

REPORT OF THE WORKSHOP ON TUNA AND SEERFISHES
IN THE NORTH ARABIAN SEA REGION

Muscat, Sultanate of Oman
7 - 9 February, 1989

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2. Country Status Reports

The country status reports are reproduced in Appendix 5 to 10.

2.1 Pakistan:

Drift gillnetters, 15 to 20 m keel-length, account for all the landings in Pakistan. The estimated tuna landings by species for 1987 was as follows:

	Sind tonnes (%)	Baluchistan tonnes (%)
longtail tuna	3402 (55)	-
yellowfin tuna	1330 (22)	-
kawakawa	1067 (17)	-
skipjack tuna	325 (5)	-
frigate tuna	64 (1)	-
Total:	6185 (100)	8387 (100)

There are 2 seasons for tuna in Pakistan; one from March to May and the other from September to January. Longtail tuna makes up the bulk of the catches in the March-May period, whereas the 4 principal species contribute to the catches of the September - January period. There were no landings in July because of bad weather.

2.2 Sri Lanka:

Seerfish in Sri Lanka are captured by large-mesh gillnets, troll lines, handlines, beach seines and small mesh gillnets. The estimated landings by gear are as follows:

	tonnes (%)
large-mesh gillnets/troll lines	2034 (55)
handlines/troll lines	1072 (29)
large-mesh gill nets/handlines	444 (12)
others (beach seines, small-mesh gillnets, etc.)	148 (4)
Total:	3698 (100)

Narrow-barred king mackerel is the most important species, followed by wahoo. The Indo-Pacific king mackerel and the streaked seerifsh are of minor importance.

3.3 Somalia:

The estimated tuna and seerfish production for 1988 was as follows:

	tonnes (%)
small scale fisheries	1300 (36)
industrial longline fisheries	2300 (64)
Total:	3600 (100)

Small-scale fishing gears used to catch tuna and seerfish include drift gillnets, floating longlines, handlines and troll lines. Motorized glass reinforced plastic (GRP) skiffs and traditional canoes are the most common crafts used in the small-scale fisheries sector. Only Korean longliners have requested licenses to fish off Somalia since 1984. The numbers of Korean longliners licenced to fish has been increasing in recent years.

Somalia is traditionally a meat-eating rather than fish-eating nation. However, demand for fish, especially in high population centers like Mogadishu, is increasing.

2.4 United Arab Emirates:

Landings of tuna and seerfish were estimated to be as follows:

	<u>tonnes (%)</u>
longtail tuna	3654 (58)
kawakawa	2108 (33)
frigate	576 (9)
sub-total:	6338 (100)
seerfish	6639
Total:	12,977

The gillnet is the most important gear for tuna and seerfish. Troll lines are also used to catch these species. Outboard powered skiffs and launches are the principal fishing crafts.

A comment was made of the importance of UAE keeping separate statistics for the Gulf and Gulf of Oman coasts. IPTP was encouraging the establishment of a sampling programme at a site on each of these coasts to collect better catch and effort statistics and size composition data of tuna and seerfish.

2.5 Peoples Democratic Republic of Yemen:

Landings of tuna and seerfish in 1987 were reported by 12 cooperatives as follows:

	<u>tonnes (%)</u>
kawakawa	751 (56)
yellowfin tuna	400 (30)
frigate tuna	77 (6)
longtail tuna	77 (6)
skipjack tuna	28 (2)
Indo-pacific bonito	8 (0)
sub-total:	1341 (100)
narrow-barred king mackerel	500
Total:	1841

These estimates do not include the catch of approximately 20% of the total catch, that made by fishermen not associated with cooperatives.

Fishing gears used to catch tuna and seerfish include troll lines, handlines, longlines, gillnets, small purse-seines and ringnets. Fishing crafts includes the smaller skiffs and larger launches which are constructed either of wood or glass reinforced plastic (GRP).

Late last year, small purse-seiners made exceptional catches, between 20 to 60 tonnes per day, of Indo-Pacific bonito. These fish ranged in size from 35 to 45 cm. In most cases, this species is captured only in small quantities. The purse-seiners had to stop fishing because of the lack of cold storage space.

2.6 Sultanate of Oman:

Tuna and seerfish landings were estimated to be as follows:

	tonnes (%)
longtail tuna	15,994 (46)
yellowfin tuna	15,307 (44)
kawakawa	3,427 (10)
sub-total:	34,728 (100)
narrow-barred king mackerel	30,227
Total:	64,955

Landings of tuna and seerfish increased by 34% and 15%, respectively, over landings of the previous year. These significant increases may be accounted for by the following factors:

- purchasing capacity increased in 1988 which may have stimulated higher fishing effort;
- subsidies to fishermen increased which may have resulted in greater effort;
- stocks may have been more abundant this year due to natural variability.

