (240 sea-days)	1.9	X	X	X	X
TRAVEL					
Consultant	4.0	X	X	X	X
Proj.Leader (domestic)	0.5	X	X	X	X
TAGGING PLATFORM					
Conversion	25.0	X	0	0	0
Operation (3mo)	45.0	X	0	0	0
Charter P&L(3mo)	75.0	0	X	0	0
Charter Troll(3vess.)	?	0	0	X	0
Purse seiner (RV CHULABORN 3mo)	60.0				
EQUIPMENT/SUPPLIES					
Tags (10,000)	5.0	X	X	X	X
Tagging needles (600)	1.2	X	X	X	X
Tagging cradles (3)	0.3	X	X	X	X
Calipers (3)	0.3	X	X	X	X
Micro-computer(1)	5.0	X	X	X	X
OTHERS					
Posters	0.2	X	X	X	X
Printed T-shirts(800)	2.0	X	X	X	X
Lottery awards (3yrs)	3.0	X	X	X	X
Data mgt	1.0	X	X	X	X
MISCELLANEOUS	4.0	X	X	X	X
TOTAL	-				

1/ X denotes item to be included in the option
O denotes item not to be included in the option

Figure 3.—Projected timetable for tuna tagging program in Thailand waters.

Activity	1	2	3	4	5	6	7	8	9	10	11	12
	(months)											
1. Selection/appointment of Consultant and Project Leader (1 mo)	/.../											
2. Work out arrangement/ agreement with Government (1.5 mo)	/...../											
3. Arrangement for tagging platform												
a. Convert vessel (3 mo)	/...../											
b. Charter (2.5 mo)	/...../											
c. Engage troll vessels (1 mo)	/...../											
4. Preparation (purchase of equipment/supplies) (2 mo)	/...../											
5. Conduct field work (2 mo)					/...../							
6. Analysis/write-up of results (2 mo)							/...../					
7. Present results to Government and fishing industry (2 wks)											/.../	

Table 6.—Budget estimate for tuna tagging in Malaysian waters.

Object class	Troll operation (Thousand US dollars)
PERSONNEL	
Project Leader (8 mo)	4.8
Bio-tech (4 mo)	1.4
Bio-tech (4 mo)	1.4
Bio-tech (4 mo)	1.4
Consultant (3 weeks)	4.2
Admin. support	Host country
Sea duty stipend	2.4
TRAVEL & PER DIEM	
Consultant	4.0
Project Leader (domestic travel)	0.5
TAGGING PLATFORM	
Usage costs (3 vessels)	9.6
Payment tagged fish (7,500)	6.0
EQUIPMENT/SUPPLIES	
Tags (10,000)	5.0
Tagging needles (600)	1.2
Tagging cradles (3)	0.3
Calipers (5)	0.5
Micro-computer (1)	5.0
OTHERS	
Posters	0.2
Printed T-shirts (800)	2.0
Lottery awards (3years)	3.0
Data mgt	1.0
MISCELLANEOUS	4.0
TOTAL	57.9

Figure 3.—Projected timetable for tuna tagging program in Malaysian waters.

Activity	1	2	3	4	5	6	7	8	9	10	11	12
	(months)											
1. Selection/appointment of Consultant and Project Leader (1 mo)	/../											
2. Work out arrangements/ agreement with government (1.5 mo)		/..../										
3. Work out arrangement for tagging platform (1 mo)		/../										
4. Preparation-purchase of equipment/supplies (2 mo)			/...../									
5. Conduct field work (2 mo)				/...../								
6. Analysis/write-up of results (2 mo)						/...../						
7. Present results to Government and fishing industry (2 wks)							/../					

Appendix Table A.—Meetings and consultations.

Several meetings and consultations were held during the consultant's visit of the Philippines, Thailand, and Malaysia. Individuals met included the following:

Philippines

Manila—(meeting in the conference room of BFAR on 10 August 1987)

Dr. Virginia Aprieto, College of Fisheries, Univ. Philippines
Mrs. Aurora Reyes, BFAR
Ms. Filomena Gande, Planning Officer, BFAR
Mr. Reuben Ganaden, Chief, Fisheries Biology Section, BFAR
Mr. Noel Barut, Biologist, BFAR

Note—also met briefly with Director Juanito Malig to inform him of the overall objectives of the project

General Santos—(meeting in BFAR regional office on 11 August 1987)

Mr. Expidito Respicia, SAPI
Mr. Mario Mallorca, RS Albina Fishing Co.
Ms. Minda L. Regidor, DFE Co.
Mr. Eliseo Aguinaldo, Dela Pena Fishing Co.
Mr. Rudy Rivera, RD Fishing Industry, Inc.
Mr. Rene Kintanar, QBRO Fishing Co.
Ms. K.L. Yamanaka, Univ. of British Columbia, Canada
Mr. Eliseo Depra, Jr., Provincial Fisheries Officer, BFAR, General Santos Office
Mr. Reuben Ganaden, BFAR
Mr. Noel Barut, BFAR

Thailand (Bangkok)

Met with Mr. Boonlert Phasuk (Director, Marine Fisheries Division for the Government of Thailand) and Dr. Veravat Hongskul (Secretary-General, SEAFDEC) on 17 August 1987.

Malaysia (Penang)

Met with the following individuals at the Fisheries Research Institute:

Mr. ONG Kah Sin, Acting Director of Research (Fisheries Research Institute)
Mr. LUI Yean Pong, Senior Fisheries Officer (Acting Head of Resources Section, Fisheries Research Institute)
Mr. Abdul Hamid Yasin, Fisheries Officer, Branch of the Fisheries Research Institute, Kuala Terengguanu
Ms. CHEE, Phaik Ean, Fisheries Officer, Fisheries Research Institute

Appendix 6

Research Papers presented:

6.1 The Status of Exploratory Fishing by Oceanic Purse Seine in the Andaman Sea.
by Dhammasak Poreeyanond

6.2 Recoveries of tagged skipjack in the Philippines.
by Reuben A. Ganaden

6.3 Interaction in Skipjack Tuna Fisheries (Abstract)
by M. Yesaki

6.4 Tuna FAD's in the Philippines.
by Virginia L. Aprieto

6.5 Some Aspects of the Biology and Population Dynamics of Skipjack in Philippines waters.
by D. D. Tandog - Edralin
E. C. Cortez - Zaragoza
P. Dalzell
D. Pauly

6.6 Estimations of growth parameters and migrations of skipjack tuna, Katsuwonus Pelamis (Linnaeus, 1758) in the Eastern Indonesian waters as indicated by Tagging Experiments.
by Jacobus C. B. Uktolseja

6.7 Methods of aging yellowfin tuna, Thunnus albacares, by increments on sagittal otoliths and preliminary results of southern Philippines samples. (Abstract)
by K. Lynne Yamanaka

6.8 Seasonal abundance, morphometrics and hook selectivity of yellowfin (Thunnus albacores) off Darigayos cove, La Union, Philippines.
by E. C. Cortez - Zaragoza
P. Dalzell
D. Pauly

6.9 Stomach contents of yellowfin tuna (Thunnus albacares). (Abstract)
by N. C. Barut

6.10 Auxis fisheries in Batangas.
by F. Arce

6.11 Tuna larvae in Sulu Sea. (Abstract)
by R. B. Baguilat

6.12 Small tuna fisheries in the Philippines.
by M. Yesaki

6.1 THE STATUS OF EXPLORATORY FISHING BY OCEANIC PURSE SEINE IN THE ANDAMAN SEA[1)]

BY

DHAMMASAK POREEYANOND[2)]

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1) Paper presented on The Second Meeting of Tuna Research Groups in the Southeast Asian Region, 25-28 August 1987, Manila, the Philippines.

2) Exploratory Fishing Division, Department of Fisheries, Bangkok, Thailand.

The Status of Exploratory Fishing by Oceanic Purse Seine in the Andaman Sea

by

Dhammasak Poreeyanond

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1) Tuna and tuna-like species contribute an important fisheries resources, especially in the tropical Pacific and Indian Ocean. In those countries having little shelf area, they are often the significant fisheries resource. According to FAO statistics, the 1984 world catch of tuna and tuna-like species was 2.1 million tons and about 656,000 tons was from developing countries. Over one-half of the total catch was comprised of only two tropical species : skipjack and yellowfin tuna. In the Indian Ocean the catch of yellowfin tuna and skipjack increased from 110,000 tons in 1983 to 240,000 tons in 1985, due principle to higher landing from industrial purse seine.

2) For several years, the need for coordination of tuna fishery development, management and investigation activities in the Pacific and Indian Ocean had been discussed by both the Indo-Pacific Fisheries Commission (IPFC) and the Indian Ocean Fisheries Commission (IOFC) and in joint meeting of their respective tuna management committees. The decission to develop a tuna fishery by a developing nation requires careful analysis not only of resources availability and fishery techniques, but also of market structure and performance. In Southeast Asia,a significant quantity of tuna, often the small species is sold on the fresh fish market.

3) Catch of small tunas of Thailand have increased in the last fourteen years from 5,500 tons in 1972 to 86,890 tons in 1986. The main

species are long-tail tuna (Thunnus tonggol), Kawakawa (Euthynnus affinis) and frigate tuna (Auxis thazard). Most of the catches are caught by purse seine and supplied to canning industries. This increasing catch is the result from the rapid growth of fish canning industry; at present Thailand is the main Asian supplies of canned tuna to markets in the USA as well as to EEC countries which was amount of 142,000 tons in 1986.

4) With a view to develop the oceanic pelagic fisheries, it was planned in the National Economic and Social Development Plan 1930-1934 to conduct exploratory fishery in the offshore and oceanic area by purse seine. In April 1987, oceanic purse seining for tuna was first experimental carried out in the Andaman Sea of Thailand by R/V Fishery Research "CHULABHORN" with a net of 1,050 m long, 420 m depth and 10 cm mesh size.

5) Although tuna shoals which associated with FAD (Fish Aggregating Device) were encircled,the observation for tuna was also conducted by echosounder and sonar. The oceanic purse seine was successfully operated along the continental slope area of over 400 m depth where good catches were obtained the maximum succeeding was 15 tons in a single operation. The area of operation is presented in Fig I.

6) The catch was mainly compossed of Katsuwonus pelamis and Thunnus albacares in this season. K. pelamis occured in the size range 30-50 cm and T. albacares 45-70 cm. Their length frequency distribution and the length-weight relationship are presented in Fig 2-3. The length-weight relationship of the three species calculated were as follows :

K. pelamis $W = 0.000051485\ L^{2.75887}$

T. albacares $W = 0.00011067\ L^{2.57056}$

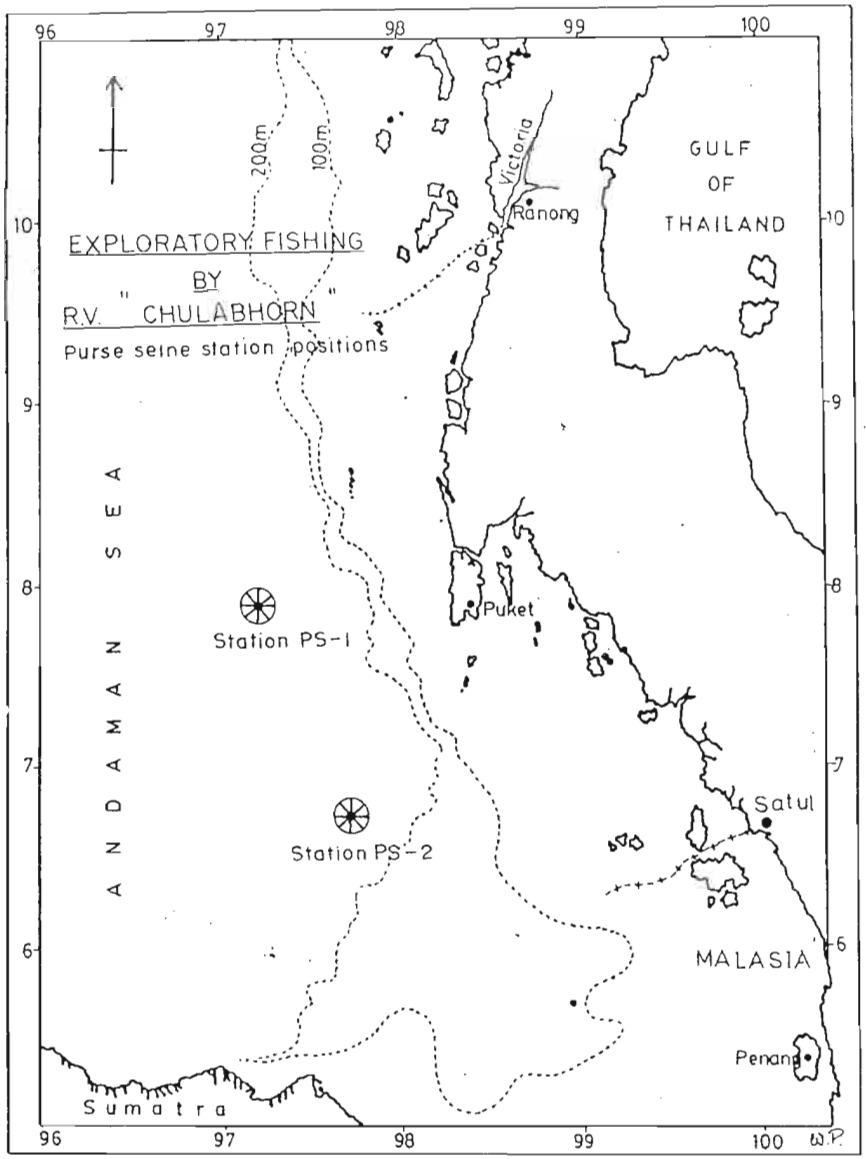


Fig. 1 R.V."CHULABORN" station positions of experimental oceanic purseining conducted on April 1987.

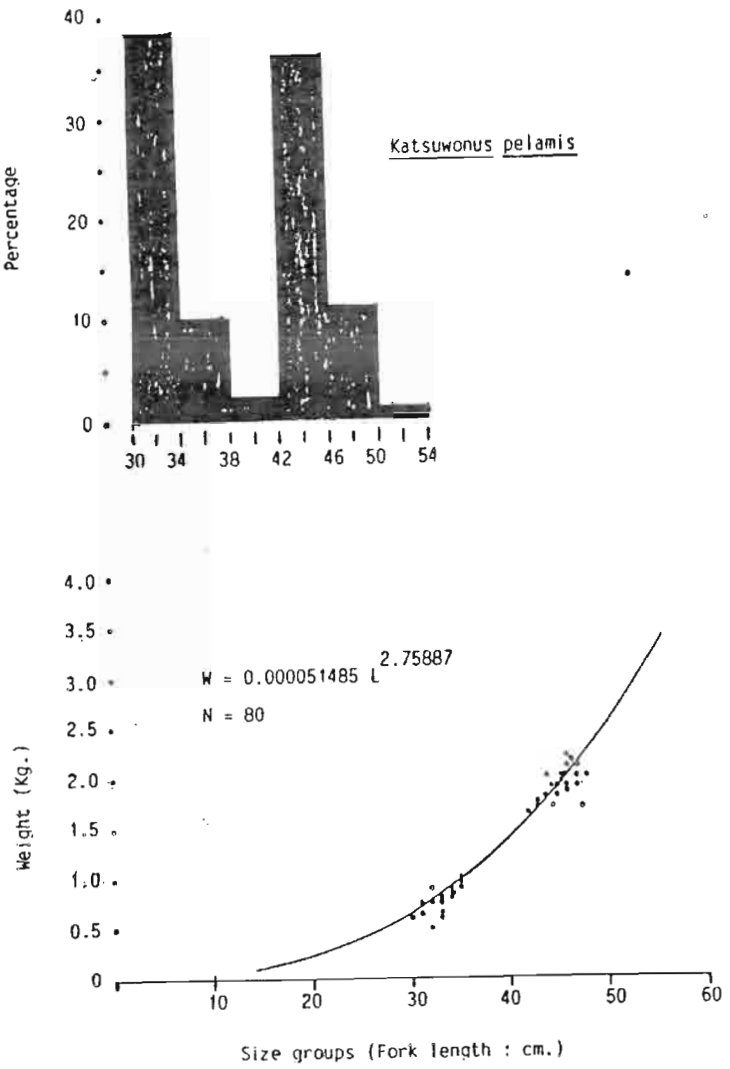


Fig. 2 Length frequency distribution (percentage) and the length-weight relationship of K. pelamis taken during the oceanic purseining.

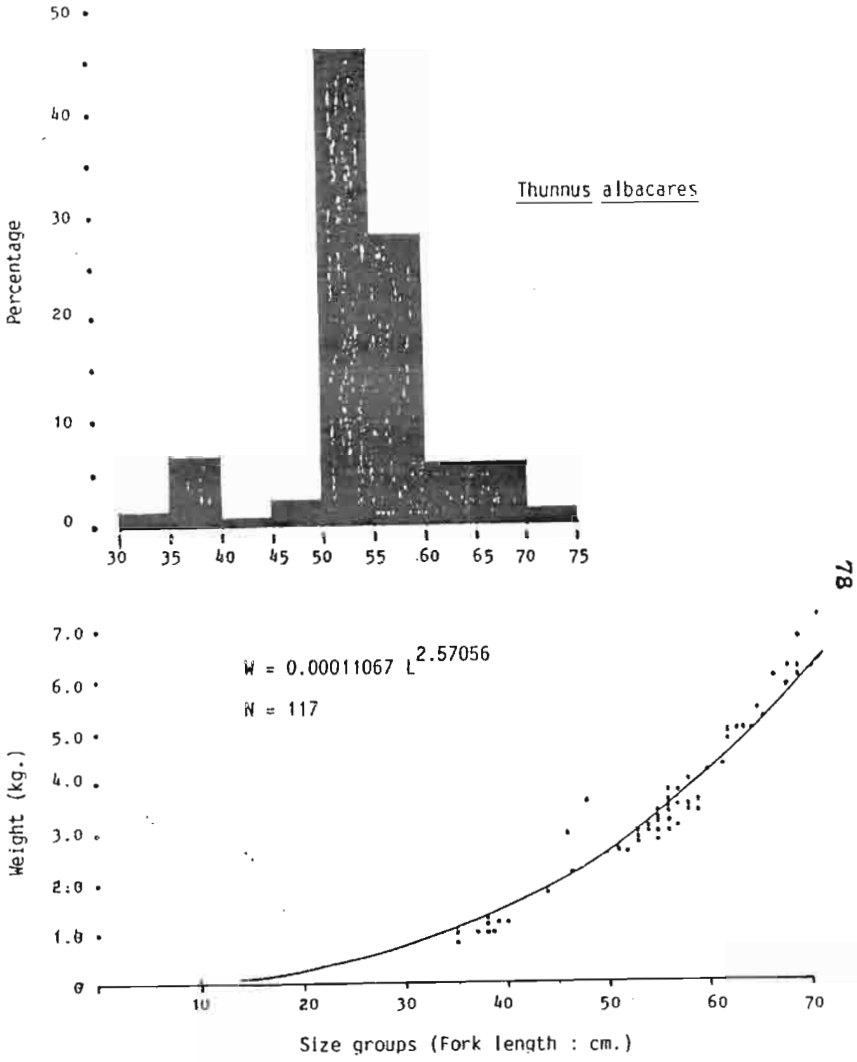
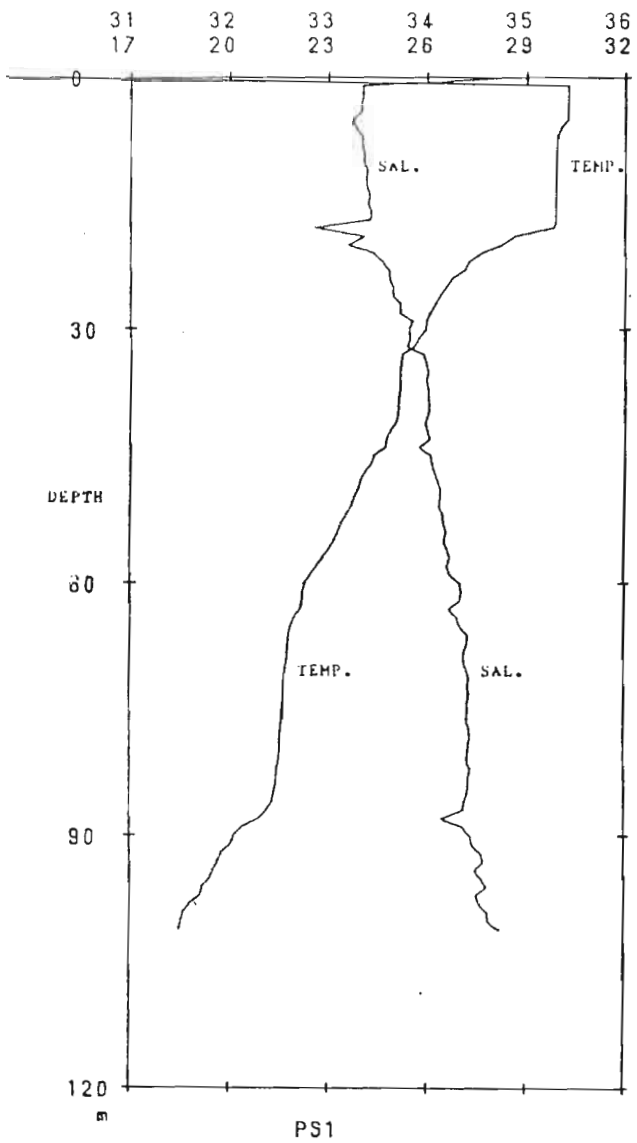


Fig. 3 Length frequency distribution (percentage) and the length-weight relationship of T. albacares taken during the oceanic purseining.



OCEANOGRAPHIC STATION PS1

RESULTS OF CTD OBSERVATIONS

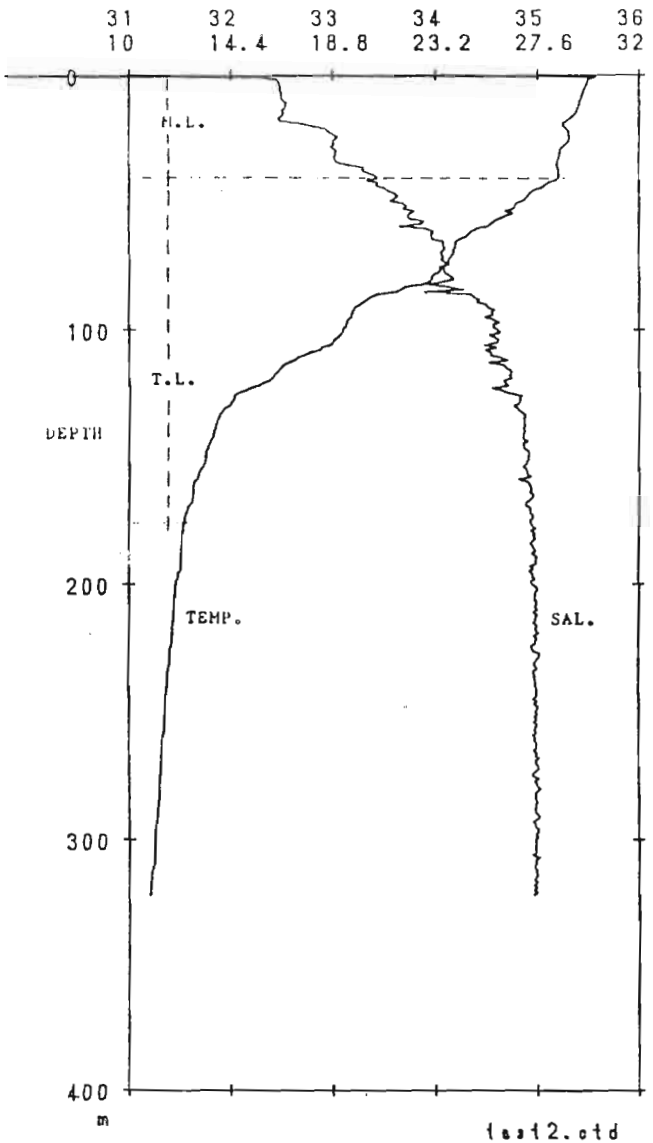
STATION PS1 : 22 Apr.1987

07°50′ N., 97°18′ E.;DEPTH 505 m.

AREA ; ANDAMAN SEA.

DEPTH m.	TEMP. °c.	SAL. ‰
2	30.28	33.35
10	29.91	33.36
20	28.25	33.21
30	25.95	33.82
40	25.10	34.01
50	23.77	34.13
75	21.62	34.42
100	18.54	34.63

Fig. 4 Graph showing of thermocline layer and salinity at station PS-1.



OCEANOGRAPHIC STATION PS2

N.L.:MIXED TEMPERATURE LAYER ; T.L.;THERMOCLINE LAYER

RESULTS OF CTD OBSERVATIONS

STATION PS2 : 25 Apr. 1987

06°43′ N., 97°45′ E.;DEPTH 425 m.

AREA : ANDAMAN SEA.

DEPTH m.	TEMP. °c.	SAL. ‰
2	29.79	32.45
10	29.46	32.51
20	28.70	32.80
30	28.56	33.03
40	28.51	33.44
50	26.69	33.69
75	23.58	34.04
100	19.25	35.61
150	13.32	34.91
200	12.04	34.95
250	11.58	34.98
300	11.14	34.98

Fig. 5 Graph showing of thermocline layer and salinity at station PS-2.

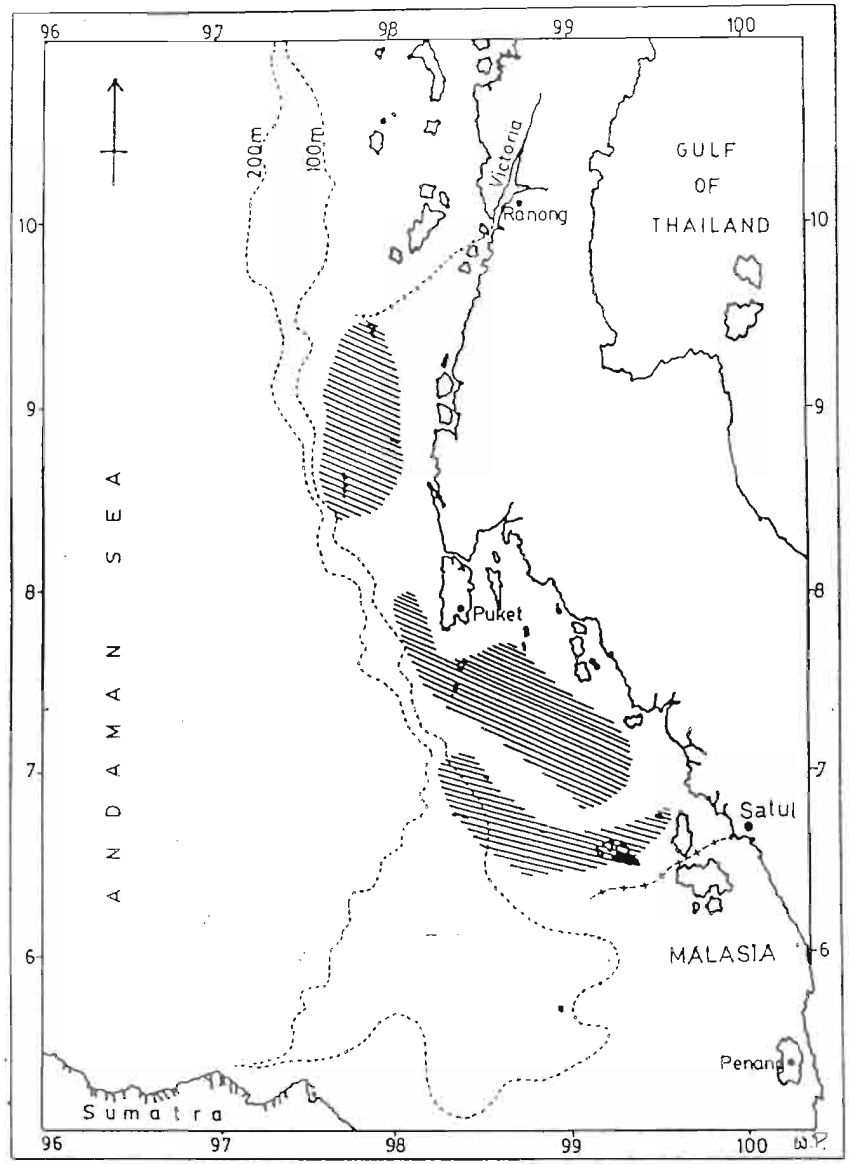
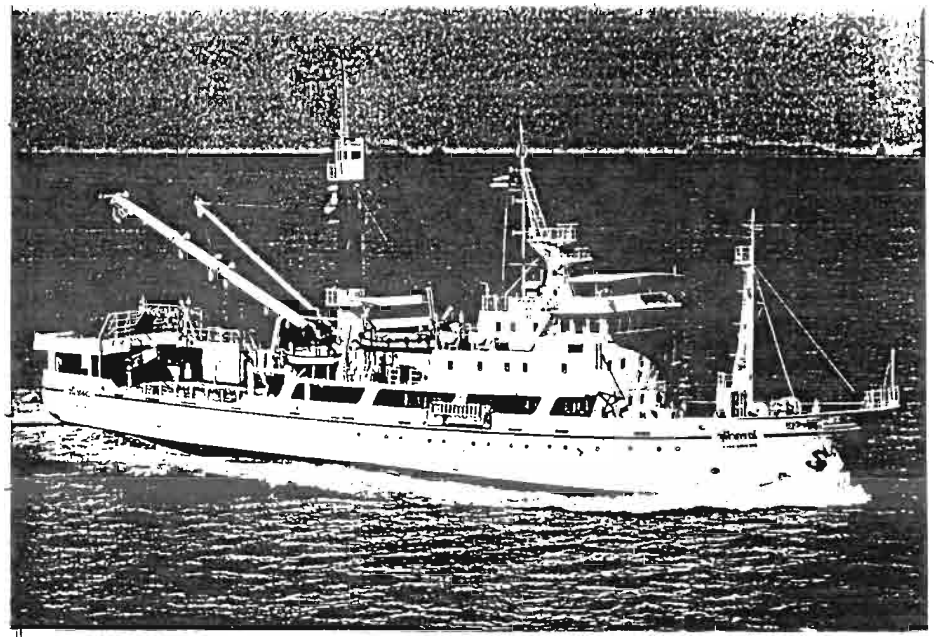


Fig. 6 The major fishing grounds for tunas in the Andaman Sea, westcoast of Thailand.



PRINCIPAL PARTICULARS

R/V "CHULABHORN"

Date of Keel Laid 25th March, 1986
Date of Launching 25th June, 1986
Date of Delivery 10th December, 1986

Length(O.A)	67.25m	Speed (trial max.)	15.385Knots
Length(Lpp)	60.00m	Speed (service)	13.000Knots
Breadth(Mld.)	12.00m	Endurance	12.000 sea miles
Depth(Mld.)to upper deck	6.90m	Complement (Royal 2p·Vip 2p·Officer 10p·Crew 20p·	
Draft(Mld.) designed	4.40m	Scientist 9p·Instructor 4p·Trainee 20p)	67 persons
Gross Tonnage	1,424ton	Capacity (Fish Hold)	137.64 cub.m
Net Tonnage	428ton	(Quick Freezing Room)	28.02 cub.m

Class ..... Nippon Kaiji Kyokai(NK), NS*, "Research and Training Vessel", MNS*

FISHING AND RESEARCH EQUIPMENTS

Kind of Fisheries and Equipment	· Purse Seine Fishing · Otter Trawl Fishing · Tuna Long Line Fishing · Drift Gill Net Fishing	One(1) complete set One(1) complete set One(1) complete set One(1) complete set
Research Fittings	· Oceanographic winch and Accessories	
	· Dry Laboratory: Physical Laboratory(BT, CTD, Data Analyzer Chemical Laboratory	
	· Wet Laboratory: Chemical Laboratory, Biological Laboratory, aquarial Space	
	· Acoustic Space: Scientific Echo Sounder, Scanning Sonar, Colour Fish Finder, Net Recorder, Net Sonde, Weather Station etc	
Fish Processing Equipments	Frozen Fish Processing Equipment. Minced Fish Product Line	

6.2

RECOVERIES OF TAGGED SKIPJACK IN THE PHILLIPINES [1/]

by Reuben A. Ganaden [2/]

1. INTRODUCTION

The rapid expansion of the tuna fisheries in the Philippines during the last decade and the increase effort that has been brought to bear on the tuna resources has placed new demands in the management of said resources. The highly migratory nature of the tuna stocks and their exploitation by countries where they are found at any given time necessitates the gathering of information on the migration of these species in order that we can understand their migratory behavior and therefore determine to what stocks they belong. Prior to 1979, when the Philippines initiated biological sampling for tunas, there was little biological research conducted on tunas. Previous research includes studies on maturity and spawning. Wade (1950 b) determined maturity stages of skipjack, (Katsuwonus pelamis), yellowfin (Thunnus albacares) and eastern little tuna (Euthynnus affinis) from visual examination of external features of gonads and made an attempt to define spawning season of these species. Bunag (1958) made a more detailed microscopic examination of ovaries of these species.

Wade also described the juvenile forms of skipjack, yellowfin and eastern little tuna (1950 a) and the spatial and temporal distributions in the Philippines (1951).

Ronquillo (1953) studied stomach contents of skipjack, yellowfin, eastern little tuna and dolphin fish (Coryphaena hippurus).

The results of biological sampling of tunas in the Philippines until June 1982 has been summarized by White (1982). He described for each locality catch and effort of skipjack, yellowfin and frigate/bullet (Auxis sp.) as well as growth, yield and recruitment

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[1/] Paper presented at the 2nd IPTP Tuna Research Groups Meeting in the Southeast Asian Region, Manila, Philippines, Aug. 25-28, 1987.

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of skipjack and yellowfin tunas.

Yesaki (1983) summarized the distribution of juvenile yellowfin and skipjack, determined the sex ratio, size of mature females and spawning season of yellowfin captured by handline under payaos, estimated the number and weights of juvenile tunas consumed by adult yellowfin captured handline and calculated growth.

However, no research on tuna movements have been made although recoveries of tagged skipjacks and some yellowfin are being reported from the tagging program of the Japanese government, the South Pacific Commission and the Indonesian government. This paper will attempt to summarize the data of tag recoveries to document migration of skipjack and compare the sizes of fish being exploited in the Philippines and the Western Pacific.

2. SOURCE OF INFORMATION

2.1 Length frequency distribution was obtained from the Tohoku Regional Fisheries Research Laboratory, particularly Mr. Tamatsu Tanaka, Senior Biologist, Yaizu Branch particularly the data on the monthly length frequency distribution of catches by pole and line and purse seine (1984-1985) in the Western Pacific by Japanese vessels.

The other source of length frequency distribution is the tuna sampling programme established by the Bureau of Fisheries and Aquatic Resources in seven (7) locations in Mindanao and Luzon from 1980-1985.

2.2 Tagging data was obtained mainly from the tagging experiments of the Tohoku Regional Fisheries Laboratory based on the data of tag release (November 1977 - February 1985) and data on recaptured skipjacks in the vicinity of the Philippines from May 1978 to April 1987.

The other source is the data on recoveries from the Philippines from the South Pacific Tagging Program.

3. SIZE COMPOSITION OF LANDINGS

3.1 Philippine (Bohol Sea, Sulu Sea, Celebes Sea)

3.1.1 Ringnet fisheries

Skipjack captured by ringnet ranged in length from 12 cm to 76 cm(Fig. 1). The smallest and largest fish was captured at Sta. Cruz, Davao del Sur. There are two modes in the catches of ringnets at Labuan, Zamboanga City, 48 cm and 56 cm. In General Santos City, the landings of skipjack by ringnets show two modes at 28 cm and 40 cm. The landings at Sta. Cruz have two distinct size classes, 20-30 cm and 40-60 cm. Ringnet landings of skipjack in Opol Misamis Oriental have modes of 20 cm and 50 cm.

3.1.2 Purse seine fisheries

There is considerable variation in the size of purse seines in the Philippines which ranges from less than 10 GT to seiners of 850 GT.

The length frequency distribution of purse seine landings of skipjack is shown in Figure 2. The size range of skipjack captured at Recodo, Zamboanga City was 36 cm to 76 cm. The relatively bigger size class of the landings is attributed to the bigger size vessels landings at the site by fishing boats owned and operated by MAR Fishing, a 50-ton capacity cannery.

The length frequency distributions of skipjack landings at Gen. Santos City have a size range of 16 to 58 cm. Most of the skipjack landings at this locality are of the 30 cm size class. The skipjack landings at Navotas show a length frequency distribution similar to that of the General Santos landings. Since most of the landings are made by carrier boats of vessels operating

at the Celebes and Sulu Sea area which are bigger than those landing at General Santos, the size of skipjack should have been larger at Navotas. The apparent discrepancy may be due to the fact that these fishes measured are only for the local market and not those for export which are bigger not less 2 kg.

