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THE STATUS OF TUNA FISHERIES IN INDONESIA AND THE PHILIPPINES

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INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME
Colombo, Sri Lanka

The Indo-Pacific Tuna Development and Management Programme seeks to assist the governments in the area in the preparation of long-term management and development of tuna and tuna-like species. Recognizing the need for intensive efforts in selected countries to generate the information to support this management and development in the Government of Japan, established a trust fund with FAO to enable directed Investigation on Indian Ocean and Western Pacific Small Tuna Resources. These investigations form a valuable part of the overall Indo-Pacific Tuna Programme (IPTP). This publication is made possible by Japan's support.

The project supported by Japan is carried out under the general direction of the IPTP in close cooperation with FAO's regional fisheries projects. The initial work has concentrated in the Philippines and Indonesia in cooperation with the UNDP/FAO South China Sea Fisheries Development and Coordinating Programme (SCSP).

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PREPARATION OF THIS REPORT

This document was prepared by T. F. White and M. Yesaki of the South China Sea Fisheries Development and Coordinating Programme (SCSP). Information contained herein were obtained from many sources including the Statistical and Research Divisions, respectively, of the Bureau of Fisheries and Aquatic Resources (BFAR) in the Philippines, an internal report prepared by Woo Il Choo, a consultant to the SCSP, and the Marine Fisheries Research Institute (BPPL) in Indonesia. A full list of contributions is supplied at the end of this Report.

1. INTRODUCTION

Commercial tuna fishing has developed rapidly during recent years in the Southern Philippines and Eastern Indonesia. The initiative for this development has come primarily from the private sector in the Philippines while in Indonesia, the Government has provided the impetus.

1.1 Philippines

Two related developments during the last decade were responsible for this development in the Philippines. Two tuna purse-seine vessels, the 420 GRT, FB "Southward Ho" and the 283 GRT, FB "Royal Venture", chartered by the FAO South China Sea Fisheries Development and Coordinating Programme (SCSP), conducted exploratory tuna fishing in Southern Philippine waters from late 1974 to mid-1977. Initially, these vessels attempted to capture free swimming tuna schools and schools associated with floating objects during daylight, but with mixed success. However, at this time, the Philippine fishing fleet had been evolving an artisanal fishing technique involving floating bamboo rafts (payaos) to capture smaller pelagic species (sardines, *Sardinella* sp; mackerel, *Rastrelliger* sp; round scad, *Decapterus* sp and bigeye scad, *Selar* sp) as well as tunas. These species were captured around the payaos at night using ringnets (a "purse-seine" type of net, which has the bunt in the centre, rather than the end of the net) and small purse-seines. Larger, deeper swimming tunas also attracted to the payaos were captured by handlines.

The "Southward Ho" and "Royal Venture" adapted the payao technique for their larger purse-seine nets and made some impressive catches attracting the attention of the Philippine fishing industry (Chikuni, 1978). The local fishermen quickly expanded and further developed the payao purse-seine fishery, introducing payaos into deeper, offshore waters in increasing numbers. By 1979, eight fishing companies were operating about 50 large commercial purse-seiners (250+ GRT) in the Philippines, with an aggregate tonnage of over 10,000 tonnes (Aprieto, 1980). The fleet comprised a wide variety of vessel sizes and engine capacities, as practically the entire fleet consisted of vessels converted from some other fishing activity, e.g., trawling, longlining, pole and line fishing, etc. Many of these used vessels were imported, including some older and smaller vessels from the U.S. purse-seine fleet.

Payaos, referred to internationally as Fish Aggregating Devices (FAD) consist of rafts constructed of bamboo and more recently, a wide variety of materials including steel, from which are suspended fish shelter materials such as palm fronds. These are anchored in favourable locations, attracting smaller pelagic species which in turn attract tunas and other larger pelagic fish. Payaos are now sometimes anchored more than 100 miles from shore in depths up to 2,000 fathom (for details of payaos construction and deployment, see de Jesus, 1982).

Payaos attract a variety of species and consequently sizes of fish. The ringnetters and smaller purse-seiners principally target their efforts around the payaos upon the smaller pelagic species and consequently adopt an appropriate mesh size for their nets. Stretched mesh sizes in the bunt typically range from 14 to 23 mm and in the wings from 43 to 50 mm. Ringnets typically measure between 300 and 500 meters in length and from 20 to 50 meters in depth. Similarly, the smaller purse-seine nets measure around 600 to 650 meters in length and around 150 meters in depth. While these gears do catch considerable quantities of tunas, they are generally inefficient for the purpose. The larger (250+ GRT) purse-seiners, targeting principally on tunas, employ gear specifically for this purpose. Nets average 1,000 meters in length by 600 meters in depth with mesh size in the bunt around 60 mm and in the wing around 85 mm.

While the tuna landings in the Philippines have increased considerably in recent years, the combination of increasing numbers of payaos being deployed further offshore, together with the rapid expansion of the purse-seine and ringnet fleet, particularly the smaller class of vessel (50 to 200 GRT) has resulted in increasing catches of juvenile tunas.

1.2 Indonesia

In Indonesia, state-owned pole and line fishing enterprises were established in Aer Tembaga (Sulawesi) and Ambon (Ambon) in 1961. The Indonesian Government encouraged the expansion of tuna fisheries in the early 1970's by increasing credit to the existing State enterprises and by establishing another pole and line fishing enterprise at Sorong (Irian Jaya). The majority of the vessels owned by the State enterprises are 30 gross tonnes. Besides the State enterprises, there are private pole and line fishing companies at Aer Tembaga, Ambon, Kendari (Sulawesi) and Ternate (Halmahera). Pole and line vessels of the private companies are generally smaller and range in size from 9 to 30 GRT. At Ternate, there is also a joint-venture company operating with two, 200 GT pole and line vessels and very recently, a 550 GT purse-seiner (Unar, 1981).

Tuna longline fishing was introduced to Indonesia, in Bali in 1973, using a fleet of ex-Japanese longline vessels. The fleet now consists of 20 vessels from 111 to 300 GRT.

Skipjack tuna landings in Indonesia during 1978 totalled 33,515 tonnes, of which 28,117 tonnes or 84% was landed in Eastern Indonesia.

1.3 Research

The expansion of tuna fisheries in these two countries and the reported high incidence of juvenile tunas caught in the Philippines has raised concern among officials and called attention to the need to monitor developments for proper assessment and management of the resource. In Indonesia, there is concern about the development of the payao fishing techniques and introduction of purse-seine vessels and the impact of these upon the present, successful pole and line fishery.

The South China Sea Fisheries Development and Coordinating Programme (SCSP) convened a workshop on the tuna resources of Indonesia and Philippine waters in Jakarta on 20-23 March 1979 (SCS/GEN/79/21) to review the available information and define priority research activities. One of the recommendations of this workshop was the "planning and carrying out by both countries of a comprehensive survey programme of the size and species composition of the tuna catches by different gears in various areas throughout the year". Following this recommendation, a joint Indonesian/Philippine Working Group was formed under the South China Sea Fisheries Programme and the Biological Data Collection System for Tuna and Related Species in Mindanao (Philippines) and Eastern Indonesia was established with financing through the Programme of Assistance to Developing Countries in Planning the Utilization of the Living Resources of the Expanded Economic Zones (GCP/RAS/089/NOR). This project was approved in June 1979 and funded for one year with monies totalling US$65,100 from Norway. Sampling activities were initiated in November 1979 and continued through December 1980. The purpose of this project was "to set up the operational infrastructure for sampling in the region described, and obtain biological data on species composition, length/weight composition, maturity and seasonality of tunas and associated species (small pelagics) in the landings of Mindanao (Philippines) and Eastern Indonesian region for stock assessment and management purposes" (Buzeta, 1981).

Subsequently, the programme has been continued by the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) and the Indonesian Institute of Marine Fisheries Research (BPPL), respectively.

At the 6th Joint Meeting of the IOFC/IPFC Tuna Management Committees, held in Western Australia in February 1979, many coastal States expressed a strong interest in entering or expanding the fisheries on surface tuna in their waters. The Committee, however, noted that the lack of information available about the tuna resources, the current exploitation rate, size, species composition, etc., was a serious constraint to national development.

A project entitled "Investigation on Indian Ocean and Western Pacific Small Tuna Resources" (GCP/RAS/099/JPN), funded by the Japanese Government was initiated in September 1981, to provide information on the magnitude and distribution of stocks, the location and timing of productive fishing grounds and catch rates to be expected by different types of fishing gears. The Philippine/Indonesian fishery was identified as a priority area for the study.

This document is a report on current progress with the project. As most effort to date has been directed towards the Philippine fishery, this report deals essentially with the situation in that country.

2. BIOLOGICAL PARAMETERS

2.1 Identification of species

The tunas and tuna-like species belong to the family Scombridae. Seven species from this family are the basis of the tuna fisheries in Indonesia and the Philippines. These are listed in Table 1, together with certain morphological information about those fish commonly landed in these two countries. The "common" size range shown on this Table depends upon the type of fishing gear used. For instance, skipjack and yellowfin tuna captured by ringnets are generally in the 20 to 40 cm size range, whereas yellowfin tuna caught by handlines are generally much larger between 80 and 150 cm.

Identification of the tuna species is a major problem in this area, both for the compilation of the published National statistics and some aspects of this sampling programme. Bigeye tuna are extremely difficult to distinguish from yellowfin tuna in the size range of the fish commonly encountered in the catches of the surface fishing gears, i.e., less than 40 cm, and are generally pooled together as "yellowfin" tuna. Where sampling has attempted to differentiate between these two species, the results suggest that perhaps 10% of the smaller "yellowfin" tuna landed by surface gears and perhaps 2% of the larger "yellowfin", landed by the handline vessels in the Philippines may be bigeye tuna. In Indonesia, industry sources suggest that 1% of the yellowfin landed by the pole and line fishery are bigeye tuna. The tuna longline fishery in Indonesia does however differentiate between these two species and here, the ratio of yellowfin/bigeye is around 3:1.

Table 1. Maximum and common size range of tunas landed in the Philippines and Indonesia

S P E C I E S		L E N G T H (cm)	
Common name	Scientific name	Maximum	Common size range
Bullet tuna	*Auxis rochei*	30	20 - 30
Frigate tuna	*Auxis thazard*	50	20 - 40
Eastern little tuna	*Euthynnus affinis*	70	20 - 50
Skipjack tuna	*Katsuwonus pelamis*	80	20 - 60
Yellowfin tuna	*Thunnus albacares*	190	20 - 150
Bigeye tuna	*Thunnus obesus*	200	20 - 150
Longtail tuna	*Thunnus tonggol*	105	30 - 50
Southern bluefin tuna	*Thunnus maccoyii*	-	-
Albacore	*Thunnus alalunga*	-	-

There are similar difficulties in differentiating between frigate tuna (*Auxis thazard*) and bullet tuna (*Auxis rochei*). Only frigate tuna (*Auxis thazard*) are recorded in the Philippine national statistics. However, detailed sampling indicates that at some landing centres, particularly those around the inner Archipelagic waters, up to 80% of these fish are actually bullet tuna (*Auxis rochei*). Overall, it is probable that 50% of the "frigate tuna" landed in the Philippines are actually bullet tuna. The situation appears to be similar in Indonesia. This is discussed further in Section 3.2.1.

"Albacore" and "Bonito" are sometimes listed among the Philippine landings. Albacore (*T. alalunga*) occur rarely in Philippine waters and it can be generally assumed that the fish referred to are yellowfin tuna. "Bonito" is a general term used to include small species of frigate tuna, bullet tuna, eastern little tuna (*E. affinis*), longtail tuna (*T. tonggol*), and occasionally the oriental bonito (*Sarda orientalis*).

2.2 Maturity and spawning

A principal objective of the biological sampling programme was to determine the proportion of juvenile tunas landed by the various fishing gears. "Juvenile" was defined as all individuals that have not yet spawned. Table 2 summarizes published estimates of size at first maturity for selected tuna species in Indonesia and the Pacific Ocean. In January 1982, a study was initiated as part of this project on the maturity status of female yellowfin tuna landed by the handline fishing fleet at General Santos, Mindanao, in the Philippines.

Table 2. Estimates of size at first maturity for selected tuna species in the Indian and Pacific Oceans

Species	Area	Size at first maturity (cm)	Source
Frigate tuna	Eastern Indian Ocean	38 -	Yesaki et al., 1981
	Eastern Pacific Ocean	37 - 41	Klinmaung, 1978
Eastern little tuna	Western Indian Ocean	43 -	Yesaki et al., 1981
	Eastern Pacific Ocean	37 - 42	Klinmaung, 1978
Skipjack tuna	Pacific Ocean	45 -	Kearney, 1974
Yellowfin tuna	Pacific Ocean	52 - 91	Given in Cole, 1980
	Eastern Pacific Ocean	70 - 80	Knudsen, 1977
	Philippines	60 - 70	Wade, 1950
Bigeye tuna	Pacific Ocean	93 - 119	Given in Calkins, 1980
	Pacific Ocean	84 - 95	Yuen, 1955
	Western Pacific Ocean	90 - 100	Kikawa, 1953
Longtail tuna	Western Indian Ocean	44 -	Yesaki et al., 1981
	Eastern Indian Ocean	45 - 50	Sivasubramanian, 1981
	Western Pacific Ocean	45 - 50	Klinmaung, 1978

Results to date suggest that yellowfin tuna above 110 cm in length contribute the greatest to recruitment of the species in Philippine waters, due to the apparent absence, or at least relative absence, of the smaller (60 to 70 cm) fish which is the size at first maturity described by other workers. No similar data has been collected during the present study for the other tuna species. The following are assumed as the size of first maturity for the species occurring in Indonesia and Philippine waters; frigate tuna - 38 cm; bullet tuna - 38 cm; eastern little tuna - 42 cm; skipjack - 45 cm; yellowfin - 60 to 70 cm; bigeye - 90 cm; longtail tuna - 45 cm. Bullet tuna probably reach maturity at a smaller size than frigate tuna (Uchida, 1981), however, as these species are not differentiated in landing statistics, 38 cm is assumed for both.

The International Commission for the Conservation of Atlantic Tuna (ICCAT) recommends a minimum weight limit for yellowfin tuna in the Atlantic fishery of 3.2 kg (corresponding to a length of 56 cm), based on evidence which suggested that the average long-term yield in this fishery would increase accordingly. The relevance of this recommended size limit to the Philippine/Indonesian yellowfin tuna stock (not necessarily implying the existence of a unique local stock) is not known in the absence of any other population parameters. This size is less than the size at first maturity.