Fishing seasons reported for tuna in the country status reports are summarized in Table 1. All countries have two fishing seasons, one before and the other after the South-west monsoon.

Table :1 Fishing seasons for tuna

	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
1. PAKISTAN	<u>skj</u>		<u>lot</u>							<u>lot</u>	<u>yft</u>	<u>kaw</u>
2. UAE			<u>lot</u>		<u>kaw</u>					<u>lot</u>	<u>kaw</u>	
3. OMAN			<u>yf</u>								<u>yf</u>	
4. PDRY				<u>tun</u>						<u>tun</u>		
5. SOMALIA			<u>k, y, l, s</u>					<u>kaw, yft, lot, skj</u>			<u>tun</u>	
				<u>tun</u>								

Table 2 shows the fishing seasons for seerfish for selected countries in the Indian Ocean.

Table :2 Fishing seasons for seerfish

	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
1. UAE				com								
2. OMAN			com							com		
3. PDRY		com									com	
4. SOMALIA				kgx						kgx		
5. SRI LANKA						kgx				kgx		

Information currently being collected in the various countries of the North Arabian Sea region are given in Appendix 4.

3. Review and research papers

Review and research papers presented at the workshop are given in Appendixes 11 to 20.

3.1 Trend of tuna and seerfish landings in the Indian Ocean.

The 1986 landings of tuna in the Indian Ocean was 547,000 tonnes, a 98 percent increase over that of 1980. This increase was considerably higher than in the Atlantic and Pacific Oceans. Twenty tuna and tuna-like species are captured in the Indian Ocean. Skipjack, yellowfin tuna and small tunas account for 26, 20 and 21 percent, respectively, of the total catch. Seerfish contributed 17 percent and billfishes 2 percent to the total catch.

Japanese longliners started fishing the Indian Ocean in 1952 and were soon followed by Korean and Taiwanese longliners. Longliners accounted for 17 percent of the total catch in 1987. The industrial purse-seine fishery commenced in 1979, expanded rapidly and by 1987 accounted for 25 percent of the total catch.

Small-scale tuna fisheries are well developed in many coastal countries of the Indian Ocean. These small-scale fisheries landed 58 percent of the total catch in 1987.

Southern bluefin tuna is the only species for which there are management regulations. A strict quota has been imposed on Australian, Japanese and New Zealand fishermen as a measure to increase the spawning biomass.

The catches of skipjack and yellowfin has increased in recent years as a result of the operations of industrial purse-seiners. There is no evidence yet that these stocks are being affected by the current level of exploitation, but these stocks should be closely monitored because of the rapid increase in effort in recent years.

Big-eye and albacore tunas are exploited primarily by the longline fishery. Increasing longline effort is unlikely to give substantial increases in landings of these species. However, new breakthroughs in fishing technology that targets an unexploited part of these stocks could impact on these stocks. The recently developed gillnet fishery for albacore should be closely monitored to determine the affects of harvesting smaller sized albacore.

Sufficient information is generally not available for small tuna, seerfish and billfish for an assessment of these stocks.

3.2 A review of the small tuna stocks in the Gulf of Thailand and the east coast of Peninsular Malaysia.

The available information on effort, catch, species and size composition of small tunas in the Gulf of Thailand and east coast of Peninsular Malaysia was reviewed. Fishing grounds for drift gillnetters and purse-seiners in the Gulf of Thailand have shifted from the inner Gulf in the seventies to the outer half and outside of the Gulf in the eighties. Catch rates are not a good index of relative abundance of small tunas because of shifting fishing grounds, differing target species and changing efficiencies of the fishing gears.

Catches off the east coast of Peninsular Malaysia during 1987 were lower than for the 1983-85 period. It is still unknown if there was a decline in relative abundance of small tunas or if some discrepancies in sampling during these 2 periods caused this difference. The species composition of the catches has not changed since 1983. The mean size of longtail, kawakawa and frigate has increased from 1983 to present. This is attributed to expansion of the troll fishing grounds further offshore.

3.3 Gill raker counts: a possible means of stock separation for longtail tuna (Thunnus tonggol) in the Indian Ocean.

Gill rakers were counted on 162 longtail tuna captured in Oman. The mean number of gillrakers on the upper limb was 8.1728 and on the lower limb was 17.8950. The mean number on the upper limb differed significantly from fish captured in the Gulf of Mannar, India, whereas there was no difference in the mean number on the lower limb. These stocks of longtail tuna probably do not mix.