3.1.3. Total fisheries

There is a wide variety of fishing gear capturing tunas in the Philippines. In the commercial sector, purse seine and ringnets accounts for more than 90% of the skipjack catch. Hook and line, gill net, bagnet and fish corral area the main gear exploiting skipjack in the municipal sector with about 88% of the skipjack catch.

The percentage length frequency of skipjack landings by gear in the sites for a 6-year period (1980-1985) is shown in Figure 3. It will be noted that purse seine landings show three distinct modes, 26 cm, 34 cm and 56 cm. The ringnet landings, on the other hand indicates that majority of the fishes caught are in the 20 to 30 cm size class.

The sizes of fish captured by handlines are bigger, 40 to 60 cm which is similar to that caught by troll line. Fish corral which is a stationary gear, capture a wide range of sizes but more on the 40 to 70 cm size class.

3.2 Japanese distant-water fleets

3.2.1 Pole and line

The size composition of skipjack tuna in Western Pacific in the area from 00°～25°N lat and 135°～180°E long. show that the smallest captured by pole and line is 29 cm and that biggest fish is 81 cm. Most of the fish caught is in the 45 to 65 cm size class.

3.2.2 Purse seine

The purse seine fleet of the Japanese operating in the same area during the same period show that the size range is 24 cm to 69 cm. Most of the fish captured are of the 35-60 cm size class. The catching of fairly small size skipjack by the purse seine might suggest that there are also small tunas in the area and are not being caught because of the bigger meshes of their nets.

4. TAG RELEASES/RECAPTURES

4.1 Japanese tagging experiments

The Japanese government since April 1967 has been conducting tuna tagging in the Northwestern Pacific. The agencies undertaking this programme are the Tohoku Regional Fisheries Research Laboratory and the Far Seas Research Laboratory.

It will be noted that the area of tag releases in the Western Pacific is from lat 05-53N ~ 24-04N, long 122-38 E~144-05 E.

The first tag recapture of skipjack in the Philippines was made on May 1978 in the vicinity of Eastern Samar. Since then there were 56 tag skipjack recovered in Philippine waters. Figure 4 show the release position and the place where the recoveries were made. Most of the recoveries were made in Davao Gulf, Moro Gulf, the waters between Samar and Surigao del Norte.

The longest that the tag fishes were at large was 756 days and the shortest was 73 days.

While there were 56 recoveries reported, data of some were not given by the finder so that the records were incomplete.

The recapture of tag skipjack in Philippine waters released in the Northwestern Pacific would seem to indicate that skipjack move from the Western Pacific to Philippine waters during certain times of their lives.

4.2 South Pacific Commission tagging experiments

The South Pacific Commission started its tagging program sometime October 1977, in the Trust Territory and Guam. A total of 15,402 skipjack were tag and released in the area. Most of the releases were in the waters of Palau(7,233) and Federated States of Micronesia (7,647).

Releases in Palau resulted in 77 tag returns from fisheries in Papua New Guinea, 69 tag returns from fisheries in Federated States of Micronesia and the other returns from the Philippines, Indonesia, Marshall Islands, Kiribati, Solomon Islands and Japan.

Releases in Federated States of Micronesia resulted in 37 tag recoveries from fisheries in Marshall Islands, and only 19 returns in total from waters of Japan, Northern Mariannas Island, the Philippines, Indonesia, Palau, Kiribati, Papua New Guinea, Nauru and Howland Island.

There were 7 tag returns from the fisheries in the Philippines from tag release in Palau and one return from the Federated States Micronesia.

The seven recoveries made in the Philippines was released between 0706N-0748N lat and 134408E - 1349E long and were recaptured between 0610N - 0650N lat and 12410E - 12545E long. The longest that the fishes recaptured were at large is 551 days and travelled a distance of about 450 nautical miles.

The recoveries in the Philippines from the SPC tagging is insignificant to even make a hypothesis as to whether the stocks being fished in the Philippines is part of those being exploited in the Trust Territories.

4.3 Indonesia tagging experiments

The Government of Indonesia through the Marine Fisheries Research Institute (BPPL) conducted their tagging experiments

on January 1983. Initially, they were able to tag 987 yellowfin and 5,425 skipjack in the vicinity of Bitung and Sorong. From this there were 27 recoveries reported. In the second experiment conducted on January 1986 in Bitung, 81 yellowfin and 1,344 skipjack were tagged. There were only two yellowfin and 54 skipjack recovered. Inspite of the proximity of the Philippines, to the area of tagging only tag fish was recovered in the vicinity of Zamboanga City. The low recovery rate of tag fish in the Philippines, although the tagging and release area is very near the Philippines, might suggest very low interaction of stocks exploited by the fishermen in both countries.

4.4 Size composition of released and recaptured fish

The Japanese tagging experiment were able to tag 6,885 skipjacks from where the recoveries were made. The size range of the tagged skipjack was 32 to 58 cm. Figure 5 gives the percentage length frequency distribution of the tag skipjacks released during the period. It shows that most of the tag skipjack were of the 40-48 cm size class.

Out of the 6,885 skipjack released 56 were recovered in the Philippines waters during the period from May 1978 to April 1987. The Percentage length frequency distribution of the recaptured fish are shown in Figure 5. The recaptured skipjack have a size range of 38 to 65 cm which would indicate that they have grown to a bigger size when recovered.

5. DISCUSSION

White(1982) suggest that skipjack and yellowfin tuna spawn throughout the year particularly in Moro Gulf/Celebes Sea areas. This assumption is based upon the size of tunas landed in these areas. It would appear that juvenile or "young" tunas remain inshore waters until they reach approximately 30 cm in length and then disperse to the Pacific. About 90%(by number) of all tunas

landed in the Philippies are captured during this early phase of their life cycle.

While there is no direct evidence that young skipjack disperse out into the Pacific it is most likely since the predominant size in the surface purse seine and the pole-in-line fishery in in the Western Pacific (40-60 cm) correspond to the subsequent age class of fish caught in Philippine waters after dispersion from the Philippines.

Yesaki (1983) suggest that skipjack and yellowfin disperse from coastal waters at around 30 cm may be related to the ability of coastal waters to support the biomas of tunas above this size.

There seems to be a difference in recovery rates of skipjack tagged in the Western Pacific particularly in the area 14° 21°N lat and 131° 144°E long by the Japanese tagging experiment. In the Philippines, 56 tag recoveries were made as compared to the 4 taken by the Indonesians. The South Pacific Commission tagging experiment in the area 03° or 8°N lat. 131° or 134° long. which is below the area where the Japanese were tagging, there were 31 recoveries from the fisheries in Indonesia. This compares to the only 7 recovered from the Philippines. The Indonesia releases, on the other hand, in area of Bitung and Sorong, 4 tag skipjack were recovered in the South Pacific and one recovery from the Philippines. Figure 6 show the area of the Japanese and SPC releases.

The reason for the differences in recovery of tag skipjack might be attributed to the effect of the North Equatorial Current which is running westward along 06°N and when it reaches Mindanao it goes in a North and South direction which might be favoring the Philippines. The counter current which is below the North Equatorial Current might be affecting the releases of the Indonesians which show that more recoveries are taken in the South Pacific than in the Philippines.

A seperation of stocks between those being exploited by the Philippines and those of the Indonesians is a probability. This is however, only a hypothesis for lack of a more conclusive basis. This problem might be answered with a tagging program in the Philippines so that we could have a definite record movement of the fishes being exploited in the Philippine waters.

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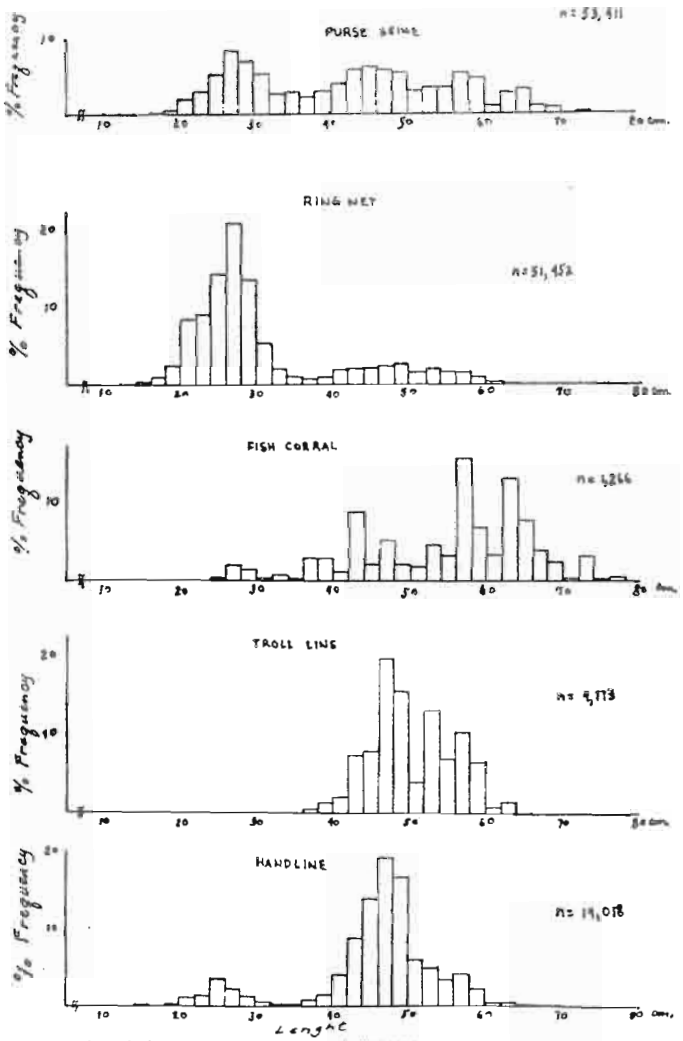
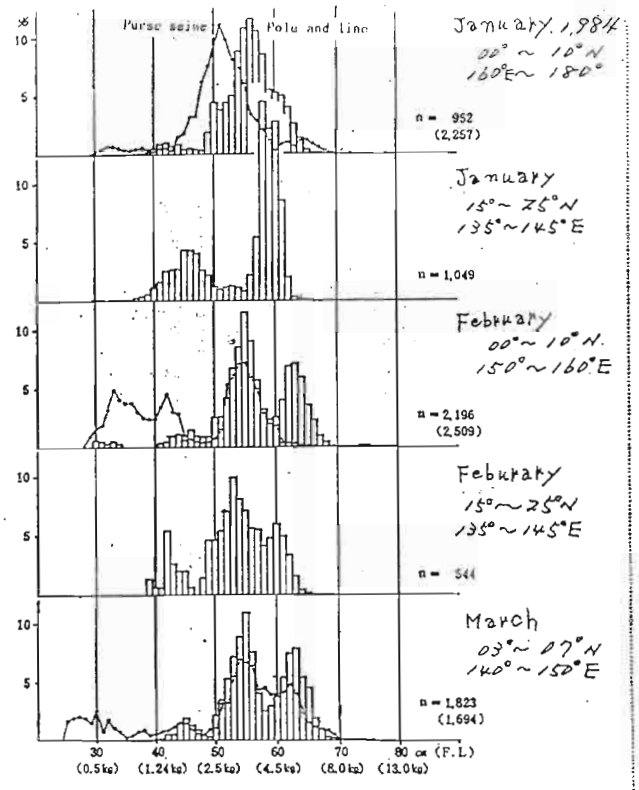
Fig. 3



Length Frequency Distribution of SKIPJACK by GEAR in all Areas 1980-1985

Fig. 4-A



Size composition of skipjack tuna in Western Pacific Ocean
(by fishery and month)
Tanaka (1987) ( ):Number of fish by purse seine

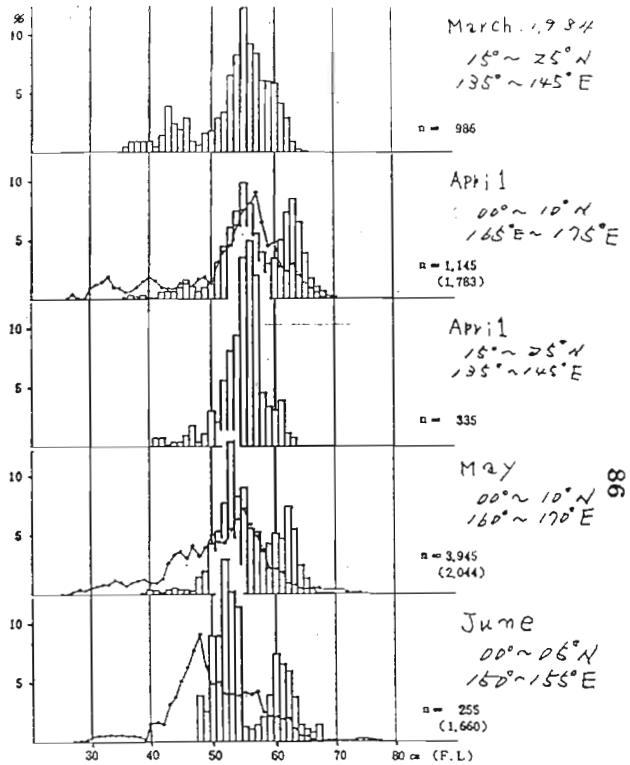
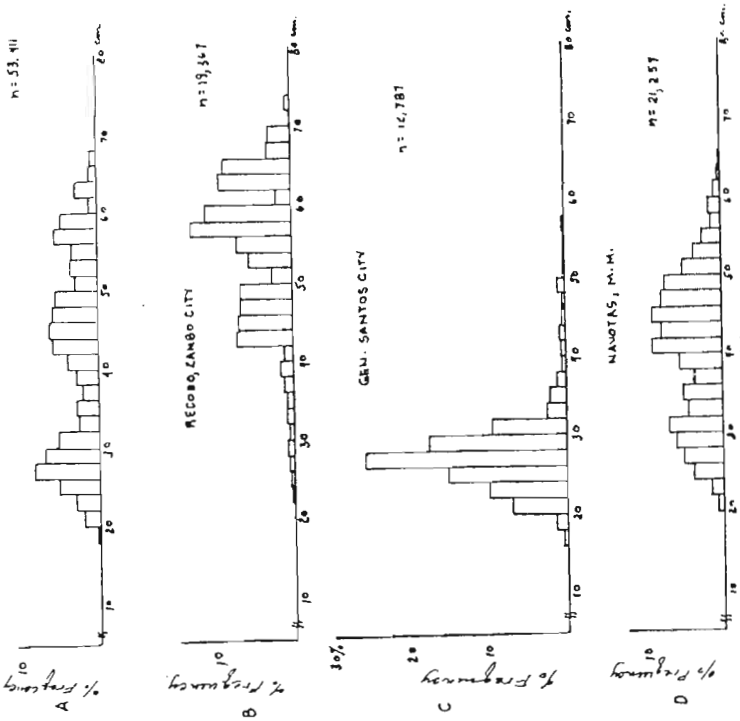


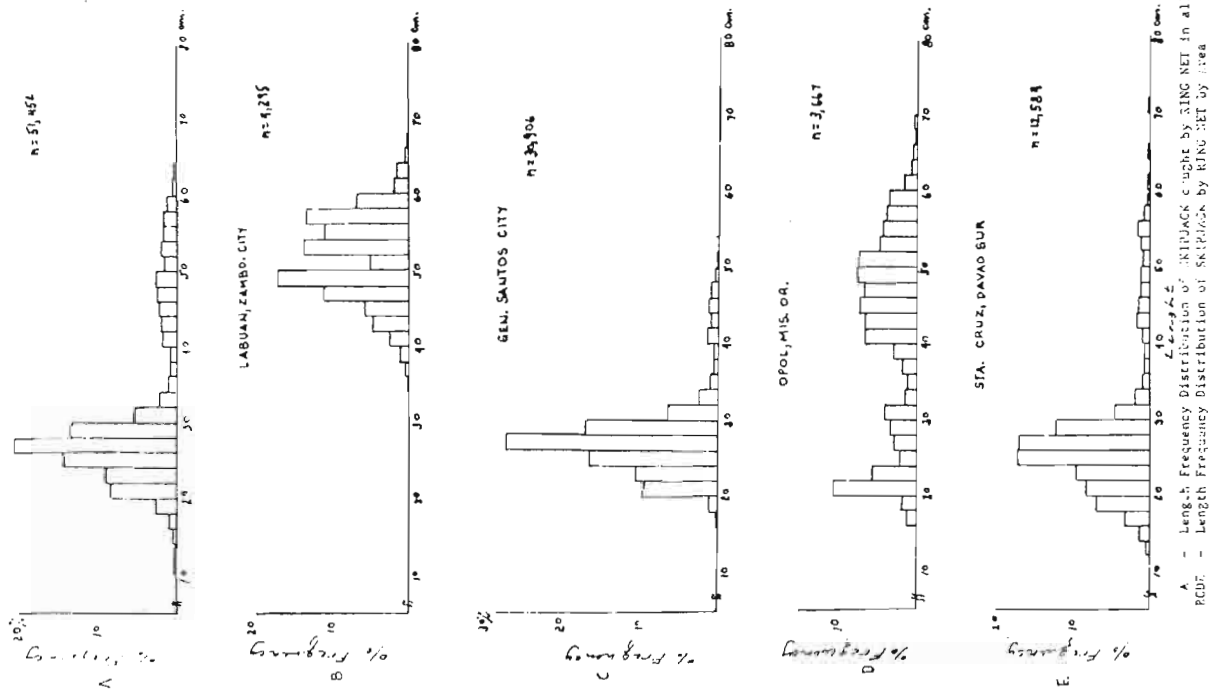
Fig. 2



A - Length Frequency Distribution of SKIPJACK caught by PURSE SEINE in all sites - 980-1985

BCD - Length frequency Distribution of SKIPJACK caught per AREA by PURSE SEINE

Fig. 1



A - Length Frequency Distribution of SKIPJACK caught by RING NET in all sites

BCDE - Length Frequency Distribution of SKIPJACK by RING NET by area

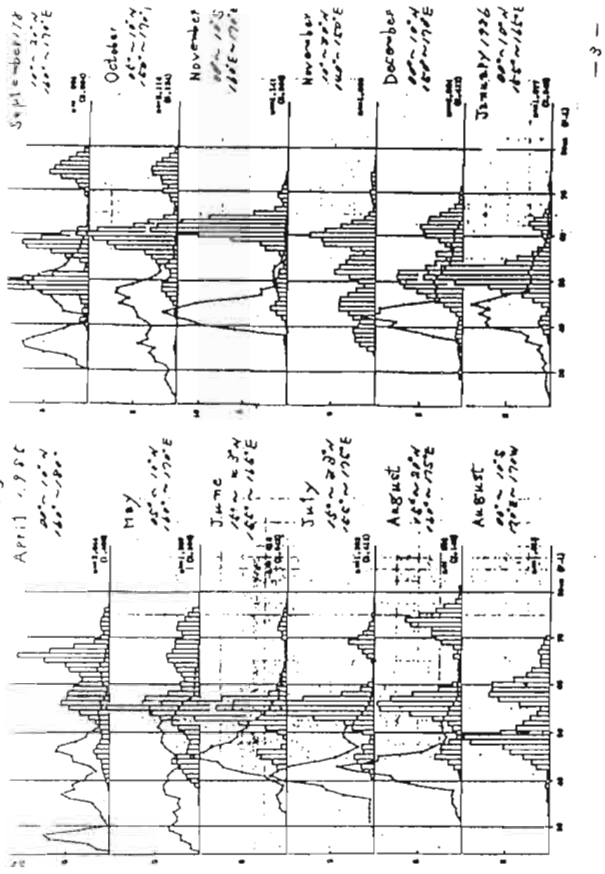


Fig. 5-6

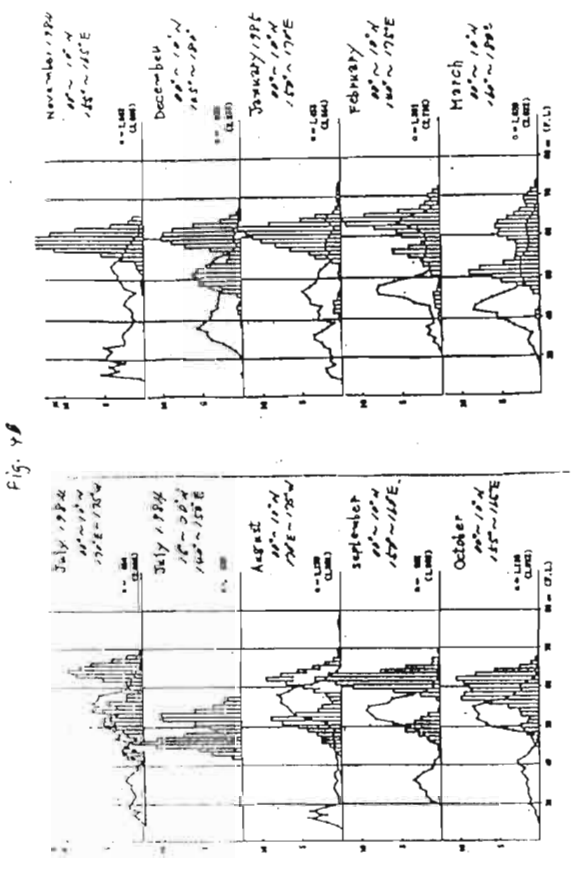


Fig. 5-7

Fig. 4-D

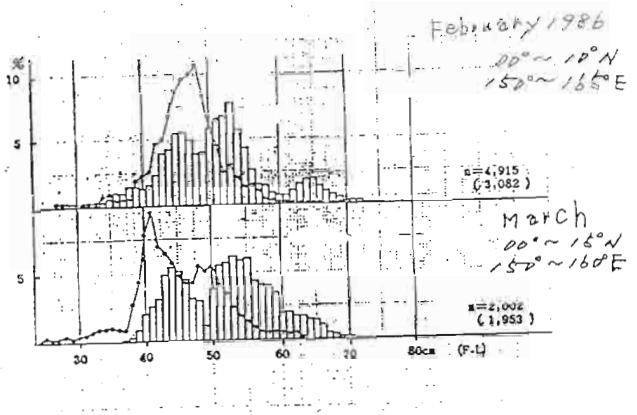
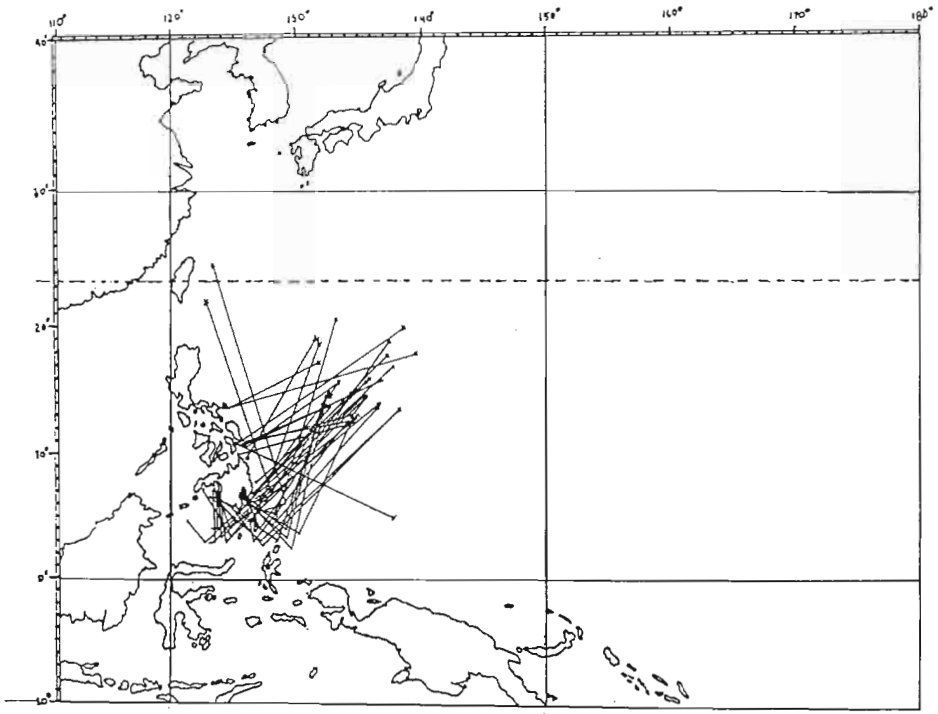
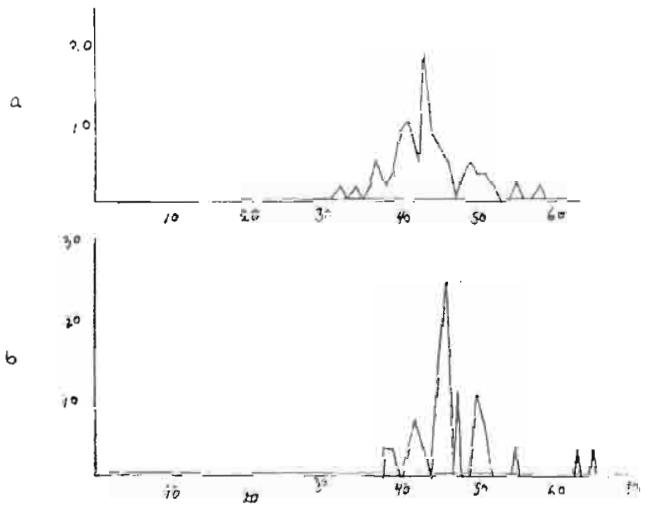


Fig. 5



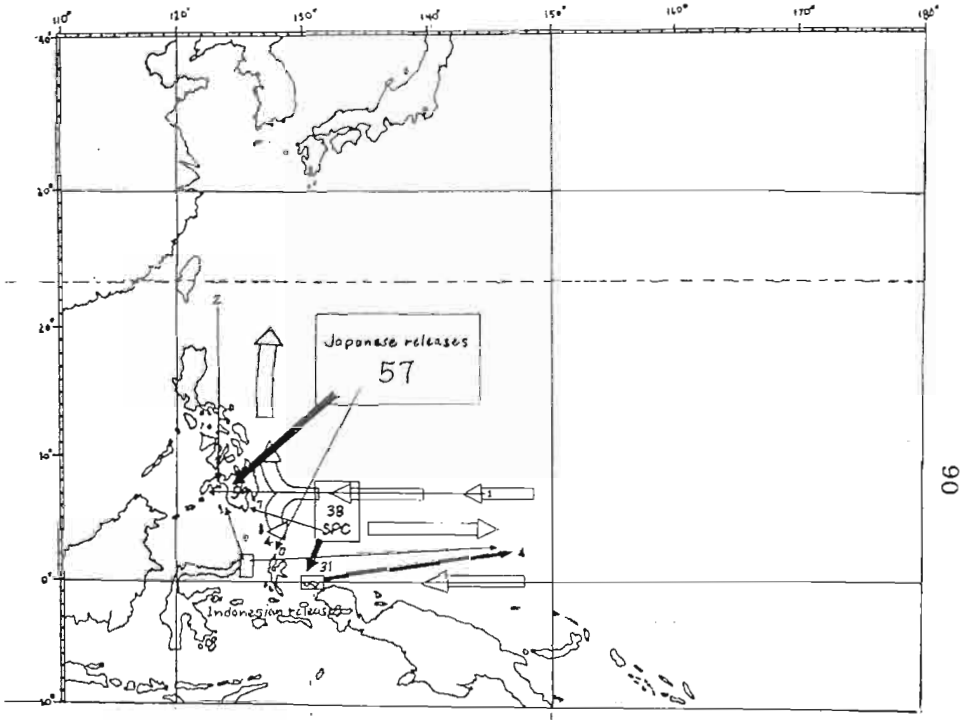
Release position of tag skipjack and position of recoveries. × release · recapture

Fig. 6



% Size composition of tag (a) and recaptured (b) skipjack

Fig. 7



Position of release fm Japanese, SPC and Indonesia tagging program and recoveries showing current direction

6.3 Simulation on Interactions Between Small-Scale and Industrial Tuna Fisheries

by

Mitsuo Yesaki

General descriptions of small-scale and industrial fisheries as well as the size composition of skipjack tuna captured in these fisheries are reviewed for various countries and/or areas of the Indo-Pacific region. Hypothetical populations of skipjack tuna are simulated with selected parameters for growth and natural mortality. Fishing mortality was inflicted on 16-30 cm fish to simulate a small-scale fishery for juvenile fish and on 45-58 cm fish to simulate an industrial fishery for mature fish. These respective simulations predicted a decrease from the unexploited population of 47% and 67%. The effect of the small-scale fishery is not as pronounced as that of the industrial fishery because of the shorter time intervals over which juvenile skipjack tuna are vulnerable to exploitation. Furthermore, the impact of the small-scale fishery for juvenile skipjack would be less than predicted by the model because of the limited area of the fishery in relation to the distributional range of juvenile skipjack tuna. On the other hand, the industrial fishery for mature fish will have the pronounced effect predicted by the simulation, with possible adverse consequences for island fisheries targeting to an appreciable extent on large mature skipjack tuna.

A model of skipjack tuna migration based primarily on the distribution of different size classes is described.

6.4

TUNA FADs IN THE PHILIPPINES

VIRGINIA L. APRIETO

ABSTRACT

Tuna production increased phenomenally from less than 10,000 MT in 1971 to 124,000 MT in 1976 when bamboo raft or payao, a FAD was innovated in tuna fishing. Peak production of 261,000 MT was attained in 1985 comprising 20% of the national fish catch that year. Consequently, the Philippine maintained self sufficiency in food fish and became the biggest tuna producer in Southeast Asia, and the fifth in the world.

The use of payao, however, is rapidly removing undersized juveniles from the stock, and issue that has remained dormant among countries in Southeast Asia with developed tuna fishery and in the Western Pacific where no regional tuna management arrangement exists.

Local fishermen have expressed apprehension over the significant quantities of undersized juveniles captured and declining catches in traditional tuna fishing grounds. They have proposed regulatory measures such as mesh size regulation, seasonal ban of purse seining, licensing of bamboo rafts, etc. Situations negating these proposed regulations are: 1. tunas caught in free schools and payao - associated schools are of similar size; 2. majority of tunas are captured by purse seines and ring nets of the same mesh size which catch a variety of small pelagic fish (round scad, mackerel, sardines, etc) that is the mainstay of pelagic fisheries in off-tuna season; 3. pelagic yellowfin and skipjack tunas in the Philippines are of juvenile stock; any ban on tuna fishing in Philippine waters is merely saving them for capture in other seas.

INTRODUCTION

The Philippine tuna fishery* developed rapidly from an obscure artisanal to industrial scale in the mid 1970's. Tuna fishing in the Philippines is unique in that bamboo rafts locally known as payao, a fish aggregating device (FAD), are used extensively to aggregate pelagic fish for capture with a variety of fishing gears. Consequently, large quantities of small sizes of skipjack and yellowfin are captured compared to other major tuna fisheries in the world. The use of payao, triggered increased tuna production that enabled the Philippines to maintain self-sufficiency in food fish and become a major tuna producer an exporter. Since the innovation of payao in tuna fishing the average annual production increased to 207,000 MT, the highest in Southeast Asia and fifth in the world. The export market has been a principal stimulus in the expansion of the tuna fishing industry.

*Philippine fisheries, for administrative purposes, are categorized into two, namely: "commercial"/"industrial" when utilizing vessels 3 GT and above, and "municipal" including artisanal or small scale when utilizing vessels below 3 GT.

Presented at the 2nd Tuna Research Group Meeting
in Southeast Asian Region, August 25-28, 1987

Prior to the development of the industrial tuna fishing industry, tunas were not popular as a food fish except in the Bicol provinces, Batangas, Quezon and Laguna where the freshly caught "litte tunas" locally called "tulingan" are cooked "sinaing" style; i.e., boiled in water, tamarind fruit or vinegar and salt in large earthen pots until the water dries up. Thus prepared, "sinaing na tulingan" has a shelf life of one week and when refrigerated lasts for two weeks.

Today, tunas are popular foodfish countrywide. The largest consumption areas are the Mindanao and the Visayan islands where tunas are caught in abundance and prices are relatively lower. Heretofore, tunas were shunned in urban areas because of the poor quality at which the fish reach the markets and the suspected poisonous nature of the meat as a result of bad post harvest handling practices.

The rapid and unregulated development of the tuna fisheries since 1976 and the reported high incidence of small juvenile tunas caught in the Philippines has raised concern among Philippino fishery scientists who called the attention of the government to the need to monitor developments for proper assessment and management of the resource especially in relation to Payao fishing and the impact of this on the tuna stocks.

Prior to 1980, there was scarce information on the biology, fishery and population structure of Philippine tunas. Aside from the review of the tuna fishery its rapid development (Aprieto, 1980, 1981) and, few biological studies on the stomach content (Ronquillo, 1953, 1964) there was very little attention given to the study of tunas.

Since 1980, however, significant information on the biology and fishery of Philippine tunas in its center of abundance in Southern Mindanao has been generated from a research project initiated and coordinated by FAO South China Sea Programme (SCSP) from which much recent information in this report has been derived. The first year of the project was funded by the Government of Norway and subsequently by the Government of Japan upto 1982. The purpose of the project was to set up the operational structure for sampling in the region and obtain biological data on species composition including length/weight relationship, maturity, seasonal landings of tuna and associated species Mindanao for stock assessment and management purposes. The project has since been continued by the Philippine Bureau of Fisheries and Aquatic Resources, lead fishery agency in the country upto July 1987.

This report aims to highlight the opportunities and constraints posed by the innovation of a fish attracting device in the development and management of the Philippine tuna fisheries resource and industry.

MAJOR SPECIES OF TUNA

Twenty one species of tuna and tuna like fishes are found in Philippine waters. Of these, six are caught in commercial qualities beneath bamboo rafts. However, because of difficulties in the identification of early juvenile stages only four are listed in the Philippine fisheries catch statistics namely, yellowfin (Thunnus albacares), skipjack (Katsuwonus pelamis), frigate tuna (Auxis thazard) and eastern little tuna (Euthynnus affinis).

Big eye tunas (Thunnus obesus) are also captured but are not differentiated from the yellowfin at the size range of the fish commonly caught, i.e. less than 40 cm and are recorded as juvenile yellowfin in the catch data. Attempts to differentiate between these two species suggest that perhaps 10% of the smaller "yellowfin" caught by handline maybe bigeye tuna. Similar difficulties in differentiating between the early juveniles of frigate tuna (Auxis thazard) and bullet tuna (Auxis rochei) exists. Although only frigate tuna are listed in the Philippine catch statistics there are indications that about 50% of this fish is actually bullet tuna (A. rochei). It is also not uncommon that field enumerators often identify early juveniles of frigate, bullet, and eastern little tunas as juvenile yellowfin or skipjack.

The yellowfin, skipjack and bigeye are exported and the rest, which are collectively called "little tunas" are consumed locally.

THE BAMBOO RAFT

The bamboo raft is a native accessory fishing gear that lures small pelagic fishes and shrimps in rivers, estuaries, coves and nearshore quiet waters (Figure 1). The original payao consisted of a layer of bamboo ties together with the rattan or abaca rope. It is provided on the underside with a hanging line of dried twigs. At night the raft is lighted with a kerosene lamp to enhance its attraction effectiveness. Floated across known migratory paths of fishes, payaos are fished with simple hook and line or enclosing nets to harvest the concentrated fish and shrimp.

Today, the bamboo raft comes in a variety of design. In tuna fishing, the raft is made of two layers of bamboo 10 to 15m long and 2 - 4 m wide or lashed together in a V-shape with scrap tire (Figure 2). The weight used to anchor the payao is an empty oil drum filled with rock and concrete. A side rim of an automobile tire is embedded on top of the drum to attach it to the payao with a monofilament line. Each weight is about 500 kg. Three to four weight are needed for depths between 1500 and 2200m and 5 to 6 weights for depths up to 5000m. Usually the upper length of the anchor line (40m) is made of wire to prevent vandals from cutting the line. A buoy is attached to the anchor line to prevent its loss even if the raft is destroyed by strong wind and current. The payao attractor is a hanging line 25 to 35m long with coconut fronds tied to it at 2-meter interval. It is weighted at the lower end with a 10 kg weight and attached to rear end of the payao so it will not get entanged with the anchor line. Big purse seine operators use steel payao for longer life (figure 3). Generally 30 payaos are deployed for each catcher boat.

Payaos attract a variety of species and sizes in a step-wise manner. The coconut fronds attached to the hanging line become colonized with algae and small invertebrates and attract small pelagic fish which in turn attract the free swimming schooling tunas. Non-tuna species attracted include round scads (Decapterus spp.) big eye (Selar sp.) sardines (Sardinella spp.) and rainbow runner (Elagatis bipinnulata).

It is not unusual to observe large concentrations of tunas swimming underneath the payaos after they had been in place for three weeks. In clear water, tunas can be seen swimming around the payao at dusk and dawn. Small scout boats with fish finders monitor the bamboo rafts to determine the concentration of fish.