From a more practical point of view, the majority of the "larger", yellowfin/bigeye and skipjack tuna are exported. These exports are the basis for the development and operation of the purse-seine fleet in the Philippines and the pole and line and longline fleets in Indonesia. European and Japanese export markets will only accept yellowfin/bigeye tuna equal to or greater than 10 kg, although U.S. markets accept yellowfin/bigeye above 10 lbs (4.5 kg) and skipjack tuna above 4 lbs (1.8 kg). No other species are exported from the Philippines and only albacore additionally from Indonesia. However, yellowfin tuna between 1.8 kg and 4.5 kg, which are too small to export to the U.S.A. as "yellowfin" are usually exported as "skipjack". Marketing criteria, therefore, provide yet another set of critical sizes, 1.8 kg for skipjack and yellowfin tuna and 4.5 kg for yellowfin tuna. 1.8 kg is equivalent to a length of 45 cm for skipjack and 46 cm for yellowfin. 4.5 kg is equivalent to a length of 63 cm for yellowfin tuna. For practical purposes, the length/weight relationship for yellowfin tuna can be used for bigeye, as they are not differentiated by the market in the smaller size ranges. Table 3 gives the coefficients a and b for the relationship between length and weight in the formula $WT = a L^b$, for selected tuna species over the size ranges of tuna encountered during this study.

To summarize the above, the following lengths are of interest for this study:

Yellowfin tuna	-	46 cm minimum exportable size to USA
(Bigeye)	-	63 cm minimum exportable size to Europe
	-	60 cm size of 1st maturity
	-	56 cm ICCAT recommended minimum size 1st capture
Skipjack tuna	-	45 cm minimum exportable size
	-	45 cm size of 1st maturity
Eastern little tuna	-	42 cm size of 1st maturity
Frigate/bullet tuna	-	38 cm size of 1st maturity
Longtail tuna	-	45 cm size of 1st maturity

Table 3. Length-weight relationships of selected tuna species in the Indian and Pacific Oceans

Where Weight = a Length^{b})

Species	Area	Size range (cm)	Coefficients	Source
Frigate tuna	Western Indian Ocean	22-45	a 1.1×10^{-5} b 3.119	Yesaki et al., 1981
Eastern little tuna	Western Indian Ocean	25-29	a 1.5×10^{-5} b 3.034	Yesaki et al., 1981
Skipjack tuna	Indonesian waters	30-58	a 1.425×10^{-5} b 3.085	Unpublished
Yellowfin tuna	Indonesian waters	27-70	a 3.106×10^{-5} b 2.869	Unpublished
Bigeye tuna	Western Pacific Ocean	70-	a 3.66×10^{-5} b 2.902	Nakamura et al., 1966
Longtail tuna	Eastern Indian Ocean	20-61	a 2.2×10^{-5} b 2.947	Yesaki et al., 1981

Lengths may in turn be converted to age by means of the von Bertalanffy growth equation. Selected estimates for the parameters of this equation are given in Table 4. Table 5 illustrates the age of the fish corresponding to the lengths shown above. It is not intended here to debate merits of the various growth equations that have been derived for skipjack and yellowfin tuna. This is examined by Wankowski (1981). It appears, however, that yellowfin tuna spawn sometime after their second anniversary (2+ years) and probably at the third. Most other species in this study, including skipjack, spawn after their first anniversary (1+ year).

3. PHILIPPINE TUNA FISHERY

3.1 Landing statistics

Philippine fisheries statistics differentiate between the commercial and municipal sector of the industry. The differentiation is based on the vessel tonnage; vessels below 3.0 GRT are classed as "municipal", and above, "commercial". Prior to 1976, published statistical data is only available for the commercial fishery.

Tuna production in the Philippines (both sectors) has increased from 9,261 mt in 1971 to a peak landing of 216,000 mt in 1977. The tuna landings in 1980 were 201,000 mt.

Tuna production by species group and fishery sector for 1976 to 1980 is shown in Table 6. The municipal sector provided 57% of the total tuna landings in 1980 and the commercial sector 43%. These compare with 85% and 15%, respectively in 1976. The major reason for the increase in the contribution from the commercial sector has been the development of the purse-seine and ringnet fleets.

These published statistics show frigate tuna to be the major tuna species landed by both commercial and municipal fisheries. In 1980, the proportion of the tuna landings contributed by the various species were as follows:

Species	% of Commercial landings	% of Municipal landings	% of Total landings
Frigate tuna	61	38	48
Yellowfin/Bigeye	13	32	24
Skipjack	14	16	16
Eastern little tuna	11	13	12

As discussed in Section 2.1, misidentification of tuna species is one of the major problems with the published tuna landing statistics. In fact, a considerable proportion of the "frigate" tuna are small skipjack and even small yellowfin tuna. Unskilled enumerators often classify mixed small tuna as "frigate". This partially explains the high percentage of "frigate" in the Philippine tuna landings and will be discussed further under the analysis of the tuna sampling programme results (Section 3.2).

3.1.1 Landings by region

Tuna landing statistics are published both by political Region and by Statistical Fishing Area. The former has no relationship to fishing grounds, seas, or bays, whereas the latter divisions are based on fishing areas. The 24 Statistical Fishing Areas and the fishing grounds they include are shown on Appendix Table A. The 1978 and 1980 landings for these Regions are shown on Table 7 and Appendix Figure 1. Approximately, 40% of the total tuna landings are caught in the seas surrounding Mindanao, approximately 15% around Luzon, 15% from the Sulu Sea and off Palawan and the remainder (30%) from the inner Archipelagic waters such as the Sibuyan Sea, Visayan Sea, Leyte Gulf, etc. The majority of the tuna from the latter area are frigate and eastern little tuna. The majority of the larger yellowfin tuna are caught in the seas around Southern Mindanao.

3.1.2 Landings by fishing gear

The published fishing statistics for the Philippines distinguish between the tuna catches by fishing gear for the commercial (vessels above 3 GRT) and the municipal (vessels under 3 GRT) sector of the industry. Landing by fishing gear for 1980 by fishing sector are shown on Tables 8.1 and 8.2.

Tunas are captured with seven fishing gears by the commercial sector (Table 8.1). In 1980, 71% of the commercial landings were made with purse-seines and ringnets, 26% by bagnets and the remaining 3% by various other gears. Note however that 96% of the skipjack and yellowfin are caught by the purse-seine/ringnets, while the bagnets are mainly responsible for the capture of frigate and eastern little tunas. These statistics reflect the areas of operation of the gear more so than their relative efficiencies at catching the various tuna species. The bagnets are typically used in the nearshore areas and the inner Archipelagic waters where frigate and eastern little tuna are more abundant, whereas the purse-seine and ringnet gears are generally used further offshore in conjunction with the payaos which tend to attract more yellowfin and skipjack than the other species.

Table 4. Estimates of parameters of von Bertalanffy growth function for tuna species

Species	Area	Methods	Range of body length (cm)	Growth parameters			Source
				K	L_{∞}	To	
Auxis thazard	Western Indian Ocean	Length/freq. analysis	16-45	0.80	47	0	Yesaki et al., 1981
Euthynnus affinis	Western Indian Ocean	Length/freq. analysis	8-65	0.46	76	0	Yesaki et al., 1981
Katsuwonus pelamis	Papua New Guinea	Length/freq. analysis	30-75	0.0429*	75	?	Wankowski, 1981
Thunnus albacares	Papua New Guinea	Length/freq. analysis	30-92	0.0243*	181	?	Wankowski, 1981

* K is expressed as a monthly rate, not annual.

Table 5. Age of tuna species at selected sizes

Species	Size (cm)	Age (years)*
Frigate tuna	38	2.1
Eastern little tuna	42	1.7
Skipjack tuna	45	1.8
Yellowfin tuna	46	1.2
Yellowfin tuna	56	1.5
Yellowfin tuna	63	1.8
Yellowfin tuna	110	3.0

* Calculated from equations given in Table 4.

Table 6. Tuna landings (mt) 1976-1980 by species and fishery sector*

Species category	TOTAL					COMMERCIAL					MUNICIPAL				
	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980	1976	1977	1978	1979	1980
Frigate tuna	28,238	43,007	50,899	79,909	96,874	6,101	11,318	20,897	39,694	53,310	22,227	31,689	30,002	40,215	43,564
Yellowfin & Bigeye	44,478	63,059	47,029	49,224	48,023	12,845	12,260	5,519	11,407	11,496	31,633	50,799	41,510	37,817	36,527
Skipjack	29,174	55,090	49,730	45,084	31,178	9,816	22,519	14,816	19,834	12,486	19,358	32,571	34,914	25,250	18,692
Eastern little tuna	23,004	54,744	36,341	23,094	24,730	4,098	14,289	9,468	7,269	9,958	18,906	40,455	26,873	15,825	14,772
T O T A L	124,984	215,900	183,999	197,311	200,805	32,860	60,386	50,700	78,204	87,250	92,124	155,514	133,299	119,107	113,555

* Source: Bureau of Fisheries and Aquatic Resources (BFAR) Fishery Statistics of the Philippines, 1980.

Table 7. Philippine tuna landings by region, 1978 and 1980 (See Appendix Figure 1)

Statistical Fishing Area	Tuna Production 1980 (mt)	%	Tuna Production 1978 (mt)	%
1. Lingayen Gulf	4,042	2.0	2,352	1.3
2. Manila Bay	3,342	1.7	1,492	0.8
3. Batangas Coast	14,767	7.4	3,229	1.8
4. Tayabas Bay	6,864	3.4	10,043	5.5
5. West Palawan Water	317	0.2	242	0.1
6. Cuyo Pass	9,889	4.9	-	-
7. West Sulu Sea	24,751	12.3	1,283	0.7
8. South Sulu Sea	1,459	0.7	26,812	14.6
9. East Sulu Sea	9,342	4.7	4,201	2.3
10. Moro Gulf	36,351	18.1	42,833	23.8
11. Davao Gulf	8,479	4.2	7,903	4.3
12. Bohol Sea	18,789	9.4	11,327	6.2
13. Leyte Gulf	2,781	1.4	6,775	3.7
14. Camotes Sea	3,384	1.7	2,561	1.4
15. Visayan Sea	18,817	9.4	5,475	3.0
16. Guimaras Strait	3,146	1.6	230	0.1
17. Sibuyan Sea	1,459	0.7	74	-
18. Ragay Gulf	18,242	9.1	1,092	0.6
19. Samar Sea	2,365	1.2	5,118	2.8
20. Lagonoy Gulf	1,486	0.7	1,285	0.7
21. Lamon Bay	5,431	2.7	2,140	1.2
22. Casiguran Sound	137	0.1	-	-
23. Palanan Bay	-	-	-	-
24. Babuyan Channel	177	0.1	234	0.1
TOTAL	200,805	100	183,999	100

Table 8.1. Philippine tuna landings for 1980 by type of fishing gear (mt)

Commercial Landings

Species	Total	Bagnet	Trawl	Purse-seine	Ringnet	Round Haul seine	Hook & line	Others
Frigate tuna	53,310	19,384	834	20,949	11,614	170	356	3
Yellowfin & Bigeye	11,496	280	41	8,188	2,855	1	131	-
Skipjack	12,486	149	179	9,135	2,786	-	237	-
Eastern little tuna	9,958	3,083	29	5,296	1,510	-	37	4
T O T A L	87,250	22,896	1,083	43,568	18,765	171	761	7

Table 8.2. Philippine tuna landings for 1980 by type of fishing gear (mt)

Municipal Landings

Species	Total	Bag-net	Purse-seine/ringnet	Gill-net	Round haul seine	Hook & line	Fish corral	Beach seine	Long-line	Troll	Pole & line	Others
Frigate tuna	43,564	679	11,275	6,426	201	13,947	2,625	7,398	567	203	206	42
Yellowfin & Bigeye	36,527	371	1,420	2,301	32	30,700	383	35	1,169	73	35	8
Skipjack	18,692	48	3,083	4,908	2	9,914	205	43	358	41	83	1
Eastern little tuna	14,772	757	3,625	4,498	-	5,201	143	113	133	297	4	4
T O T A L	113,555	1,855	19,043	18,133	235	59,762	3,356	7,589	2,227	614	328	55

A greater variety of gears is employed by the municipal sector of the industry to catch tunas (Table 8.2). The hook and line fishery is the most productive, accounting for 53% of the total municipal landings in 1980, followed by the purse-seine/ringnet gear and gillnets with around 17% of the landings, respectively. A variety of gears account for the remainder (13%) of the catch. Note that nearly 75% of the municipal yellowfin and skipjack catch is landed by hook and line.

The significant feature of these landings by both the commercial and municipal sectors of the industry is the part played by payaos. The major proportion of the purse-seine/ringnet and hook and line catch of tunas made by both sectors of the industry are in conjunction with payaos. Catches by these gears represented 70% of the total Philippine tuna landings in 1980.

3.2 Sampling programme results

3.2.1 Species composition of the landings from the seas surrounding Mindanao

The published landing statistics for the Philippines provide an analysis of the catch by species and fishing gear. As mentioned previously, there is some doubt concerning the identification of tuna species. During the sampling programme, the major fishing gears were sampled and it is possible therefore to reanalyze the commercial landing statistics, according to the species composition of the sampled gears.

The four sampling sites, Opol, General Santos, Santa Cruz and Labuan correspond to the Statistical Fishing Areas of Bohol Sea, Moro Gulf, Davao Gulf and East Sulu Sea, respectively. Landings from these four areas in 1980, accounted for nearly 40% of the total Philippine tuna landings (Table 7) and nearly 50% of the total skipjack and yellowfin landings

Tables 9.1 to 9.5 list the tuna landings by species for these four Statistical Fishing Areas. Table 10 lists the percentage species composition in the sampled landings by gear type at these four places. On Tables 9.1 to 9.5, the species composition of the landings are also provided after adjustment according to the ratios shown on Table 10. From the results on Tables 9.1 to 9.5, it is evident that the published Philippine Statistics probably over-estimate the catch of frigate and little eastern tuna by about 25% and correspondingly under-estimate the catch of skipjack and yellowfin tuna by 50% and 10%, respectively, at least for the sampling area.

Table 9.1. Total tuna landings for Bohol Sea by gear and species 1980 (mt)

Species	Purse-seine/ ringnet	%	Other gears	%	Total weight	%
Frigate	3,558	80	10,981	77	14,539	77
Yellowfin/Bigeye	174	4	375	3	549	3
Skipjack	472	10	1,172	8	1,644	9
Eastern little tuna	315	6	1,742	12	2,057	11
T O T A L	4,519	100	14,270	100	18,789	100

As above, but adjusted according to data from Table 10

Species	Purse-seine/ ringnet	%	Other gears	%	Total weight	%
Frigate	1,446	32	10,981	77	12,427	66
Yellowfin/Bigeye	1,085	24	375	3	1,460	8
Skipjack	1,988	44	1,172	8	3,160	17
Eastern little tuna	-	-	1,742	12	1,742	9
T O T A L	4,519	100	14,270	100	18,789	100

Table 9.2. Total tuna landings for Davao Gulf by gear and species 1980 (mt)

Species	Purse-seine/ ringnet	%	Other gears	%	Total	%
Frigate	1,105	21	472	15	1,577	19
Yellowfin/Bigeye	1,813	35	2,173	67	3,986	47
Skipjack	2,315	44	590	18	2,905	34
Eastern little tuna	0	0	11	-	11	-
T O T A L	5,233	100	3,246	100	8,479	100

As above, but adjusted according to data from Table 10

Species	Purse-sine/ net	%	Other gears	%	Total	%
Frigate	1,779	34	472	15	2,251	27
Yellowfin/Bigeye	837	16	2,173	67	3,010	35
Skipjack	2,617	50	590	18	3,207	38
Eastern little tuna	0	0	11	-	11	-
T O T A L	5,233	100	3,256	100	8,479	100

Table 9.3. Total tuna landings for Moro Gulf by gear and species, 1980 (mt)

Species	Purse-seine	%	Ring-net	%	Hand-line	%	Other gears	%	Total	%
Frigate	3,029	59	6,798	64	1,347	7	1,080	45	12,254	34
Yellowfin/Bigeye	1,507	29	987	9	15,259	84	576	24	18,329	50
Skipjack	606	12	2,668	25	1,117	6	382	16	4,773	13
Eastern little tuna	16	-	144	1	461	3	374	16	995	3
T O T A L	5,158	100	10,597	100	18,184	100	2,412	100	36,351	100

As above, but adjusted according to data from Table 10

Species	Purse-seine	%	Ring-net	%	Hand-line	%	Other gears	%	Total	%
Frigate	1,135	22	3,073	29	-	-	1,080	45	5,288	15
Yellowfin/Bigeye	877	17	1,166	11	18,184	100	576	24	20,803	57
Skipjack	3,146	61	6,252	59	-	-	382	16	9,780	27
Eastern little tuna	-	-	-	-	-	-	374	16	374	1
T O T A L	5,158	100	10,597	100	18,184	100	2,412	100	36,351	100

Table 9.4. Total tuna landings for East Sulu Sea by gears and species, 1980 (mt)

Species	Purse-seine/ ringnet	%	Hand-line	%	Troll-line	%	Beach seine	%	Other	%	Total	%
Frigate	218	6	414	9	-	-	126	73	239	21	997	11
Yellowfin/ bigeye	876	25	3,610	81	4	8	1	-	152	13	4,643	50
Skipjack	318	9	159	4	15	92	-	-	78	7	570	6
Eastern little tuna	2,131	60	272	6	-	-	46	27	683	59	3,132	34
T O T A L	3,543	100	4,455	100	19	100	173	100	152	100	9,342	100

As above, but adjusted according to data from Table 10

Species	Purse-seine/ ringnet	%	Hand-line	%	Troll line	%	Beach sine	%	Other	%	Total	%
Frigate	1,382	39	-	-	1	3	-	-	239	21	1,622	17
Yellowfin/ bigeye	815	23	4,366	98	14	75	-	-	152	13	5,347	57
Skipjack	1,169	33	89	2	4	22	-	-	78	7	1,340	14
Eastern little tuna	177	5	-	-	-	-	173	100	683	59	1,033	11
T O T A L	3,543	100	4,455	100	19	100	173	100	152	100	9,342	100

Table 9.5. Total tuna landings (mt) for areas surrounding Mindanao, according to 1980 published statistics and adjusted according to sampling programme results

Species	Published Statistics		Sampling Programme Adjusted	
	Weight	%	Weight	%
Frigate	29,367	40	21,588	30
Yellowfin/Bigeye	27,507	38	30,620	42
Skipjack	9,892	14	17,487	24
Eastern little tuna	6,195	8	3,160	4
T O T A L	72,961	100	72,955	100

Table 10. Percentage species composition of landings for sampling site and fishing gear

Sampling site	Fishing gear	S P E C I E S				
		Skipjack	Yellowfin	Frigate	E.little	Bigeye
Santa Cruz (Davao Gulf)	Ringnet	50	16	34	-	-
General Santos (Moro Gulf)	Ringnet	59	11	29	0	-
	Purse-seine	61	17	22	0	-
	Handline	0	99	-	-	1
Laguan (East/South Sulu Sea)	Ringnet	26	5	58	11	-
	Purse-seine	41	41	18	-	-
	Handline	2	98	0	-	-
	Troll line	22	73	3	-	2
	Beach seine	-	-	-	100	-
Opol (Bohol Sea)	Ringnet	44	24	32	-	-

As there were no sampling sites established outside Mindanao in 1980 and 1981, it is not possible to draw any similar conclusion about the species composition of the catch for waters other than these. Observations, however, suggest that in the inner Archipelagic waters, such as the Sibuyan Sea, Tayabas Bay, Ragay Gulf, etc., the predominant species in the catch is frigate/bullet tuna, as indicated in the published statistics.

The major fishing gears, small purse-seine, ringnet, handline, troll line and gillnet are sampled during the current programme. However, the major absence from this list are the large purse-seines and the bagnets. The latter gear is used extensively in the shallow coastal waters to catch a wide-range of pelagic species, including juvenile tunas. Observations suggest that they catch a far greater amount of tuna, albeit as post-larvae (1 to 5 cm) or juvenile than is evident from the published statistics. The present sampling programme has been modified to sample this gear also in the future.

The larger purse-seine vessels have also not been sampled sufficiently by the present programme. There are a number of reasons for this. Firstly, the vessels generally tranship their catches to port by carrier vessels. The carrier vessels also purchase fish, particularly large yellowfin tunas, from other operators in the area. Consequently, it is extremely difficult to obtain a representative sample of a purse-seine vessels' catch for either species composition or size analysis by sampling the carrier vessel landings. Additionally, as the purse-seine vessels are essentially catching fish for canning or export, they are primarily interested in skipjack and yellowfin tunas, particularly larger fish. As a result, they often sort their catches to a certain extent, diverting the smaller fish to local markets and the larger fish directly to cold storage for export. This also makes it difficult to obtain representative samples from the catches of the larger purse-seine vessels.

In order to rectify this problem, the Bureau of Fisheries and Aquatic Resources has presently placed observers/samplers onto operating purse-seine vessels and some useful information is now being gathered. Some additional data is also available from the survey conducted by the SCSP from 1974 to 1977, using the FB "Royal Venture" and FB "Southward Ho". To date, data has been analyzed from the catch of a 300 GRT commercial purse-seiner operating in Moro Gulf, Mindanao in March 1982. Seventy-three percent of the total catch was skipjack, 14% yellowfin, 2% bigeye, 4% bullet, 1% frigate, and the remaining 6% composed of round scad and other pelagic species. This proportion of skipjack is much higher (c.f. Table 10) than the catches of the smaller purse-seine vessels (50 to 100 GRT) sampled during the current landing survey programme. Catches during the "Royal Venture" and "Southward Ho" cruises consisted of 85% skipjack and 15% yellowfin/bigeye tuna. However, these results are not directly comparable with those from the commercial purse-seine vessel above, as the frigate/bullet tuna were generally discarded at sea and not included in the analyses of their data.

Tunas only represent a proportion of the total catches of all the gears listed in Tables 9.1 to 9.4 and Table 10. On Table 11, the relative proportion of tuna and non-tuna species are shown by fishing gear for each of the four sampling locations. The proportion of these non-tuna pelagic species (mainly round scad, Decapterus spp; bigeye scad, Selar sp; sardines, Sardinella sp and rainbor runner, Flagatos bipinnulata) in the ringnet catches range from 8% and 44%. As expected, the handline and troll line catches are nearly all tuna, as these are the target species.

Table 11. Relative percentages of tuna and "non-tuna" species in the sampled vessel catches by fishing gear

Gear/Species		Labuan	Opol	Gen.Santos	Sta. Cruz
Ringnet					
Tuna	%	56	68	92	60
Other	%	44	32	8	40
Purse-Seine					
Tuna	%	87	-	92	-
Other	%	13	-	8	-
Handline					
Tuna	%	72	-	99	-
Other	%	28	-	1	-
Troll					
Tuna	%	96	-	-	-
Other	%	4	-	-	-
Beach Seine					
Tuna	%	98	-	-	-
Other	%	2	-	-	-
Gillnet					
Tuna	%	0	37	-	-
Other	%	100	63	-	-

These data to a certain extent also illustrate the range of species attracted to the payaos, as the majority (but certainly not all) of the purse-seine and ringnet catches are made around payaos. The figures also emphasize the importance of the non-tuna pelagic catches to the overall economies of operation of the smaller purse-seine and ringnet vessels. In fact in certain seasons, some vessels fish exclusively for sardines, scad, etc. Thus, the number of registered small purse-seine and ringnet vessels is not a true indication of the amount of fishing effort directed towards tuna by the Philippine fishing fleet.

3.2.2 Size composition of the catch by fishing gear and species

In Section 2, the critical minimum sizes were presented for the various tuna species, on the basis of maturity or market requirements. One of the major objectives of the tuna sampling programme was to determine for each type of fishing gear, the percentage of the Philippine tuna catch which consisted of fish less than these limits. The results of this analysis are shown on Table 12. The data shown for "large" purse-seine vessels were obtained from analysis of the "Southward Ho" and "Royal Venture" data and data collected by the BFAR observer aboard a commercial seiner in March 1982. The values are expressed in terms of weight. The percentage of the catch in terms of numbers of fish is of course much greater.

Because of the nature of purse-seine/ringnet fishing, the whole or part of a school of tuna is captured during one fishing operation. Tuna generally aggregate into schools according to fish size, and consequently the percentage of large and small fish in the catch can vary significantly from haul to haul. These values presented on Table 12 represent the average for all fish/gears sampled in 1980.

If one accepts 45 cm as the minimum size of maturity for skipjack tuna, 60 to 70 cm for yellowfin and 38 cm for frigate/bullet tuna, then the majority of the fish captured by the ringnet vessels in terms of weight and certainly in terms of numbers are immature. Except for the handline catches, the majority (>80%) of the yellowfin tuna captured by all other gears in the Philippines are immature (25% by weight of the handline-caught yellowfin are immature). Similarly, practically all frigate tuna caught are immature. The percentage of immature skipjack captured depends to a larger extent upon the type of gear used. Handlines catch few juvenile fish (<10%), but as the percentage of skipjack landed by handliners in the Philippines is insignificant, this is inconsequential. On the other hand, 60% of the catch of the small purse-seine vessels consists of immature skipjack, and around 30% of the catch of the larger purse-seiners. Purse-seiners and ringnets catch the majority of the skipjack landed in the Philippines.

Sixty-three cm is the minimum size at which yellowfin tuna may be exported to Europe and Japan as "yellowfin" tuna. Examining Table 12, it is evident that only 5% of the yellowfin tuna catch of the larger purse-seine vessels consist of fish equal to or larger than this size, although all of the handline catch is. On the other hand, yellowfin tuna above 46 cm in length (1.8 kg) may be exported to the USA as "skipjack". The percentage of fish above this size in the larger purse-seine catches is considerably higher, around 85%.

Table 12. Percentage of juvenile fish and fish unacceptable to markets overseas in the sampled catch by species and fishing gears (see Section 2.2)*

Species / Gear	Skipjack	Yellowfin/Bigeye			Frigate/ Bullet	E.little tuna
	< 45 cm	< 56 cm	< 46 cm	< 56 cm	< 38 cm	< 42 cm
Ringnet	90	65	75	80	85	20
Small purse-seine	60	40	50	85	92	100
Large purse-seine	30	15	80	95	-	-
Handline	10	0	0	0	-	-
Troll line	10	10	25	45	45	-

* Based on analysis of length/frequency distribution of catch samples taken from the four sampling sites at Mindanao from November 1979 to June 1982. This analysis was carried out by BFAR biologists.

In general, the larger purse-seine vessels appear to catch less juvenile or commercially unacceptable fish than the smaller purse-seine or ringnet vessels. This could be due to the fact that they generally use deeper nets which can catch sub-surface, and therefore larger, fish than the other gears.

On Table 13, the total "converted" tuna landings for Mindanao (i.e., reported landings adjusted by sampling results), which are shown on Table 10 are partitioned into juvenile and mature fish on the basis of the data from Table 12. It must be remembered that the landings from the seas around Mindanao represent about 50% of the total Philippine skipjack and yellowfin tuna catch.

Table 13. Landings (mt) of juvenile and/or fish unacceptable to export markets on the basis of size from the seas around Mindanao, 1980

Species	Skipjack	Yellowfin	Frigate/ Bullet	E. little tuna
Size (cm)				
< 45	13,060			
> 45	4,427			
< 46		5,694		
> 46		24,926		
< 56		8,703		
> 56		21,916		
< 63		10,674		
> 63		19,946		
< 38			19,430	
> 38			2,158	-
< 42				2,860
> 42				300
Total weight	17,487	30,620	21,588	3,160

3.3 Disposition of the Philippine tuna catch

The major stimulus for the development of the Philippine tuna fisheries, particularly the expansion of the ringnet/purse-seine fleets, has been the export markets. Only skipjack, yellowfin and bigeye tuna are exported, principally to the USA, Japan and recently Europe. Market requirements in these countries have been described in Section 2.2 above.

Tunas are exported frozen, chilled, canned or smoked. Exports of frozen/chilled tuna are illustrated on Table 14. The data have been supplied from several sources and as can be seen, differ somewhat. On Table 15, the destinations of the frozen/chilled tuna are shown for 1979 to 1980 and 1981. The majority of the tuna during this period was exported to America (22 to 75%), followed by Italy (10 to 25%) and Japan (5 to 10%). As discussed in Section 2.2, the species composition of these frozen exports is misleading, as a proportion of the "skipjack" export to America are in fact smaller yellowfin tuna (under 10 lbs = 4.5 kg).

Table 14. Exports of frozen/chilled tuna from the Philippines, 1975-1982

Year	Skipjack	Yellowfin cannery	Yellowfin sashimi	Bigeye	TOTAL (mt)	Source*
1975					8,241	(4)
1976					5,819	(4)
1977					15,620 15,619	(1) (2)
1978					19,777 19,882	(1) (2)
1979					33,775 32,490 35,472	(1) (2) (4)
1980	17,767	23,695		-	47,290 41,464 48,722	(1) & (5) (3) (4)
1981	10,834	20,358	1,168	56	32,416 35,533 35,830	(3) (4) (5)
1982 (Jan-May)	3,111	4,182	318	-	7,431 7,803	(3) (5)

* (1) Fishing Statistics of the Philippines
(2) Bulletin of the National Federation of Fishing Associations
(3) Personal communications, National Federation of Fishing Associations
(4) Central Bank of the Philippines
(5) Bureau of Fisheries and Aquatic Resources - Statistical Office

Table 15. Export of fresh/frozen/chilled tuna from the Philippines by destination, 1979-1981 (mt)*

Destination	1979	1980	1981
United States of America	23,947	26,293	18,479
Italy	3,540	12,500	8,464
Japan	1,989	2,030	3,145
Singapore	1,066	5,118	1,289
Hawaii	3,374	1,697	3,464
Others	1,556	1,084	692
T O T A L	35,472	48,722	35,533

* Source - Central Bank of the Philippines

Canned tuna exports from 1975 are shown on Table 16, and since 1979 by country of destination. As with frozen tuna, the majority of the canned tuna is exported to America. Although the volume exported to the USA has increased annually, the market share has declined from about 80% of the total exports in 1979 to 60% in 1981, due to aggressive market expansion by the exporting companies principally in Europe. In 1979, canned tuna was exported to seven countries; by 1981, this had increased to seventeen. Figures available for the first four months of 1982, show a 25% increase in canned tuna exports over the same period in 1981. This compares with a 60% reduction in frozen tuna exports in the corresponding period.