Alternatively, small scale fishermen may also monitor the amount of schooling by diving, watch for poachers and in return permitted to handline around the payao. When the fish concentration is large enough for "harvest" the scout boat contacts the catcher vessel (purse seiner or ring netter) and gives it the position of the "harvestable" rafts. The catcher vessel proceeds to the payao area in time for sufficient nightlighting time to enlarge the fish concentration before setting the net. During purse seining or ring netting operations which usually starts at about 400 hr, the attractor line is transferred to a light boat and allowed to drift away with it. Fish attracted by the payao follow the light boat with the attractor line. The attractor line is returned to the payao after the completion of the set.

Bamboo rafts are harvested every 5 to 6 days. Depending on the season, upto 100 MT of young yellowfin and skipjack tunas, a mixture of "little tunas" and non-tuna species are hauled in during a single purse seining operation. Non-tuna species may consist from 5 to 40% of the haul.

Bamboo rafts are owned by fishing companies or leased by concessionaires to commercial fishing boat operators for 20% of the price of the harvest. Bigger fishing companies use the longer-lived steel rafts. Hook and line fishermen are allowed by the owners to fish the payao when commercial fishing boats are not fishing in the area. They catch the adult yellowfin tunas at the deeper water column of the payao.

The utilization of payao jointly by commecial and small scale fishermen in tuna fishing, the former fishing the surface aggregating juveniles and the latter handlining the larger deep aggregating adults has demonstrated that conflicts between group of fishermen exploiting a common resource which in the Philippine are often violent maybe eliminated and a peaceful and productive sharing can take its place. Perhaps it is due to the fact that distinct stocks albeit of the same species are exploited by the industrial and artisanal fishermen, the latter fishing only the deep water adult yellowfin beyond the reach of the purse seine.

In the fishing business, specific locations of fishing grounds are generally highly guarded trade secrets. The advent of payao has eliminated that secrecy. Bamboo rafts are indicators of tuna fishing grounds. There is no accurate enumeration of the total number of payao but it has been estimated that some 2000 payaos are deployed in Moro Gulf, and the adjacent Celebes Sea alone. Payao areas are also located in east and west Sulu Sea, Bohol Sea, Visayan Sea, west Negros, northwest and Southern Luzon and other parts of the archipelagic waters in the country providing viable tuna and small pelagic fish fishery in these places. (Figure 1).

FISHING EFFORT WITH BAMBOO RAFTS

Fishing Gears

Some 11 commercial fishing gears are used. The purse seine, ring net, and bag net, however, account for 97% of the total commercial tuna catch. Municipal fishermen employ a greater variety of fishing gears. Handline, gill net, and small purse seine comprise 83% of the municipal tuna catch. Table shows the relative abundance in terms of weight of all commercial and municipal fishing gears. Generally, the majority of juvenile yellowfin and skipjack are caught by purse seine and ring nets while bag nets and gill nets capture mainly the "little tunas".

The catch statistics of fishing gears serve more as indicators of areas of operation rather than their relative efficiencies at capturing the various species of tuna. The bag net and gill nets are used in the archipelagic waters and nearshore areas where "little tunas" are abundance whereas purse seines and ring nets are used further offshore extending to the oceanic regime to capture yellowfin and skipjacks.

Fishing Boats and Operation

The industrial tuna fishing fleet began its expansion in 1975. In previous years, a number of commercial fishing vessels 50 to 300 gross tons (GT) operated purse seines and ring nets with bamboo rafts as FAD largely to catch small pelagic fishes. Tuna test fishing surveys conducted in 1975-1976 by the South China Sea Program (SCSP) of FAO using purse seiners and bamboo rafts confirmed substantial tuna resources in Moro Gulf and the Celebes Sea and standardized the purse seine-bamboo raft fishing technique. The SCSP survey estimated that the chartered vessels Southward Ho (420 GT, 1125 HP) or the Royal Venture (283 GT, 850 HP) fishing commercially in Philippine waters for 25 fishing days per month for 10 months can catch a potential of at least 1500 MT. Subsequently, second hand fishing boats from Japan and the United States were imported and re-rigged for purse seine-bamboo raft fishing operations. Thereafter, fishing companies also began shifting purse seining operations for small pelagic fishes to tuna purse seining. In off-tuna season in the latter half of the year, however, purse seining operations are concentrated on small pelagics.

From 1978 to 1987, some 30 companies were exporting fresh and frozen tuna. Of these companies, 12 were licensed joint venture enterprises between local and foreign fishing companies involving 14 foreign purse seiners (8,854 GT) and 53 longliners (Lagua, 1987). The registered commercial fishing vessels numbered 300 on the average with an aggregate tonnage of more than 25,000 GT. In addition, an undetermined number of ring netters and bag netters from 3 to 10 GT, unlicensed fishing boats, and foreign boats poaching in Philippine waters tremendously increased the fishing pressure on the tuna fishery. As of February 1987, only one joint venture company remained operational utilizing 11 chartered longliners.

Similarly, the number of artisanal handline fishing boats increased from an insignificant number to more than 4000. Of these, about 3,500 are registered in South Cotabato fishing in Moro Gulf and Celebes Sea (Mindanao Sea). These boats range in size from 32 to 45 feet in length and are fitted with 16 to 78 HP engines. They also have built-in ice boxes for chilling the catch. There is an average of 6 fishermen per boat in each fishing trip which average 290 kg/5 days fishing trip. Handling is conducted at daytime for security reasons. Piracy is serious problem of handline fishermen.

When in the fishing ground, boats are tied to the payao and lines are lowered to depths ranging from 60 to 300 meters or where the highest concentration of fish is located. One hook is used per line, but an average of six lines maybe operated per boat. The average catch per boat is 290 kg for a five day trip or 1,450 kg for a 25-day operation per month. At current prices, the average income/month per fishermen is at least $130 per month. This is comparable to the salary of senior scientists in the Bureau of Fisheries. Tuna artisanal fishermen used to be among the poorest of the poor in the Philippines. But the payao's effectiveness at concentrating otherwise free-schooling tunas and making them more vulnerable to capture by artisanal handline fishermen is the hallmark of the benefits arising from the use of FADs in small scale tuna fishing.

TUNA PRODUCTION

Tuna production increased phenomenally from 10,000 MT in 1971 to nearly 125,000 MT in 1976 when payao was innovated in tuna fishing (Table 1). Thereafter, there were weight fluctuations in the late 70's but production increased steadily from 1982 and reached peak production of 261,607 MT in 1985 comprising 20% of the total fish production that year. The annual average landings of tunas over this period was 207,332 MT. Of these, 119,989 MT or 57% was captured by the commercial fishery sector.

The total annual average catch of tuna prior to 1975 was 30,000 MT. the recorded low catches before 1976 maybe due to the lack of catch data for the municipal fishery. It should be noted that 1976 was the first full year in which municipal fishery catch statistics was collected and there was no reliable growth of the fleet or any unit for fishing effort. The rapid increase in the deployment of payaos in tuna fishing grounds began in 1976. As mentioned elsewhere, in 1975-1976 the SCSP demonstated the effectiveness of payao in aggregating tunas and increasing tuna catch by purse seining.

The catch data for the commercial fishery was combined with the municipal fishery landings in 1976 with a total of nearly 125,000 MT which is about 16 times higher than the average catch between 1957 and 1975.

Commercial tuna catch has increased quite steadily attaining a peak production for 136,769 MT in 1985. However, municipal tuna landings show a general decline from a peak catch of 155,514 MT in 1977 which may be flaws in catch data gathering or to actual change in abundance of tunas in areas exploited by small scale fishermen.

The remarkable increase in tuna production was attributed firstly, to the effectiveness of payao as a FAD: secondly, the improved system of gathering catch statistics; thirdly, the growing demand for tuna in the export market; and fourth, there was an increasing popularity of tuna as a food fish. Heretofore, tunas were considered poisonous because of various incidences of food poisoning resulting from the consumption of apparently spoiled tuna sold in the fish markets.

STOCK STRUCTURE

Studies in Mindanao waters indicated that more than 90% of yellowfin and skipjack landed are less than 12 months old. They enter the surface fisheries at around 16 cm. Approximately 90% of the skipjack landed by the inshore ringnet and purse seine gears operating around payaos are between this size and 32 cm with a steady mode between 24 to 38 cm. Together with several species of small pelagics they are landed during all months around payaos and in free schools in this size. Large purse seiners (250 + GT) operating further offshore capture the larger skipjacks in the 40 to 55 cm range at which they are presumed to be 12-24 months old. While there has not been any direct evidence that young skipjacks and yellowfins disperse out into the Pacific, presumably such migration occurs because the size in the surface purse seine fishery (40-60 cm) in the Western Pacific corresponds to the subsequent size range of the tunas after they disappear from Philippine waters.

Unlike the skipjack, there are two district fishermen sectors exploiting two distinct age groups in the yellowfin fishery. The surface fishery is analogous to the skipjack since yellowfin tuna enter the fishery at 12 to 16 cm (= 88 cm), the size at which they begin to move offshore and also the size at which significant quantities begin to appear in the stomachs of adult yellowfin (Yesaki, 1983). At the 16 to 60 cm range juvenile yellowfins tend to concentrate off the coast in the 20-39 nautical mile interval where majority of payaos are set. Juveniles aggregate under these payaos and are captured by ring nets, purse seines and handlines. The juveniles begin to migrate at about 30 cm and practically all have left Philippine waters at 60 cm. (White and Yesaki, 1982). Yellowfins in the 60-110 cm range are not found in significant numbers in Philippine waters but are captured by handline in the area bounded by 20° - 35°N latitude and 130° - 150°E longitude and by pole and line and purse seine in fishing areas bounded by 5° - 160°E longitude (Kikawa and Warashina, 1972 as cited by White, 1982). In this area, yellowfins are 2 years of age which comprise the bulk of the biomass of the population. Adult yellowfin return to Philippine waters between 110-150 cm and older and converge in the North Celebes Sea (Mindanao Sea) to spawn. Here they are caught by handline fishermen.

In La Union in northern Philippines where tunas are not as abundant as in Mindanao, the handline fishery exploits similar sizes of yellowfin and skipjack (Zaragoza, 1983).

Last year, Indonesian fishery biologists tagged 5000 skipjacks. So far, only one of these tagged tunas has been recovered in Zamboanga in southern Philippines. Tag returns from the Japanese and South Pacific Commission tuna tagging program did not provide hard evidence of skipjack migration from the Philippines into the western Pacific.

Feeding Habits of Yellowfin Tuna under FADs

Free-schooling yellowfins swim continuously and migrate in pursuit of predatory species. Frigate tunas (Auxis) and skipjack are the principal tuna prey of yellowfin in the open ocean (Olson, 1982). Stomach contents of yellowfins in Philippine waters prior to the deployment of payaos in north Celebes Sea did not indicate yellowfin juveniles (Ronquillo, 1953, 1964). The proliferation of payaos in tuna fishing grounds in Philippine waters, however, may have altered the migratory and feeding patterns of tunas spawning and transisting in Philippine fishing grounds. Prey organisms are attracted and concentrated under payaos and establish an artificial situation of making available an almost unlimited supply of food for large predators pricipally adult yellowfin. Tunas first attracted to payaos swim quite a distance around the payao at daytime and at nighttime, extremely attracted to the lighting operation of catcher boats, approach the payao and begin feeding (personal communication, tuna boat skipper). The small pelagics (sardines, mackerel, round scads, etc.) and yellowfin juveniles are distributed under the payaos in the upper layers of the water column and the larger predators in the deeper layers. However, juvenile yellowfin are found deeper than the small pelagics and are juxtaposed to adult yellowfins in the deeper layer. Consequently, predation of adult yellowfin was higher on juvenile yellowfin than other tuna species as the stomach contents of adult yellowfins indicated. Moreover, compared to other tuna species, juvenile yellowfin have a stronger affinity to payaos, a behavioral characteristic that accounts for the increased vulnerability of juvenile yellowfin to predation.

The larger yellowfins (40-59 kg) under these payaos consume considerably more juvenile yellowfins (20-30 cm) compared to their predation in the open sea where there are no payaos. Yesaki (198) calculated that the weight of juveniles cannibolized in this manner in Moro Gulf was probably equal to the total weight of yellowfin of 2043 MT landed by purse seine and ring net. Such cannibolism of juveniles, however, has been considered as fishing and not natural mortality as it is a consequence of the use of the payao.

INDUSTRY APPREHENSIONS

The local tuna fishing industry leaders have often in dialogue with the government sector expressed compunction and alarm about the significant quantities of undersized juvenile tunas that their fishing gears are catching and the apparent decline in catch in traditional tuna fishing grounds. Consquently they have proposed the initiation of some regulatory measures that might reduce, if not prevent entirely the catch of undersized tunas such as mesh size regulation of purse seine and ring nets. This proposal is academic since research in tuna-rich Mindanao waters indicated that tunas caught in payao-associated and free schools are of similar size indicating that yellowfin and skipjack exploited by the pelagic fishery in Philippine waters are early juvenile stocks of the 16 to 30 cm size range. Moreover, the majority of tunas landed are captured by ring netters and small purse boats which catch a variety of small pelagic fishes beside tuna, such as mackerel, sardines, round scad, etc. which are the mainstay of the pelagic fishery in off-tuna season and the same mesh size is used to land all species.

The small scale fishermen have hinted at the extension of municipal waters from 7 to 9-kilometers radius from the shoreland. A presidential Letter of Instruction in 1974 reserved these nearshore areas countrywide for the exclusive use of municipal fishermen. The 2-kilometer difference in the boundary may not have an impact since commercial fishing vessels are actually fishing further out to catch the larger size group of tunas that are not present in municipal waters.

THE STATE OF THE TUNA FISHERY RESOURCE

On the basis of the 2 1/2 year data of the SCSP study in Mindanao waters, catch rates have not declined and that there is no evidence from the study results to support or refute any claim of overfishing (White, 1982).

While payaos increase the total catch of small tunas, because of the ability of payaos to attract and concentrate pelagic fish, the use of payaos will increase the catch of small tunas but not selectively because the majority of yellowfin and skipjack tunas in Philippine waters are apparently juvenile.

Current studies have not determined mortality for juvenile, dispersing, and spawning stocks, and stock recruitment relationships for yellowfin and skipjack.

The larger yellowfin tuna landed by the handline boats are apparently the spawning stock responsible for spawning the juveniles landed by the inshore surface fisheries. However, since yellowfins begin spawning in the Philippines at around 110 cm in length belonging to the III+ and IV* age class while the juvenile fish are less than one year of age and the intervening year classes are probably dispersed in the Pacific, a direct relationship between the spawning stock and recruits would be remote Whitem 1982. This maybe the same situation for the skipjacks.

The apparent pattern of migration poses the question of the possible interrelationship between the juvenile O+ fish comprising the surface fishery of the Philippines, the surface fisheries of Western Pacific based on 1+ and II+ some of which may come from the Philippines and III+ and IV* fish which the basis of the Philippine handline fishery which also provides the spawning stock for the juvenile fishery. Certainly, this situation is relevant to the Western Pacific purse seine fishery of countries with long distance fleets.

The development of tuna fishing with payao in the Philippines should be an area of concern for both the Philippines and other countries that have adopted the payao technology for fish attraction in the South China Sea and the West Pacific, an issue that has remained dominant in Southeast Asian fisheries. It should be mentioned, however, that while the use of the payao is causing the rapid removal of young juveniles of yellowfin and skipjack from the stocks, it was only due to the effective manner in which payao concentrate tunas for capture that has enabled the Philippines to share competitively in the fisheries and market of a resource that has long been the monopoly of developed countries especially those with long distance fleets.

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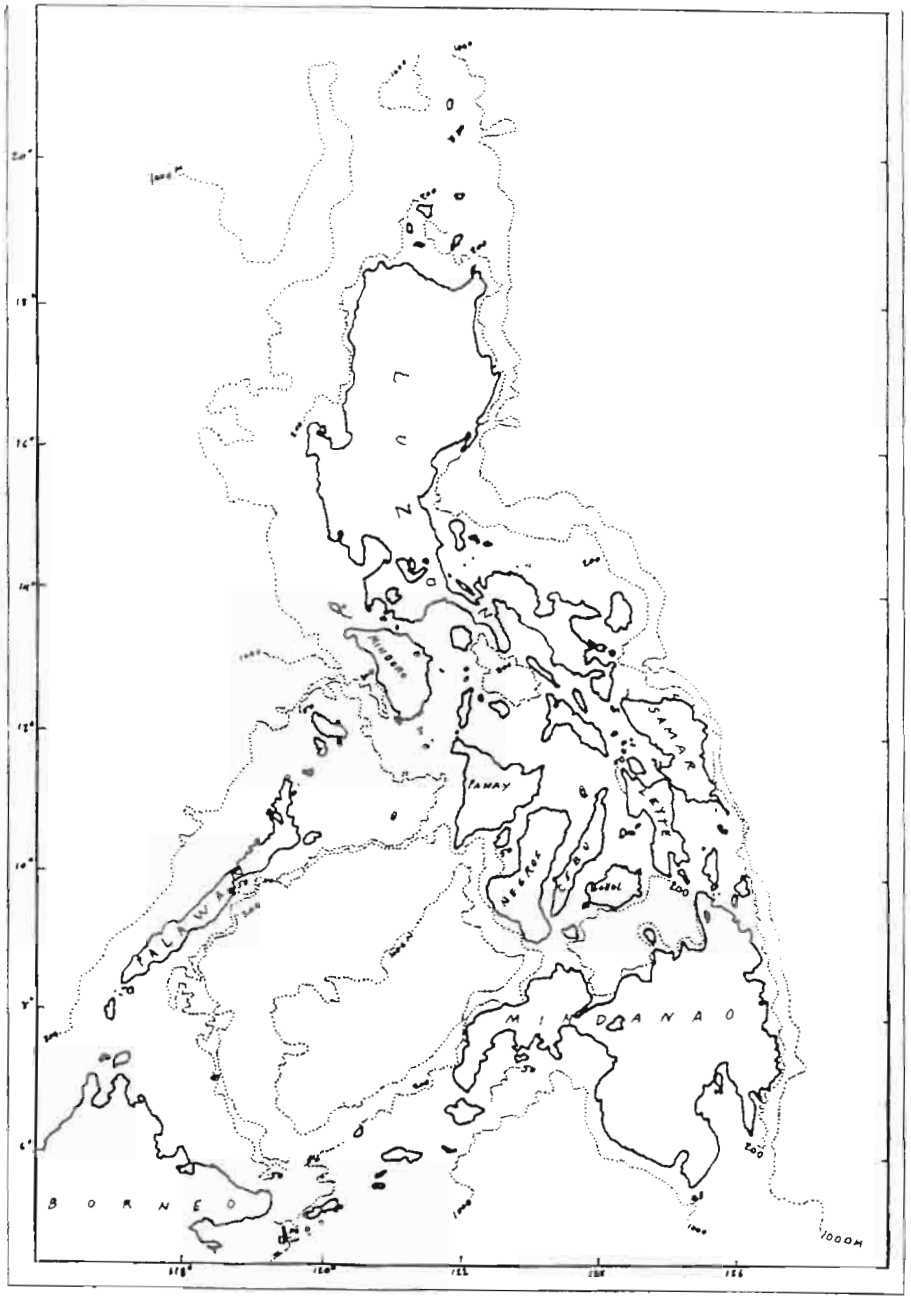
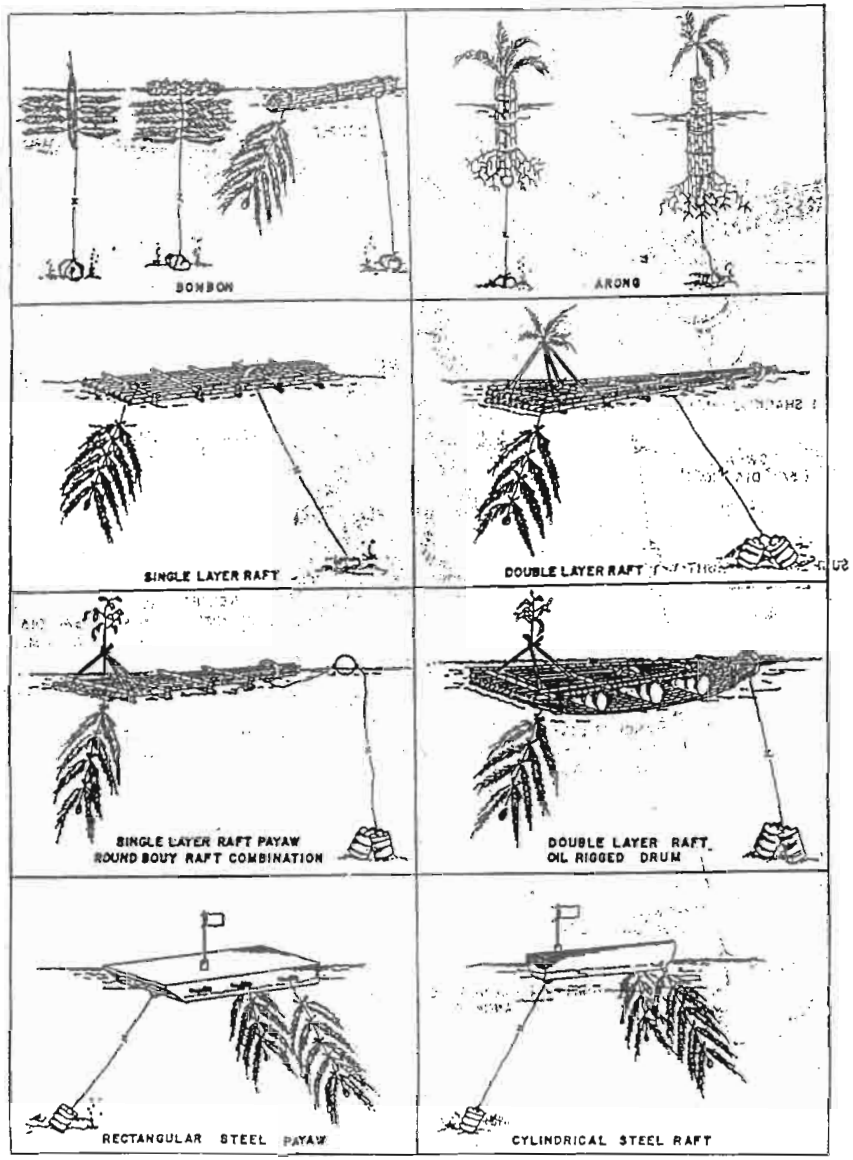
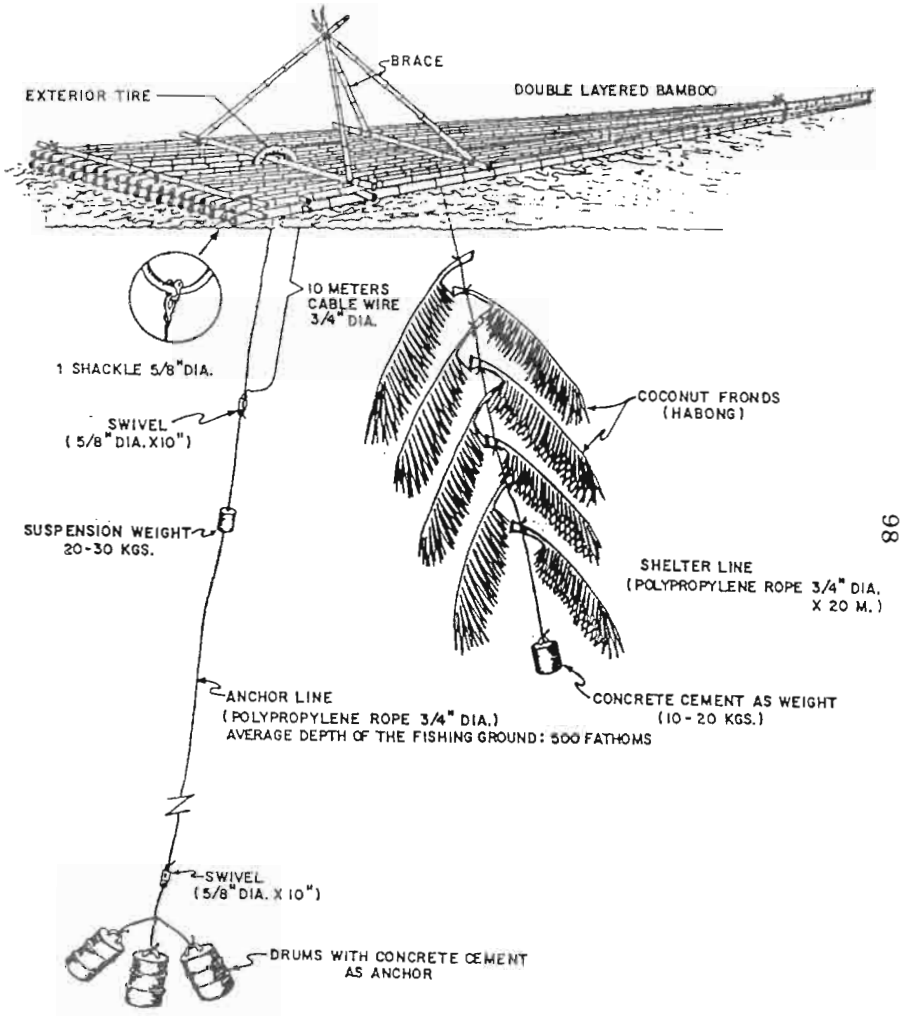


Figure 1:

Fig. Various types of payaw used through the years in the Philippines. Source: de Jesus, 1982)





TYPE : Fish aggregating device
NAME OF GEAR : Two-layer bamboo raft
LOCALITY : Throughout the Philippines

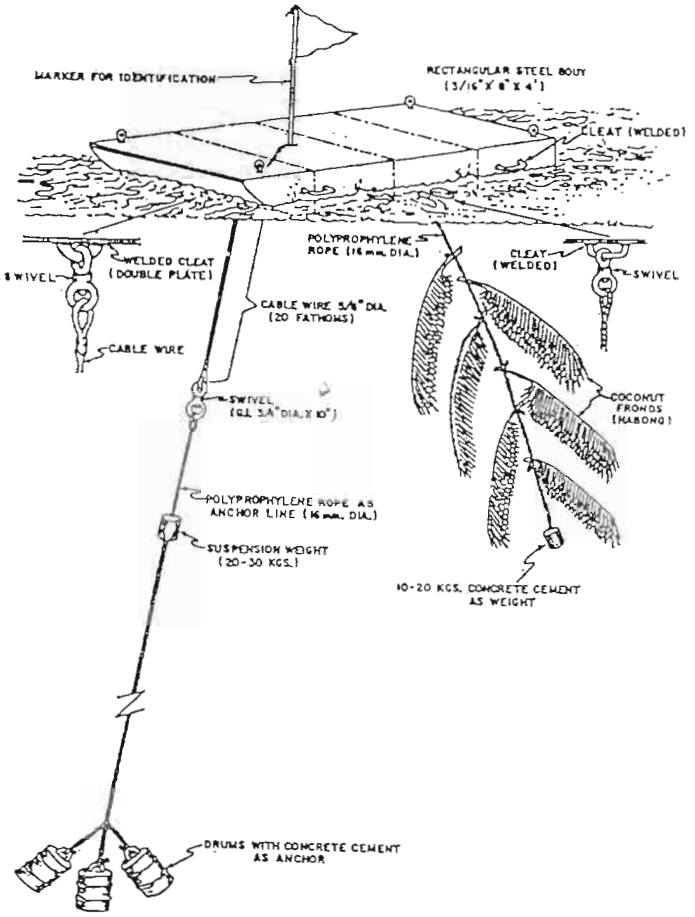


Fig. 3 Rectangular steel pontoon type payao. Source: de Jesus, 1982

Table 1. Annual total landings (MT) of tunas in the Philippines from 1976-1985

SPECIES \ YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	$\bar{X}$	%
FRIGATE/ BULLET	28328	43007	50899	79809	96874	78248	67363	74333	80305	95718	69498	33.5
YELLOWFIN	44478	63039	47029	49224	48023	56176	51922	62092	58924	64293	54522	26.3
SKIPJACK	29174	53090	49730	43084	31178	38439	50795	57068	44671	60536	46177	22.3
EASTERN LITTLE	23004	54743	36341	23094	24730	30891	46524	49064	41899	41060	37135	17.9
TOTAL	124984	215900	183999	197311	200805	203754	216604	242557	225799	261607	207332	100%

6.5 # Some Aspects of the Biology and Population Dynamics of Skipjack *(Katsuwonus pelamis)* in Philippine Waters*

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*Presented at the FAO/IPTP Meeting of Tuna Research Groups in the Southeast Asian Region, Manila, 25-28 August 1987. ICLARM Contribution No. 401.

Abstract

Aspects of skipjack *(Katsuwonus pelamis)* biology and population dynamics in Philippine waters between 1977-1982 are presented. Landings of skipjack in the Philippines are highly seasonal with peaks between February to May and October to November. The mean size at first maturity of skipjack in the Philippines is 43 cm (FL). Two spawning peaks were observed, one from March to May and a lesser one in November. The recruitment pattern of skipjack was similarly bimodal. An analysis of stomach contents showed that the dominant food items in Philippine waters were fish and squids. The estimated optimum capture length (L_{opt}) of skipjack caught by handlines increased with hook size, as did the selection range. Selection was very pronounced against smaller fishes. Growth of skipjack in Philippine waters was determined by: $L_t = 82.2\ (1 - exp. - 0.48\ (t + 0.26)$. Growth performance was within observed values for skipjack elsewhere. Total mortality estimates of skipjack suggested that they are presently overfished.

Introduction

Skipjack *(Katsuwonus pelamis)* tuna landings in the Philippines have ranged from 31,000 to 61,000 tonnes per year between 1980 and 1985 with an average of 47,000 tonnes (BFAR 1985 and unpublished data), i.e., about 3.8% of the country's total marine landings. Most tuna landed are destined for canning although some skipjack are consumed fresh. Skipjack are caught mainly by ring nets, purse seines and handlines (White and Yesaki 1982). Floyd (1986) gave an account of the economics of the Philippine tuna fishery, and pointed out that it suffers from severe economic overfishing.

Studies on the biology and population dynamics of skipjack tuna have been reported upon by Ronquillo (1953, 1964), Buñag (1956), White (1982) and Yesaki (1983). In this paper, we present data on biology and population dynamics of skipjack sampled in the Bohol Sea and northwestern Luzon from 1977 to 1982.

Materials and Methods

The sources of data on skipjack analyzed in this paper are summarized in Table 1. Landings of skipjack were sampled in two locations in the Philippines, at Darigayos

Table 1. Sources of data used in the present contribution on skipjack tuna in Philippine waters.

Subject	Sampling: Location	Sampling: Years	Source
Morphometrics	N.W. Luzon	1981	Cortez-Zaragoza (1983) & Tandog (1984)
Hook selection	N.W. Luzon	1981	Cortez-Zaragoza (1983) Tandog (1984)
Reproduction	N. Mindanao	1977-1982	Bureau of Fisheries and Aquatic Resoures Regional Office, Region X, Opol
Catch size composition	N. Mindanao	1979-1980	Bureau of Fisheries and Aquatic Resources Regional Office & Tandog (1984)
Feeding habits	N. Mindanao		Tandog (1984)
Seasonality of production	Philippines	1980-86	Navotas Fish Port Complex, Manila
	N. Mindanao	1982	Tandog (1984)
	N.W. Luzon	1981	Cortez-Zaragoza (1983)

Cove, nothwestern Luzon and Opol, northern Mindanao (Fig. 1). Detailed accounts of these fisheries and sampling methods are given in Cortez-Zaragoza (1983) and Tandog (1984). The fishery at Darigayos Cove is composed of small (approx. 0.3 gross tons (GT) vessels from which skipjack are caught by handlines around "payaos", i.e., fish attractive devices which are particularly abundant in this area (Floyd and Pauly 1984). Some

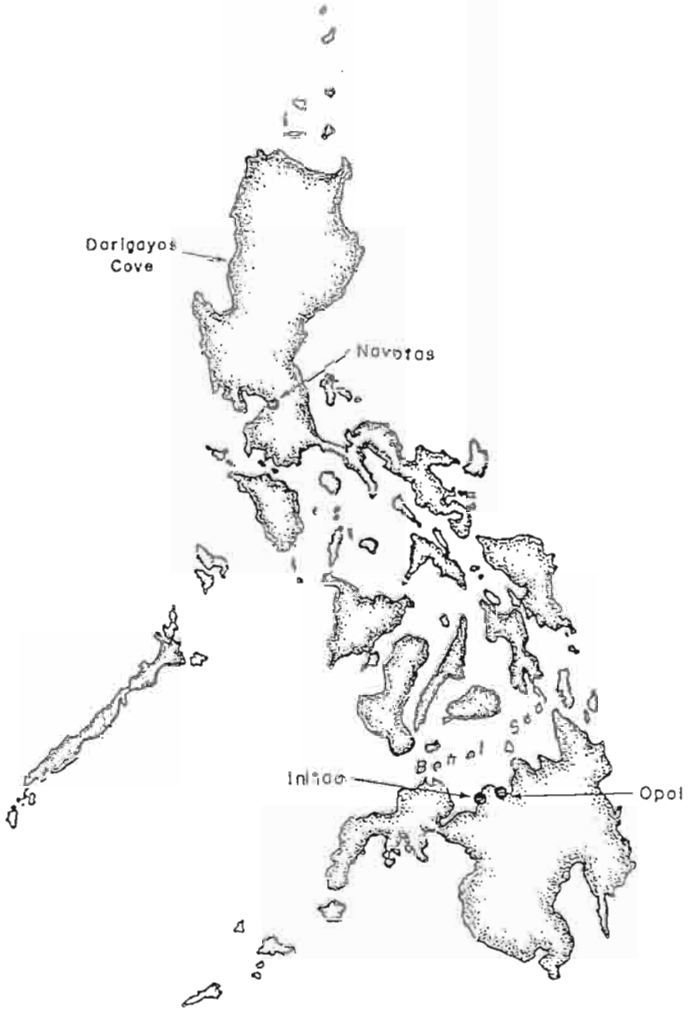

Fig. 1. Map of the Philippines showing locations from where sample data on skipjack were collected.

skipjack are caught in a similar manner in the Bohol Sea and landed at Opol or the nearby town of Initao. Skipjack caught by larger commercial ring net vessels ranging from 22-56 GT are also landed at Opol. Ringnet and handline caught fish were sampled and recorded separately.

Six maturation stages of skipjack gonads were recognized by macroscopic examination, as follows:

0	Gonads indistinct	III	Maturing ripe
I	Immature	IV	Ripe
II	Maturing	VI	Spent

These maturity stage were based on those given by Orange (1961) for yellowfin and skipjack tuna in the eastern Pacific.

Morphometrics of Hook Selectivity

Measurements were taken on fork length, eye diameter and head length of skipjack tuna captured off northwestern Luzon. Length-weight relationships were estimated based on samples from both sites.

Hook selectivity of skipjack was estimated using the Baranov/Holt method (Baranov 1914, Holt 1963), reviewed in Gulland (1983) and Pauly (1984). Hook size is defined here as the distance of the gap between the hook shank and point of the barb (Fig. 2).

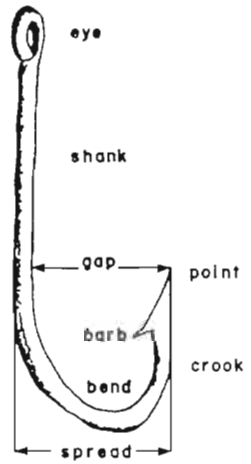

Fig. 2. Parts of a hook; "size" as defined here is the gap.

The stomach contents of 148 specimens of skipjack, caught by ring nets at Opol were examined to determine feeding habits of this species. The occurrence of each particular food item was expressed as a percentage of the number of fish examined following the method of Laevastu (1965).

Age and growth parameters of skipjack were estimated from length frequency data collected at Opol and Initao. The von Bertalanffy growth function (VBGF) was fitted to

each annual length frequency data set using the ELEFAN I computer program (Pauly and David 1981). The VBGF for length takes the form:

$$L_t = L_\infty \ (1-e^{-K(t-t_0)})$$

where L_t is length at time t, L_∞ is the asymptotic size, K is a growth constant and t_0 relates the origin of the curve to the time axis.

Total mortality rate (Z) was determined using length-converted catch curves (Pauly and Ingles 1981; Gulland 1983). Here, length-frequency data pooled over a longer period are used to construct a plot whose x-axis represents the relative age $(t-t_0)$ of the fish, and whose descending limb can be fitted with a straight line of the form

$$\text{Log}_e (N_i/\Delta t_i) = a + bt_i$$

where $b = -Z$, t_i is the relative age of the fish in length class i; Δt_i is the time taken to grow through length class i; and N_i is the number of fish in length class i.