Figures are not readily available on the production of canned tuna for domestic consumption, but industry sources suggest that the amount is less than 10% of that produced for export, i.e., approximately 2,000 mt in 1981.

In 1980, it was estimated (Bulletin of the Federation of Fishing Association of the Philippines) that the five existing canneries at that time (now eight) had a total annual raw product capacity of 360,000 mt of tuna (30,000 mt per month). This figure appears to be unrealistic and the actual capacity is probably less than this, but nevertheless, in view of the actual tonnage of tuna processed in 1981 (40,000 mt), it suggests that there exists a significant excess capacity in the Philippine tuna canning industry.

Production of smoked tuna (katsuobushi) for export amounted to 550 mt in 1980, and was all destined for Japan.

Table 16. Export of canned tuna from the Philippines (net weight) by destination (mt)*

Destination	1975	1976	1977	1978	1979	1980	1981
USA	-	-	-	-	3,211	8,217	10,699
United Kingdom	-	-	-	-	-	195	1,327
Canada	-	-	-	-	14	13	1,687
West Germany	-	-	-	-	134	1,906	2,990
Australia	-	-	-	-	670	728	294
Others	-	-	-	-	50	92	1,036
Total	0	240	113	3,411	4,079	11,151	18,033
Whole tuna weight	0	533	251	7,580	9,064	24,780	40,073

* Source - Central Bank of the Philippines

4. INDONESIAN TUNA SAMPLING PROGRAMME

4.1 Introduction

In 1979, the most recent year for which published figures are available, the reported landing of tunas in Indonesia was 127,315 mt, a 25% increase over 1978. The total comprised 52% eastern little tuna, 34% skipjack and 14% "tuna", according to the "Statistical Standard" classification system used in Indonesia (Indonesia, 1981). According to this system, the first category above includes only eastern little tuna (Euthynnus affinis). However, frigate (Auxis thazard), bullet (A. rochei) and longtail tuna (Thunnus tonggol) are generally included as well. The second category includes only skipjack (Katsuwonus pelamis) and the third combines all the larger species of the genus Thunnus (mainly yellowfin, T. albacores and bigeye, T. obesus) as well as the bill fishes (Istiophoridae and Xiphiidae).

The published fisheries statistics for Indonesia list tuna landings according to coastal region and landings of all fish by gear type and coastal region.

4.1.1 Tuna landings by species and coastal area

Tuna landings are summarized by species groups and coastal region on Table 17. Note that the 11 coastal regions on the Table do not correspond to the Provinces.

Table 17. Tuna production in Indonesia by species and coastal area for 1979 (mt)

Coastal area	S P E C I E S							
	Tunas		Skipjack		E. little		TOTAL	
	M tons	%	M tons	%	M tons	%	M tons	%
West Sumatra	3,151	18	5,333	12	5,329	8	13,813	11
South Java	85	0	1,191	3	3,462	5	4,738	4
Malacca Strait	456	3	2,063	5	8,220	12	10,739	8
East Sumatra	-	-	-	-	1,955	3	1,955	2
North Java	16	0	458	1	15,323	23	15,797	12
Bali-Nusa Tenggara-Timor	2,255	13	1,347	3	7,160	11	10,762	8
South/West Kalimantan	-	-	-	-	4,081	6	4,081	3
East Kalimantan	122	1	172	0	2,115	3	2,409	2
South Sulawesi	6,164	34	9,691	23	9,003	14	24,858	20
North Sulawesi	2,934	16	8,532	20	6,111	9	17,577	14
Maluku/Irian	2,716	15	14,047	33	3,823	6	20,586	16
T O T A L S	17,899	100	42,834	100	66,582	100	127,315	100

Highest landings of eastern little tuna are reported from North Java, South Sulawesi, Malacca Strait and Bali-Nusa Tenggara-Timor. Seventy-six percent of the skipjack landings and 65% of "tuna" landings were made in the three coastal areas of Eastern Indonesia. Significant landings of "tuna" was also recorded for West Sumatra and Bali-Nusa Tenggara-Timor.

4.1.2 Tuna landings by species and type of gear

As mentioned, published statistics do not directly provide tuna landings by gear type. However, assuming that all catches from "troll lines", pole and line and "longline" consists of tuna, plus the purse-seine catch of D.I. Aceh, then it is possible to extrapolate the data on Table 18. These gears produced 64,890 mt, or 52% of the total tuna landings in 1979, accounting for 32%, 17%, 2% and 1% of the catch, respectively.

Troll line catches were highest in South Sulawesi, Maluku-Irian and West Sumatra. Pole and line catches were confined to the three eastern coastal regions. The entire tuna longline catch was landed at Bali.

Table 18. Tuna production in Indonesia by coastal area and fishing gear for 1979

Coastal area	Purse-seine		Tuna longline		Pole & Line		Troll Line		TOTAL	
	Tons	%	Tons	%	Tons	%	Tons	%	Tons	%
West Sumatra	789	100	-	-	-	-	7,068	17	7,851	12
South Java	-	-	-	-	-	-	-	-	-	-
Malacca Strait	-	-	-	-	-	-	2,676	7	2,676	4
East Sumatra	-	-	-	-	-	-	303	1	303	0
North Java	-	-	-	-	-	-	2,100	5	2,100	3
Bali-Nusa Tenggara-Timor	-	-	2,053	100	-	-	5,551	13	7,604	12
South/West Kalimantan	-	-	-	-	-	-	281	1	281	0
East Kalimantan	-	-	-	-	-	-	405	1	405	1
South Sulawesi	-	-	-	-	1,656	8	12,028	29	13,684	21
North Sulawesi	-	-	-	-	5,499	25	2,918	7	8,417	13
Maluku/Irian	-	-	-	-	14,544	67	7,814	19	22,358	34
T O T A L	789	100	2,053	100	21,699	100	41,138	100	65,679	100

4.2 Sampling programme

In order to obtain a better understanding of the size and species of tuna landed in Indonesia, a biological sampling programme was initiated, initially at three fishing ports in Eastern Indonesia beginning in December 1979. Sampling sites were established to monitor landings of industrial (Ambon, Sorong) and small-scale (Ambon, Ternate) pole and line fishing operations. The small-scale smapling programme was discontinued at Ambon in January 1980. At each sampling site, two persons were employed to collect data on the landings. These samplers were furnished with data forms and instructed to collect catch and effort information on a daily basis and to sample the catch by species for length and weight measurements every third day. Information collected at the sampling sites included the following:

- vessel landings
- fishing area
- number of effective fishing days (efd)
- catch by species in number and weight
- length and weight measurements

For the small-scale fishery sampling programme, the following procedure was adopted.

Lengths and weights were recorded for 10 skipjack and 5 yellowfin tuna selected at random from the first vessel landing. In addition, lengths only were recorded for 20 skipjack and 10 yellowfin tuna from each of four additional vessels. Finally, the length and weight were recorded for 5 individuals of any species found on the first vessel and 10 measured only from each of a further four vessels.

For the industrial fisheries, 20 length weight measurements were taken for skipjack from the landing of the first vessel and 10 measurements from two other vessels. Ten yellowfin were measured and weighed and 15 individuals of any other species.

4.3 Methods of analysis

4.3.1 Catch/effort data

Vessels engaged in the small-scale tuna fisheries at Ambon and Ternate include both sail boats and powered boats. In Ternate, these powered vessels range from 8.0 to 17.5 GT and in Ambon from about 10 to 30 GT (Unar, 1981). For catch/effort analysis, the effort values were "standardized" by a Fishing Power factor, derived by dividing the average monthly catch rate of the motorized vessels by that of the sail boats.

During 1980, the number of small-scale pole and line vessels operating per month at Ternate ranged from 12 to 20, and averaged 15.8. During the first six months of 1980, similar figures for Ambon were 10 to 13 with an average of 12.2.

All of the vessels operating in the industrial fisheries at Ambon and Sorong are motorized. During 1980, the number of vessels operating per month at Ambon ranged from 7 to 10, and averaged 9.2. The numbers were higher at Sorong, varying from 26 to 27 each month, and averaging 26.4.

4.3.2 Length/frequency data

Length/frequency distributions obtained during a month at each sampling site for a particular species were summarized to give weighted length frequency distributions of that species for that month. The weighting factor was obtained by dividing the total numbers of fish landed by the number sampled for that day. The frequency distributions were multiplied by the factor to give the weighted frequency distribution. All daily weighted frequency distributions for the month were summed to give the absolute weighted frequency distribution and divided by the total sample number to give the percent weighted frequency distribution.

Numbers of juveniles and small tunas in the landings were determined by summing the monthly weighted frequencies below the specified critical size limit. Weights of juvenile and small tunas was calculated by multiplying the total of monthly weighted frequencies for each class interval by the average weight for that particular class interval. The average weights were derived from length-weight equations obtained from the sampling programme data.

4.4 Results

A monthly summary of number of vessels, trips, effective fishing days, catch and catch rates by species for pole and line vessels at the four sampling sites are given in Tables 19 through 22.

4.4.1 Catch

A total of 6,390 tonnes of tuna were landed at these sites by both the small-scale and industrial fisheries during the period December 1979 to December 1980, inclusive. Fifty-nine percent of the amount was landed by the industrial fishery at Sorong.

4.4.2 Species composition

Skipjack is the principal target species of the pole and line fishing operations in Eastern Indonesia, accounting for 90 to 92% of the total landed weights at these sites (Table 23). Yellowfin is the second most important species contributing 7 to 10% of total weights. One percent of total landings (by weight), at Ternate and Sorong was comprised of eastern little tuna and frigate, respectively. Longtail tuna was reported only from Sorong, but the amount was insignificant.

4.4.3 Catch rates

Catch, effort and catch rate at the three sampling sites by month and species are illustrated in Figures 2 to 5. The average total catch rate for the six-month period of the Ambon small-scale fishery (583 kg/efd) was similar to the average annual total catch rate of the Ternate small-scale fishery (599 kg/efd). There was a pronounced difference in the average total catch rate between the industrial fisheries in Sorong (1,156 kg/efd) and Ambon (688 kg/efd). Total catch rate for the peak month of November (1,713 kg/efd) at Ambon equalled the October peak at Sorong (1,789 kg/efd), but total catch rates for the remaining months were considerably lower. The same size of vessels are utilized at both localities so this preliminary analysis indicates the availability of tuna to pole and line fishing off Sorong is greater than off Ambon.

Table 19. Fishing effort, catch and sampling effort of pole and line fishing operations at Ternate, January-December 1980

MONTH	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
No. of vessels[1/]	15	12	13	14	21	20	19	19	16	13	13	15	190
No. of trips	111	129	220	248	290	200	176	248	152	232	169	101	2,276
No. effective fishing days	111	129	220	248	290	200	176	248	152	232	169	101	2,276
Catch total, kg	66,427	75,990	134,522	218,359	115,806	107,972	83,953	108,765	58,339	160,846	203,620	27,755	1,362,354
Skipjack	36,774	54,357	123,390	212,386	110,382	104,221	82,184	104,768	57,438	147,046	194,286	21,412	1,248,644
Yellowfin	23,102	20,178	6,501	4,346	4,718	3,572	1,239	3,754	626	11,823	8,416	4,046	92,321
Frigate	1,144	1,308	1,180	208	25	157	-	95	-	-	-	1,024	5,141
Others	5,407	147	3,451	1,419	681	22	530	148	275	1,977	918	1,273	16,248
Total catch rate, kg/efd	598.4	589.1	611.5	880.4	399.3	539.8	477.0	438.6	383.8	693.3	1204.8	274.8	598.6
Skipjack	331.3	421.4	560.9	856.4	380.6	521.1	467.0	422.5	377.9	633.8	1149.6	212.0	548.6
Yellowfin	208.1	156.4	29.5	17.5	16.3	17.8	7.0	15.1	4.1	51.0	49.8	40.1	40.6
Frigate	10.3	10.1	5.4	0.8	0.1	0.8	-	0.4	-	-	-	10.1	2.3
Others	48.7	1.2	15.7	5.7	2.3	0.1	3.0	0.6	1.8	8.5	5.4	12.6	7.1

1/ Includes powered and non-powered vessels; latter equated to powered vessels by a conversion factor derived by dividing the monthly catch rates of powered vessels by rates of non-powered vessels.

Table 20. Fishing effort, catch and sampling effort of small-scale pole and line fishing operations at Ambon, December 1979–May 1980

Month	Dec	Jan	Feb	Mar	Apr	May	TOTAL
Number of vessels	13	12	12	13	13	10	73
Number of trips	55	72	41	50	68	58	344
Number effective fishing days	55	72	41	50	68	58	344
Catch, total	30,831	34,570	23,944	33,580	45,457	32,137	200,519
Skipjack	29,037	29,125	20,536	30,380	43,842	30,697	183,617
Yellowfin	1,794	5,445	3,408	3,200	1,615	1,440	16,902
Frigate	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-
Total catch rate, kg/efd	560.5	480.1	584.0	671.6	668.5	554.1	582.9
Skipjack	527.9	404.5	500.9	607.6	644.7	529.3	533.8
Yellowfin	32.6	75.6	83.1	64.0	23.8	24.8	49.1
Frigate	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-

Table 21. Fishing effort, catch and sampling effort of the industrial pole and line fishing operations at Ambon, December 1979-December 1980

MONTH	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
No. of vessels	9	7	8	9	9	9	9	9	10	10	10	10	10	119
No. of trips	39	18	22	31	34	29	23	25	27	40	40	46	41	415
No. effective fishing days	106	97	114	138	110	109	108	84	93	117	157	141	141	1,515
Total catch	48,198	30,940	20,021	67,312	91,369	61,998	40,500	49,990	57,243	77,035	138,931	241,555	117,441	1,042,53[illegible]
Skipjack	43,807	25,638	14,113	54,615	78,355	58,147	31,889	40,737	52,662	69,162	124,875	237,950	104,041	935,99[illegible]
Yellowfin	4,391	5,302	5,908	12,697	13,014	3,851	8,611	9,253	4,581	7,873	14,056	3,605	13,400	106,542
Frigate	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total catch rate, kg/efd	454.7	319.0	175.6	487.8	830.6	568.8	375.0	595.1	615.5	658.4	884.9	1713.2	832.9	688
Skipjack	413.3	264.3	123.8	395.8	712.3	533.5	295.3	485.0	566.2	591.1	795.4	1687.6	737.9	617.[illegible]
Yellowfin	41.4	54.7	51.8	92.0	118.3	53.3	79.7	110.1	49.3	17.3	89.5	25.6	95.0	70.3
Frigate	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 22. Fishing effort, catch and sampling effort of pole and line fishing operations at Sorong, December 1979-December 1980