Sequential length-frequency data may be projected backwards on to a time axis corresponding to one year to determine the annual recruitment pattern (Pauly and Ingles 1981). The resulting frequency distribution, after some minor adjustments, gives the pattern of recruitment over a one-year period. (When t_0 is accurately known, the monthly pattern of recruitment can be ascribed to actual months and compared directly with spawning data). The derivation of both the recruitment pattern and the catch curve are features of the ELEFAN II computer program (Pauly and Ingles 1981).

Results and Discussion

Seasonal Abundance

The mean monthly landings of skipjack for each month at the major fish market in Navotas, Manila are shown in Fig. 3. There are two very clear peaks in seasonal abundance between February to May and October to November. The landings of skipjack at Navotas come from all the Philippines and account for about 20% of the total national catch of this species. These data are thus likely to be representative of the general

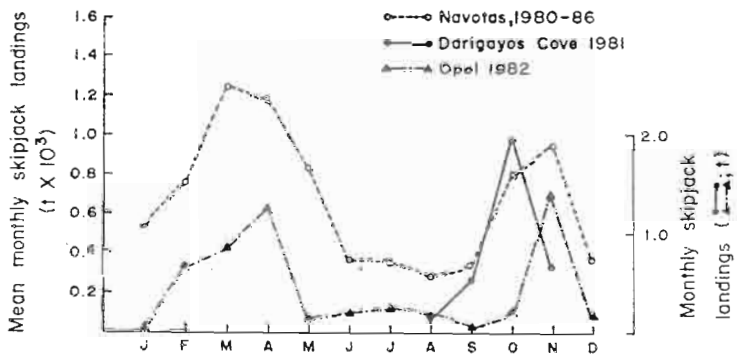

Fig. 3. Seasonality of production of skipjack tuna from different locations in the Philippines.

seasonal trends for skipjack production in the Philippines. This is supported by the landings data from Opol and to a lesser extent Darigayos Cove (Fig. 3). The annual length frequencies of these different landings are shown in Fig. 4.

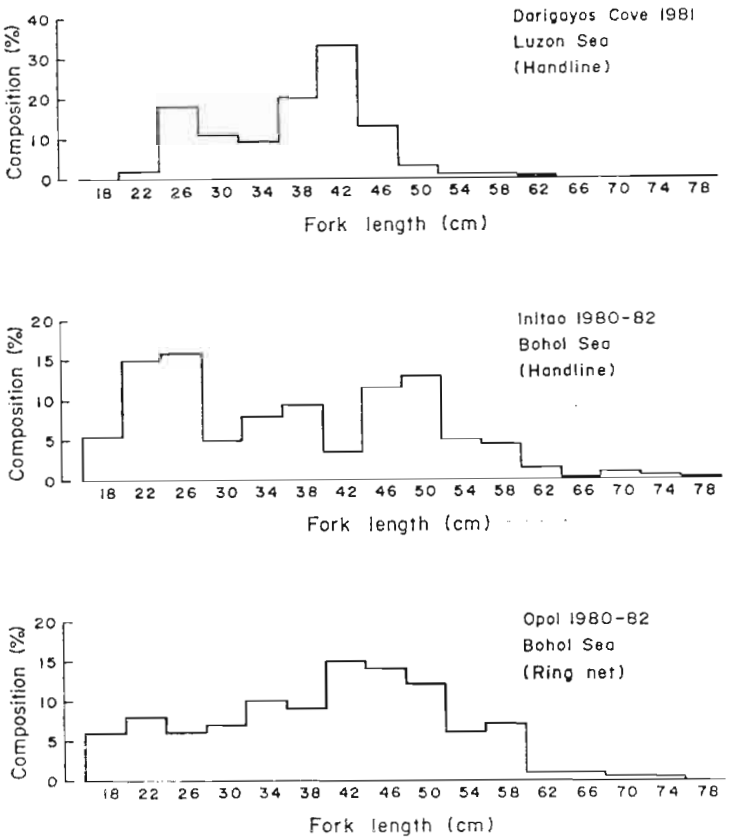

Fig. 4. Annual length-frequency distribution for skipjack off N.E. Luzon and Bohol Sea.

Reproduction

Length at first maturity is conventionally defined as the length at which 50% of the fish of a given stock become sexually mature. Skipjack with stages II-V gonads were here deemed to be sexually mature. A plot of the percentage of the numbers of these fish as a function of their length and based on the data in Table 2 is shown in Fig. 5. From this the 50% maturity length was estimated as 43.3 cm. (the data were insufficient to

Table 2. Percentage of mature and immature skipjack from the Bohol Sea.

Mid-length	Maturity Stage: Stage I	Maturity Stage: Stages II-V	% Mature
20	4	0	0
24	8	0	0
28	17	0	0
32	26	0	0
36	4	0	0
40	3	1	25
44	6	8	57
48		33	100
52		17	100
56		12	100
60		21	100
64		18	100
68		7	100
72		15	100
76		2	100

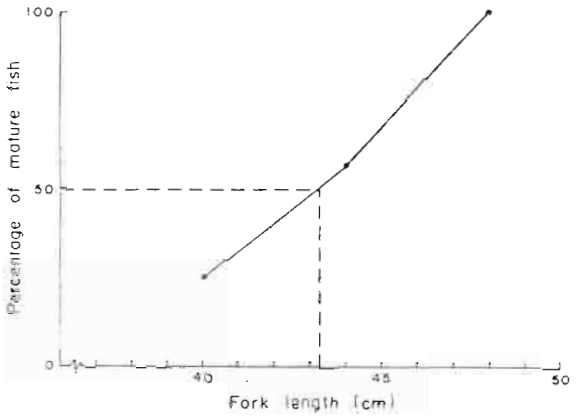

Fig. 5. Percentage of mature fishes, fork length for skipjack tuna.

obtain separate estimates for females and males). A comparison with estimates of mean length at first maturity obtained elsewhere is given in Table 3.

Data on the maturity stages of skipjack from the Bohol Sea from 1977 to 1982 were summarized on a bimonthly basis to determine spawning seasonality. Two spawning peaks were tentatively identified, one from March to June and lesser one from November to December (Fig. 6). Note that the peaks in spawning intensity coincide with the production peaks of the fishery.

Table 3. Length at first maturity of skipjack from the Philippines and other locations.

Location	Fork length (cm)	Source
Hawaii	40 - 50	Brock (1954)
Eastern Pacific	40 - 55	Orange 1961)
	40 - 45	Raja (1964)
Marqueras and Tuamotu Island	43	Yoshida (1964)
Papua New Guinea	45	Kearney (1974)
USA, North Carolina	43.5 45.4	Batts (1972)
Philippines	40	Wade (1950)
Philippines	41.9	Ronquillo (1964)
Philippines	40.5	Bunag (1956)
Philippines	43.1	This Study

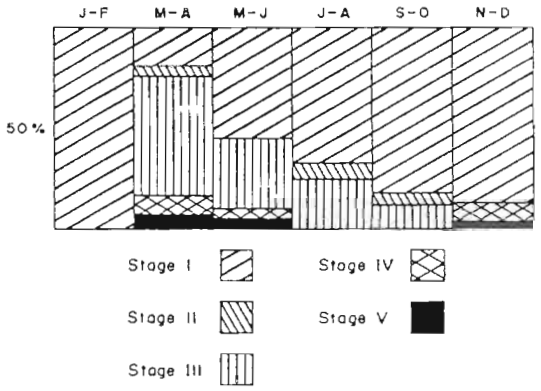

Fig. 6. Bimonthly percentage of different maturity stages of skipjack sampled from the Bohol Sea, 1977-1982.

Recruitment Patterns

The recruitment patterns generated by ELEFAN II for samples from the Bohol Sea are shown in Fig. 7. Three out of the four length-frequency samples have two well-defined recruitment peaks. Twin recruitment peaks correspond to the twin spawning peaks discussed in the previous section. These results agree well with the findings of White (1982) and Yesaki (1983) who, similarly, suggested twin spawning and recruitment peaks for skipjack in Philippine waters.

Twin recruitment patterns for Philippine marine fisheries have been reported by Pauly and Navaluna (1983), Ingles and Pauly (1984) and Corpuz et al. (1985). Pauly and Navaluna (1983) suggested that the spawning and recruitment processes were related to the two monsoon seasons of the Philippines.

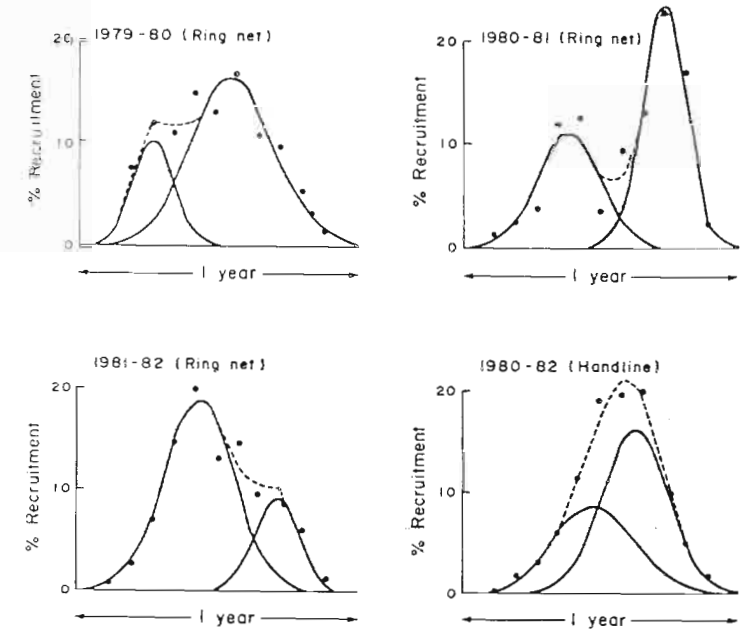

Fig. 7. Recruitment patterns of skipjack caught in the Bohol Sea, 1980-1982. Points represent estimates of relative monthly recruitment; normal curves represent recruitment pulses identified by applying the BASIC version, by Pauly et al. (1976), of the NORMSEP program in Abramson et al. (1971) to the data points.

Food

Only 31 of the 148 skipjack sampled in the Bohol Sea contained any food. A summary of the stomach contents observations is given in Fig. 8. Fish and squids comprised the major component of the diet. In the Central Pacific, the major component of skipjack diet was fish and mollusks (Alverson 1967; Waldron and King 1963) whilst in the Eastern Pacific, crustaceans were the dominant food item, followed by squids and fish (Forsbergh 1980). Thus, skipjack appear to be opportunistic feeders which prey on whatever is available to them (see also Ronquillo 1953).

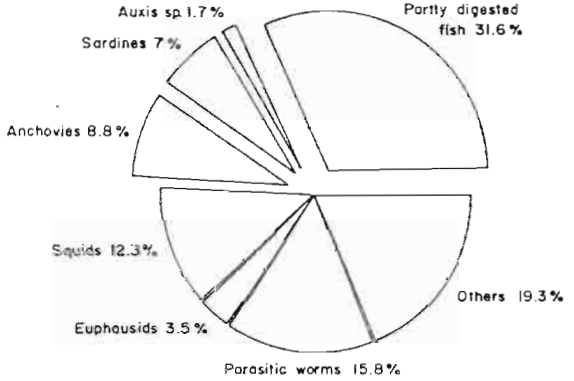

Fig. 8. Percentage composition of skipjack stomach contents.

Morphometric Relationships

A summary of the different morphometric relationships of Philippine skipjack tuna is given in Fig. 9.

Hook Selectivity

The hook sizes used to capture skipjack at Darigayos Cove are 1.1, 1.2, 1.3, 1.4 and 1.5 cm. The data on catch at length are given in Table 4. There were insufficient overlap of fish lengths captured by 1.2 and 1.3 cm hook sizes, however. Fig. 10 shows for each of the other adjacent combinations, a double logarithmic plot of the catch ratio on fork length.

The estimated *optimum capture length* for each hook size is given in Table 5. The scatter of optimum lengths versus hook size was fitted with a nonlinear function of the form $y = ax^b$ (Fig. 10). The selection range (defined here as one standard deviation either side of the optimum length) versus optimum length was fitted with a straight line forced through the origin and the means of both variates (Fig. 12).

Both analyses suggest that larger hooks capture larger skipjack and that larger hooks capture a greater range of fish sizes, with selection, overall, being very strong against smaller skipjack. A similar result was found for yellowfin tunas by Cortes-Zaragoza et al (1987).

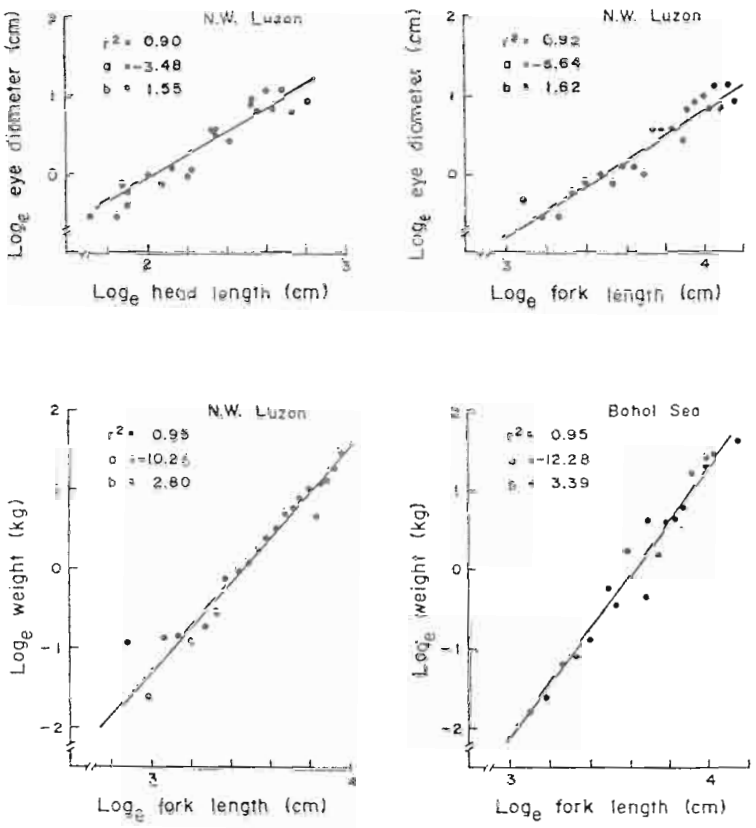

Fig. 9. Morphometric relationships for skipjack from Philippine waters.

Age and Growth

The results of the analysis of the length-frequency data from the Bohol Sea are shown in Figs. 13-16. and Table 6. Rough estimates of t_0, the origin of the growth curve, were obtained from the empirical equation:

$$\log_{10}(-t_0) = -0.3922 - 0.2752 \log_{10} L_\infty - 1.038 \log_{10} K$$

Table 4. Catch by Length of Different Hook Sizes to Estimate their Selectivity for *Katsuwonus pelamis*, off Darigayos Cove, N.W. Luzon.

Midlength of size group in cm	Hook size 1.1	1.2	1.3	1.4	1.5
22	20	2	–	–	–
24	119	35	–	–	–
26	76	45	–	–	–
28	25	76	–	–	–
30	10	60	19	–	–
32	6	56	61	–	–
34	3	17	19	1	–
36	–	–	127	16	2
38	–	1	81	43	8
40	–	1	54	70	28
42	–	–	36	130	86
44	–	–	7	60	82
46	–	–	4	24	53
48	–	–	–	14	68
50	–	–	–	3	22
52	–	–	–	1	4
54	–	–	–	2	–
56	–	–	–	–	6
58	–	–	–	–	3
60	–	–	–	–	2
62	–	–	–	–	–
64	–	–	–	–	2

estimated by Pauly (1979) based on 153 sets of t_0, L_∞, and K values of a wide variety of fish species. The growth curve for skipjack from the Bohol Sea may thus be given as:

$$L_t = 82.2\ (1 - e^{-0.48(t+0.26)})$$

According to White (1982) skipjack attain, after the first, second and third year of life, lengths of 40, 58 and 68 cm, respectively, which agrees with the values generated by the above equation.

Pauly and Munro (1984) and Moreau et al.(1986) have shown that the parameters of the VBGF can be compared directly through the use of Ø' computed from:

$$Ø' = \log_{10} K + 2\log_{10} L$$

The estimates of Ø' for a given species should correspond to a normal distribution which is indeed the case with the available values for skipjack. The values of Ø' for the Bohol Sea skipjack stock falls within the range of previous estimates (Fig. 17).

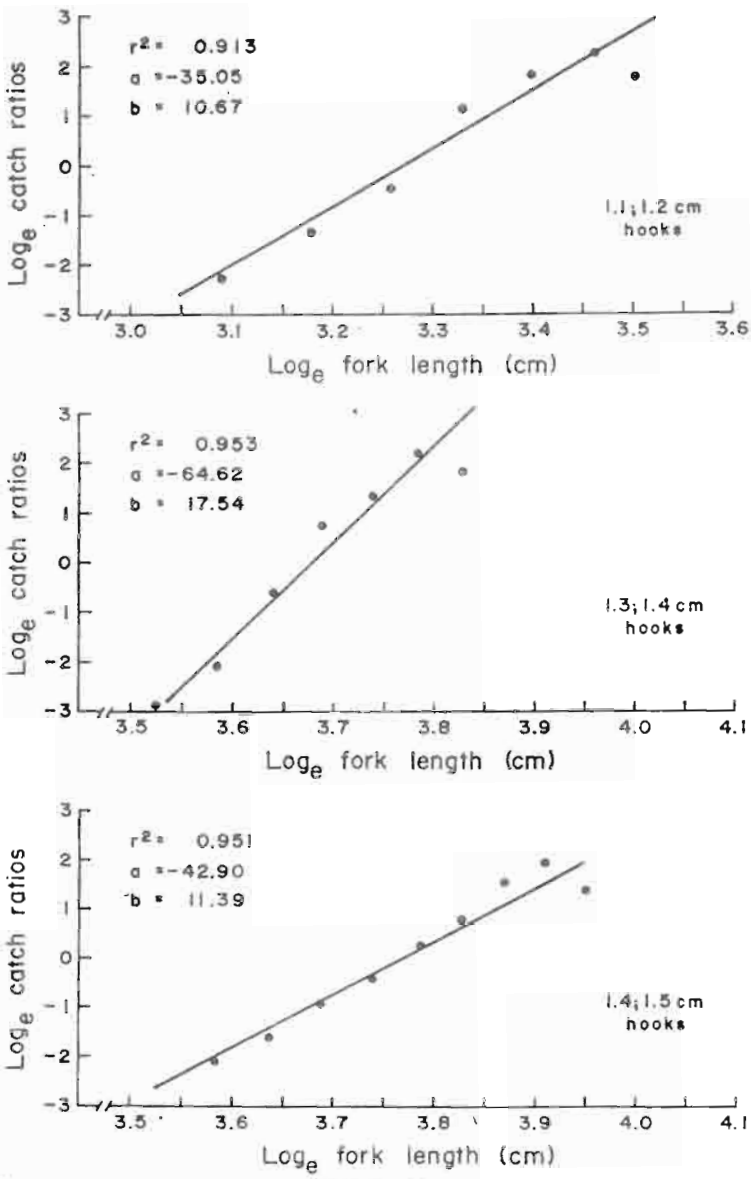

Fig. 10. Log$_e$ capture length *vs.* log$_e$ fork length of skipjack for different combination of hook size.

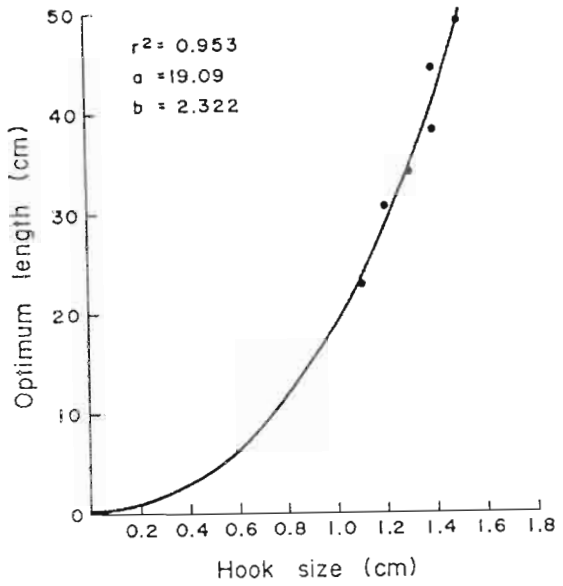

Fig. 11. Optimum length *vs.* hook size for Philippine skipjack tuna.

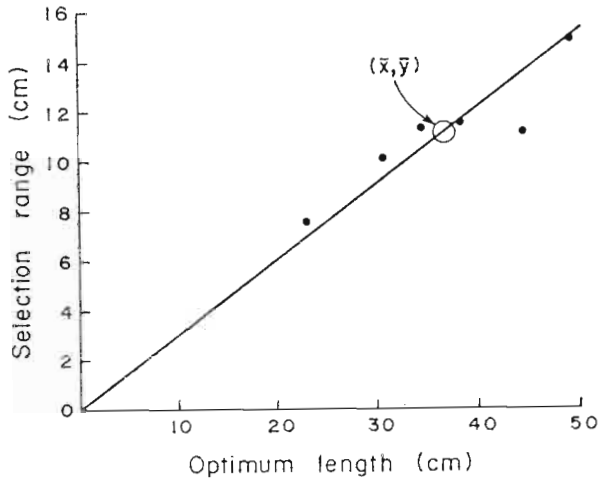

Fig. 12. Selection range (S.R.) *vs.* optimum length for skipjack tuna (see text for definition of S.R.).

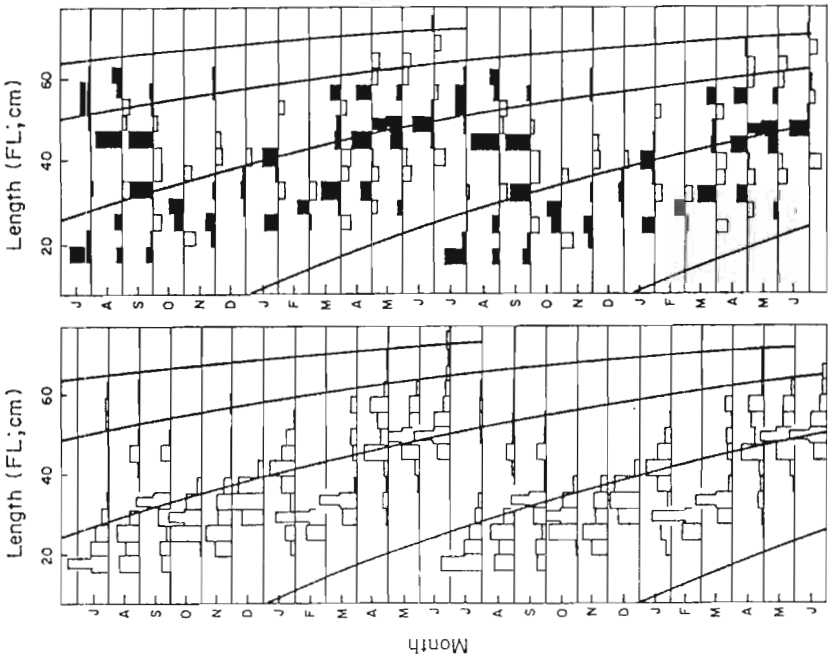

Fig. 14. Application of ELEFAN I to length-frequency data of skipjack landed 1979-1980 at Opol, Bohol Sea. *Left:* original data; *Right:* restructured data. Note that in both cases some peaks are missed by growth curve, suggesting a second cohort (see text).

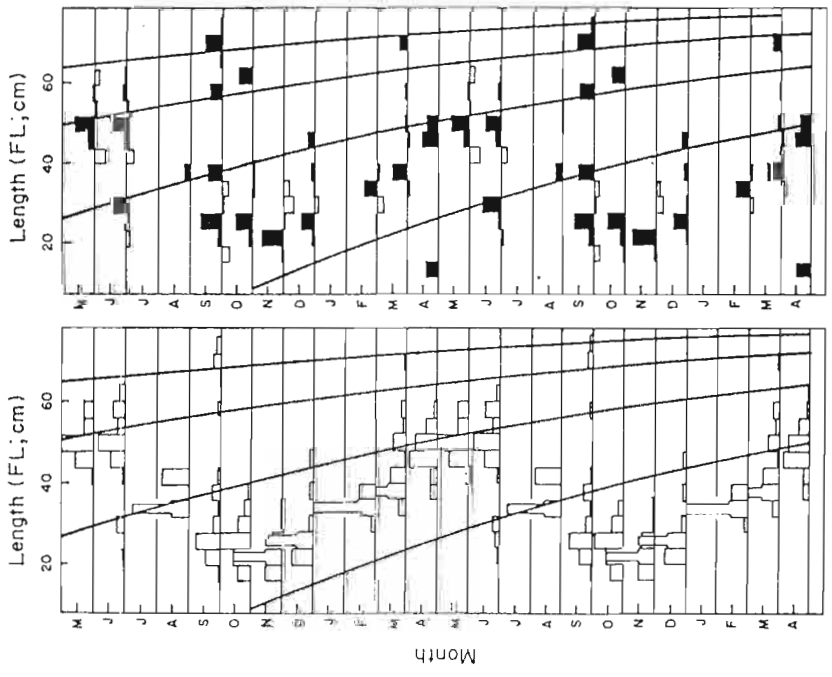

Fig. 13. Application of ELEFAN I to length-frequency data of skipjack landed 1980-1982 at Initao, Bohol Sea. *Left:* original data; *Right:* restructured data. Note that in both cases, some peaks are missed by growth curve, suggesting a second cohort (see text).

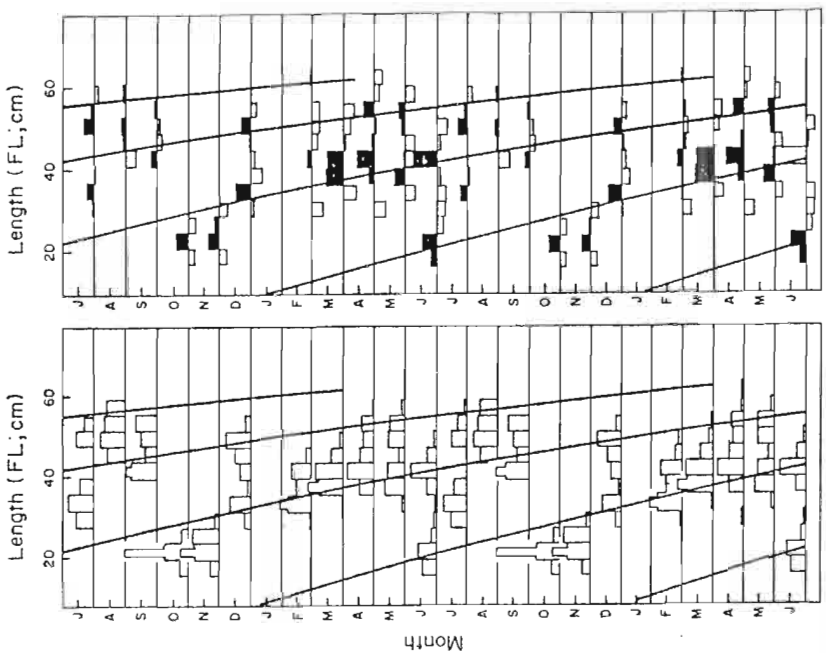

Fig. 16. Application of ELEFAN I to length-frequency data of skipjack landed 1981-1982 at Opol, Bohol Sea. *Left*: original data; *Right*: restructured data. Note that in both cases some peaks are missed by growth curve, suggesting a second cohort (see text).

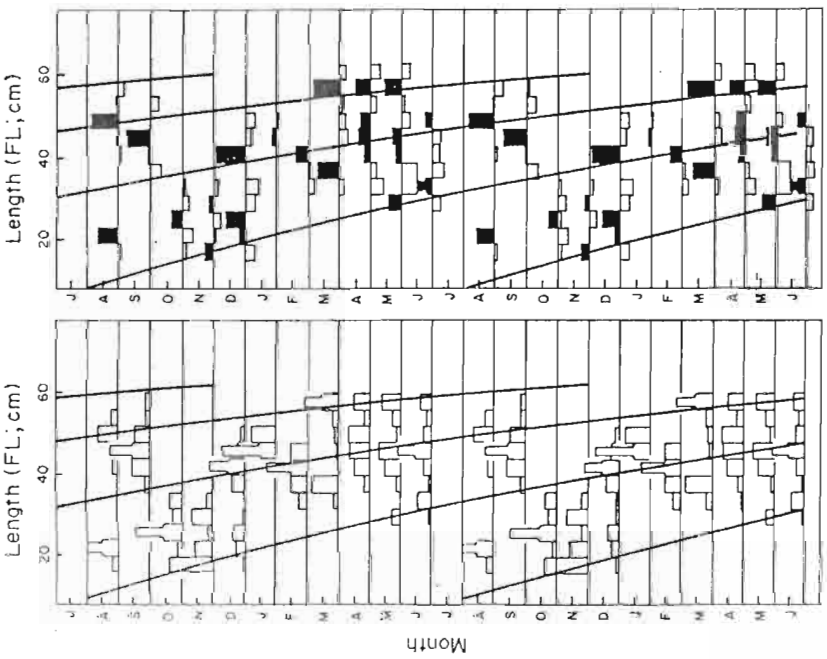

Fig. 15. Application of ELEFAN I to length-frequency data of skipjack landed 1980-1981 at Opol, Bohol Sea. *Left*: original data; *Right*: restructured data. Note that in both cases some peaks are missed by growth curve, suggesting a second cohort (see text).

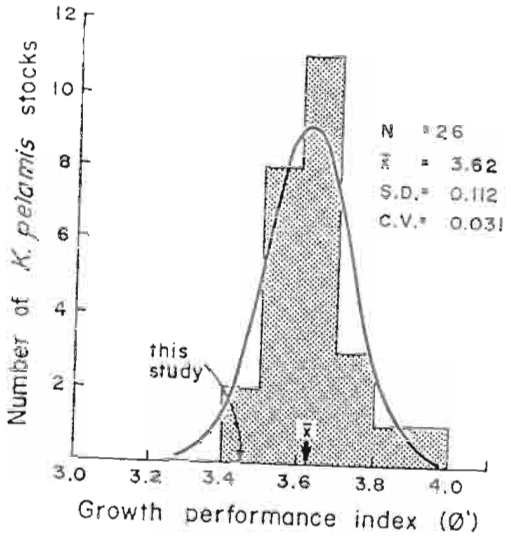

Fig. 17. Frequency distribution of ϕ' in 26 skipjack stocks.

Table 5: Hook size and predicted optimum length of Skipjack tuna.

Hook size (cm)	Optimum Capture length (cm) [a]
1.2	19.6
1.3	27.1
1.4	36.1
1.5	42.4

[a] Where there was more than one optimum length for a hook size means are given.

Table 6 : Growth parameter estimates derived from application ELEFAN 1 to skipjack length frequency data from the Bohol Sea.

Year	Location	Gear	Loo (FL; cm)	K (yr -1)	ESP/ASP ratio
1979 - 80	Opol	Ringnet	84.7	0.54	0.337
1980 - 81	Opol	Ringnet	80.6	0.40	0.564
1981 - 82	Opol	Ringnet	80.0	0.42	0.523
1980 - 82	Initao	Handline	83.6	0.54	0.424

TABLE 7. Estimates of the growth parameters (Loo and K) in skipjack tuna with computed value of ϕ'(= logK + 2logLoo).

Area	Loo (cm)	K (y^{-1})	Ø'	Source
Hawaii	84.6	1.16	3.92	Uchimaya and Struhsaker, 1981
Hawaii	85.1	0.95	3.84	Brock, 1954
Eastern tropical Pacific	85.1	0.44	3.50	Scheefer, 1961
Hawaii	82.3	0.77	3.72	Rochschild, 1967
Pacific Ocean 10 N 100 W	80.5	0.63	3.61	Joseph and Calkins, 1969
North of Madagascar	62.3	0.98	3.58	Marcille and Stequert, 1976
Central Pacific	102.0	0.55	3.76	Uchimaya and Struhsaker, 1981
Hawaii	92.4	0.47	3.60	Uchimaya and Struhsaker, 1981
Eastern Pacific	142.5	0.29	3.77	Uchimaya and Struhsaker, 1981
Eastern Pacific	72.9	0.83	3.64	Joseph and Calkins, 1969
Eastern Pacific	107.5	0.41	3.68	Joseph and Calkins, 1969
Eastern Pacific	88.1	0.43	3.52	Joseph and Calkins, 1969
Papua New Guinea	65.5	0.95	3.61	Josse et al., 1979
Papua New Guinea	74.8	0.52	3.46	Wankowski, 1981
Papua New Guinea	65.0	0.92	3.59	Kearney, 1974
Philippines (Southern)	84.5	0.51	3.56	White, 1982
Philippines (Southern)	82.5	0.48	3.45	This paper
Hawaii	101.1	0.39	3.60	Skillman, 1981
Taiwan	103.6	0.30	3.51	Chi and Yang, 1973
Taiwan	103.8	0.43	3.67	Chi and Yang, 1973
Eastern Pacific	79.1	0.64	3.60	Josse et al., 1979
Western Pacific	61.3	1.25	3.67	Sibert et al., 1983
Eastern Pacific	75.5	0.77	3.64	Sibert et al., 1983
East tropical Atlantic Ocean	80.0	0.60	3.58	Bard and Antoine, 1983
Vanuatu, Western Pacific (1)	60.0	0.75	3.43	Brouard et al., 1984
Vanuatu, Western Pacific (2)	62.0	1.10	3.63	Brouard et al., 1984

Mortality

The length-converted catch curves the Bohol Sea skipjack are shown in Fig. 18. A summary of the results is presented in Table 8. As no independant estimate of natural mortality (M) was available, Pauly's (1980) empirical formula was used to estimate natural mortality:

$$\log_{10}M = -0.0066 - 0.279\log_{10} L_\infty + 0.654 \log_{10}K + 0.463\log_{10}T$$

where L_∞ (cm) and K (year $^{-1}$) are the VBGF growth parameters and T(°C) is the mean environmental temperature. Mean surface water temperature for Philippine waters is given by Dalzell and Ganaden (1987) as 28.2°C. Annual fishing mortality (F) could be obtained by subtraction of M from Z, and the exploitation rate (E = F/Z) computed (Table 8).

Gulland (1971) proposed that optimum fishing mortality should be approximately equal to the natural mortality rate or $F_{opt} = M$, and hence $E_{opt} \approx 0.5$. The estimates of E for those fish taken by ring nets are greater than 0.5 and suggest overfishing, thus confirming Floyd (1986). Apparent E for handline caught tuna is considerably lower. The reasons for this are most probably biases caused by hook selectivity.

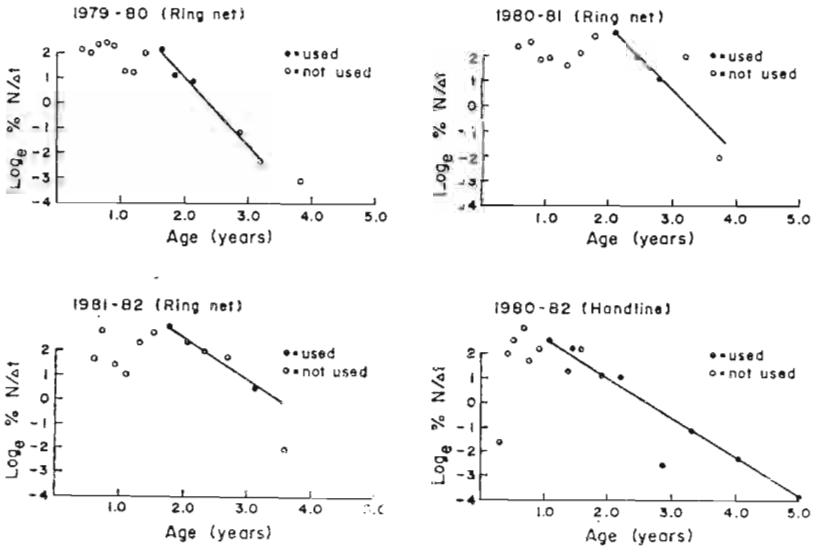

Fig. 18. Length-converted catch curves for skipjack caught by handline and ring net from the Bohol Sea, 1979-1982.

Table 8. Estimates of mortality rates of skipjack captured in the Bohol Sea; all values are expressed on an annual basis.

Year	Location	Gear	Z	M	F	E
1979-1980	Opol	Ringnet	3.00	0.89	2.11	0.70
1980-1981	Opol	Ringnet	2.64	0.74	1.89	0.72
1981-1982	Opol	Ringnet	1.76	0.77	0.99	0.56
1980-1982	Initao	Handline	1.38	0.90	0.48	0.35

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6.6 ESTIMATIONS OF GROWTH PARAMETERS AND MIGRATIONS OF SKI SKIPJACK TUNA, KATSUWONUS PELAMIS (LINNAEUS, 1758), IN THE EASTERN INDONESIAN WATERS AS INDICATED BY TAGGING EXPERIMENTS.