MONTH	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	TOTAL
No. of vessels	26	26	26	27	27	27	26	26	27	26	27	26	26	343
No. of trips	56	81	76	131	213	142	84	64	146	132	123	150	102	1,500
No. of effective fishing days	169	198	136	261	358	433	183	90	205	265	362	370	250	3,280
Catch total	93,170	125,620	93,046	273,277	444,194	512,333	152,180	66,858	203,440	367,985	647,477	464,835	345,766	3,790,181
Skipjack	77,423	108,615	58,347	248,649	419,755	463,945	146,881	61,384	186,692	357,599	609,920	444,926	289,828	3,473,964
Yellowfin	14,548	14,827	30,577	24,628	23,718	41,092	3,831	880	10,556	8,000	34,798	17,595	49,647	274,697
Frigate	803	2,178	402	-	402	333	541	696	6,123	2,337	2,759	1,291	6,291	24,156
Others	396	-	3,720	-	319	6,963	927	3,898	69	49	-	1,023	-	17,364
Total catch rate, kg/efd	551.3	634.5	684.2	1047.0	1240.8	1183.2	831.6	742.9	992.4	1388.6	1788.6	1256.3	1383.1	1155.5
Skipjack	458.1	548.6	429.0	952.7	1172.5	1071.4	802.6	682.0	910.7	1349.4	1684.9	1202.5	1159.3	1059.1
Yellowfin	86.1	74.9	224.8	94.3	66.3	94.9	20.9	9.8	51.5	30.2	96.1	47.5	198.6	83.7
Frigate	4.8	11.0	3.0	-	1.1	0.8	3.0	7.7	29.9	8.8	7.6	3.5	25.2	7.4
Others	2.3	-	27.4	-	0.9	16.1	5.1	43.3	0.3	0.2	-	2.8	-	5.3

Table 23. Percent species composition of landings at sampling site

Sampling site	Ternate	Ambon[1/]	Ambon[2/]	Sorong	Total
Total catch (kg)	1,362,354	200,519	1,042,533	3,790,181	6,395,587
Skipjack	92	92	90	92	91
Yellowfin	7	8	10	7	8
Frigate	-	-	-	1	0.5
Eastern little tuna	1	-	-	-	0.5

1/ Small-scale
2/ Industrial

Seasonal trends in the monthly total catch rates are similar for all localities with a minor peak in April and prominent peak in October-November. These peaks resulted from increased availability of skipjack during these months. A similar pattern has been noted for night time purse-seine catches of tuna under flotsam in Philippine waters (Chikuni, 1978), where total catch rates reached a minor peak in March and a prominent peak in October for explorations conducted during 1975.

The prominent peaks in skipjack catch rates at all localities resulted from recruitment of smaller fish to the fisheries. Higher catch rates occurred with the influx of 47 to 48 cm (model length) fish beginning in October at Ternate (Fig. 7) and in August at Sorong (Fig. 10) Appearance of 50 cm fish in October coincided with increases in catch rates in Ambon (Fig. 9).

4.4.4 Size composition

Size composition of skipjack captured at the three sampling sites are shown in Figures 6 to 9. Skipjack captured by the small-scale fisheries are generally smaller than those landed by the industrial fishery. In the former fishery, monthly modes ranged from 46 to 51 cm. Two distinct size classes are apparent in the size distribution polygons for January (37 cm, 49 cm) and February (46 cm, 55 cm) at Ternate and in February (32 cm, 50 cm) at Ambon.

Size of skipjack captured by the industrial fisheries was least variable at Ambon (range 40 to 66 cm) and most variable at Sorong (range 21 to 69 cm). Monthly modes of skipjack at these localities ranged from 47 to 53 cm. Distinct size classes are not discernible in the monthly size distribution polygons.

Yellowfin captured by the small-scale fishery in Ternate were generally smaller than those captured at the other localities. These fish range from 27 to 78 cm with two size classes in the 31 to 41 cm and 55 to 60 cm intervals, respectively (Fig. 10). Yellowfin captured by the small-scale fishery in Ambon and the industrial fisheries in Ambon and Sorong ranged from 39 to 88 cm (Figs. 11 to 13). The prominent size class of these fish occurred in the 52 to 60 cm interval.

4.4.5 Percentage of small and juvenile tunas in the landings

Percentages of juvenile skipjack (less than 45 cm) and yellowfin (less than 70 cm) by numbers and weight captured by the small-scale fishery in Ternate and the industrial fisheries in Ambon and Sorong are given in Table 24. Also, given in this table is the percentage of small yellowfin (less than 55 cm) captured at these localities. Catches of juvenile skipjack were highest among the small-scale fishermen in Ternate and negligible by the industrial fisheries in Sorong and Ambon. Almost the entire catch of yellowfin at these localities were juveniles. Percentage of yellowfin less than 55 cm was highest in Sorong, moderate in Ambon and lowest in Ternate.

5. DISCUSSION

Various fishing gears are used to capture tuna species in Indonesia, of which troll line is the most important followed by pole and line. Troll lines are used primarily to capture frigate, bullet, eastern little and longtail tunas ("tongkol"). Pole and line fisheries target principally on skipjack tuna and are established exclusively in Eastern Indonesia. The biological sampling programme was initiated in late 1979 to monitor catch, species and size composition of pole and line fisheries at three sites in Eastern Indonesia. The 1979 landing of tuna was 127,315 tonnes, of which 21,699 tonnes was landed by pole and line. Assuming the 1980 landings were similar to those of 1979, then the biological sampling programme monitored approximately 17% of the total tuna landings in Indonesia.

As the sampling programme was directed towards the pole and line fishery in Eastern Indonesia, it is not surprising that 91% of the landings were found to be skipjack and 8% yellowfin.

The pole and line fishery appears to be quite selective for skipjack tuna in the 45 to 55 cm size range, and less than 4% of its landings by number (or 2% by weight) is comprised of juveniles (less than 45 cm). On the other hand, practically all of the yellowfin tuna landed are juveniles (less than 70 cm). In addition, 34% of the yellowfin (by weight) and 25% by number are less than 55 cm, the maximum size limit recommended by the tuna commission for the Eastern Pacific and Atlantic Ocean.

On the basis of the 1980 sampling programme and the published landing statistics, it is calculated that in 1979, the landings of juvenile skipjack (less than 45 cm) and yellowfin less than 55 cm, were 390 and 440 tonnes, respectively.

Although landings of both skipjack and yellowfin will undoubtedly increase in the future, and therefore the landings of juvenile fish, the proportion of the juveniles in the landings are very low and of no immediate cause for concern.

Table 24. Percentage of small and juvenile tunas by number and weight in the landings at 3 sampling sites

Locality	TERNATE			AMBON			SORONG			TOTAL		
Species	Skip-jack	Yellowfin		Skip-jack	Yellowfin		Skip-jack	Yellowfin		Skip-jack	Yellowfin	
Size limit	< 45	< 55	< 70	< 45	< 55	< 70	< 45	< 55	< 70	< 45	< 55	< 70
Numbers	14	35	100	0	35	99	2	44	99	4	34	99
Weight	8	14	100	0	26	97	1	37	98	2	25	98

Table 25. Length-weight relationships of skipjack and yellowfin measured at 3 sampling sites

Species	Area	Number of fish	SIZE OF FISH				a	b
			Length (cm)		Weight (kg)			
			Range	Mean	Range	Mean		
Katsuwonus pelamis	Sorong	5,260	36-69	50.9	1.0- 7.6	2.8	1.359×10^{-5}	3,115
	Ambon	2,962	40-66	50.4	1.3- 5.7	2.7	0.965×10^{-5}	3.201
	Ternate	5,635	30-58	48.3	0.5- 5.3	2.2	1.425×10^{-5}	3.085
Thunnus albacares	Sorong	1,080	37-74	55.3	1.0- 7.2	3.3	4.587×10^{-5}	2.787
	Ambon	731	45-88	56.8	1.8-12.3	3.6	4.400×10^{-5}	2.799
	Ternate	509	27-70	52.3	0.4-6.0	2.6	3.106×10^{-5}	2.869

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APPENDIX

PHILIPPINE TUNA SAMPLING PROGRAMME

The tuna sampling project referred to in the Introduction of this Report was implemented in November 1979 at four sites in Mindanao in the Philippines. The locations were Opol, Labuan, General Santos and Santa Cruz (Fig. 1).

A supervisor from the Provincial Fisheries Office and a sampler were recruited for each sampling site. These teams were furnished with data forms and instructed in sampling techniques and schedules. Each team was required to schedule the sampling effort according to the patterns of the tuna fisheries in their area. Sampling was carried out every third day regardless of weekends and holidays at Santa Cruz, Labuan and Opol for a total of ten sampling days per month and every other day at General Santos for fifteen sampling days per month.

The sampling teams were instructed to collect the following information:

- Number of landings by fishing gear
- Estimated total landed weight by fishing gear
- Estimated weight of sampled landings
- Species composition of sampled landings
- Length frequencies of tuna in sampled landings

The general sampling methods adopted were as follows; with minor modifications at each of the sites. Vessels unloading their catches were monitored for total and species catches. One basket of each category was separated from every landing to be sampled and the contents weighed. Fork lengths were measured of 25 individuals from the skipjack, yellowfin/bigeye and frigate categories. A mixed basket was sorted to species, weighed and a length/frequency sample of 25 individuals of each species was taken. Fish from every handline vessel sampled were individually weighed and measured.

Information collected at each sampling site is summarized at the end of the month by fishing gear and species. These summaries included numbers of total monitored vessels, weight of total and monitored landings and species composition of monitored landings, weight and species composition of samples.

Samples of length/frequency distributions obtained during a month for a particular fishing gear and species are summarized to give weighted percent length/frequency distribution of total landings for that month.

Mindanao was selected for the initial phase of the project, as approximately 40% of the total Philippine tuna landings come from the surrounding waters.

(i) To determine more accurately the proportion of tuna species landed by fishing gear type.

(ii) To determine the relative sizes of the tunas captured by the different fishing gears.

(iii) To determine the size and type of tunas attracted to the payaos.

(iv) To determine the percentage of small (juvenile) tunas landed by the different fishing gears.

(v) To determine seasonal (and in the long-term, annual) trends in catches and catch per effort in the fishery.

(vi) To monitor the development of the purse-seine fleet.

Recently, the programme has been expanded to include six additional sites throughout other areas of the Philippines.

Appendix Table 1
Statistical Fishing Areas and Marine Fishing Grounds

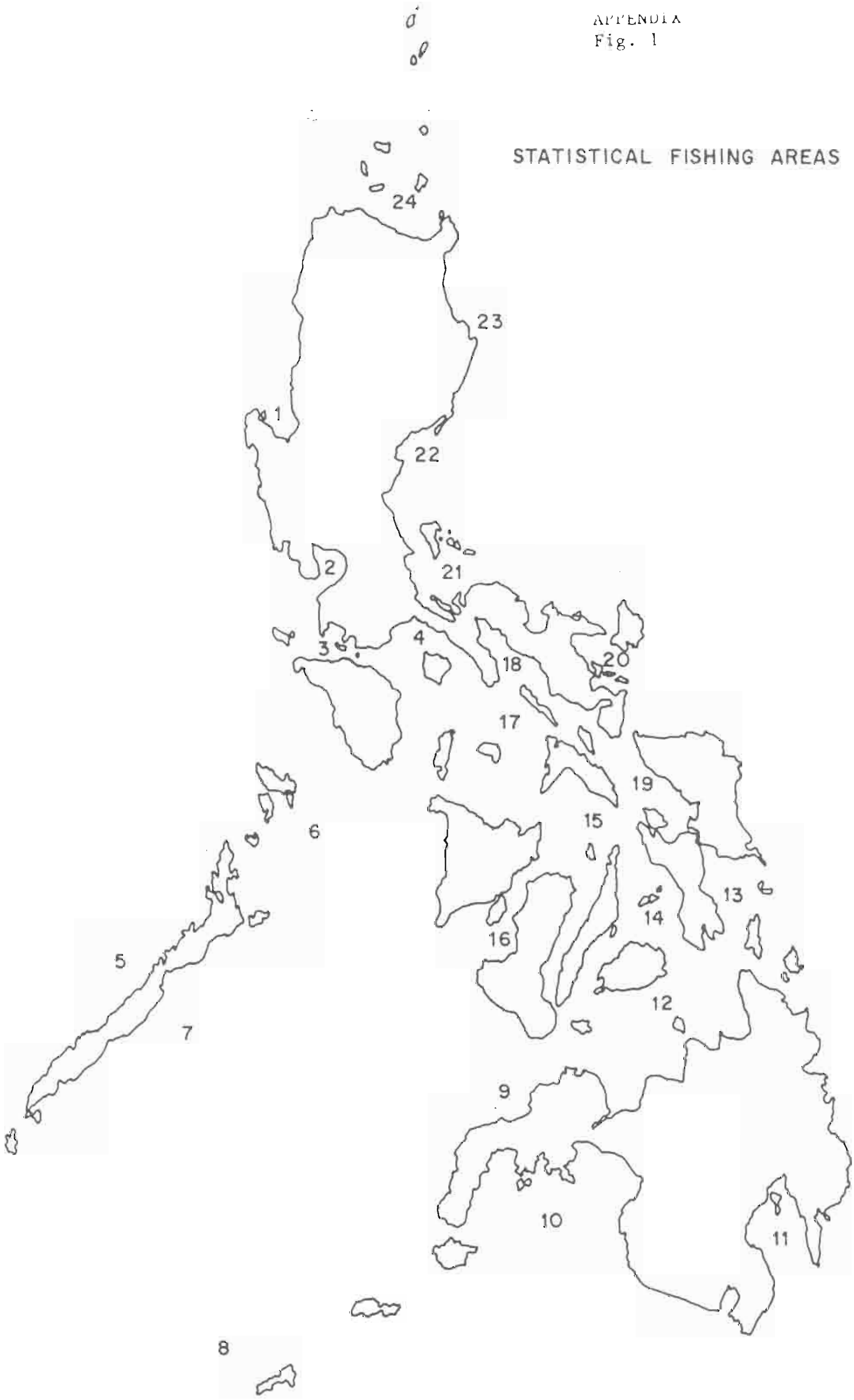
Statistical Areas	Marine Fishing Grounds
1. Lingayen Gulf	Bangui Bay Dasol Bay Ilocos Coast Lingayen Gulf Pasaleng Bay
2. Manila Bay	Subic Bay Manila Bay Zambales Coast
3. Batangas Coast	Balayan Bay Batangas Bay Batangas Coast Verde Is. Passage
4. Tayabas Bay	Mogpog Pass Tayabas Bay
5. West Palawan Water	Bacuit Bay Balabac Strait Imuruan Bay Malampaya Sound
6. Cuyo Pass	Coron Bay Cuyo Pass Dumaran Channel Linapacan Strait Mindoro Strait Taytay Bay
7. West Sulu Sea	Green Island Bay Honda Bay Island Bay San Antonio Bay West Sulu Sea