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JAKARTA, INDONESIA
1987.

Paper presented on the 2nd Tuna Research Group Meeting in the Southeast Asean Region, 25-28 August, 1987. Manila, Philippines.

1. INTRODUCTION

Skipjack tuna and other tunas are present in commercial quantities along both the Indian and the Pacific Oceans coasts of Indonesian waters. The importance of these species to Indonesia is well appreciated, particularly in East Indonesia, in the south coast of Java and Bali, and in the west coast of Sumatra.

The goverment of Indonesia support the development of its skipjack tuna and tuna fisheries, encouraging the export of non-feul and natural gas commodities such as shrimp, skipjack tuna and other tunas, and by providing lo loans for the fishermen. The total yield of skipjack tuna in Indonesia has increased remarkbly from 14,000 metric tons (mt) in 1970 to 87,445 mt in 1985 with annual growth rate of 10.6 per cent, of which 64,585 mt or 76, per cent was landed in East Indonesia (DGF 1987).

The Research Institute for Marine Fisheries (RIMFRI) or "Balai Penelitian Perikanan Laut" Jakarta has collected data on biology, catch and effort rouitinely from several sampling sites in the eastern (Sorong, Ambon, Ternate, Bitung) and western (Prigi, Pelabuhanratu) sides of Indonesia since 1978, in order to study the population parameters of these species especially the skipjack tuna. This study serves as a starting point for a better understanding of the present state of the skipjack tuna fishery and to support further biological studies.

Due to the recent expansion of skipjack pole-and-line fisheries in the estern Indonesian waters, knowledge of the biological information of skipjack tuna in this area such as migration, growth, age, mortality, and population structure are needed to provide scientific basis for rational management.

Various methods have been used to determine the age and growth of skipjack tuna, but tag-recaptured study is the most reliable (Forsberg 1980, Matsumoto et al. 1984). This study also provides direct information of migrations and population structures (single population or sub-populations) of the skipjack tuna.

The growth, age, and migration of skipjack tuna based upon the tagging have been well studied by many authors (Blunt and Messersmith 1960, Schaefer et al. 1961, Rotschild 1967, Joseph and Calkins 1969, Fink and Bayliff 1970, Kasahara 1976, Josse et.al. 1979, Sibert et al. 1983, Kearney 1983,

Skillman 1984, Yonemori et al. 1985).

The RIMFRI has commenced the skipjack and young yellowfin tuna tagging in the eastern Indonesian waters over the period December 1983 to February 1986. A total of 7059 skipjack and 784 yellowfin tuna have been tagged, and 8 skipjack tuna and 5 yellowfin tuna have been recaptured (through December 22, 1986) as listed in Tables 1 and 2.

This paper presents the priliminary results of the above tagging program and reference will only be made on the skipjack tuna because there is very insufficient data available for the yellowfin tuna.

2. MATERIALS AND METHODS

2.1. Tagging duration

The tagging activities in the waters adjacent to Sorong, Ambon, and Bitung could be divided into 5 periods and are as follows :

1). Sorong, Irian Jaya, December 18, 1983 to January 29, 1984.
2). Sorong, Irian Jaya, April 14 to May 27, 1984.
3). Ambon, Moluccas , April 14 to June 4, 1984.
4). Bitung, North Celebes, April 12 to May 20, 1984.
5). Bitung, North Celebes, January 9 to February 7, 1986.

2.2. Equipments and methods of tagging

The equipments used for tagging such as tag, applicator, tag holder, tagging cradle, boat, and the methods of tagging are shown in Figures 1 to 7. The descriptions of the equipments used and the procedures of tagging are described and discussed in Yonemori et al. (1985).

2.3. Methods of analysis

2.3.1 Estimates of growth parameters

To estimate the length increment (mm), the least squares method proprosed by Schaefer et al. (1961) was utilized.

$$Y = a + bX \quad \ldots\ldots\ldots\ldots \quad (1)$$

where Y = Length at recapture (Lr) - Length at tagging (Lt), mm
X = time at liberty, day
a = constant
b = daily length increment, mm

The parameters of the von Bertalanffy growth formula (VBGF), the K parameter and the Loo can be estimated by using a regression for the relationship of change in length per unit time on mean length as proposed by Gulland and Holt (1959) by the equation :

$$Y = a + bX \quad \ldots\ldots\ldots\ldots \quad (2)$$

where $Y = (Lr - Lt) / t$, cm ; t = time at liberty
$X = (Lr + Lt) / 2$, cm

and the intercept (a) and the slope ( ) could provide the values of K (growth coefficient) and Loo (asymptotic length) through the relationships,

$$K = -b$$
$$Loo = a/K$$

The VBGF for length is described by the equation (Cushing 1968, Ricker 1975, Pauly 1980 and 1982) :

$$L_t = Loo \left[1 - e^{-K (t - t_o)} \right] \quad \ldots\ldots\ldots \quad (3)$$

where L_t = length at age t, cm
Loo= asymptotic length, cm
K = growth coefficient
t = time interval between estimates of modal size
t_o = theoritical age where L_t is zero

Fabens (1965) procedure for estimating K and Loo by avoiding the iterations of the least-squares method is identical with equation (2) can be approached in section 9 of his paper. These parameters can be determined from the formula :

$$L_t = Loo \left(1 - p\, e^{-Kt} \right) \quad \ldots\ldots\ldots\ldots \quad (4)$$
$$Y = a + bX \quad \ldots\ldots\ldots\ldots \quad (5)$$

where Y and X as described in equation (2)

$$K = (\Sigma X \Sigma Y - n \Sigma XY) / (n \Sigma X^2 - (\Sigma X)^2 = -b$$

$$L_{oo} = (X \; XY - Y \; X^2) / (n \; XY - X \; Y).$$

p = constant

The parameters t_o and p, which is related to the size of the fish at birth cannot be estimated from recaptured data. Some data relating size at known age (i.e. L_o) must be supplied to determinate t_o and p. The length L_o at t_o is estimated based on the skipjack tuna larvae at time of hatching. Joseph and Calkins (1969) and many authors chose the mid value of the circumference of skipjack eggs ranges from about 2.50 to 3.50 mm fo L_o. Thus L_o of 3 mm was assigned to skipjack tuna in this study to fit the equations (3) and (4).

2.2.2 Length-weight relationship

The length-weight relationship is described by the equations :

$$W = a \, L^b \qquad \ldots\ldots\ldots \quad (6)$$

where W = weight of skipjack, kg ; FL = fork length, cm ; a = constant ; b = coefficient of allometry.

3. RESULTS AND DISCUSSION

3.1 Tag recovery and migration

A total of 7059 skipjack and 784 yellowfin tuna have been tagged. From these fish, 88 skipjack tuna (1.25%) and 5 yellowfin tuna (0.64%) were re - covered from the domestic pole and liners and foreign purse-seiners. The numbers of fish tagged and recaptured by yearly period, and cruise and percentage rates of recaptured upto December 22, 1986 are tabulated in Tables 1 and 2, and shown in Figures 8A to 8E. The size frequency distrilutions of skipjack released and recaptured are illustrated in Fig. 9.

The results showed that 0.37 percent of the 7944 fish released in Sorong, 2.52 percent of the 2852 fish released in Bitung and none of the 2270 fish released in Ambon were recovered. Out of 93 recovered fish, 64 fish or 71 percent (61 skipjack and 3 yellowfin tuna) came from the batch of fish which were released in the waters adjacent to Bitung during the last period from January to February 1986, while the rest came from the release period, January 1983 to June 1984. Figure 10 shows that most of the fish were recaptured within 30 days.

It is interesting to note that from 64 recaptured fish as mentioned above, 62 (97.0%) of them were recaptured around "Rumpon" or Payaos, where 38 fish were recaptured within 30 days, 7 fish in the period 100 to 330 days with longest recaptured time being 342 days as shown in Fig. 11. From the total of 12 recaptured fish in Sorong, 4 of the fish were recovered within 30 days, 3 within 100 to 330 days and the maximum recapture time was 334 days.

Figure 12. shows the location of the released and the recovered fish including the tagged fish released by the Japanese fishing boat. The figure also illustrates the fact that fish dispersed to all direction from area of release. Some of the skipjack tuna showed local movement in the waters adjacent to Sorong and Bitung, particularly in Bitung where plenty of them were caught around the rumpon. The movement of tagged skipjack tuna also indicate that some of them underwent extensive migration throughout the study area with the greatest distance being 1,229 miles.

Fish tagged in Sorong were recovered in Western Central Pacific Ocean near Caroline Islands. Fish tagged in Bitung were recovered in all directions such as Seram Sea, Molluca Sea, Sulu Sea (Zamboanga, Philippines) and in the Halmahera Sea (Pacific Ocean). Some of the skipjack released by the Japanese fishing boat in the Western Central Pacific Ocean were recovered in the Eastern Indonesia waters such as Molluca Sea, northern part of Irian Jaya, and the waters adjacent to Buton Island. This means that the skipjack tuna in the eastern Indonesia waters are mixed or interchange with those from the Pacific Ocean and the Sulu Sea (Fig. 12.). The migration of skipjack tuna to the Central Pacific Ocean (eastern migration) originated from the waters adjacent to Bitung and Sorong seems to agree with the hypothesis of Rothschild (1965). For the migration of skipjack tuna in the central-eastern Pacific Ocean. Rothschild (1965) hypothesized that a large portion of the skipjack tuna caught in the eastern Pacific Ocean originated in the equatorial Pacific and that a large component of prerecruits (>35 cm) moves eastward and split into a northern group that enters the Baja California fishery area, and that the skipjack tuna remain in the eastern Pacific for several months before they migrate offshore into equatorial waters to spawn.

The distance between tag release and tag recovery points do not necessarily represent the actual movement of skipjack tuna. In Fig. 13 are plotted the distance of movement for skipjack tuna.

It shows that most of the fish move/migrate within 200 miles.

3.2. Growth Increment.

Using equation (1) the length increment for the skipjack tuna could be expressed by :

$$Y = 7.230 + 0.249\ X \qquad r = 0.70 \quad \ldots\ldots\ldots(7)$$

The slope of this line (length increment) is 0.249 mm/day or 91 mm/year as shown in Fig. 14. The 95% confidence limit of yearly increment is 91 $\pm$ 24 mm (range 67 - 115 mm). The length increment of skipjack tuna tagged from the eastern Pacific Ocean and the waters of Papua New Guinea are 126 mm/year (Shaefer et al 1961) and 107 mm/year (Jose et al=1979), respectively, while Kearney (1983) pointed out that the growth increment is 76 mm/year in the SPC waters. Thus the growth increment of the skipjack in the Western Pacific Ocean fall within the range of those from the Indonesian waters.

Other studies on the length increment presented in Table 3 indicate that the older the fish the lower its growth increment.

3.3. The Von Bertalanffy growth parameters.

Data on age and growth of the skipjack tuna obtained as a result of observation on fish tagged in the eastern Indonesian waters based on equation (2) is as follows :

$$Y = 0.111 - 0.000129\ X \qquad \ldots\ldots\ldots\ (8)$$

where $K = 0.470$ on annual basis and

$L_{oo} = a/b = 86.0$ cm

For the $L_o = 0.3$ cm, t_o will be -0.006.

Substituting these parameters(L_{oo}, K and t_o) into equation (3) and (4) give von Bertalanffy and Fabens growth function for length of skipjack in this study area by the equations (Table 4 and Fig. 15)

$$L_t = 86.0(1-e^{0.470(t + 0.006)}) \qquad \ldots\ldots\ldots(9)$$

$$L_t = 85.5(1-0.996\ e^{-0.482\ t}) \qquad \ldots\ldots\ldots(10)$$

and for weight*) ,

$$N_t = 14.1(1 - e^{0.470\ (t + 0.006)})^3 \qquad \ldots\ldots\ldots(11)$$

$$Wt = 13.8(1 - 0.996\ e^{-0.482\ t})^3 \qquad \ldots\ldots\ldots(12)$$

*) Based on the length-weight relationship in equation 13 to obtain W_{oo}

where $L_{oo} = 85.5$ cm, $K = 0.482$, $b = 0.996$

which related to the size of fish at birth (Fabens 1965)

Comparing the Von Bertalanffy growth parameters for $K = 0.44$, $L_{oo} = 85.1$ cm (Schaefer 1961) and $K = 0.43$, $L_{oo} = 88.1$ cm (Joseph and Calkins 1969) of the tagged skipjack tuna from the eastern Pacific Ocean (25° N to 20° S latitude) with those in the present study, it seems remarkbly similar as listed in Table 4. Using the length-frequency data of the skipjack tuna collected from the waters adjacent to Sorong, Uktolseja (1987) estimated the L_{oo} to be 83.0 cm for 1978, 80.3 cm for 1979 and 77.9 cm for 1980. The growth coefficient was constant at $K = 0.4$ for all the years.

The t_o's were estimated to be -0.3051 for 1978, -0.3080 for 1979, and -0.3106 for 1980 respectively. For the Papua New Guinea waters, Jose et al. (1979) estimated K and L_{oo} for tagged skipjack tuna to be 0.9451 and 65.7 cm, respectively. While Wankowski (1981) using the modal length at age groups in the Papua New Guinean skipjack pole and line catches estimated for K and L_{oo} of 0.5148 and 74.8 cm, respectively.

The results for K and L_{oo} in the present study show slight difference with those from PNG region and the data given in Table 7, probably due to the use of different methods and different approaches to interpreting growth marks and analyzing the data.

3.4. Length-weight relationship

Tabulations of the length-weight relationships for the skipjack tuna from the eastern Indonesian waters by area and period of tagging are presented in Table 5. The analysis of covariance (ANCOVA) was applied for comparing the differences of regression line, regression coefficient, and adjusted mean among areas according to the procedures described by Snedecor (1956) and Sokal and Rohlf (1969). The ANCOVA indicates no significant differences among the sample regression coefficient ($P=0.05$, $F=2.41$), but adjusted mean and regression line show significant difference ($F=78.6$, and 40.6, $P=0.05$).

The aeras were combined (Sorong, Ambon and BItung) for the purpose of calculating W_{oo} (Weight asymptotic) in VBGF in weight equation and is given by the equation :

$$W = 1.0773 \times 10^{-5} L^{3.1620}, \quad r = 0.9210 \quad \ldots\ldots (13)$$

4. SUMMARY AND CONCLUSSIONS

The Research Institute for Marine Fisheries Jakarta has conducted the Regional Skipjack and Tuna Tagging Programme in the eastern Indonesian waters since December 1983. The priliminary results of these activities during the period pecember 1983 to February 1986 could be summarized in terms of rhe following conclussions :

1. A total of 7059 skipjack tuna and 784 yellowfin tuna were tagged in the waters adjacent to Sorong, Ambon and Bitung, of which 93 fish (88 skipjack tuna and 5 yellowfin tuna) were recovered within 342 days after the last period of tagging.

2. The recovery rates are 0.40 percent in Sorong, 3.10 percent in Bitung a and none in Ambon, respectively.

3. Some of the skipjack tuna showed local and long distance migrations. The farthest distance migrated by a skipjack was 1229.1 miles while the nearest distance of migration was zero mile.

4. The payaos can keep the skipjack tuna to stay in the fishing ground for more than 340 days.

5. The skipjack tuna in the eastern Iddonesian waters are intermingling wit with those from the western central Pacific Ocean and Sulu Sea.

6. The annual growth increment of tagged skipjack tuna ranging from 41 to 56 cm in fork length was 91 mm.

7. Growth parameters of skipjack tuna were estimated by means of Gulland and Holt's method, Faben's least-squares method. The equations are as follow :

von Bertalanffy, $Lt = 86.0\ (1 - e^{-0.470\ (t + 0.006)})$, cm year.

Fabens , $Lt = 85.5\ (1 - 0.996\ e^{-0.482\ t})$, cm year.

5. Length-weight relationship for skipjack tuna combined from Sorong, Ambon, and Bitung was described by the equatuon,

$$W = 1.0773 \times 10^{-5}\ L^{3.1360}$$, cm and kg.

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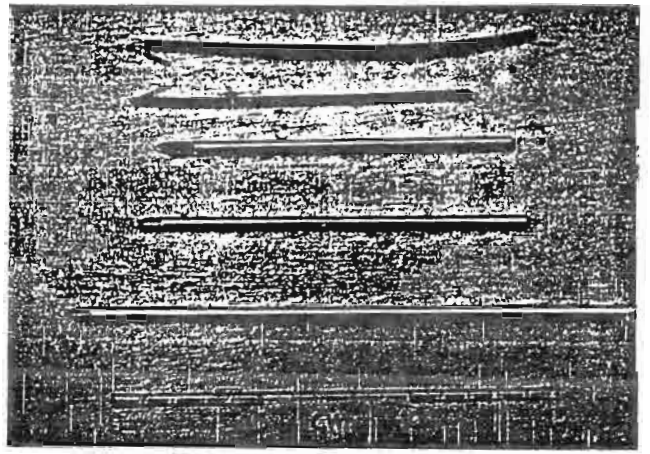


Fig. 1. Tag and applicator

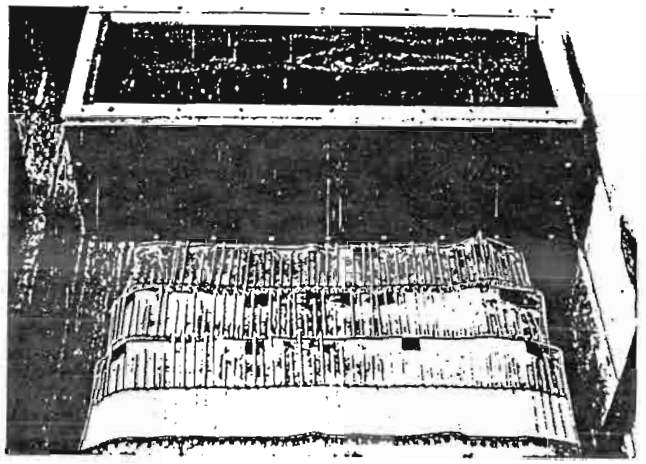
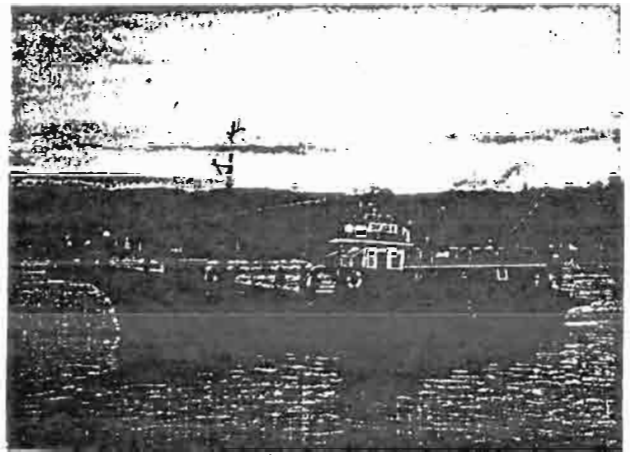


Fig. 2. Tagging cradle and tag holder



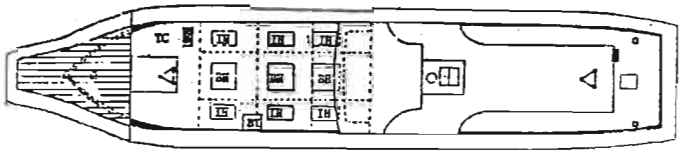
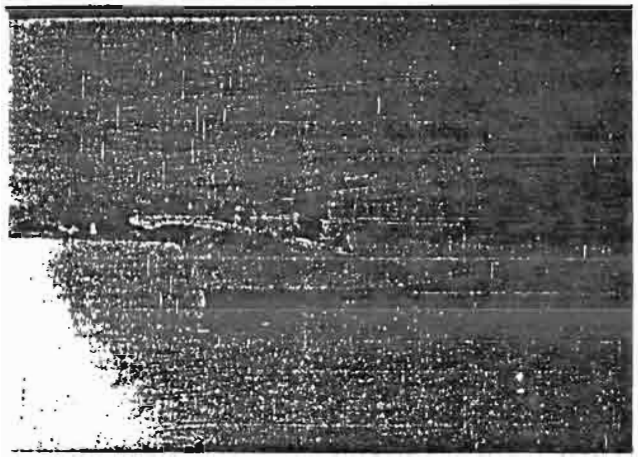


Fig. 3. 30 GT Indonesian standard pole and line boat

TC = Tagging cradle
BH = Bait hold
BT = Bait tank
IH = Ice hold



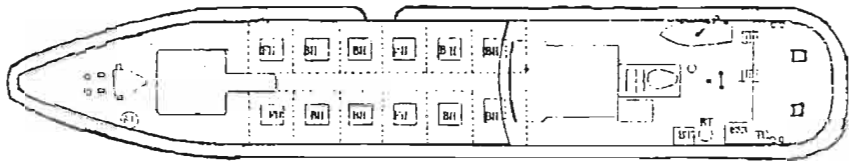


Fig. 4. 300 GT Indonesian pole and line boat

TC = Tagging cradle
BH = Bait hold
BT = Bait tank
FH = Fish hold (brine)

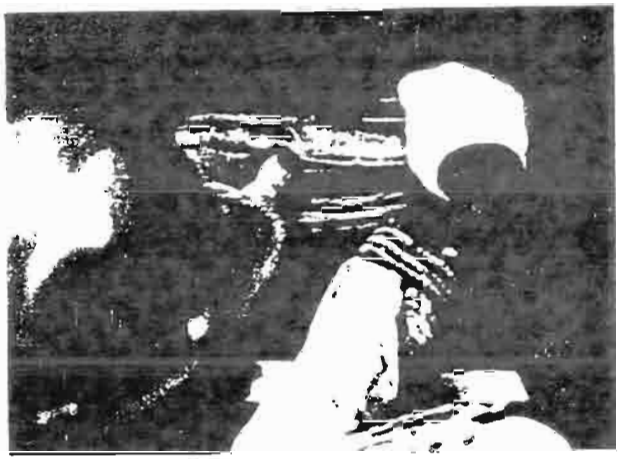


Fig. 5. Skipjack tagging

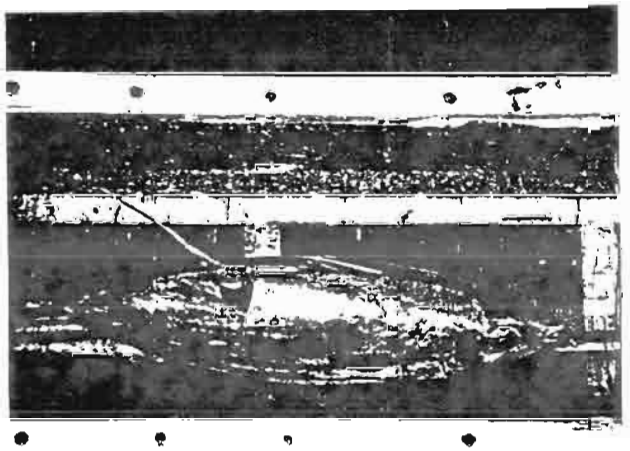


Fig. 6. Cut portion, showing the inserted tag at pterygiophorus of the second dorsal fin.

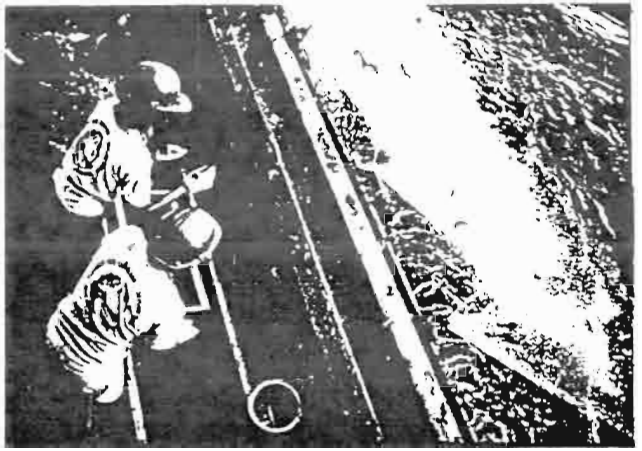


Fig. 7. The tagger (author) and his assistant watching the tagged fish being released into the sea.

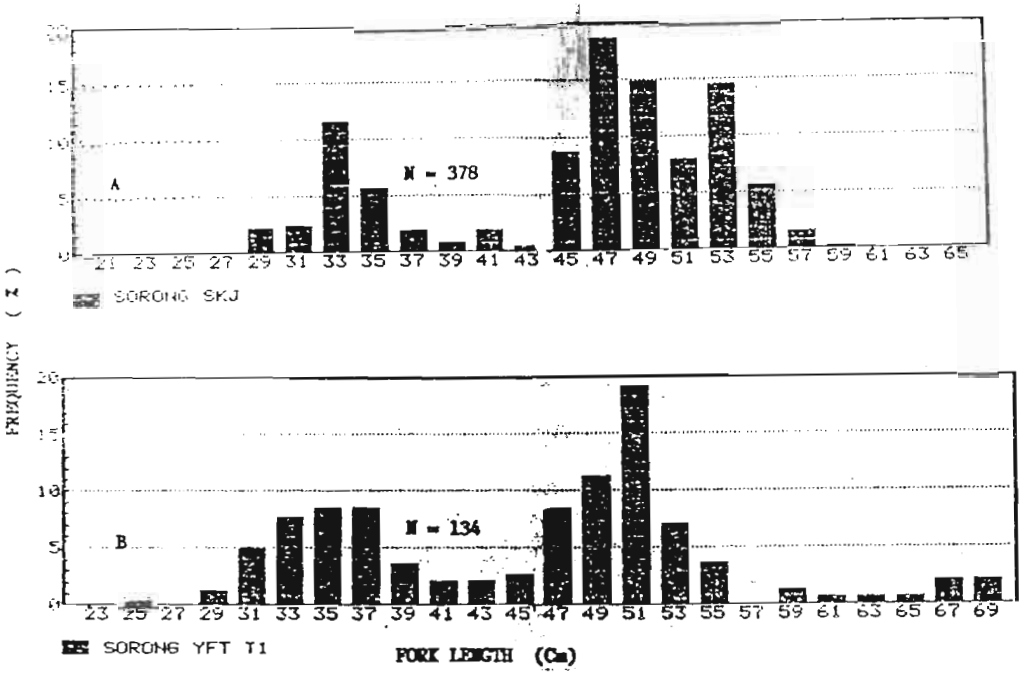


Fig. 8A. Length-frequency distributions of skipjack (A) and yellowfin (B) tagged from the waters adjacent to Sorong during the period Dec. 1983 - Jan. 1984.

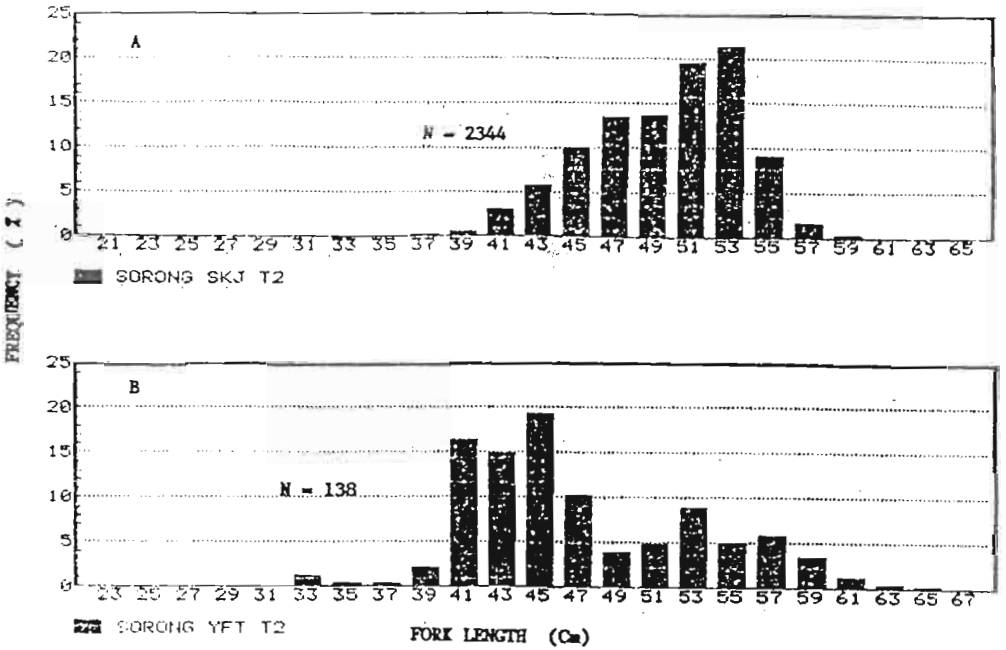


Fig. 8B. Length-frequency distributions of skipjack (A) and yellowfin tuna (B) tagged from the waters adjacent to Sorong over the period April to May 1984.

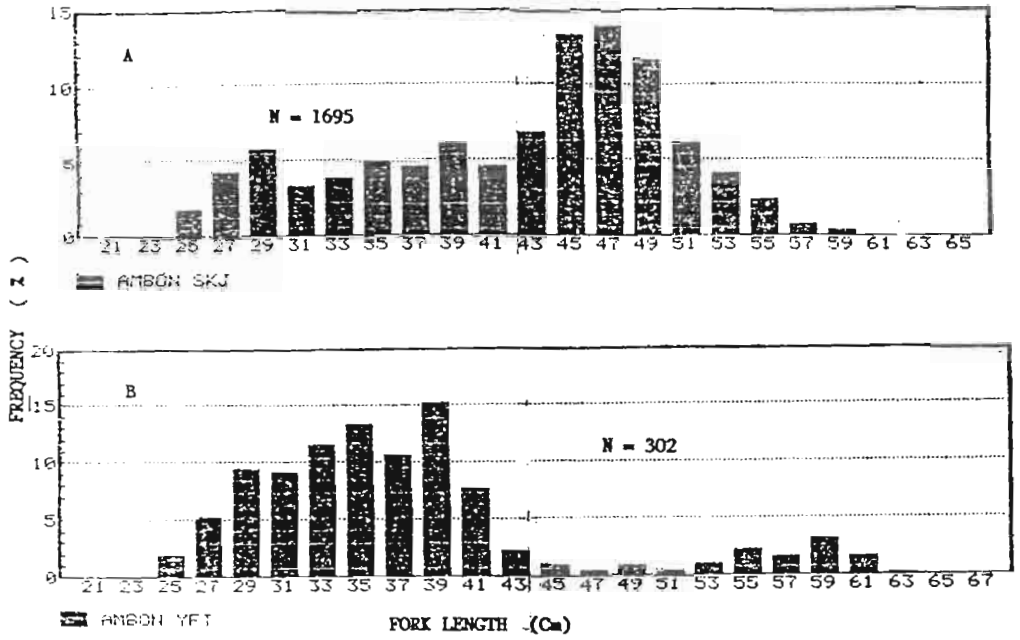


Fig. 8C. Length-frequency distributions of skipjack (A) and yellowfin tuna (B) tagged from the waters adjacent to Ambon during the period April - June 1984.

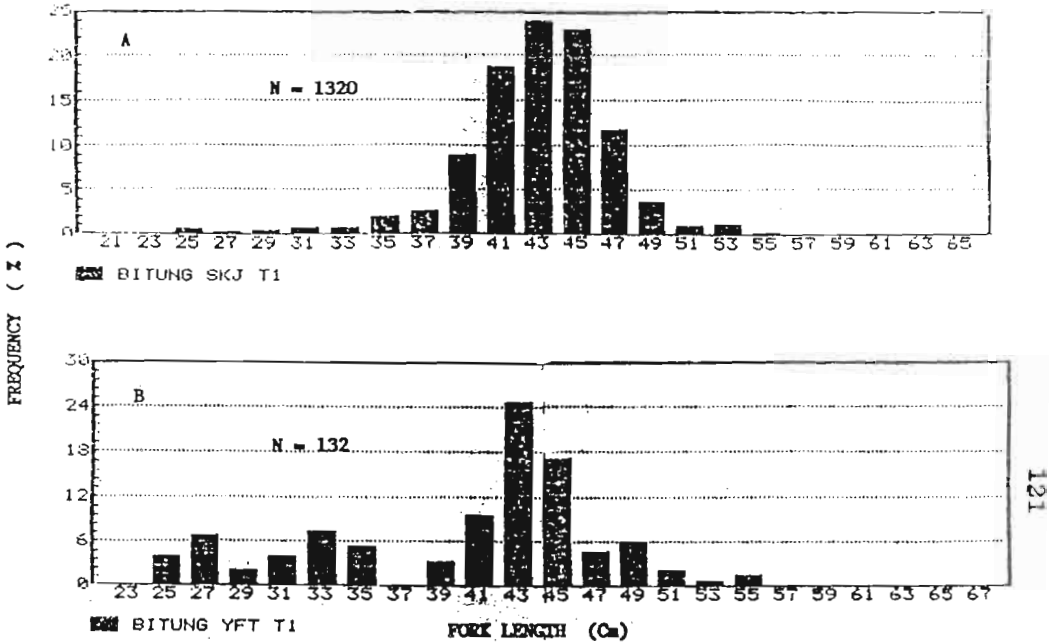


Fig. 8D. Length-frequency distributions of skipjack (A) and yellowfin tuna (B) tagged from the waters adjacent to Bitung during the period April to May 1984.

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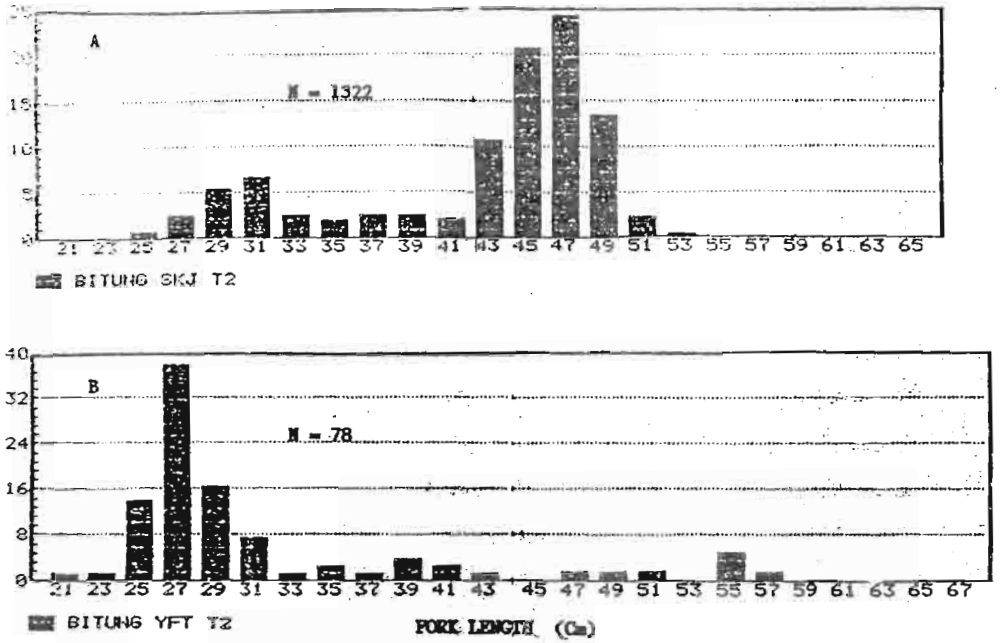

FIG. 8E. Length-frequency distributions of skipjack (A) and yellowfin tuna (B) tagged from the waters adjacent to Bitung over the period January to February 1986.

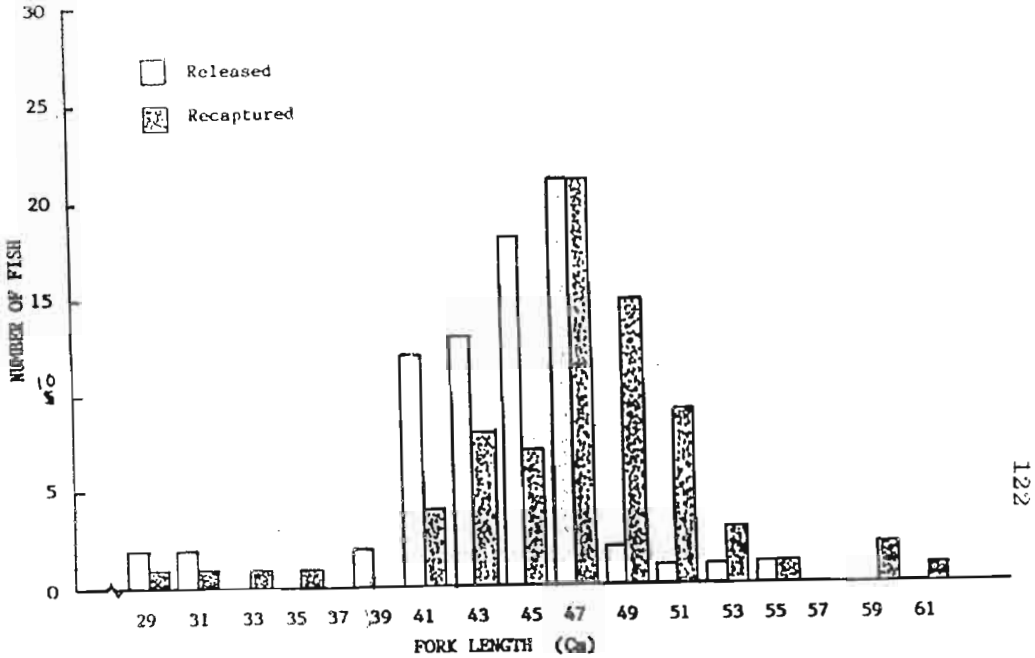

Fig. 9. Length-frequency distributions of skipjack released and recaptured.