Statistical Areas	Marine Fishing Grounds
8. South Sulu Sea	Basilan Strait Tawi-Tawi Bay South Sulu Sea
9. East Sulu Sea	Coronado Bay Dapitan Bay Dipolog Bay East Sulu Sea Sibuco Bay Siocon Bay Sindanagan Bay
10. Moro Gulf	Dumaguilas Bay Illanas Bay Linao Bay Maligay Bay Moro Gulf
	Pagadian Bay Sarangani Bay Sibugey Bay
11. Davao Gulf	Baculin Bay Bislig Bay Cateel Bay Davao Gulf
	Lanuza Bay Lianga Bay Mayo Bay Pujada Bay
12. Bohol Sea	Butuan Bay Gingoog Bay Guindulman Bay Iligan Bay Macajalar Bay Murcielagos Bay Panguil Bay Sogod Bay

Statistical Areas	Marine Fishing Grounds
13. Leyte Gulf	Cabalian Bay Dinagat Sound Gamay Bay Leyte Gulf Matarinao Bay Oras Bay San Pedro Bay Surigao Strait
14. Camotes Sea	Camotes Sea Cebu Strait Maribojoc Bay Ormor Bay
15. Visayan Sea	Asid Gulf Asuncion Pass Tañon Strait Visayan Sea
16. Guimaras Strait	Aguisan Bay Banate Bay Guimaras Strait Iloilo Strait Panay Gulf
17. Sibuyan Sea	Jintotolo Channel Nin Bay Pilar Bay Romblon Pass Sapian Bay Sibuyan Sea Tablas Strait
18. Ragay Gulf	Burias Pass Ragay Gulf
19. Samar Sea	Biliran Strait Carigara Bay Maqueda Bay Samar Sea Sorsogon Bay Ticao Pass

Statistical Areas	Marine Fishing Grounds
20. Lagonoy Gulf	Albay Gulf Cabugay Bay Lagonoy Gulf San Bernardino Strait
21. Lamon Bay	Alabat Sound Lamon Bay Maqueda Channel Polillo Strait San Miguel Bay
22. Casiguran Sound	Baler Bay Casiguran Sound Diapitan Bay Dingalan Bay
23. Palanan Bay	Divilican Bay Palaman Bay
24. Babuyan Channel	Babuyan Channel Balintang Channel

APPENDIX
Fig. 1



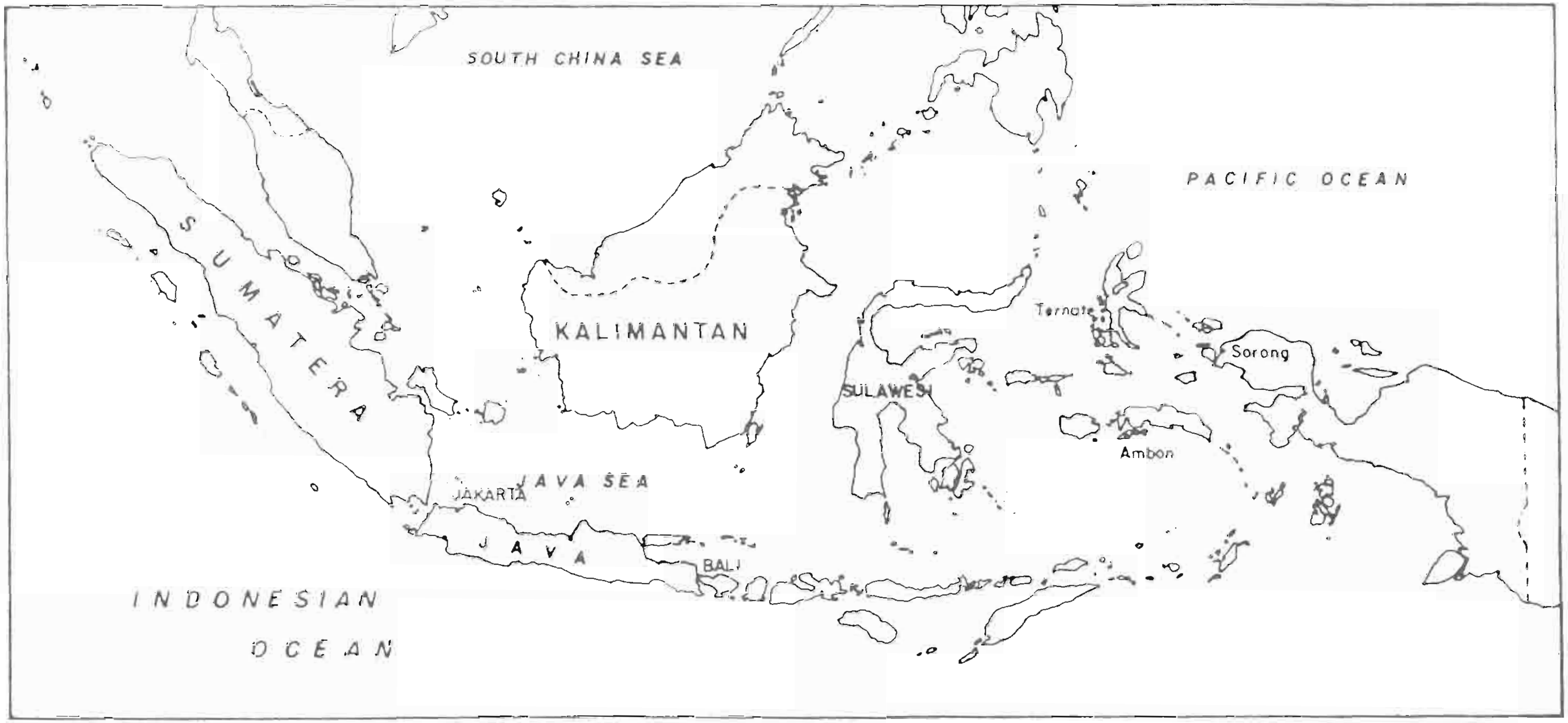


Fig. I Map of Indonesia showing the biological sampling sites

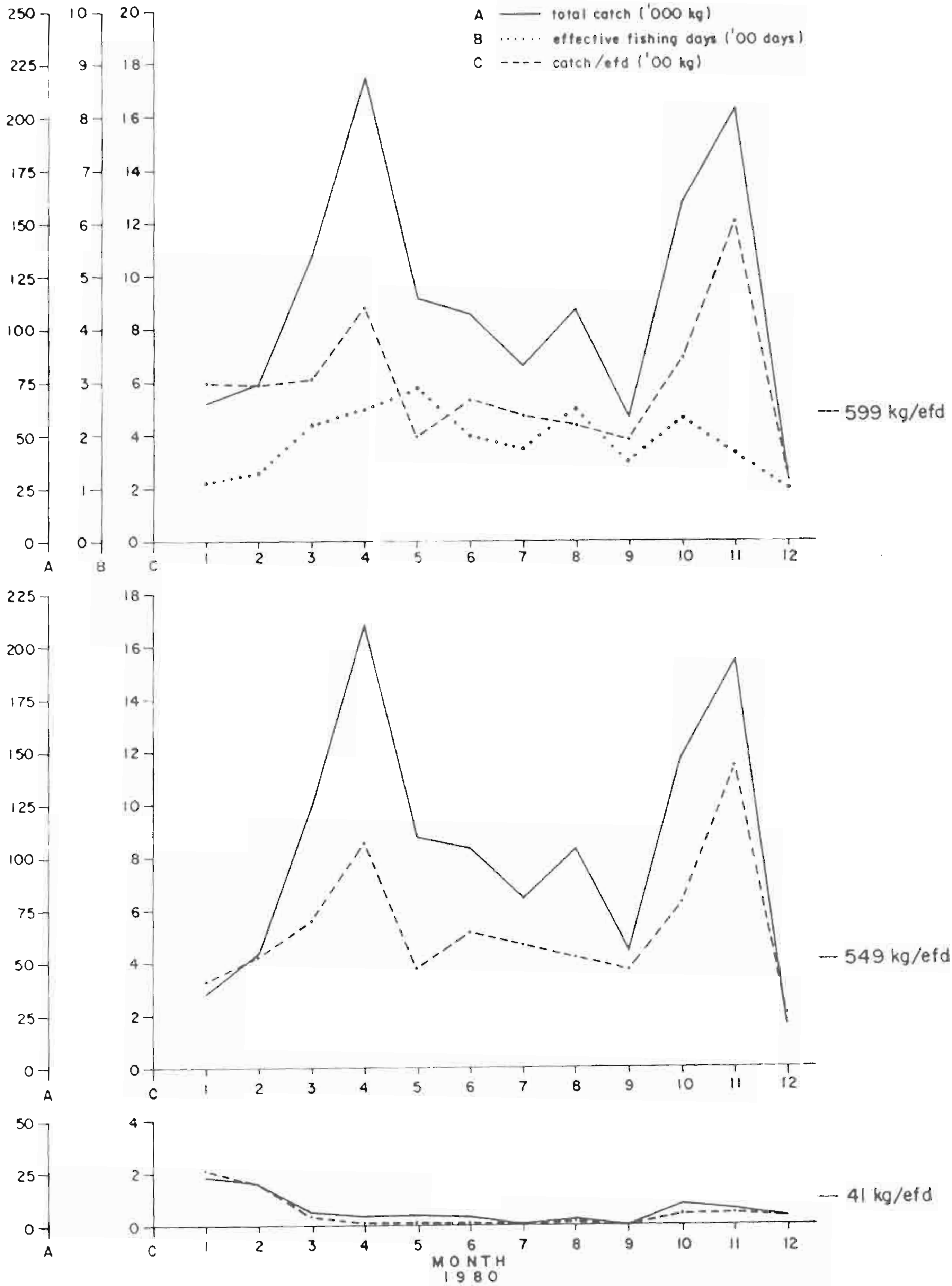


Fig 2 Catch, effort and catch rate of small-scale pole and liners in Ternate from January to December 1980

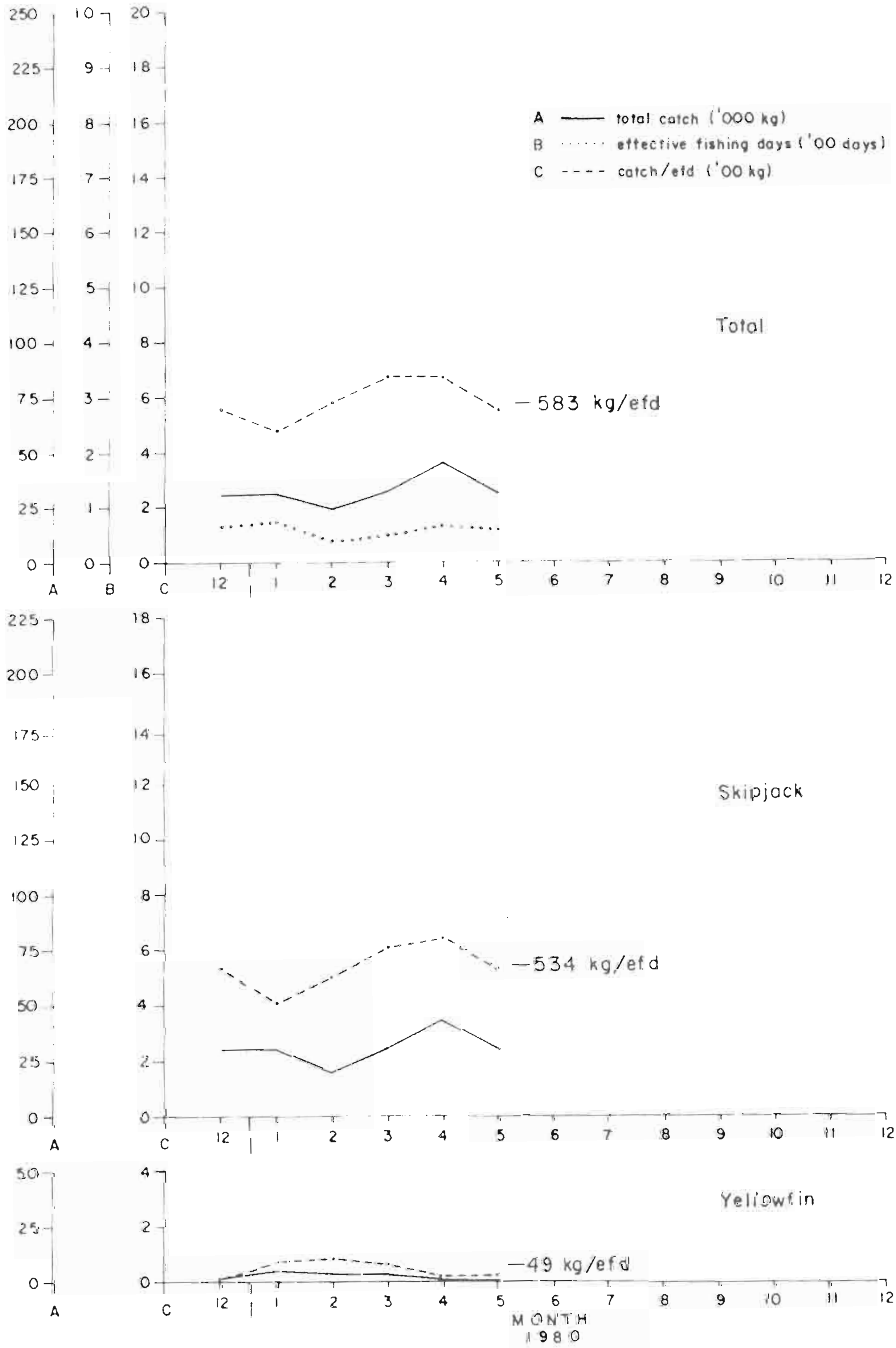


Fig. 3 Catch, effort and catch rate for small-scale pole and liners in Ambon from December 1979 to May 1980