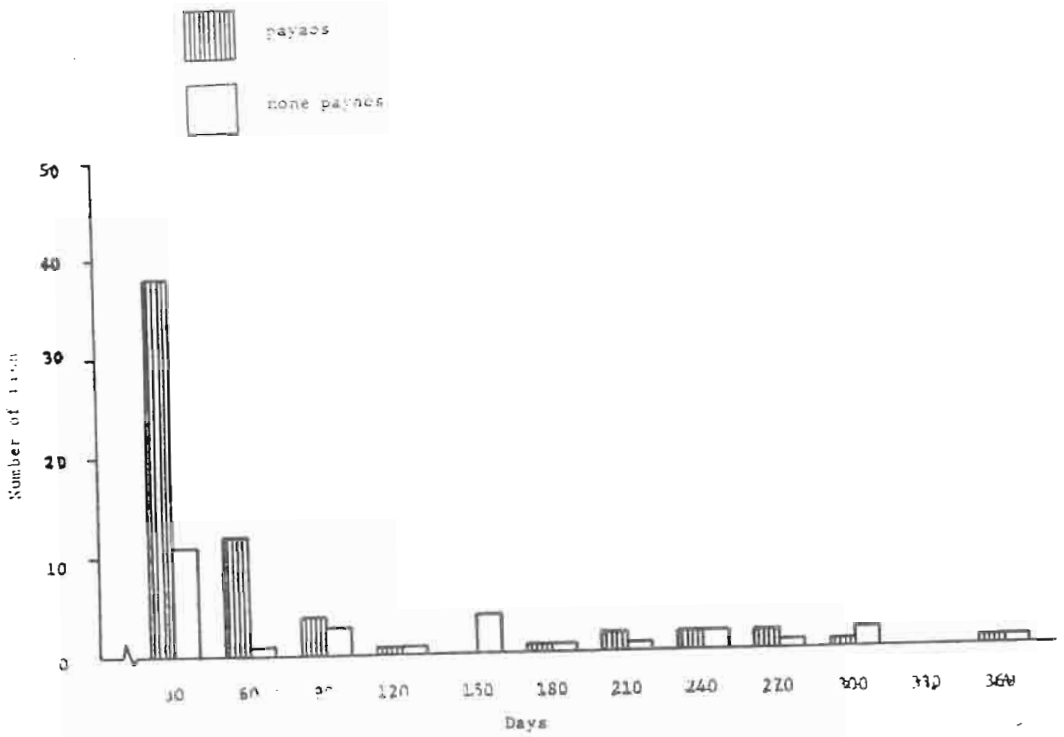

Fig.10 Number of fish recovered around and outside payaos at 30 day intervals

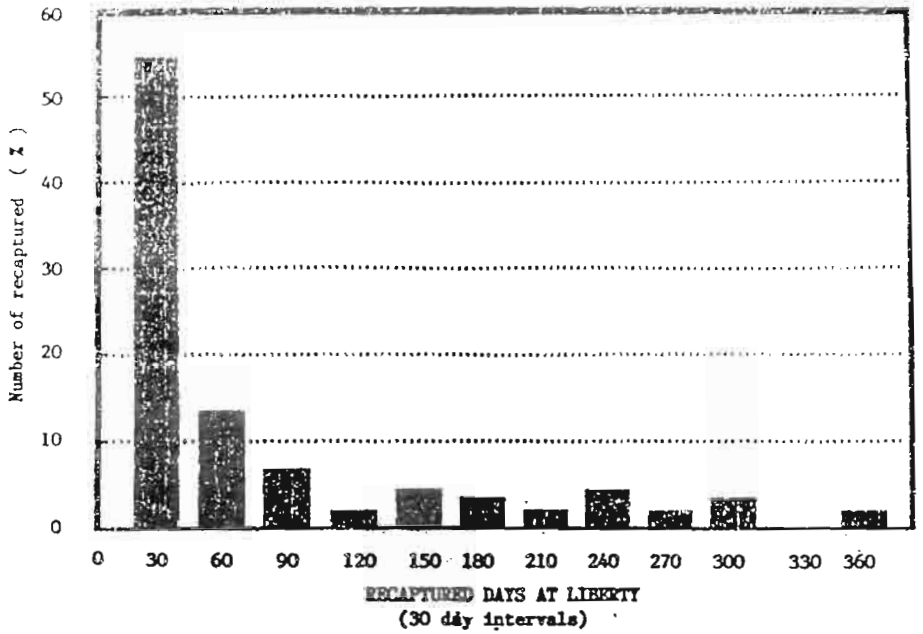

Fig. 11 . Histogram of number of recaptured skipjack tuna at 30 day intervals.

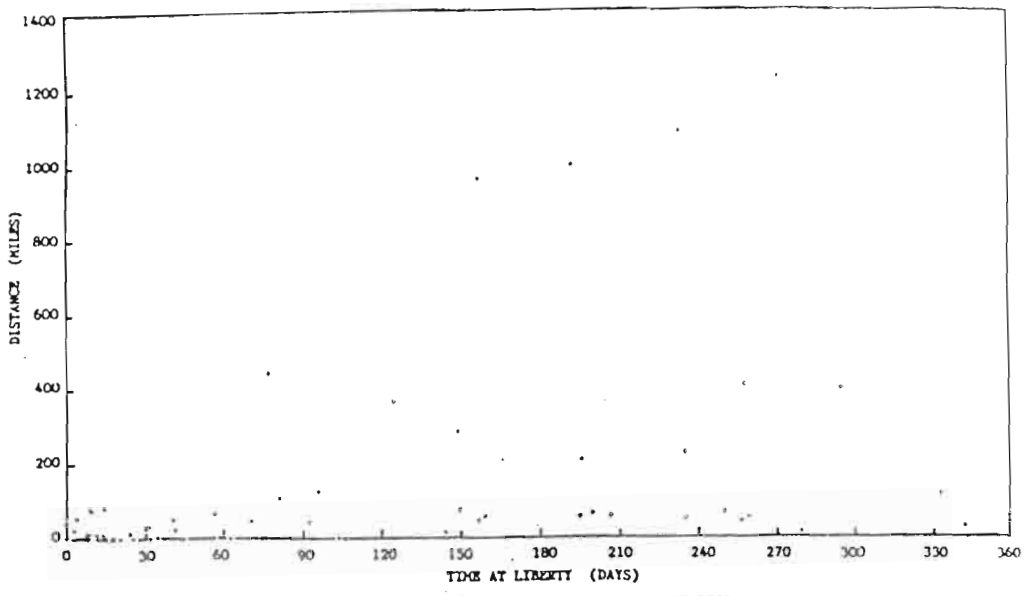

Fig 13 Relationship between distance and time at liberty of skipjack tuna.

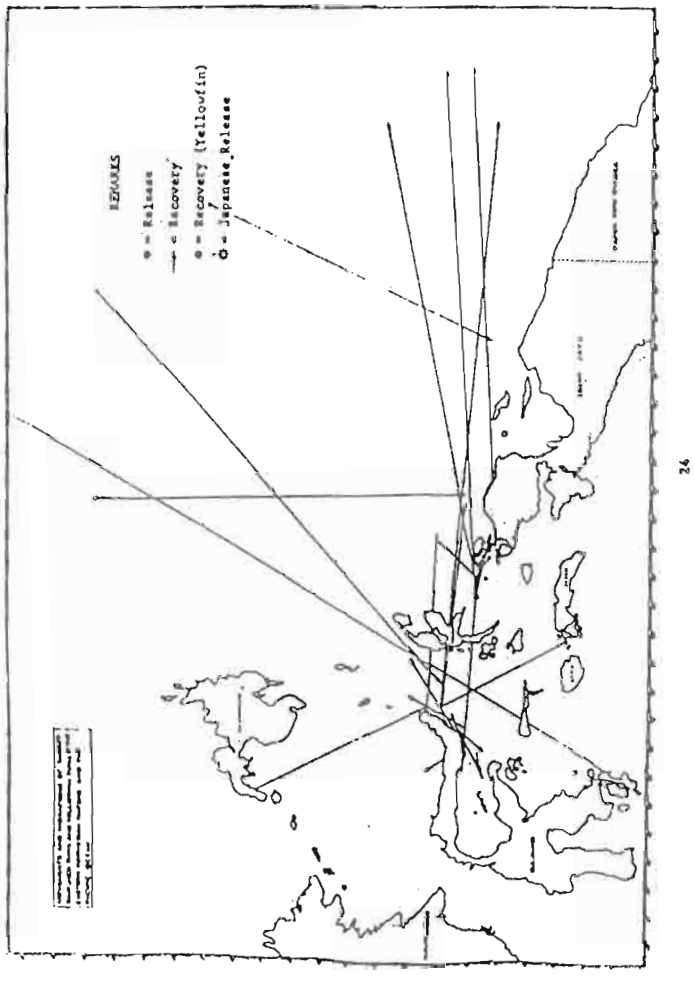

Figure. 12

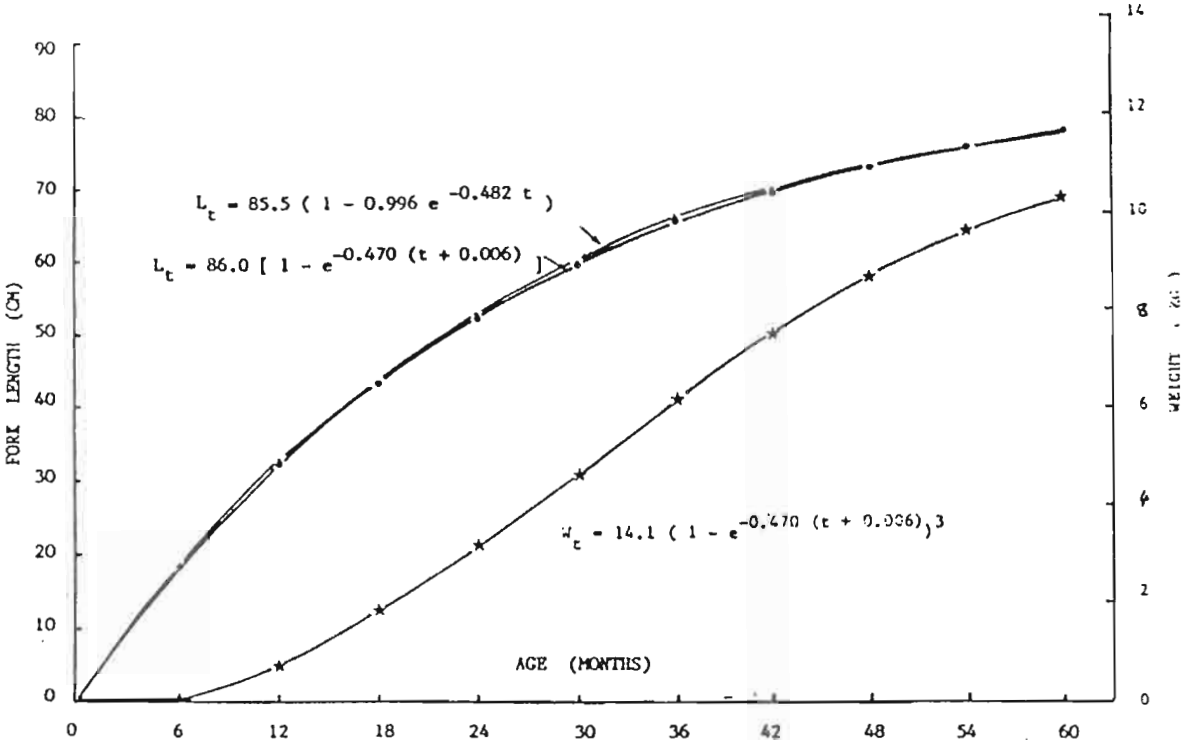

Fig.15. Theoritical growth curves of age-length and age-weight relationships for the skipjack tuna, obtained by the von Bertalanffy's and Fabens' growth formulas

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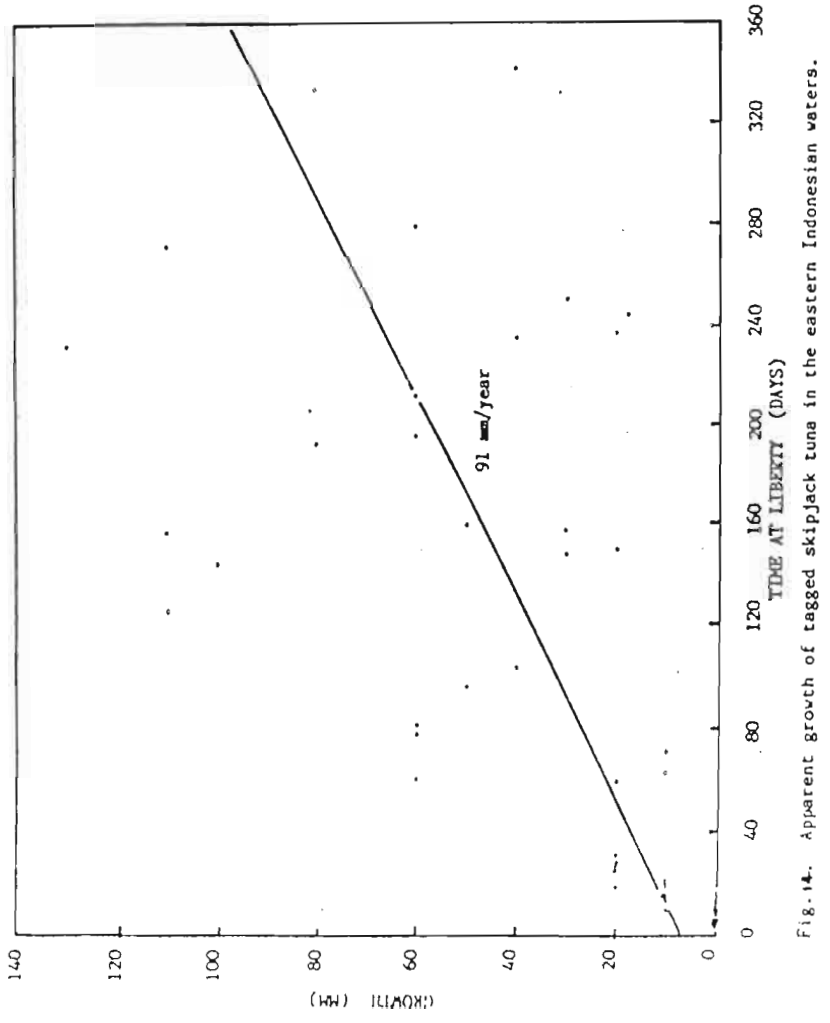

Fig.14. Apparent growth of tagged skipjack tuna in the eastern Indonesian waters.

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TABLE 1. Number and size range of skipjack tuna and yellowfin tuna tagged in eastern Indonesian waters over the period 1983-1986.

Year	Cruise No.	Name of vessels	Cruise / tagged dates	Skipjack No.	Skipjack Size range,Cm	Yellowfin No.	Yellowfin Size range,Cm	Total tagged fish
1. Sorong, Irian Jaya.								
1983	1	Cakalang 15	Dec. 18-19	17	37-52	113	31-63	130
1984	2	Usaha Mina IV	Jan. 7-29	361	29-60	21	25-54	382
	3	Cakalang 15	Apr. 14-16	187	37-58	53	41-62	240
	4	"	Apr. 18-21	488	33-58	12	33-54	500
	5	"	Apr. 24-28	716	41-62	12	43-64	759
	6	"	May 02	30	47-56	-	-	30
	7	"	May 11-12	528	43-60	2	59-60	530
	8	"	May 16-20	193	43-58	11	55-62	204
	9	"	May 25-27	202	39-60	17	51-66	219
Sub total			32 days	2722		272		2994
2. Ambon, Molucca.								
1984	10	Skipjack 02	Apr. 14	28	45-56	-	-	28
	11	"	Apr. 26-27	109	39-64	14	49-62	123
	12	"	May 2- 8	393	23-64	167	25-60	560
	13	"	May 18-24	491	25-60	62	25-64	553
	14	"	May 29- June 4	674	25-58	59	25-40	733
Sub total			17 days	1695		302		1997
3. Bitung, North Celebes.								
1984	15	AGA 23	Apr. 12	206	29-56	40	39-56	246
	16	"	Apr. 18-20	185	31-56	15	26-53	200
	17	"	Apr. 25	456	25-54	60	26-51	516
	18	"	May 4- 8	221	27-58	15	25-47	236
	19	"	May 20	252	39-50	2	31-54	254
Sub total			11 days	1320		132		1452
1986	20	AGA 5	Jan. 9-11	202	23-58	23	25-58	225
	21	"	Jan. 14-18	384	23-54	43	21-42	427
	22	"	Jan. 30-Feb. 1	492	27-52	6	25-32	498
	23	"	Feb. 5-7	244	29-52	6	31-48	250
Sub total			14 days	1322		78		1400
Totals			74 days	7059		784		7843

TABLE 2. Released and recaptured of tagged fish.

Cruise No.	Skipjack Released	Skipjack Recaptured	Skipjack Recap. (%)	Yellowfin Released	Yellowfin Recaptured	Yellowfin Recap.(%)
1. Sorong.						
1	17	-	-	113	2	1.77
2	361	2	0.55	21	-	-
3	187	1	0.53	53	-	-
4	488	4	0.82	12	-	-
5	716	-	-	43	-	-
6	30	-	-	-	-	-
7	528	2	0.38	2	-	-
8	193	-	-	11	-	-
9	202	-	-	17	-	-
Sub total:	2722	9	0.33	272	2	0.74
2. Ambon.						
10	28	-	-	-	-	-
11	109	-	-	14	-	-
12	393	-	-	167	-	-
13	491	-	-	62	-	-
14	674	-	-	59	-	-
Sub total:	1695	-	-	302	-	-
3. Bitung.						
15	206	6	2.91	40	-	-
16	185	1	0.54	15	-	-
17	456	3	0.66	60	-	-
18	221	5	2.26	15	-	-
19	252	1	0.40	2	-	-
Sub total	1320	16	1.21	132	-	-
20	202	9	4.46	23	-	-
21	384	34	8.85	43	1	2.33
22	492	15	3.05	6	1	16.67
23	244	5	2.05	6	1	16.67
Sub total	1322	63	4.77	78	3	3.85
Totals	7059	88	1.25	784	5	0.64

Table. 3. Estimates of growth of skipjack tuna from recovered tagged specimens.

Size at tagging	Regression of growth in mm on days free.			Regression through the origin	
	N	b	Yearly growth increment (b x 365)	b	Yearly growth increment (b x 365)
400-499	29	+ 0.475	173	+ 0.567	207
500-599	82	+ 0.290	106	+ 0.318	116
600 & over	28	+ 0.160	58	+ 0.003	1
All sizes	139	+ 0.341	124	+ 0.335	122

Unit in mm

Sources : Schaefer et al. (1961)

Table 4 Size in mm, at a given ages in months for various estimates of the growth of skipjack tuna from the Pacific Ocean and the Eastern Indonesian waters.

Age in months	1 K=0.82	2 K=0.43	3	4 K=0.19	5	6 K=0.95	7 K=0.77	8 K=0.59	9 K=0.44	10 K=0.41	11* K=0.482	12** K=470
0	3	3		3		3	3	3	3	3	3	3
6	247	173		131		323	265	233	170	203	185	183
12	409	310	<270	247	370	523	443	405	304	366	329	323
18	516	421		352		647	564	533	411	498	420	436
24	588	510	270-370	448	520	724	647	628	498	605	529	525
30	635	582		536		772	703	699	567	693	600	595
36	667	640	370-460	615	645	802	741	752	623	764	655	650
42	688	687		688		820	767	791	668	822	697	695
48	702	725	460-550	754	750	832	785	820	704	869	732	729
L_∞	729	881	>800	1418	1400	851	823	906	851	1075	855	860

1. Tagging, Joseph and Calkins (1969)
2. Tagging, Joseph and Calkins (1969)
3. Aikawa and Kato, 1938
4. Kawasaki, 1963
5. Yokota, et al. (1961)
6. Brock (1954)
7. Rotchahild (1966) corrected
8. Rotschild (1966) uncorrected
9. Schaefer (1961)
10. Modal progressions, Joseph and Calkins (1969)
* 11. Present study, this reporr based on equation 10 (Fabens')
** 12. Present study based on equation 9 (von Bertalanffy)

Sources : Joseph and Calkins (1969).
Calculated based on Fabens' least square method.

Table 5 Length-weight relationship of skipjack tuna, Katsuwonus pelamis, in the Eestern Indonesian Waters, December 1983-May 1984.

	Area	N	Size of Fish				a	Reg. Coefficient	r
			Length, cm		Weight, kg			b with 95% CL	
			Range	Mean	Range	Mean			
1.	Sorong	680	40.1 - 68.0	49.9	1.33 - 7.20	2.62	2.1806×10^{-5}	2.9912 ± 0.0912	0.9268
2.	Sorong	660	41.6 - 68.6	51.8	1.44 - 6.70	2.83	9.4177×10^{-6}	3.1992 ± 0.0734	0.9578
3.	Ambon	540	41.0 - 59.7	50.1	1.31 - 4.36	2.53	1.2987×10^{-5}	3.1129 ± 0.1315	0.8945
4.	Bitung	580	35.3 - 57.7	48.3	0.92 - 3.82	2.15	1.7280×10^{-5}	3.0267 ± 0.1023	0.9237
5.	Combine	2460	35.3 - 68.6	50.1	0.92 - 7.20	2.55	1.0773×10^{-5}	3.1620 ± 0.0528	0.9210

1. Period December 1983 to January 1984

2-4. Period April to May 1984.

6.7

Methods of aging yellowfin tuna, Thunnus albacares, by increments on sagittal otoliths and preliminary results of southern Philippine samples

by K. Lynne Yamanaka

ABSTRACT

Methods of etching otoliths and reading increments are described. Samples were obtained from commercial ringnet catches from the Moro Gulf, Celebes Sea for length frequencies and for otoliths. Examination of otolith microstructure using a JEOL scanning electron microscope verified the presence of growth zones analogous to daily increments described by Wild (1986) for eastern Pacific yellowfin. Increment counts indicated a 38 cm fork length yellowfin was 6 months old and a 50 cm fish as 1 year old. Growth estimates were 8 cm and 270 g per month for 20 to 35 cm fish and 2 cm and 210 g per month from 35 to 50 cm fish. The progression of prominent modes in the monthly length frequency distributions suggest growth is 7-8 cm per month for fish in the 22 to 42 cm interval and 2 cm per month for 42 to 54 cm fish, which corresponded with growth estimates from incremental readings. Characteristic increment readings were recognized and related to changes in the early life history of yellowfin tuna.

6.8

Seasonal Abundance, Morphometrics and Hook Selectivity of Yellowfin *(Thunnus albacares)* off Darigayos Cove, La Union, Philippines*

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*Presented at the FAO/IPTP Second Meeting of Tuna Research Groups in the Southeast Asian Region, Manila, 25-28 August 1987. ICLARM Contribution No. 402.

Abstract

Daily samples of yellowfin tuna were collected from a handline fishery at Darigayos Cove, northern Philippines, between May and November, 1981. Measurements of body length, weight, head length and eye diameter were used to determine different morphometric relationships. A modified Baranov/Holt selection model was used to determine the effects of hook selectivity. The estimated optimum capture length (L_{opt}) increased with hook size, as did the selection range. Overall, selection was found to be highly asymmetrical, with yellowfin n cm below L_{opt} having, for any hook size, a much lower probability of capture than large yellowfin n cm above L_{opt}.

Introduction

Recent landings (1980-1985) of yellowfin tuna *(Thunnus albacares)* in the Philippines have ranged between 48,000 and 64,000 tonnes, accounting for 4.5% of total marine landings (Table 1). Small fish are consumed fresh or canned, whilst fish larger than 1 m are greatly esteemed for sashimi or raw fish. These large tunas are particularly abundant in the northern waters of the Celebes Sea and a large handline fishery was established along the southeastern coast of Mindanao (Ganaden and Ali 1983).

In this paper, we present some observations on the seasonality, morphometrics and hook selectivity of yellowfin tuna caught around payaos by a seasonal handline fishery of the northeastern coast of Luzon. A recent analysis by Ralston (1982) of a handline fishery in Hawaii for percoid fishes, suggests that selectivity is strongest against smaller fish. We present data which suggests that this may also be the case for yellowfin tuna caught by handline.

Table 1. Annual landings of yellowfin tuna in the Philippines and contribution to the total marine landings.

Year	Yellowfin landings	Percent of total marine landings
1980	48023	4.23
1981	56176	4.66
1982	51922	4.21
1983	62036	4.81
1984	58924	4.52
1985	64293	4.49

Materials and Methods

A detailed description of the Darigayos Cove (Fig. 1) handline fishery and the methods of data collection is given in Cortez-Zaragoza (1983). All handline fishermen

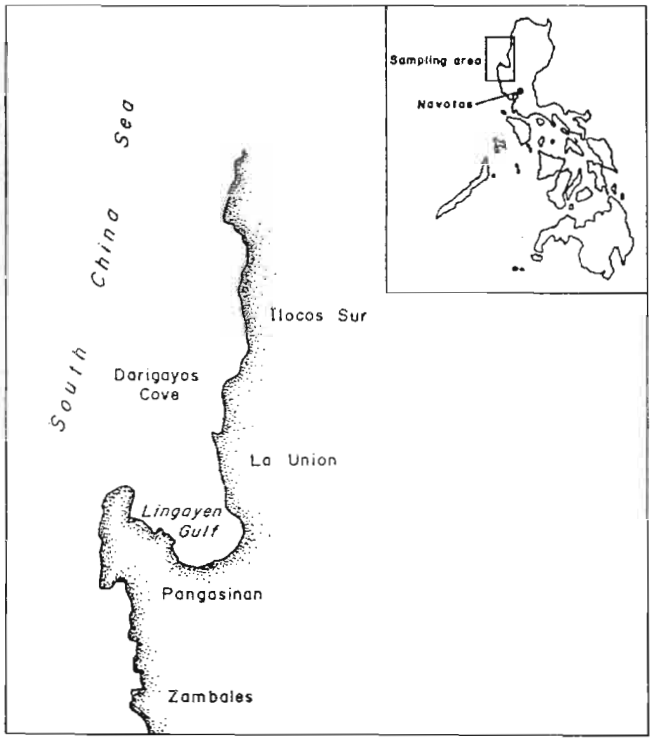


Fig. 1. Map of sampling area

operate from small boats or bancas with an average length of 10 m, an average gross tonnage (GT) of 0.3 which are powered by 16 hp Briggs and Stratton gasoline engines. Observations on catch, fishing effort, fork length and weight of catch were made between May and November 1981. Fishing effort was expressed as the number of line days per month or the product of number of days at sea and the number of handlines per vessel. The hook sizes used in the fishery were 1.2, 1.3, 1.4, 1.5, 1.6, 2.4, 2.7 and 2.9 cm. Hook size refers specifically to the gap between hook point and shank (Fig. 2).

The length distribution of each yellowfin catch was recorded by hook size and standardized per unit of effort. The whole weight of individual fish in the catch was recorded where possible. Yellowfin larger than 90 cm were landed already gilled and gutted. A comparison of the weights of gutted and ungutted fish less than 90 cm was used to compute ungutted weights for larger yellowfins. In addition to fork length, measurements of head length and eye diameter were made on 30 specimens of yellowfin tuna.

Gulland (1983) suggested that the selection effects of different hook size in fish catches can be compared by a modification of the Baranov/Holt model for gill net

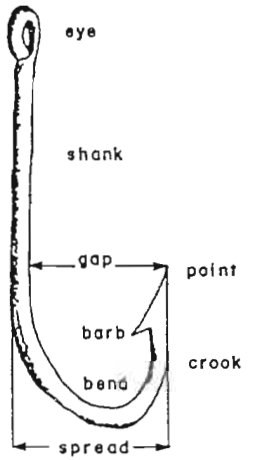


Fig. 2. Parts of a hook; "size" as defined here is the gap.

selection (Baranov 1914; Holt 1963), whose properties and fitting are explained in detail in Pauly (1984). Selection curves of handline catches were estimated by comparing the length-frequency distributions of yellowfin caught by two adjacent hook sizes after standardization for fishing effort.

Given the smaller hook size A and the larger hook size B, it is possible to convert the catch data into a linear equation of the form ($y = a + bx$), where:

$$Y = \log_e \frac{C_B}{C_A} \qquad \ldots 1)$$

where C_A is catch by length class for hook size A and C_B is the corresponding for hook size B, and where

$$X = L_i \text{ (class midlength)} \qquad \ldots 2)$$

The intercept (a) and slope (b) of this regression are used to estimate optimum length for hook size A from:

$$L_A = \frac{-2a\ A}{b\ (A + B)} \qquad \ldots 3)$$

and

$$L_B = \frac{-2a\ B}{b\ (A + B)} \qquad \ldots 3b)$$

The standard deviation of either selection curve ($S_A = S_B = S$) is given by:

$$SD = \sqrt{\frac{2_a (A - B)}{b^2 (A + B)}} \quad \ldots 4)$$

When L_A, L_B and S have been estimated the probability of capture (P) at a given length (L_i) is given for a hook size A by:

$$P_A = \exp\left(-\frac{(L_i - L_A)^2}{2S^2}\right) \quad \ldots 5)$$

and for hook size B by:

$$P_B = \exp\left(-\frac{(L_i - L_B)^2}{2S^2}\right) \quad \ldots 6)$$

In its original form, this selection model yields symmetrical curves about the optimum capture length. However, asymetrical curves, where selection is less intense at larger sizes can be fitted by replacing length by $\log_e$ (length) in the above equations.

Results

Seasonal Abundance

The monthly catch and effort data for handline caught yellowfin at Darigayos Cove between May to November are summarized in Table 2. Over this period, twenty tonnes of yellowfin were caught that comprised 55.3.% of the total catch of this fishery.

Table 2. Fishing Effort, Catch and Catch Rate of Hook and Line Line Fishermen at Darigayos Cove, La Union, May-November, 1981.

Months	May	June	July	August	September	October	November
No. of line-days	704	508	128	336	508	584	336
Catch, total (kg)	20745	3499	52	491	3431	6070	1928
Yellowfin	11548	1094	–	95	2627	3615	1052
Total catch/line-day	29.47	6.89	0.41	1.46	6.75	10.39	5.74
Yellowfin catch/ line-day	16.4	2.15	–	0.28	5.17	6.2	3.13

Although the data for Darigayos Cove are rather sparse, the seasonal pattern of yellowfin catches appears to be similar to that of the Philippines as a whole. The monthly landings of various fish species at Navotas Fish Port Complex (NFPC) in Manila are kept on file by the Philippine Fisheries Development Authority. The monthly landings of yellowfin at the NFPC between 1980 and 1986 were kindly made available to the authors. From these, the mean monthly catches of this species were estimated for 1980-1986. Landings of yellowfin at the NFPC account for about 10% of the total catch and come from all over the Philippines. Both the NFPC yellowfin landings data and the landings data for Darigayos Cove show very similar trends between May to November (Fig. 3).

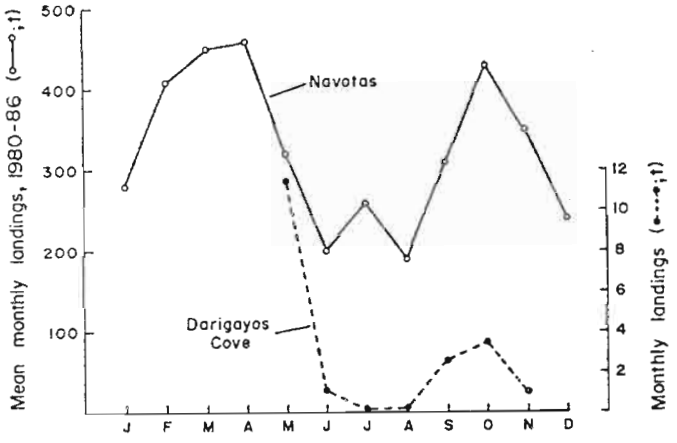


Fig. 3. Mean monthly landings of yellowfin tuna at Navotas, Manila, 1980-1986 (o) and monthly landings of yellowfin tuna at Darigayos Cove, May to November 1981, Philippines.

Morphometric Relationships

Length-weight and other morphometric relationships for yellowfin tuna are shown in Fig. 3. The ratio between gutted and ungutted weight was established as 0.82:1.

Hook Selectivity

Plots of the logarithms of catch ratios versus the logarithms of the corresponding midlengths for the different hook size combination are shown in Fig. 4, based on the data in Table 1. Apart from one instance the data were well described by linear functions. The exception was the comparison of 1.4 and 1.5 cm hooks, which could not be performed. The optimum capture lengths estimated from each pair of hook sizes are given in Table 4.

A non-linear relationship was fitted to the scatter of optimum lengths versus hook size. A straight line was forced through the mean and the origin for the scatter of the selection range (defined here as one standard deviation on either side of the optimum length) versus optimum length.

Table 3. Catch by Length of Different Hook Sizes to Estimate their Selectivity for Thunnus albacares, off Darigayos Cove, La Union

Midlength of size group in cm	Hook size							
	1.2	1.3	1.4	1.5	1.6	2.4	2.7	2.9
22	124	10	–	–	–	–	–	–
26	145	17	–	–	–	–	–	–
30	170	82	8	96	7	–	–	–
34	60	91	20	160	29	–	–	–
38	50	143	67	125	88	–	–	–
42	15	60	91	190	455	–	–	–
46	1	8	24	45	160	–	–	–
50	1	6	23	3	25	–	–	–
54	–	1	8	5	25	–	–	–
58	–	1	5	4	15	–	–	–
62	–	–	1	–	1	–	–	–
126	–	–	–	–	–	26	3	–
130	–	–	–	–	–	53	11	–
134	–	–	–	–	–	31	18	2
138	–	–	–	–	–	5	8	3
142	–	–	–	–	–	3	7	4
146	–	–	–	–	–	2	10	15
150	–	–	–	–	–	1	7	25
154	–	–	–	–	–	–	4	17
158	–	–	–	–	–	–	1	6
162	–	–	–	–	–	–	1	4
166	–	–	–	–	–	–	–	–

Discussion

The results presented here document the selective effects of different hook sizes on yellowfin tuna. Similar observations of hook selectivity on skipjack were made by Tandog et al. (1987). Larger hooks catch larger fish but the standard deviations of the selection curves increase as the hook size increases, suggesting that bigger hooks capture a wider range of lengths. Ralston (1982) suggested that hook selection conformed to a flat-topped sigmoidal curve similar to that observed for trawls (Fig. 7A). In Ralston's analysis, the largest hook used was 71% greater than the smallest whilst in this study, the difference was 240%. Koiki et al. (1968) and Kanda et al. (1978) used series of hooks in which the largest sizes were 215% and 115%, respectively, larger than the smallest of sizes. Both studies reported shifts in the size composition of the catch. Saetersdal(1963) reported a change in the selective characteristics of fishing hooks which differed in size by 76%.

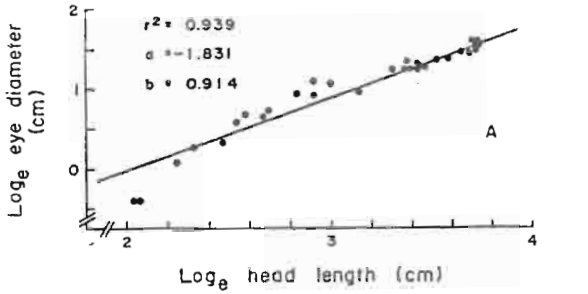
Table 4. Hook size and predicted optimum length of yellowfin tuna.

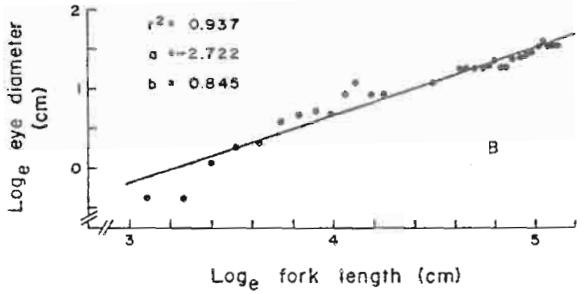
Hook size (cm)	Optimum capture length (cm) [a]
1.2	29.4
1.3	37.6
1.4	47.6
1.5	36.5
1.6	46.4
2.4	102.6
2.7	152.7
2.9	173.8

[a] Where there was more than one optimum length for a hook size, means are given.

The schematic forms of different proposed selection curves are shown in Fig. 7. Curves A and B correspond to the Baranov/Holt model and the flat-topped sigmoidal curve, respectively. The latter may include, as suggested by S. Ralston (pers. comm.), a descending limb, albeit at very large sizes (dotted in Fig. 7B). Curve C is a suggested possible compromise between the two models; it has a slowly declining right hand limb beyond the optimum capture length.

An appreciation of hook selectivity (or lack of it) is important for two reasons. First, where length data are used for stock assessment purposes in a fishery employing a wide range of hook sizes, adjustments to the data based on probabilities of capture may be necessary. Simply pooling all data in the hope that selectivity effects may be negligible or will cancel, out may introduce biases into estimates of growth and mortality parameters. Secondly, hook size may be used to regulate minimum capture sizes from a fishery, in the same way that minimum mesh sizes are employed in net fisheries. We suggest that further investigation of this type should be undertaken, especially on the large handline fisheries for tunas around the southern coast of Mindanao.





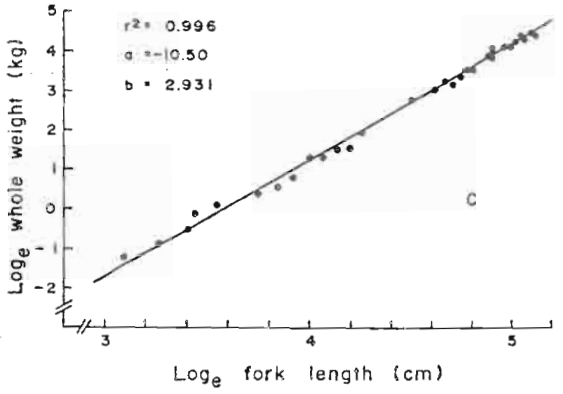


Fig. 4. Morphometric relationships for yellowfin tuna.

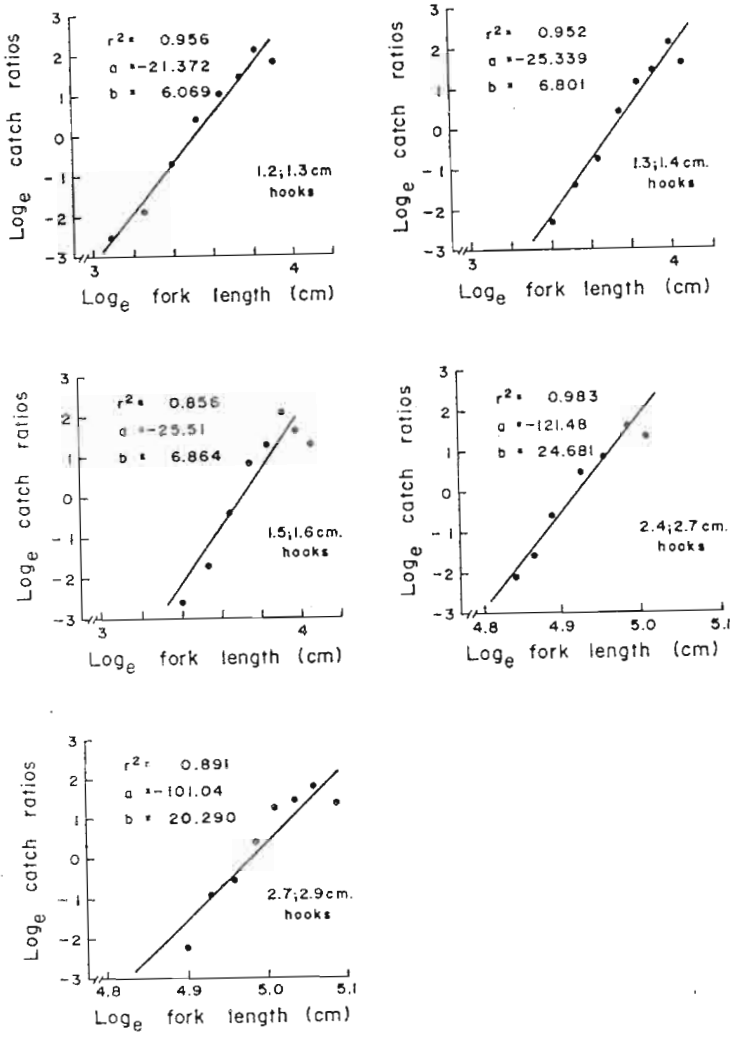


Fig. 5. Log$_e$ catch ratio *vs.* log$_e$ fork length for catches of yellowfin tuna for different hook size combinations.

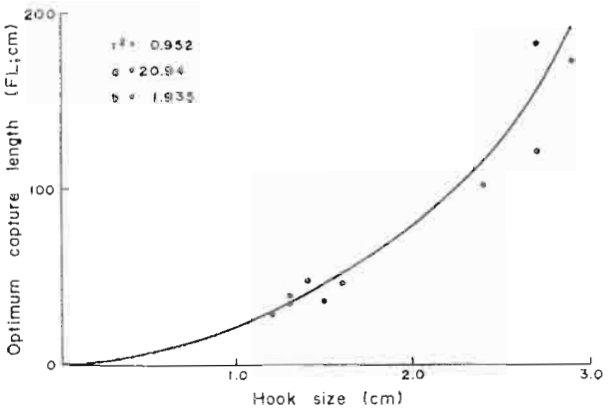


Fig. 6. Optimum capture length *vs.* hook size for yellowfin tuna.

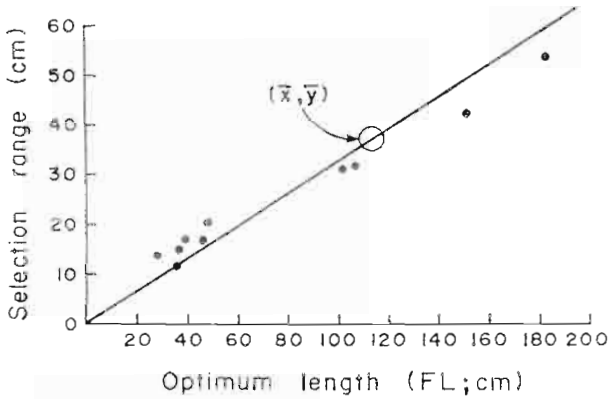


Fig. 7. Selection range *vs.* optimum length for yellowfin tuna.

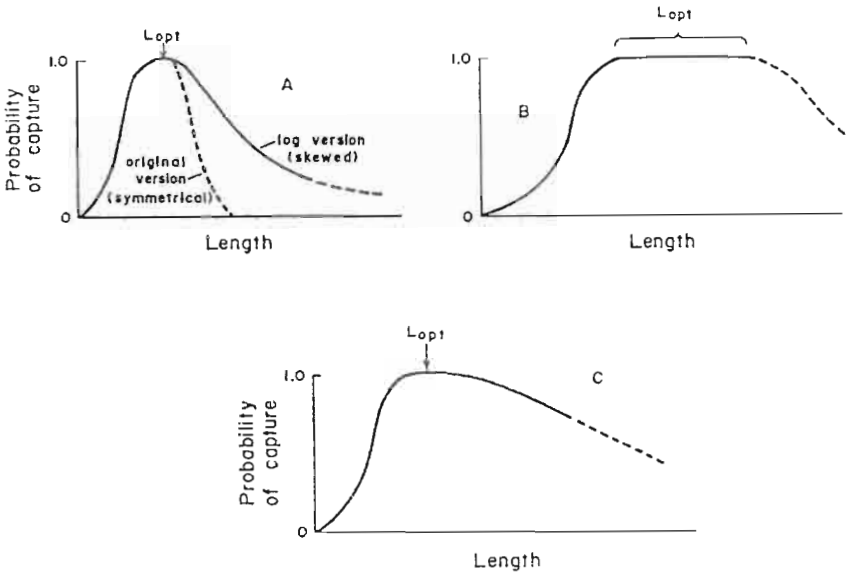


Fig. 8. Different types of possible selection curves for fish hooks. Type A is the Baranov/Holt model, Type B was proposed by Ralston (1982) and Type C is a suggested compromise between A and B (see text).

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6.9

An analysis of stomach contents of yellowfin tuna captured by handlines under payaos in the north Celebes Sea

by Noel C. Barut

ABSTRACT

Stomach of 620 yellowfin were collected from November 1983 to October 1984 and examined for prey composition and volume. The average weight of the 403 males and 217 females was 52 and 40 kg, respectively. Twenty-four families, 20 genera and 11 species of prey organisms were identified. Total stomach contents (chum + prey organisms) averaged 8.1 g/kg for males and 10.0 g/kg for females, which was not statistically significant. The most important item, in terms of weight, in the stomachs was chum followed by digested food. The Index of Relative Importance (IRI) showed the principal prey organisms were skipjack (504), yellowfin (434), Loliginidae (256), Balistidae (129) and Pseudobalistes fuscus (34).

THE AUXIS SPP. FISHERIES OF BATANGAS, PHILIPPINES

by

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ABSTRACT

The paper presents the result of monitored landings of small tunas caught by bagnets and ringnets of Batangas from April 1983 to December 1984.

The species composition, relative abundance and seasonality of the small tunas, locally called "tulingan" and some biological features of the dominant species, Auxis rochei, is presented.

1/ Paper presented to the 2nd IPTP Tuna Research Groups Meeting held at the U.P. PCED Hostel, Quezon City, Philippines from August 25-28, 1987.

I. Introduction

The frigate tuna forms about 30% of the total landed catch of tuna from 1982 to 1984 (BFAR Statistics) which show that this group is one of the important marine resources of the country. In the province of Batangas alone, this resources locally termed "tulingan" is considered important and served as the mainstay of most fishermen especially during the season. It is not a delicacy but is a common fish on the tables of both rich and poor Batangueños.

Inspite of its importance, very little attention has been given to this group as compared to the larger and more expensive ones - the yellowfin the big-eye and the skipjack. For years, studies have been concentrated on these larger groups.

In the Philippines, studies conducted on these species were on the taxonomic differentiation of the adult and juvenile forms of the genus Auxis (Wade, 1984), on the description, distribution and abundance of larval forms and their spawning areas (Wade, 1951) and on the distribution and relative abundance of larval Auxis in Sulu Sea (Baguilat, 1987). Except for the recorded catches of frigate tuna reported yearly in the Fisheries Statistics of the Philippines, no other study on his fishery including their biological characteristics, has been made.

The landings of bagnets were monitored at Wawa Fish Landings, Batangas City during the dark phase of the moon from April 1983 to October 1984 and those of ringnets at Sambal, Lemery from April 1983 to December 1984. The sampling methods adopted are those of the Tuna Research Project with modification on the sampling frequency.

Fishing Gear

It is reported that there are various gears catching the frigate tuna in Batangas but the most commonly used are the bagnet, locally known as "basnig" and the ringnet or "pukat".

The bagnet is of the lift net type which uses out riggered banca and lights to attract or concentrated fish. The tonnage of the vessels ranged from 7 to 30 G.T. The ringnet uses bancas with or without riggers and catches fish by surrounding them. It either operates in conjunction with "bobo" (fish aggregating device made of bamboo and coconut fronds) or catches the free schooling fish. The method of fishing operation of both gear is described by de Jesus, 1982.

Fishing Grounds

The traditional fishing grounds of bagnets are the waters of Batangas Bay, between Mindoro and Batangas, around Maricaban Island, off Lobo, up to the Anilao side of Balayan Bay. The ringnets based in sambal fish regularly in Balayan Bay off Lemery and sometimes off Anilao (Figure 1).

Species Composition, Relative Abundance and Seasonality

The "tulingan" catch being landed in Batangas is usually composed of three species, namely: the bullet tuna (Auxis rochei), the frigate tuna (A. thazard) and the eastern little tuna (Euthynnus affinis). The bullet tuna is the dominant species landed followed by the frigate tuna. The eastern little tuna is seldom landed, particularly if the catch is less than a bañera, as they are the ones given away to labor and crew as wage in kind.

The bagnet catch is predominantly Auxis rochei throughout the year with big landings from April to September and peak in August of 1983 and in May and June of 1984. A. thazard were landed in several months of the year with peak landings in September 1983 and March 1984. Euthynnus affinis were landed in large quantities in June 1983 but were not found in 1984.

Small Auxis spp. below 15 cm. FL were landed from August, 1983 and from July to October of 1984. This probably indicate that they have been spawned in March to June.

The ringnet catch is a mixture of both species throughout the year. The peak season for A. rochei in February and May. A. thazard were landed in July and August when most of the fishing activity were done in conjunction with "bobo" or "payao". E. affinis, as well as the small T. albacares and K. pelamis were landed occasionally.

Size Composition

The sizes of A. rochei caught by both gear do not differ considerably. There is also not much variation in the monthly size composition except for the appearance of the smallest-sized group with a fork length of 9.5 cm in the ringnet catch in December 1984 and 10.0 cm. FL in the bagnet catch in September 1984. However, since the external characteristics differentiating A. rochei from A. thazard is not yet prominent, these size groups could be a mixture of both species. At sizes below 15 cm, the only means by which the two species can be separated is through the gill raker counts; 39-43 in A. thazard (Wade, 1950) and 44 to 48 in A. rochei (Wade, 1949).

Conadal Condition, Spawning Season and Size at Sexual Maturity

In Batangas Bay and approaches juvenile of A. rochei were recorded from March to May and from July to September with peaks in October of 1983 and September to October in 1984. Maturing ovaries were found in fish measuring 20 cm. FL in March, June, July, November and December which indicate that the spawning period could be protracted.

In Balayan Bay, juvenile fish appeared in May and mature ones were observed in March, July, September and December.

The size at first maturity was estimated at about 18.8 cm FL (Fig. 1).

Length-Weight Relationship

The length-weight conversion values for A. rochei caught by both gear were computed to be:

For the bagnet catch:

σ = W = $0.004527\ L^{3.36}$

φ = W = $0.005337\ L^{3.303}$

Both sexes = W = $0.004375\ L^{3.367}$

For the ringnet catch:

σ = W = $0.002033\ L^{3.616}$

φ = W = $0.001486\ L$

Both sexes = W = $0.0016625\ L^{3.676}$

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OCCURENCE AND DESCRIPTION OF TUNA AND TUNA-LIKE LARVAE IN THE SULU SEA

By

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ABSTRACT

A total of 248 tuna larvae was sorted from the ichthyoplankton samples collected on board the RV SARDINELLA in the Sulu Sea during the October-November, 1982 and February-March, 1983 cruises.

Six genera and 6 species were identified. These are: Thunnus albacares (yellowfin), Katsuwonus pelamis (skipjack), Gymnosarda unicolor (dogtooth tuna) Acanthocybium solandri (wahoo) Auxis thazard (frigate tuna) one unidentified species of the genus Euthynnus and four unidentified species of the genus Auxis.

During the October-November, 1982 cruise, T. albacares and K. pelamis were the most abundant with T. albacares larvae more widely distributed. Auxis species predominated during the February-March, 1983 cruise. In general, tuna larvae were found to be abundant during the February-March, 1983 cruise and more concentrated in southern Sulu Sea. The abundance of tuna larvae during the said period coincided with the prominent peak of spawning as reported in the literature.

Small Tuna Fisheries in the Philippines

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August 1987

Indo-Pacific Tuna Development and Management Programme (IPTP)

1. Introduction

Marine fish production in the Philippines totalled 1,867,701 mt in 1985, a slight decrease from the previous 2 years. Tuna production, on the other hand, increased 15% over 1984 and 8% over 1983 to 261,607 mt. Small tunas, specificially frigate/bullet and kawakawa, accounted for 52% of this total.

Recent studies on tuna in the Philippines have concentrated on the larger species, skipjack and yellowfin tuna (White, 1982; Yesaki, 1983; Ganaden and Stequert, 1987). These species are targeted for export, either canned or fresh, to generate foreign exchange. Small tunas are fished for the food economy of the country and are important in providing cheap protein to the populus.

The present paper investigates the fisheries for small tunas in the Philippines. Small tuna landings are described by fishing area, fisheries sector and fishing gear. Landings are correlated to wind stress patterns and yields per unit area derived for selected areas. Potential for future increases of frigate/bullet tunas and kawakawa are discussed.

2. Tuna landings

The present fishery statistics collection scheme was implemented in 1976. This scheme categorizes scombrid landings into Indo-Pacific and Indian mackerels, spanish mackerel, mackerel, frigate, eastern little, yellowfin and skipjack tunas. The following species are included in the 4 tuna categories:

frigate	- frigate tuna (*Auxis thazard*)
	- bullet tuna (*Auxis rochei*)
eastern little	- kawakawa (*Euthynnus affinis*)
yellowfin	- yellowfin tuna (*Thunnus albacares*)
	- bigeye tuna (*Thunnus obesus*)
	- longtail tuna (*Thunnus tonggol*)
skipjack	- skipjack tuna (*Katsuwonus pelamis*)

Tuna landings in the Philippines have increased 2.1 times in the 10 year period since 1976 (Fig. 1). Of the 4 tuna categories, frigate landings increased the most (3.4 times) and yellowfin landings the least (1.5 times). Frigate landings prior to 1980 were over-estimated with the inclusion of juvenile skipjack and yellowfin. White and Yesaki (1982) calculated the frigate figure for 1980 was over-estimated by at least 8,000 t. However, the frigate landing was high during this year and was surpassed only in 1985. Kawakawa landings peaked in 1977, decreased to a low level in 1979, then steadily increased to 1982. Landings have since stabilized at about the 40,000 t level.

3. Tuna landings by fishing areas

Distribution of frigate and kawakawa landings by statistical fishing areas are shown in Figures 2 and 3, respectively. Highest landings of frigate are made in the large, deep, exposed seas (Moro Gulf, Sulu Sea, Bohol Sea). Kawakawa landings, on the other hand, are highest in the small, shallow archipelagic seas (Ragay Gulf, Cuyo Pass, Guimaras Strait).

Statistical fishing areas were grouped either as shallow-water or deep-water, depending on whether the extent of the continental shelf was more than or less than half the entire area, respectively. The neritic zone accounts for 61% of the total area of the 6 shallow-water fishing areas (Table 1) and only 18% of the total area of the 7 deep-water fishing areas (Table 2). The shallow-water fishing areas encompasses 18% of the total area of the 13 fishing areas.

Kawakawa is a neritic species usually associated with the continental shelf. Sixty-three percent of total kawakawa landings are taken from the shallow-water fishing areas, versus 32% from the deep-water fishing areas. Frigate, yellowfin, skipjack and to a lesser extent, frigate are oceanic species. Approximately 73% of total landings of these categories are made in the deep-water fishing areas.

A very high percentage of the Philippine tuna production is captured in association with payaos or FADs (fish aggregating devices). Payaos are deployed almost exclusively in the shallow and deep-water fishing areas. These areas are all relatively small bodies of water bounded by numerous islands. Winds in these areas rarely exceed Beaufort force 3, whereas winds frequently exceeds force 4 in the Pacific Ocean and South China Sea fishing areas (Fig. 4). Wave action would be minimal in the shallow and deep-water fishing areas because of low wind stress and protection from the numerous islands. This is a principal reason for the success of payaos in the Philippines. The shallow and deep-water fishing areas account for 89% of the Philippine tuna production.

3.1 Yield per unit area

Tuna yields averaged 0.58 mt/km^2 for the shallow and 0.33 mt/km^2 for the deep-water fishing areas. Yields of kawakawa decreased almost 10-fold from the shallow (0.28 mt/km^2) to the deep-water 0.03 mt/km^2) fishing areas, whereas yields of frigate, yellowfin and skipjack were identical for these fishing areas. Kawakawa accounted for 48% and frigate for 43% of the total yields for the shallow and deep-water fishing areas, respectively.

4. Small tuna landings by fishing gear

Philippine statistics discriminate landings by commercial and municipal fisheries. Vessels larger than 3 gross tonnes are considered in the former and smaller vessels in the latter.

4.1 Commercial fisheries

The commercial fishery accounts for 59% of the frigate (Table 3) and 45% of the kawakawa landings (Table 4). Essentially the entire commercial landings of frigate and kawakawa are made by ringnet/purse-seine and bagnet. Kawakawa is more susceptible to capture with bagnet than frigate. Percent landings by fishing gear of frigate and kawakawa differed markedly, between shallow and deep-water fishing areas (Fig. 5). Ringnet/purse-seine and bagnet each accounted for approximately half the landings of frigate and kawakawa in the shallow-water fishing areas. In contrast, ringnet/purse-seine accounted for almost the entire landings of these 2 species in the deep-water fishing areas. Vessels lie at anchor when fishing bagnets thereby restricting use of this fishing gear to grounds with relatively shallow depths and weak currents (de Jesus, 1982).

4.2 Municipal fisheries

A greater variety of fishing gears are employed by the municipal sector to capture frigate and kawakawa (Table 3 and 4). The most important fishing gear for both species is the hook and line. The second most important gear for frigate is the gillnet, followed by ringnet/purse-seine. Ringnet/purse-seine, bagnet and gillnet are equally important fishing gears for kawakawa after hook and line.

The highest percentage of frigate landings by the municipal sector is taken by gillnets in the shallow-water areas and by hook and line in the deep-water areas. Hook and line accounts for the highest proportion of kawakawa landings in both the shallow and deep-water fishing areas (Fig. 5).

5. Methods of capture

Ringnets and purse-seines are usually fished in conjunction with payaos. Table 5 shows percent of frigate and kawakawa captured under payaos and as free-schools by these gears at 6 landing sites. Free schools of pelagic fish are fished by ringnetters at only 3 of the landing sites. Purse-seiners operated out of 3 of these sites and fished exclusively on fish aggregated under payaos. An estimated 80% of the frigate and kawakawa are captured by ringnetters/purse-seiners after aggregating under payaos (Table 6).

5.1 Species composition

The composition of tuna catches by ringnets under payaos is given in Figure 6 and as free-schools in Figure 8. Kawakawa accounts for a significant proportion of the tuna landings at Labuan, where ringnet fishing is targeted on free-schools. This species is an insignificant component of ringnet catches under payaos by purse-seiners at Labuan (Fig. 7). These low catches could result from either non-attraction to payaos or deployment of payaos in offshore areas outside the normal range of the species.

The proportion of frigate was slightly higher in ringnet catches made on free-schools than those made under payaos. Frigate is the smallest of the tunas and may not be able to swim out of an encircling gear as readily as the larger tuna species. Yellowfin constituted a significant portion of the ringnet catches under payaos at Opol, but was negligible in catches made as free-schools. This species was also insignificant in the ringnet catches on free-schools in Labuan (Fig. 8).

Frigate and bullet were lumped in the frigate category during the initial years of the biological sampling programme. These species were identified and recorded separately from 1982. The relative abundance of these species appears to fluctuate annually with strong year class for bullet in 1983 and for frigate in 1984 (Fig. 9).

The proportion of oceanic species is higher in catches made under payaos by purse-seines (Fig. 7) than by ringnets (Fig. 6). This higher proportion results primarily from higher catches of yellowfin. Skipjack and yellowfin are distributed lower in the water column and consequently more vulnerable to capture with the deeper sinking purse-seines.

5.2 Size composition

Size composition of all tuna species captured under payaos by ringnets and purse-seiners were very similar, except for yellowfin tuna (Fig. 10). Small numbers of larger yellowfin (40-70 cm) were captured by purse-seines, but not by ringnets. This catch of larger fish results from purse-seines fishing deeper than ringnets.

Maximum size of frigate, kawakawa, skipjack and yellowfin is approximately 55, 100, 105 and 200 cm, respectively. However, almost the entire catch of all species captured under payaos was less than 30 cm (Fig. 30). In contrast, significant proportions of the catches of frigate, kawakawa and skipjack captured as free-schools by ringnet were larger than 30 cm. These pronounced differences in size composition indicate tuna species less than 30 cm have a greater affinity for fish aggregating devices than fish larger than this size.

6. Discussion

There does not appear to be further scope for expansion of areas for deploying payaos in the EEZ of the Philippines. An estimated 5,000 payaos are currently deployed in the Philippines, principally in the shallow and deep-water fishing areas (Ganaden and Stequert, 1987). Payaos are also deployed off the west coast of Luzon Island during the northeast monsoon, when seas are relatively calm. The next phase in the development of Philippine tuna fisheries will have to be expansion into the Western Pacific Ocean and fishing on either free-swimming schools or schools aggregated by drifting FADs.

Landings of kawakawa peaked at 49,000 mt in 1982 and have since decreased to about 41,000 mt. The reported landing of 55,000 mt in 1977 is discounted because figures for the initial 2 years of the present statistical collection system are suspect. Kawakawa in the shallow and deep-water fishing areas is probably being fully exploited at present. Therefore, further increases in kawakawa landings are probably possible only with expansion of fishing effort into the Pacific Ocean and South China Sea fishing areas with extensive continental shelves. These include the West Palawan, Leyte Gulf and Lamon Bay fishing areas (Munro, 1986).

The shallow-water fishing areas are relatively small bodies of water so that the oceanic zones are restricted and in close proximity to land. It is not unreasonable in the context of large pelagic species, therefore, to consider the entire extent of these fishing areas as continental shelf.

Yields per unit area of continental shelf have been used to define densities of demersal species. This method has generally not been applied for pelagic species because of their greater mobility, low affinity to the substrate and their three-dimensional life-styles. Nevertheless, the habits of kawakawa permit the use of this method for deriving first estimates of density. This species spends its entire life cycle within the neritic regime (Yoshida, 1979).

Yield of kawakawa per square kilometer of shallow-water fishing area averaged 0.28 mt. This is probably about the maximum potential yield per square kilometer of continental shelf of a neritic tuna species.

Kawakawa are restricted to the neritic regime of continents and islands, whereas Auxis species are more widely distributed in the neritic regime and contiguous zone. Nishikawa, et al (1985) found kawakawa larvae near land masses and Auxis larvae from near land to the open ocean. However, Auxis larvae were associated more with land masses in the Western Pacific, but were distributed throughout the oceanic regime in the Eastern Pacific.

Landings of Auxis species peaked at 95,000 mt in 1985. There is scope for further increase in landings as the distributional range of Auxis species is probably not yet fully exploited. Yields of Auxis species in the deep-water fishing areas averaged 0.14 mt/km^2. This compares with estimate of 0.12 mt/km^2 of Auxis species consumed by yellowfin each year in the Commission Yellowfin Regulatory Area (CYRA) of I-ATTC (Yesaki, 1983).

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Table 1. Area of shallow-water fishing grounds, tuna landings 1/ and yields per unit area

Fishing ground	Tayabas Bay	Cuyo Pass	Visayan Sea	Guimaras Strait	Ragay Gulf	Samar Sea	km²	Total %
Area, neritic zone 2/	2,500	29,100	11,500	4,400	3,100	7,200	57,800	61
oceanic zone 2,3/	1,300	24,300	4,000	2,800	1,900	2,800	37,100	39
total	3,800	53,400	15,500	7,200	5,000	10,000	94,900	100
							mt	% of total
Species, frigate	3,094	2,614	4,251	522	1,011	1,434	12,956	16
yellowfin	246	3,814	1,660	2,006	154	849	8,729	15
kawakawa	328	7,149	3,561	6,366	8,784	343	26,531	63
skipjack	485	4,307	176	19	888	452	6,327	15
total	4,153	17,884	9,648	8,943	10,837	3,078	54,543	24
							mt/km²	%
Yield/area, frigate	0.81	0.05	0.27	0.08	0.20	0.14	0.14	27
yellowfin	0.06	0.07	0.11	0.29	0.03	0.08	0.09	16
kawakawa	0.09	0.13	0.22	0.88	1.76	0.03	0.28	48
skipjack	0.13	0.08	0.01	0.00	0.18	0.05	0.07	12
total	1.09	0.33	0.61	1.25	2.17	0.30	0.58	100

1/ - 1984 landing statistics
2/ - Munro, 1986
3/ - Yesaki, 1983

Table 2. Area of deep-water fishing grounds, tuna landings 1/ and yields per unit area

Fishing grounds	Batangas coast	Sulu 1/ Sea	Moro Gulf	Davao Gulf	Bohol Sea	Comotes Sea	Sibuyan Sea	km² Total	%
Area, neritic zone 2/	300	50,400	12,400	3,100	500	5,300	7,000	79,000	18
oceanic zone 2,3/	3,000	188,900	101,600	3,900	28,500	7,600	23,500	357,000	82
total	3,300	239,300	114,000	7,000	29,000	12,900	30,500	436,000	100
								mt	% total
Species, frigate	4,989	12,926	22,960	2,212	11,643	3,454	2,057	60,241	75
yellowfin	688	13,842	21,742	2,840	1,604	159	430	41,305	70
kawakawa	6	6,396	4,505	-	1,820	16	799	13,532	32
skipjack	863	13,880	10,562	1,551	3,050	91	621	30,618	73
total	6,546	47,034	59,769	6,603	18,117	3,720	3,907	145,696	65
								mt/km²	%
Yield/area, frigate	1.51	0.05	0.20	0.32	0.40	0.27	0.07	0.14	43
yellowfin	0.21	0.06	0.19	0.41	0.06	0.01	0.01	0.09	27
kawakawa	0.00	0.03	0.04	-	0.06	0.00	0.03	0.03	9
skipjack	0.26	0.06	0.09	0.22	0.11	0.01	0.02	0.07	21
total	1.98	0.20	0.52	0.95	0.63	0.29	0.13	0.33	10

1/ - includes East, South and West Sulu Sea fishing grounds
2/ - Munro, 1986
3/ - Yesaki, 1983

Table 3. Landings of frigate by fisheries sector and fishing gears

Fishing gear	Commercial mt	%	Municipal mt	%	Total mt	%
Ringnet/purse-seine	41,067	87	4,839	15	45,906	57
Bagnet	5,781	12	2,281	7	8,062	10
Gillnet	-	-	9,521	29	9,521	12
Hook and line	117	0	11,919	36	12,036	15
Longline	357	1	1,358	4	1,715	2
Troll line	-	-	1,987	6	1,987	3
Beach seine	14	0	562	2	576	1
Trawl	15	0	25	0	40	0
Others	9	0	182	1	191	0
	47,360	100	32,674	100	80,034	100

Table 4. Landings of kawakawa by fisheries sector and fishing gear

Fishing gear	Commercial mt	%	Municipal mt	%	Total mt	%
Ringnet/purse-seine	12,549	67	3,758	16	16,307	39
Bagnet	6,240	33	3,761	16	10,001	24
Gillnet	-	-	3,267	14	3,267	8
Hook and line	11	0	11,122	48	11,133	27
Longline	4	0	165	1	169	0
Troll line	-	-	10	-	10	0
Pole and line	-	-	195	1	195	0
Trawl	28	0	698	3	726	2
Others	-	-	167	1	167	0
	18,832	100	23,143	100	41,975	100

Table 5. Percent frigate and kawakawa captured under payaos and as free-schools at 6 landing sites on Mindanao Island.

Landing site	Fish. gear	Year	Frigate payao	Frigate free-school	Kawakawa payao	Kawakawa free-school
General Santos	ringnet	1980-84	100	0	100	0
	purse-seine	1980-84	100	0	100	0
Opol	ringnet	1980-84 1/	48(?)	52(?)	100	0
Labuan	ringnet	1980-1985	0	100	0	100
	purse-seine	1980,1982-83	100	0	0	-
Santa Cruz	ringnet	1980-83	100	0	100	0
Recordo	ringnet	1980-83	86	14	-	0
	purse-seine	1983, 1985	100	0	-	0
Malita	ringnet	1984	100	0	100	0

1/ - 1983 data for free-schools missing

Table 6. Estimates of frigate and kawakawa landings made under payaos and as free-schools from fishing areas around Mindanao Island

Species	Frigate				Kawakawa			
Type of fishing	Payao		Free-school		Payaos		Free-school	
Fishing gear	Ringnet	Purse-seine	Ringnet	Purse-seine	Ringnet	Purse-seine	Ringnet	Purse-seine
Moro Gulf (General Santos)	12,083	7,281	0	0	1,529	1,015	0	0
Opol (Bohol Sea)	3,216	-	3,483	-	1,102	-	0	-
Labuan/Recordo (East Sulu Sea)	0	2,017	2,634	0	0	179	899	0
Santa Cruz/Malita (Davao Gulf)	1,766	-	0	-	0	-	0	-
Gear total	17,065	9,298	6,117	0	2,631	1,194	899	0
Fishing type totals	26,363		6,117		3,825		899	
Percent	81		19		81		19	