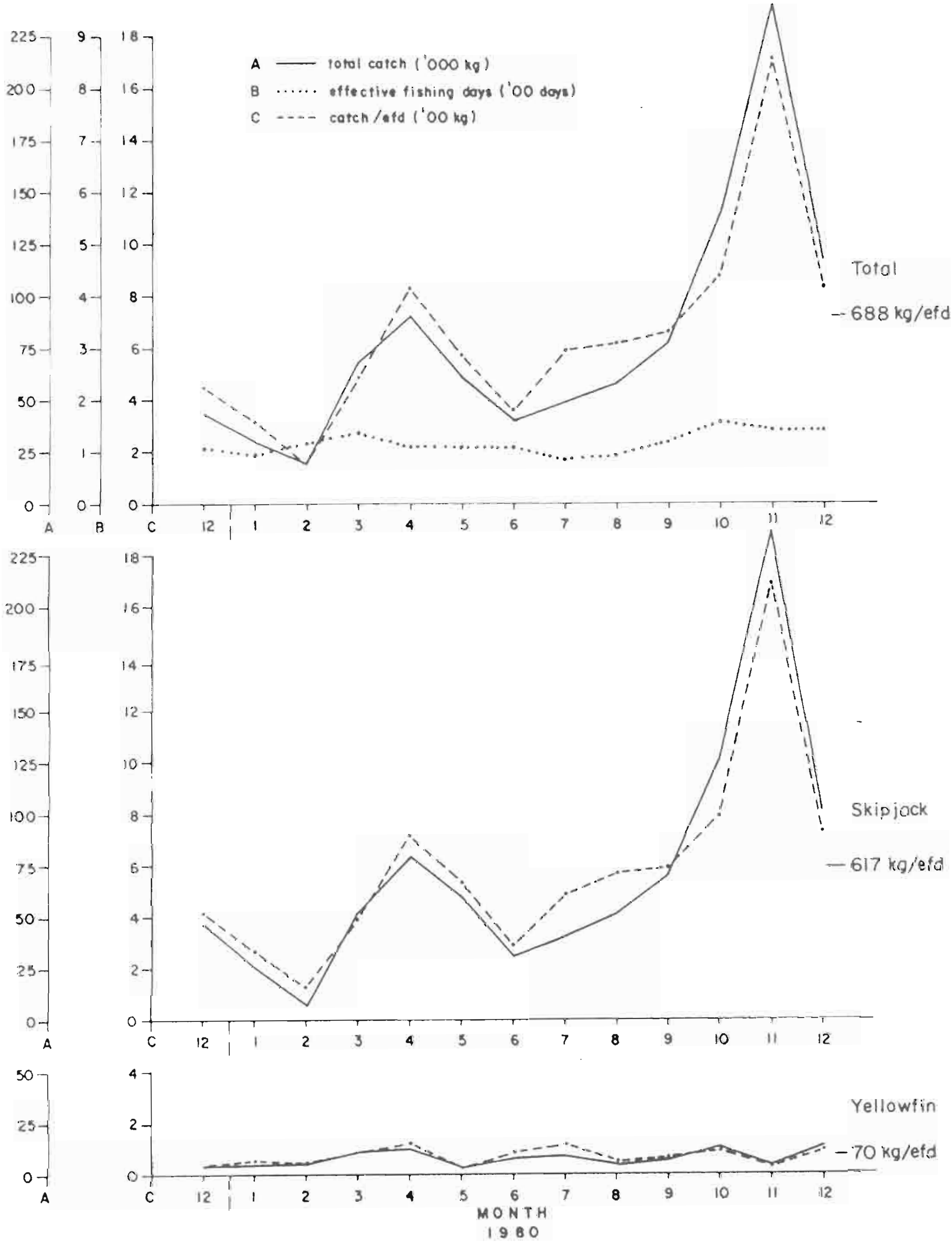


Fig. 4 Catch, effort and catch rate of industrial pole and liners in Ambon from December 1979 to December 1980

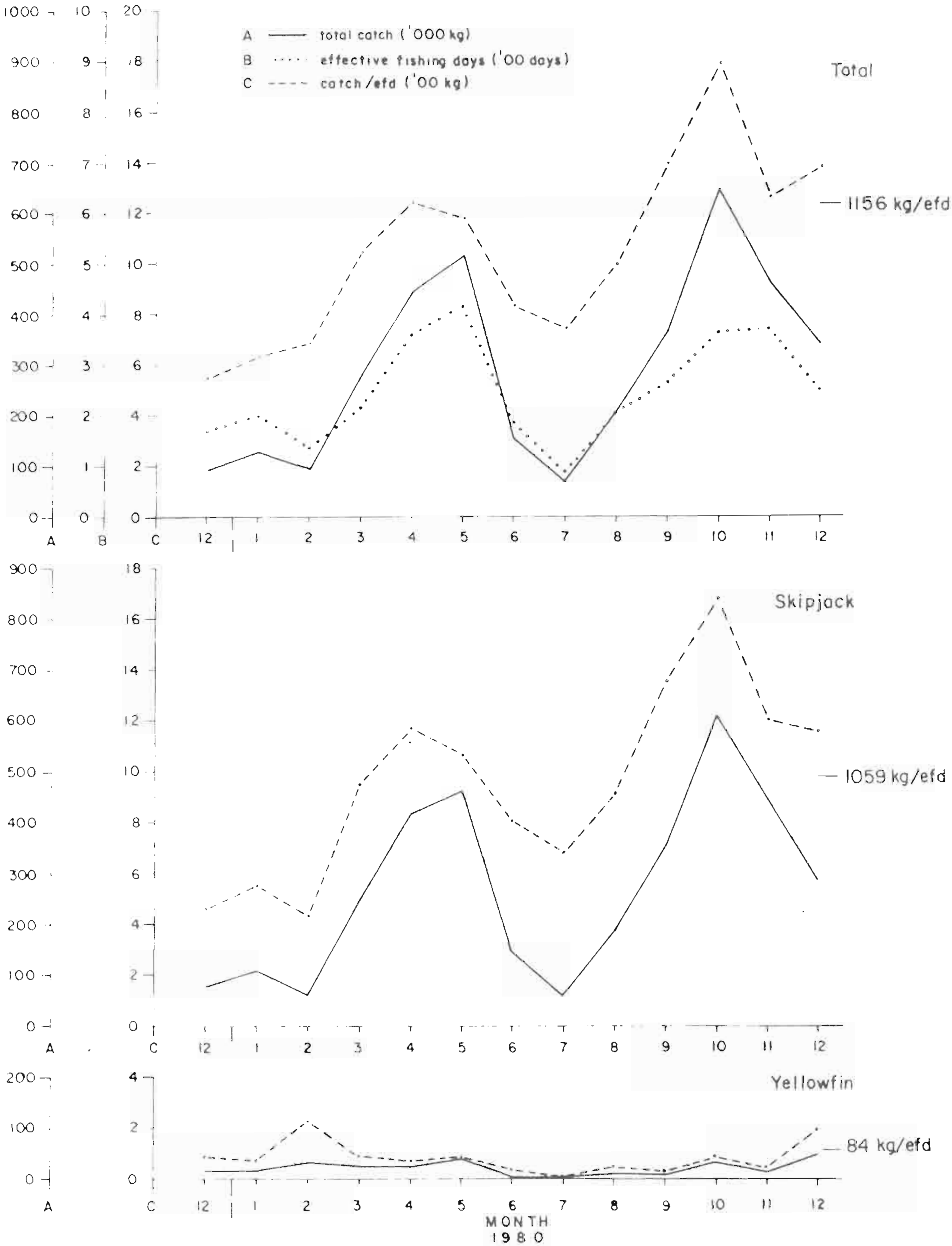


Fig. 5 Catch, effort and catch rate of small-scale pole and liners in Sorong from December 1979 to December 1980

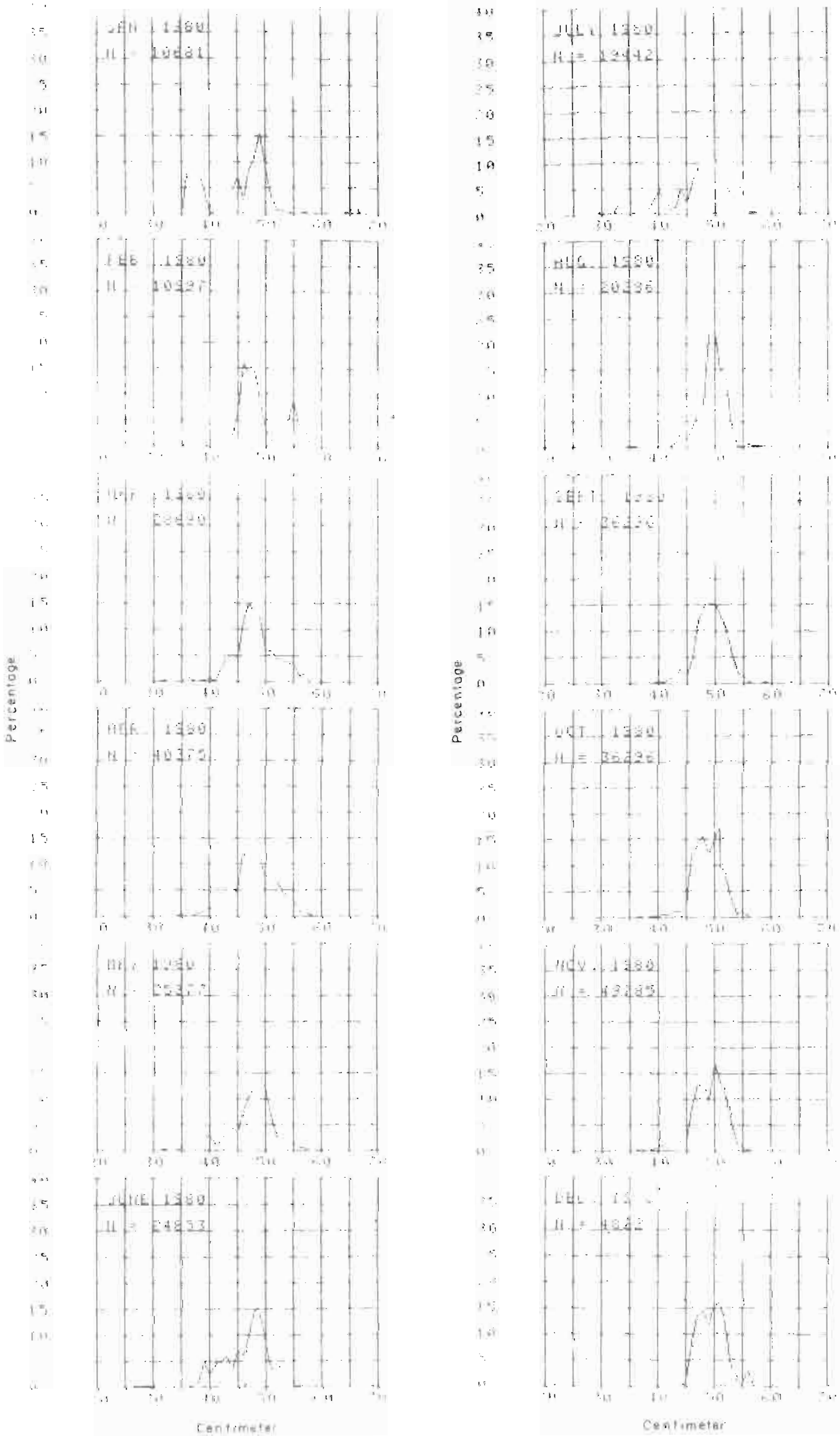


Fig. [illegible] Monthly weighted length frequency distributions of skipjack tuna captured by the small-scale fishery in Ternate

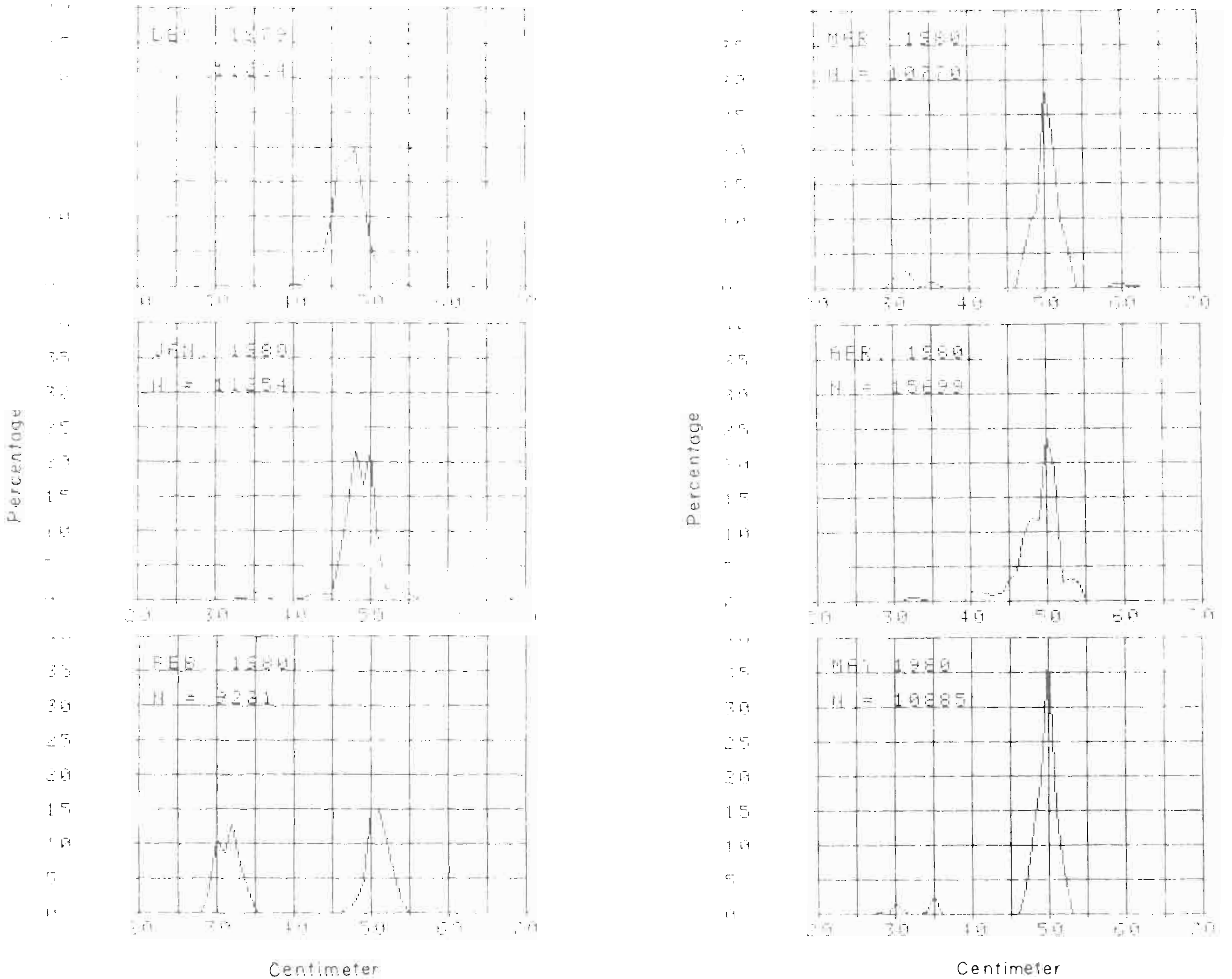


Fig. 7. Monthly weighted length frequency distributions for skipjack tuna captured by the small-scale