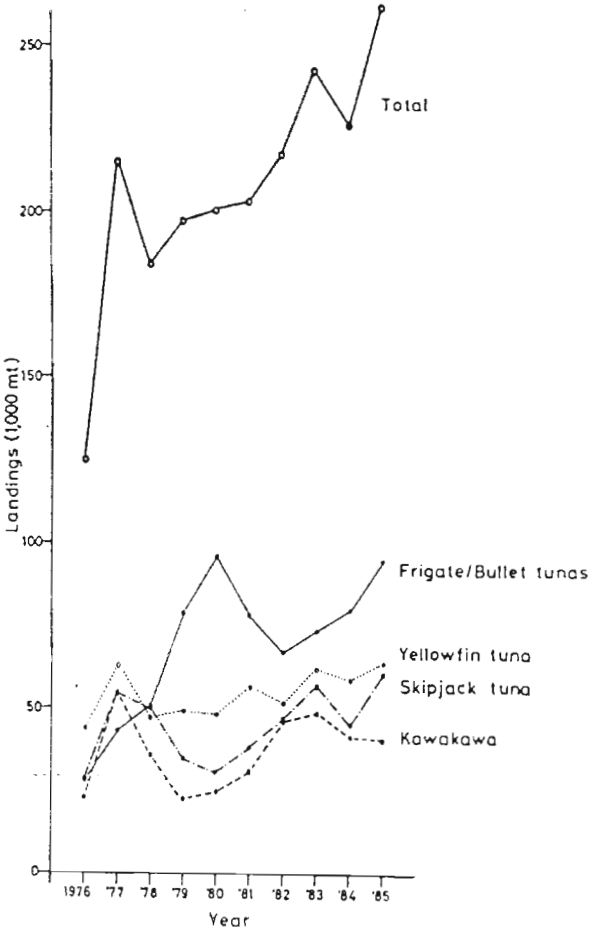

Fig. 1. Landings of tuna by species in the Philippines from 1976 to 1985

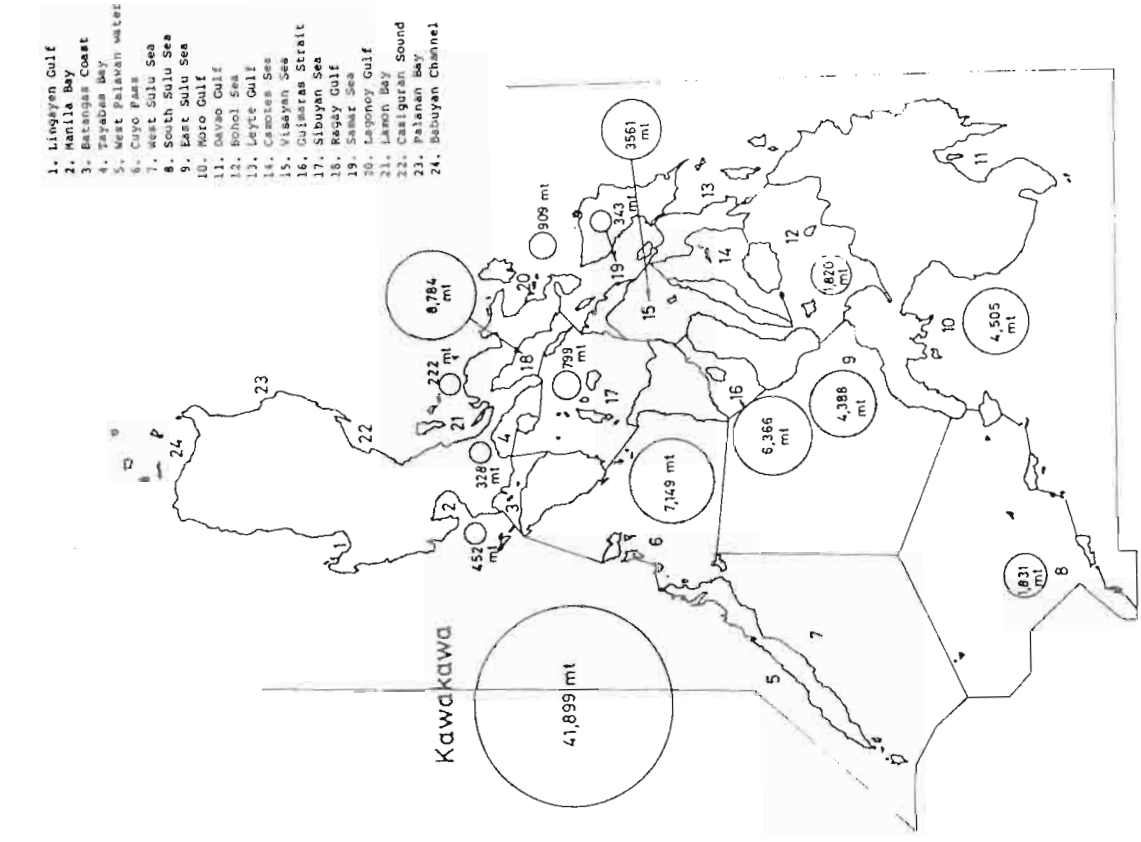

Fig. 3. Distribution of kawakawa landings by fishing areas

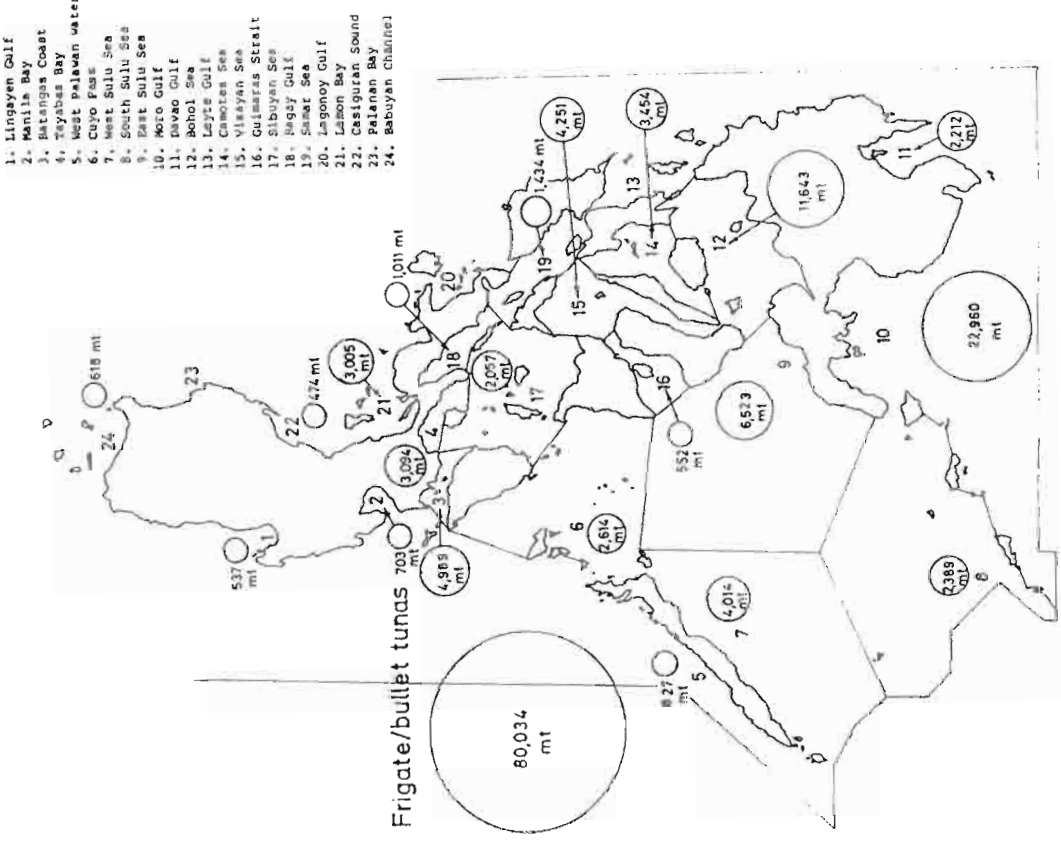

Fig. 2. Distribution of frigate/bullet tuna landings by fishing areas

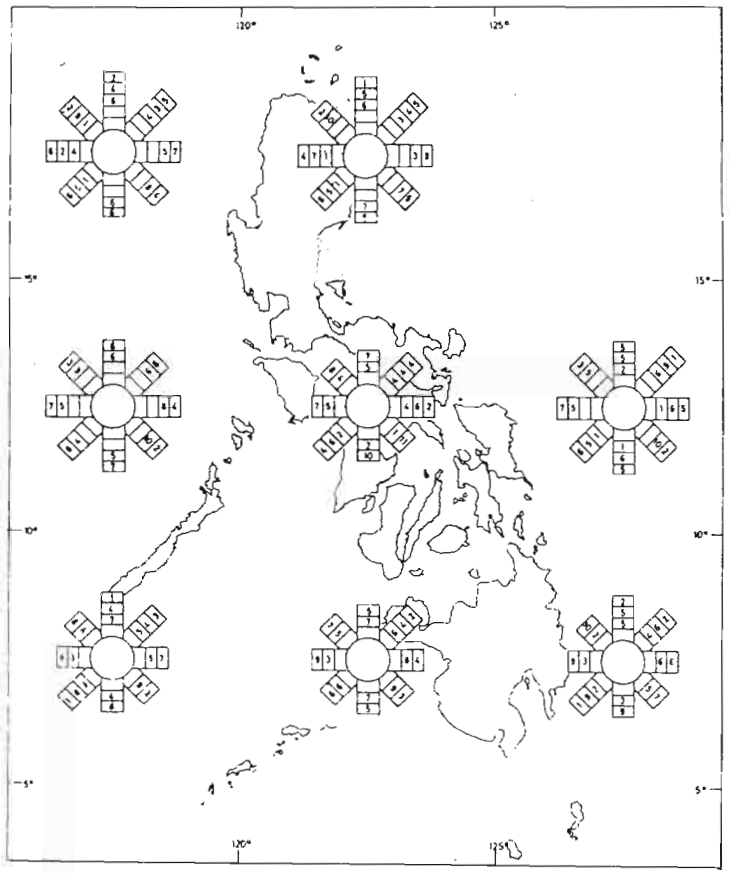

Fig. 4. Wind stress patterns in the EEZ of the Philippines. Wind direction represented by bars. Wind force represented by divisions of the bar beginning with Beaufort force 1 at the center and increasing outward. Numbers in the division represents number of months of the year (12 observation for each direction) (from U.S. Defence Mapping Agency, 1979)

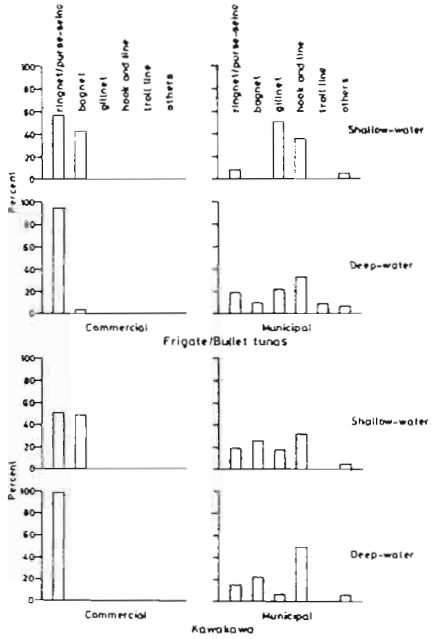

Fig. 5. Landings of frigate/bullet tunas and kawakawa by fisheries sector, gear type and fishing areas

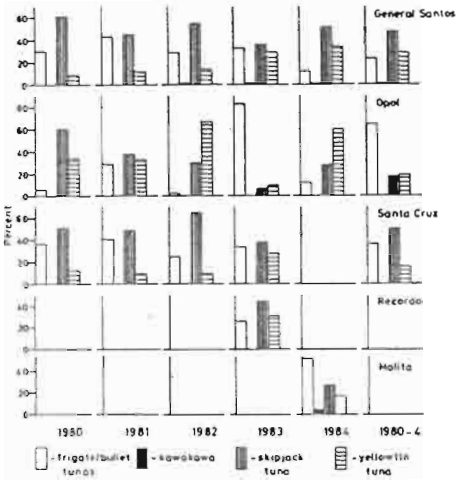

Fig. 6. Species composition of tuna landings by ringnetters fishing payao-associated schools at various landing centers for the years 1980-84

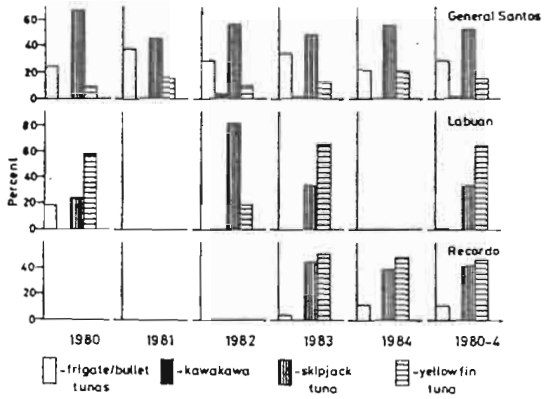

Fig. 7. Species composition of tuna landings by purse-seiners fishing payao-associated schools at various landing centers for the years 1980-84

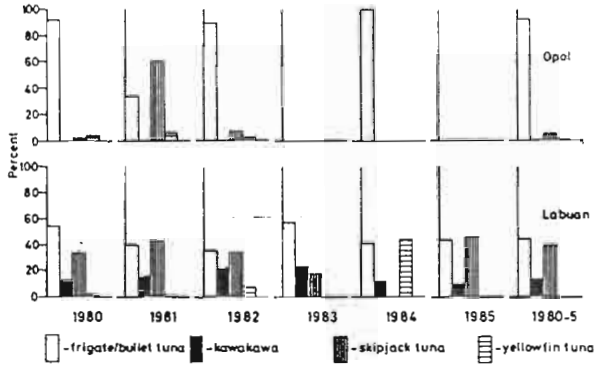

Fig. 8. Species composition of tuna landings by ringnetters fishing free-schools at 2 landing centers for the years 1980-85

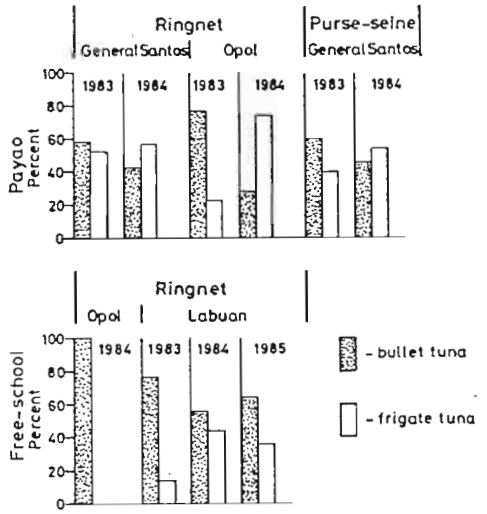

Fig. 9. Composition of Auxis landings by ringnetters and purse-seiners fishing payao-associated schools and free-schools

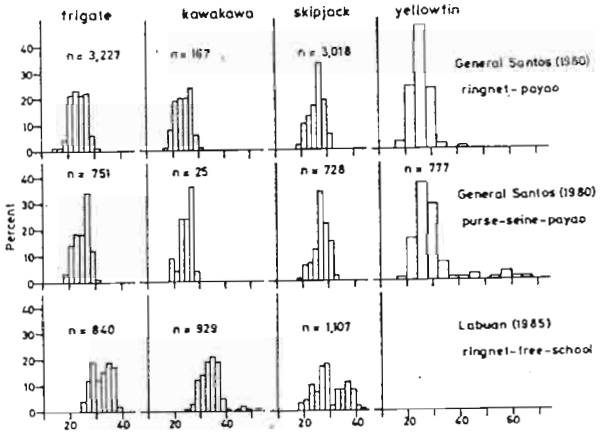

Fig. 10. Length frequency distributions of tuna species captured under payaos and as free-schools by ringnetters and purse-seiners

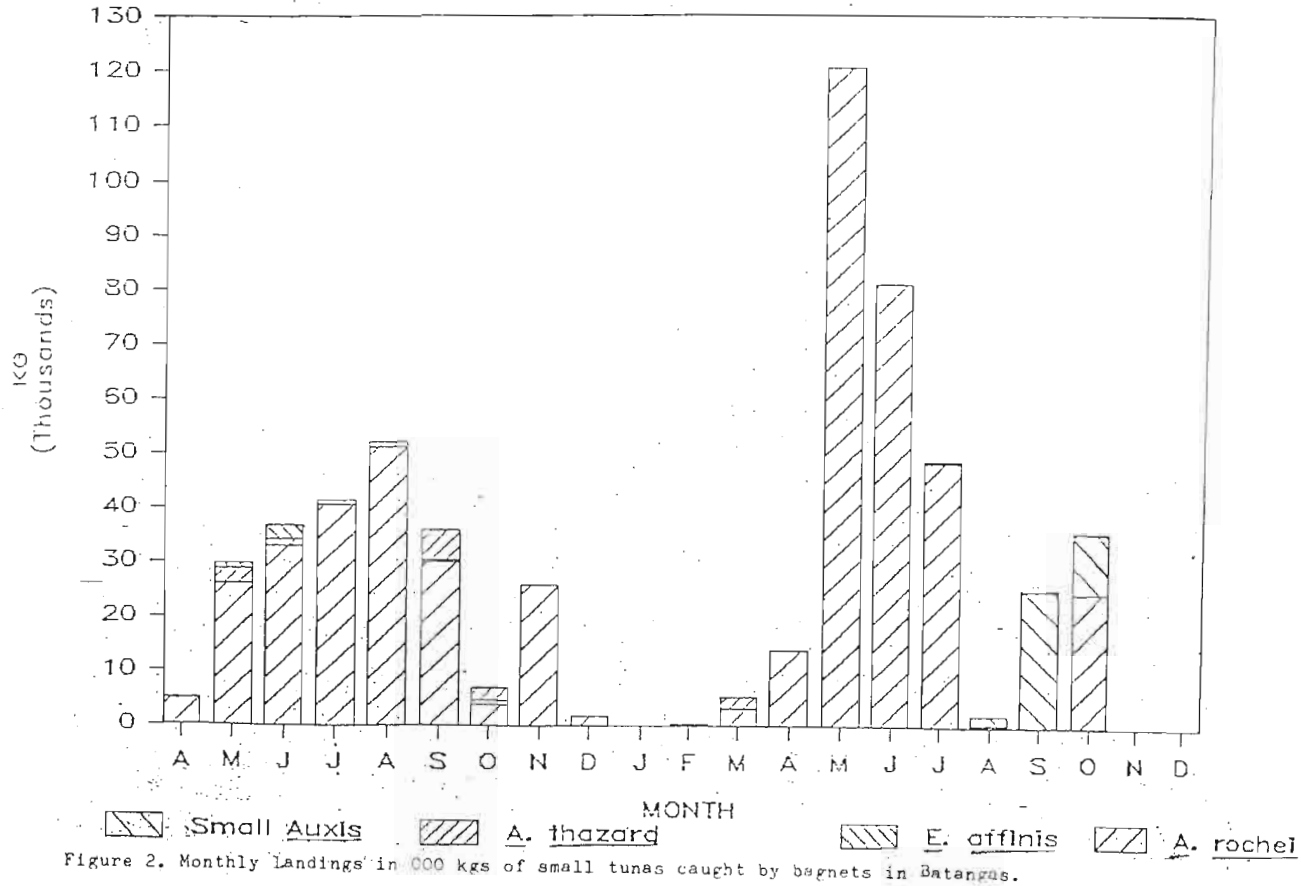

Figure 2. Monthly Landings in 000 kgs of small tunas caught by bagnets in Batangas.

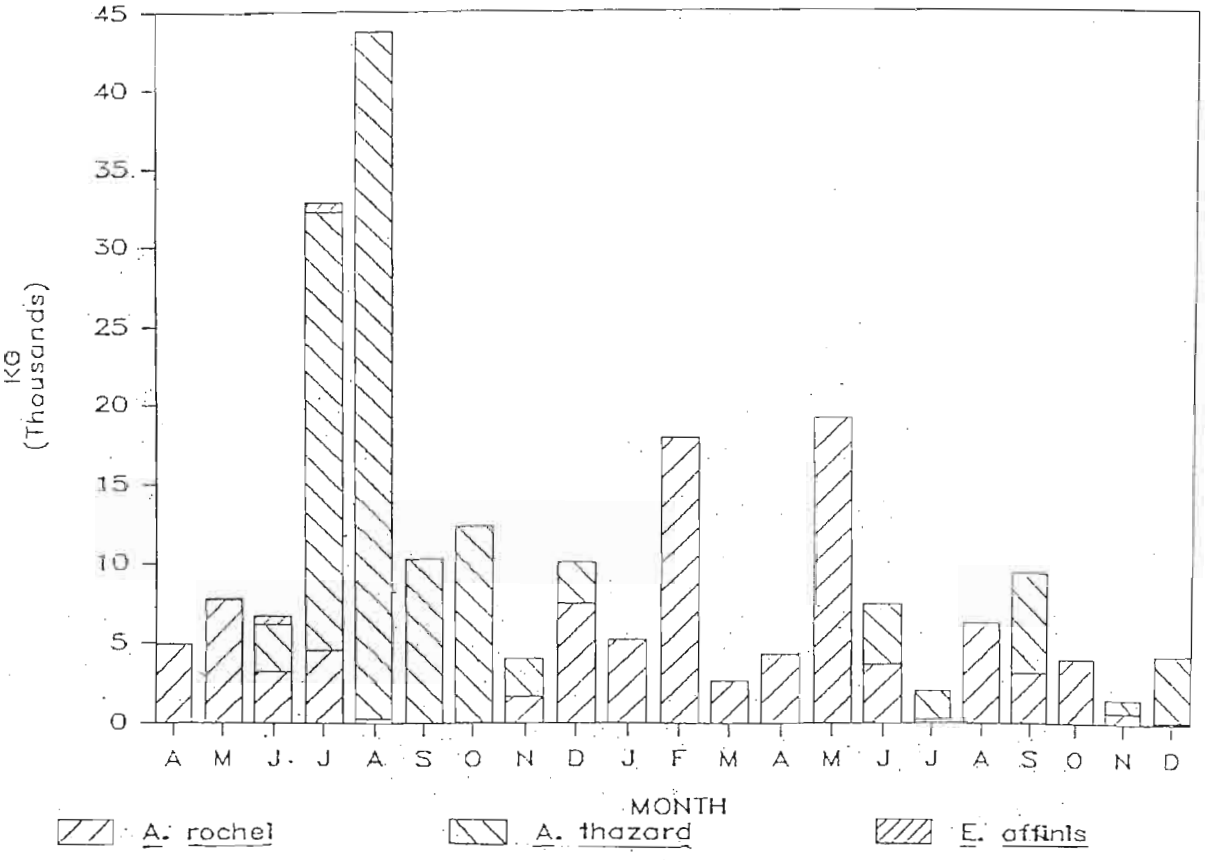

Figure 3. Monthly landings in 000 kgs of small tunas caught by ringnets in Batangas.

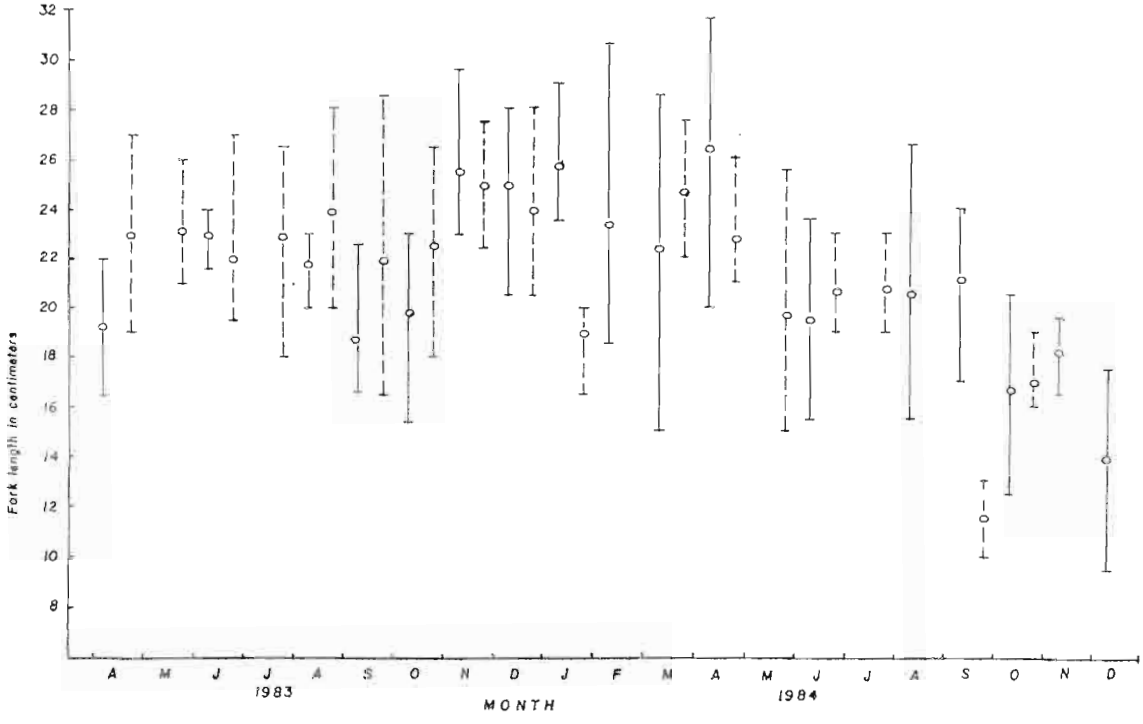

Fig. 4. Monthly mean and range of fork lengths of Auxis rochei caught by ringnets (—) and bagnets (---) in Batangas (April 1983 - December 1984).

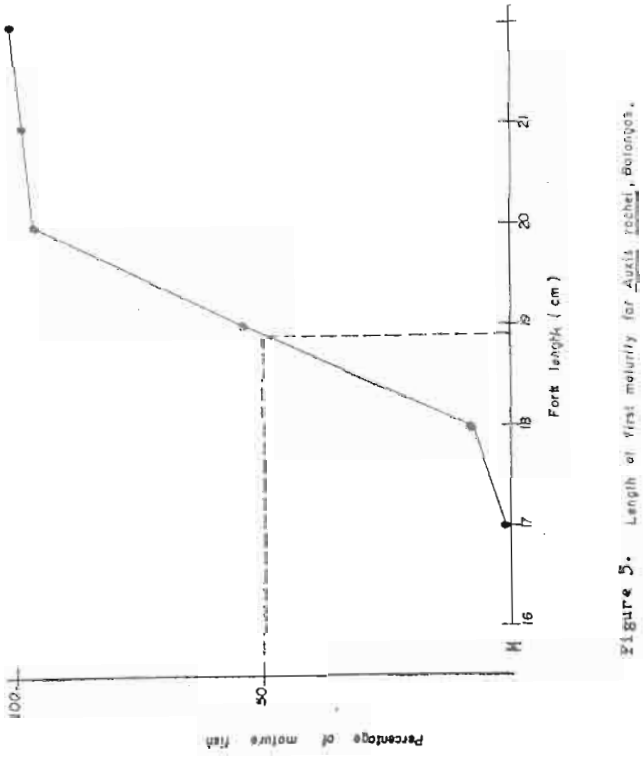

Figure 5. Length at first maturity for Auxis rochei, Batangas, Philippines.

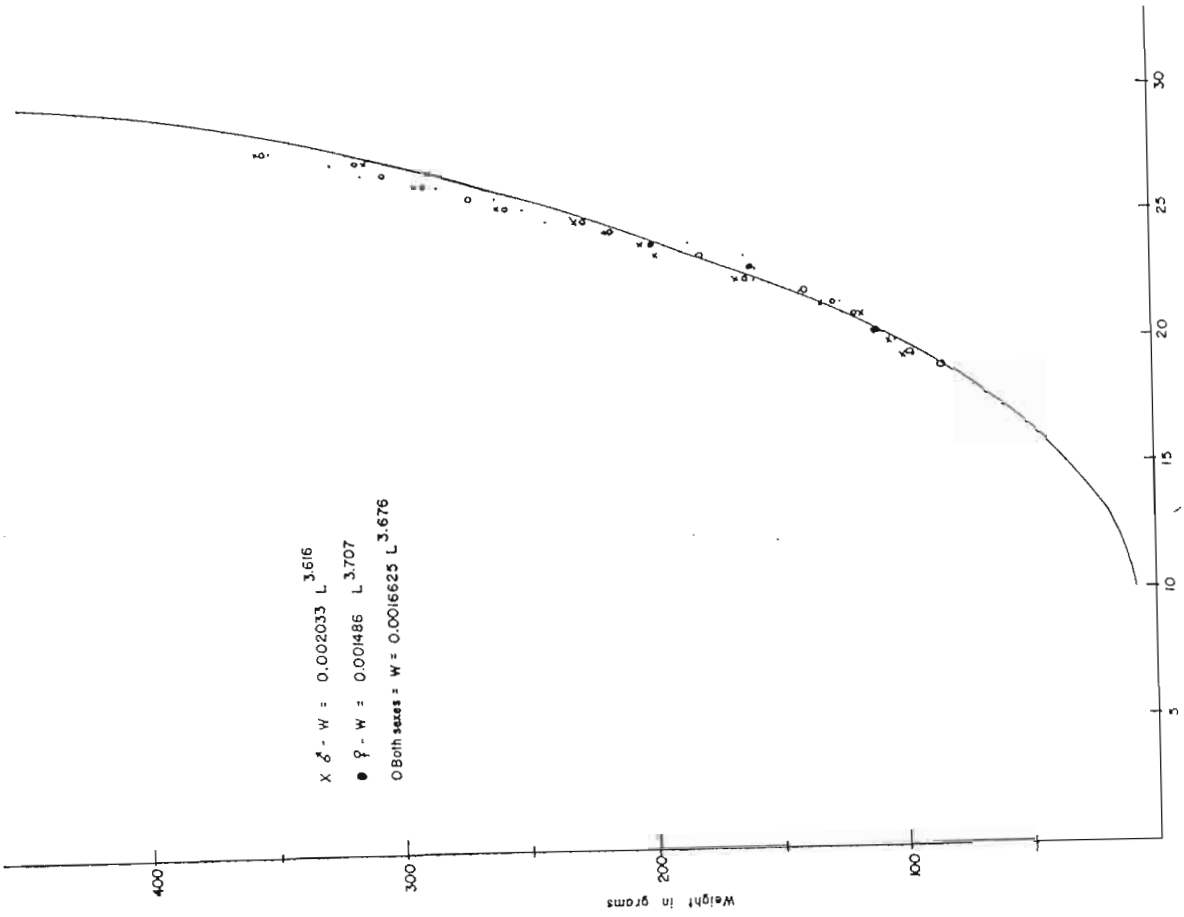

Fig. 7. Length - weight relationship of Auxis rochei caught by ringnets in Batangas.

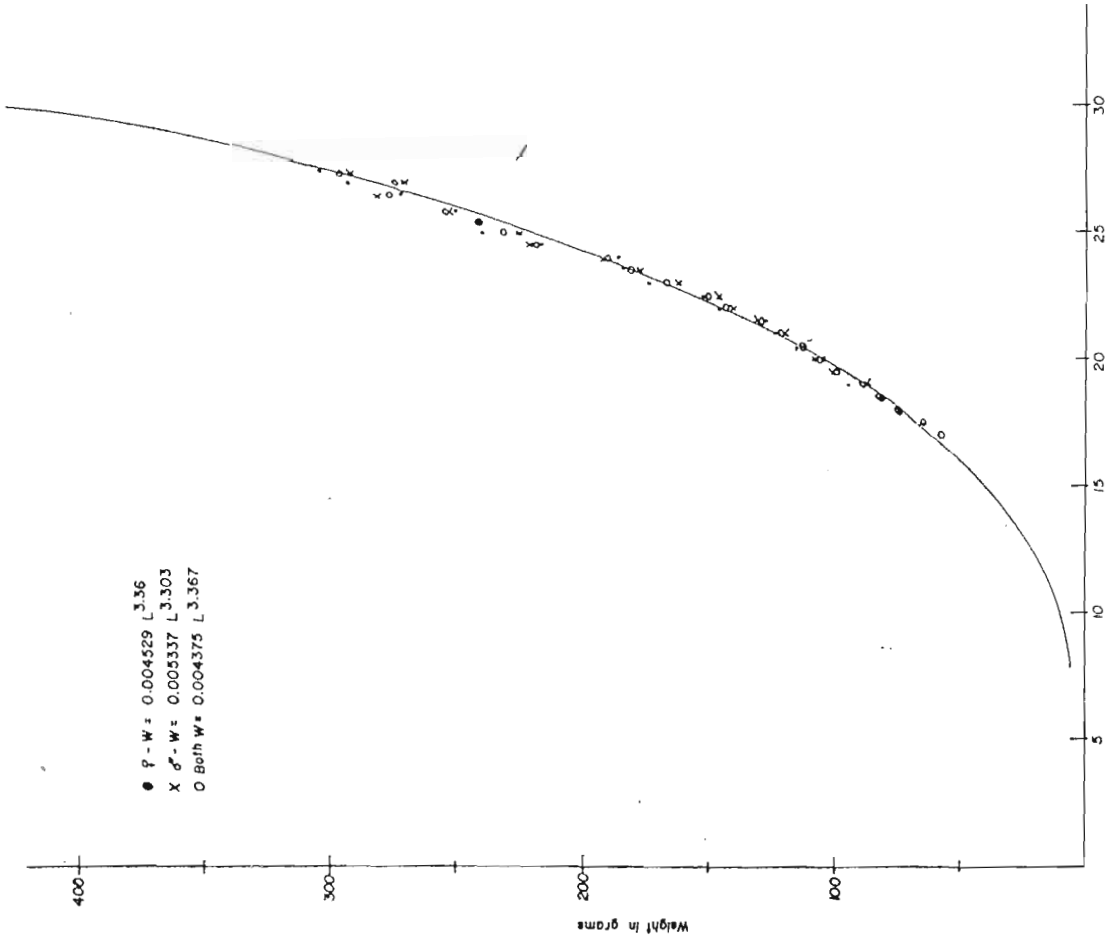

Fig. 6. Length-weight relationship of Auxis rochei caught by bagnets in Batangas.

Table 1. Monthly data on landed catch of bagnets at Wawa, Batangas City

Month	No. of Sampling Days	No. of Boats Landed	Total Landed Catch	Catch per Boat (kg)	Species Composition/Weight in Kilograms						
					A. rochei	A. thazard	E. affinis	T. albacares	Decapeterus spp	Other fish	Squid
April '83	7	40	11661	291	5020				6166	50	425
May	20	135	50148	371	26120	2840	880		11740	977	7760
June	25	178	45,493	256	33034	1240	2511		6684	1900	124
July	16	87	43010	494	40680		740		560	1030	
August	17	145	55310	381	51040	40* 880			2650	500	200
September	19	194	38307	197	30146	220* 5453	20		1720	688	60
October	17	147	9451	64	3800	838* 2280			620	1633	280
November	12	117	29760	254	25780				2120	1860	
December	4	17	2942	173	1858				995	89	
January '84	9	205	74312	362	86				34703	39218	305
February	6	123	18713	152	400	120			13685	4508	
March	8	209	23053	110	3185	2115			13306	4020	427
April	7	161	19315	120	13964	75			2756	1095	1425
May	10	204	133825	656	120405				11565	840	1015
June	8	141	82845	587	80815				1060	660	310
July	12	168	49848	297	48185	320*			760	243	280
August	3	41	5850	143	510	1640* 160					
September	10	173	46067	266	27	24934* 77		210	17800	1871	1148
October	10	170	45613	268	24440	10973*	80		8090	580	1450

* "tulingan" small Auxis below 15 cm.

Table 2. Monthly data on landed catch of ringnets at Sambal, Lemery, Batangas

Month	No. of Sampling Days	No. of Boats Landed	Total Catch Landed (kg)	Catch per Boat	Species Composition/Weight in Kilograms						
					A. rochei	A. thazard	E. affinis	K. pelamis	T. albacares	Decapterus spp	Others
April'83	7	206	6755	33	4955					1800	
May	31	793	105202	133	7805	13				97169	215
June	27	694	78304	113	3293	2914	570			70925	575
July	28	548	59083	108	4636	27653	560			24845	1390
August	24	530	48818	92	279	43434				5005	100
September	29	431	21093	49		10313				7640	3140
October	27	418	15870	38	117	12296			45	1692	1720
November	21	263	10110	39	1750	2328		180			5860
December	28	572	11988	21	7565	2573		90			1760
January '84	30	607	7305	12	5250				135	320	1600
February	26	749	20250	27	17960					1080	1210
March	15	184	3525	19	2678	88					760
April	12	120	4509	38	4235	95	59				120
May	15	194	26250	135	19250					5760	1240
June	11	195	15990	82	3675	3835				7980	500
July	15	182	11195	62	200	1855				8560	580
August	15	110	7745	70	6265					1040	440
September	17	293	17775	61	3156	565* 6287			200	4168	3400
October	15	150	6685	45	3970	15				1160	1540
November	15	225	10765	48	735	770				5320	3940
December	8	216	6935	32	140	4095					2700

* small Auxis

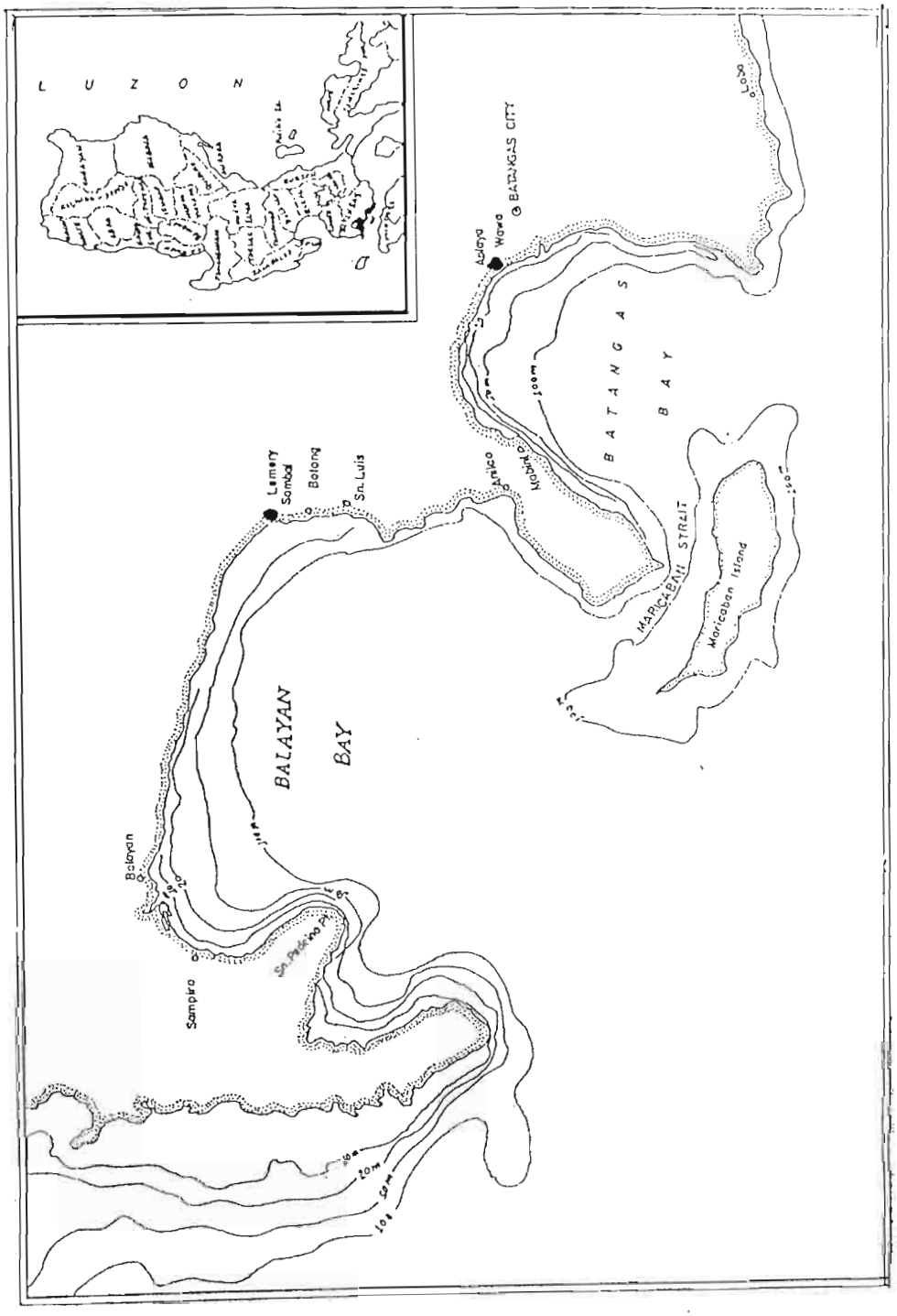

Figure 1. Fishing areas for Auxisspp and monitoring stations Sambal, Lemery for the ringnets and Wawa, Batangas City for bagnets.

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