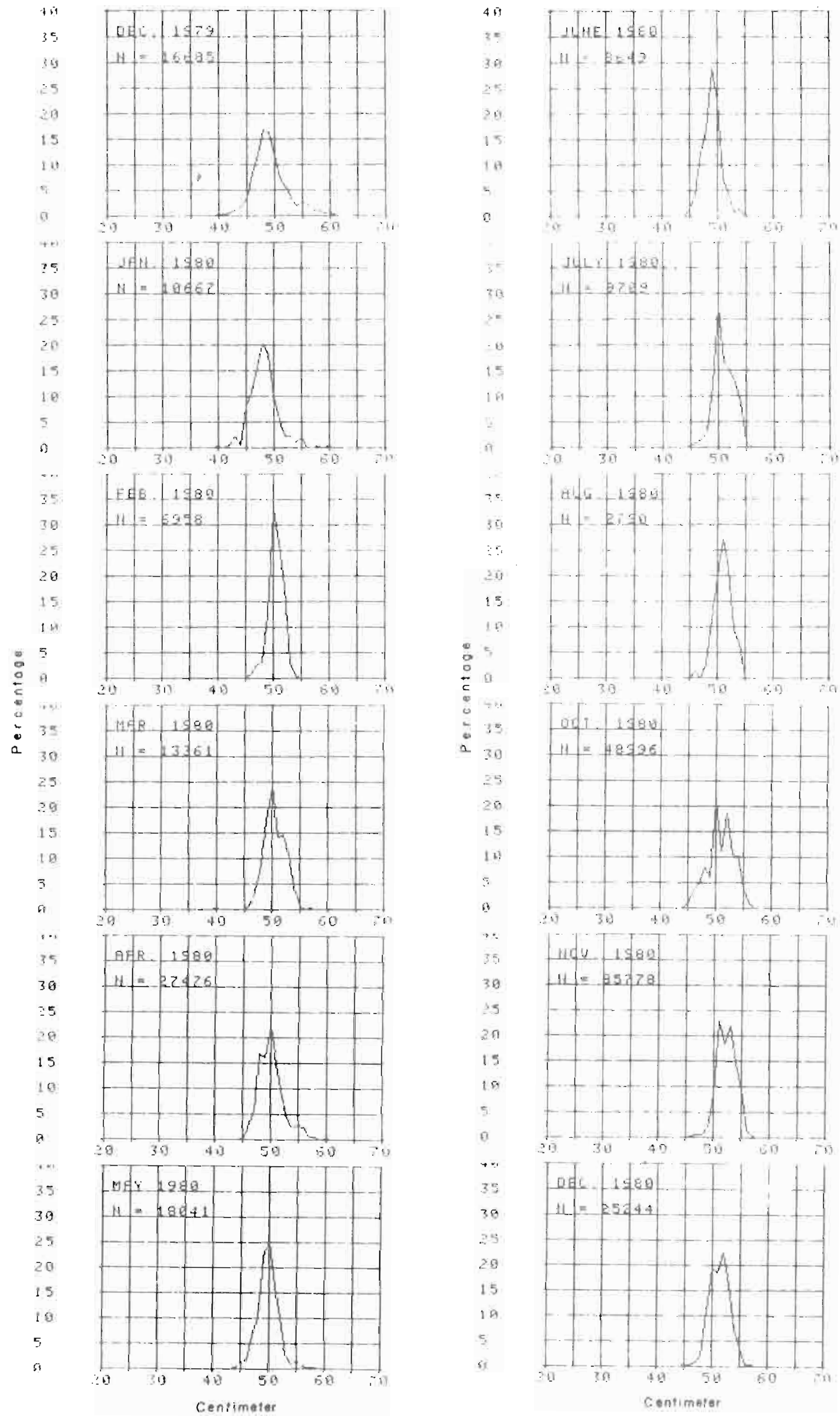


Fig. 8. Monthly weighted length frequency distributions for skipjack tuna captured by the industrial fishery in Ambon

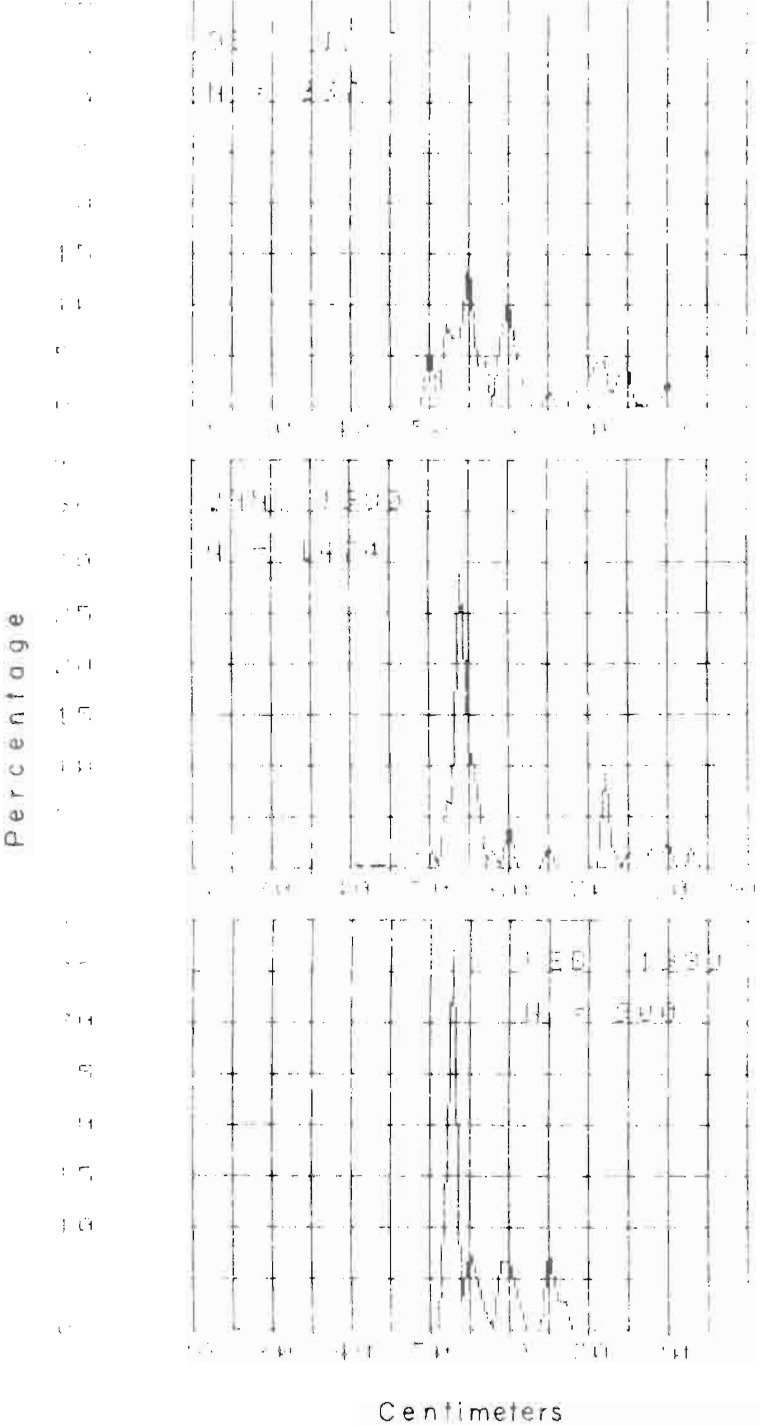


Fig. 11. Monthly weighted length frequency distributions of yellowfin tuna captured by the small-scale fishery in Ambon

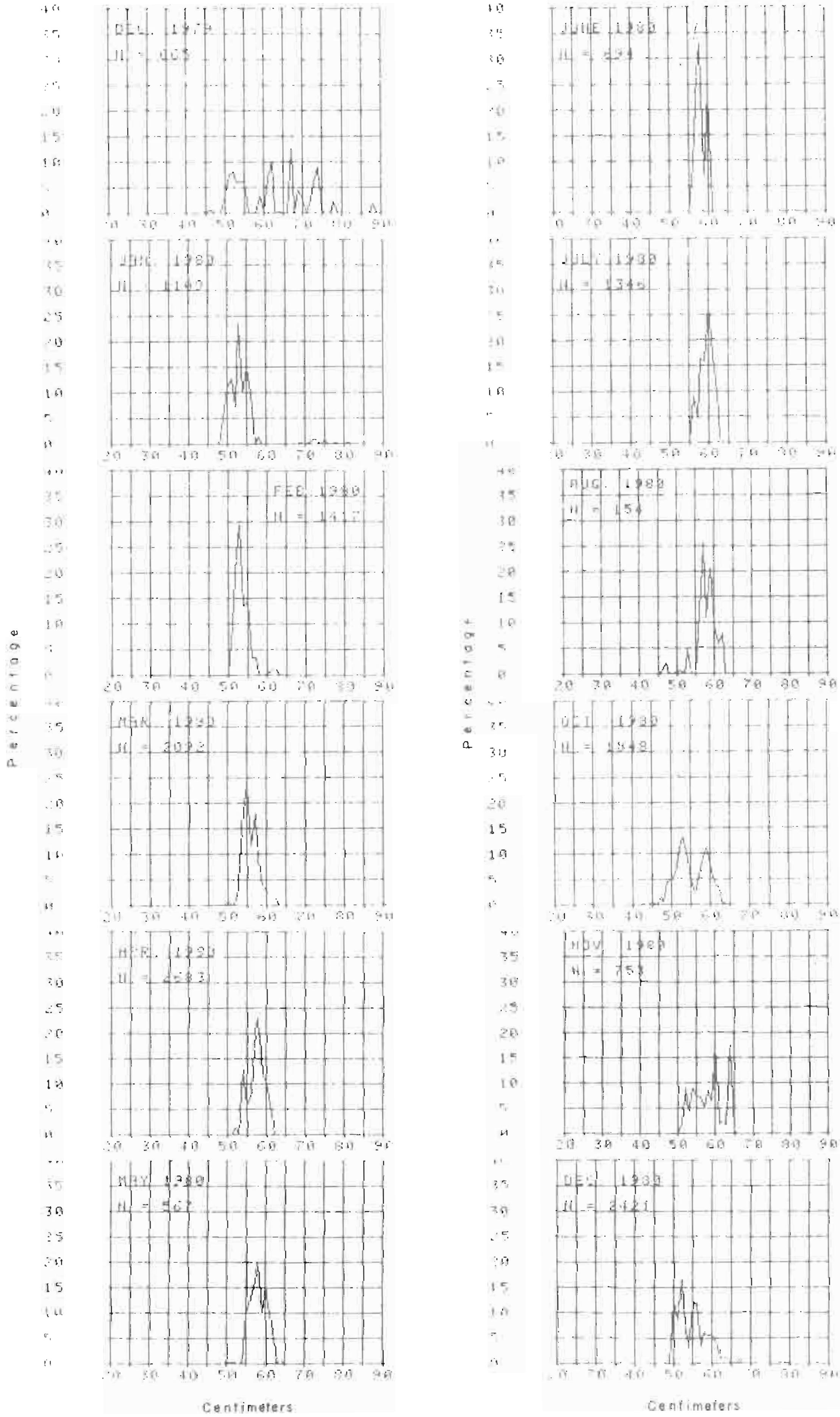


Fig. 12. Monthly weighted length frequency distributions of yellowfin tuna captured by the industrial fishery in Ambon

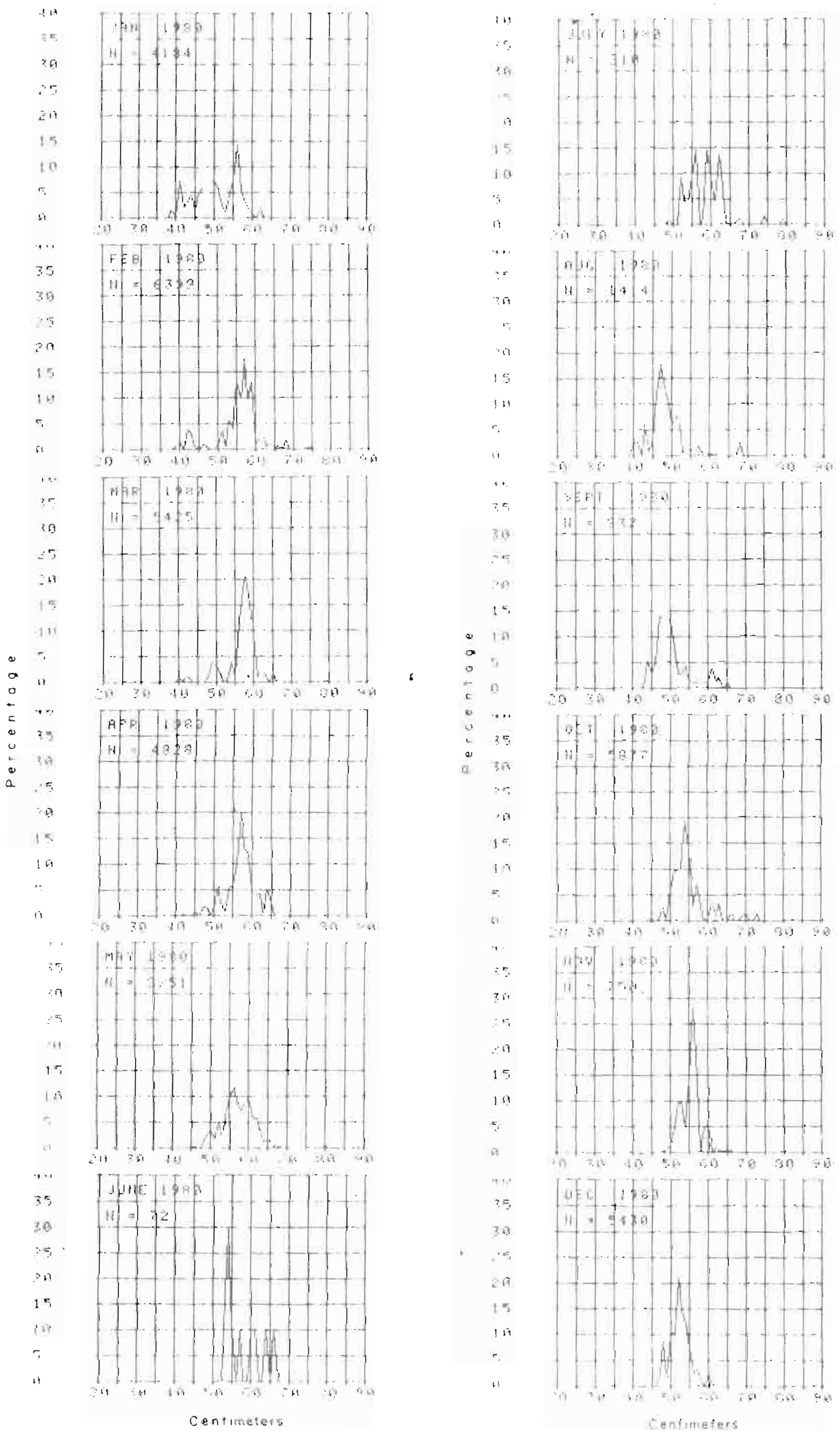


Fig. 13. Monthly weighted length frequency distributions of yellowfin tuna captured by the industrial fishery in Sorong.

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