The author was complimented on her interesting paper and urged to coordinate with participants from the neighbouring countries in a cooperative study to cover the north Arabian Sea region.

3.4 Interviews with traditional fishermen near Sur, Oman.

Open ended interviews were made with 20 fishermen from Sur, for their beliefs about tuna and seerfish fisheries. These fishermen had definite views of large fish migrations, feeding habits, spawning seasons, spawning grounds and nursery areas. They were also aware of the environmental factors effecting fishing in the area.

Several participants congratulated the author for his interesting paper. Suggestions were made that this work be continued and expanded to other areas of Oman and that similar studies be conducted in other countries of the region.

3.5 Underestimates of growth of small tunas from length frequency analyses.

Age and growth studies of longtail, kawakawa and frigate tuna completed in the Indo-Pacific region were reviewed. The results of the otolith increment studies of longtail and kawakawa differed from those of length frequency analyses for these respective species and showed faster growth. Length frequency distribution of juvenile kawakawa and rearing experiments of black skipjack (Euthynnus lineatus) indicate very rapid growth of juvenile stages. These studies show 27 cm Euthynnus to be about 5 months old versus 27-31 cm fish to be 1 year old from length studies. The underestimation of growth by approximately half a year in length frequency studies may result from combining cohorts from two spawning seasons.

3.6 Growth of Scomberomorus commerson based on length frequency data in Oman.

Length data from Scomberomorus commerson collected monthly from February 1987 through January 1989 were analyzed to determine basic growth and population parameters. The growth curve which fit the data best had the following parameters. $L_{inf}=164$, $k=0.340$, $c=0.360$ and $wp=0.100$. The estimated value of total mortality based on a length converted catch curve using these growth parameters is $Z=1.151$. Natural mortality based on the growth parameters and annual mean environmental temperature ($T=25.5C$) is $M=0.526$. Fishing mortality is $F=0.625$. These values indicate that current fishing effort should be stabilized. However, the analyses also indicates that several other combinations of growth parameters fit the data almost as well. Some of the other combinations indicate that fishing effort should be decreased. Thus, caution is suggested in managing the fishery for the present.

3.7 Age, growth, mortality estimates of Scomberomorus commerson from the west coast of Sri Lanka.

Length frequency distributions of Scomberomorous commerson captured in various fisheries off the west coast of Sri Lanka were analyzed to extract growth and population parameters. The growth parameters for frequency distributions corrected for gillnet selectivity were $k=0.37$ and $L_{inf}=146$ cm. The natural mortality coefficient (M) was estimated by using the above growth parameters and mean annual environmental temperatures to be 0.605. The mean of 2 total mortality (Z) estimates was 1.63. Fishing mortality (F) was calculated as 1.03 and the exploitation rate (E) as 0.63.

Nine centimeter juvenile S. commerson were obtained in late July and subsequently sampled at progressively larger sizes till late November. Otoliths from 92 juveniles were examined for primary growth rings. Otolith increments were validated as daily events by the corresponding increase in increment counts and days between samples for fish ranging from 9 to 37 cm. Ages of 10, 20 and 45 cm fish were estimated to be 30, 60 and 165 days old, respectively. Growth estimated by this method was considerably faster than that derived from length frequency analysis.

3.8 Biological parameters and stock assessment for Thunnus tonggol and Euthynnus affinis in the western Gulf of Aden.

Studies conducted on longtail tuna and kawakawa stocks in the western Gulf of Aden were reviewed. The following growth and population parameters for these species were obtained from length frequency distributions.

	longtail	kawakawa
Linf	104 cm	95 cm
k	0.25	0.20
z	0.80	0.80
m	0.48	0.50
f	0.305	0.357

3.9 Age, growth and mortality rates of longtail tuna, Thunnus tonggol (Bleeker) in Omani waters based on length data.

Age, growth and mortality rates of Thunnus tonggol were determined from length data. Minimum and maximum sizes of fish examined during this study in Oman were 22 and 116 cms fork length, respectively. The seasonally oscillating version of the generalised von Bertalanffy Growth Function fitted to this data resulted in values of Linf= 133.6 cms, k=0.228, c=0.12 and wp=0.2 as the best fit estimates. Using these values of Linf and K and an estimate of natural mortality ($M=0.429$) based on these parameters and annual mean water temperature, total mortality Z, fishing mortality F, and exploitation E rates were estimated: $Z=1.784$, $F=1.355$, $E=0.760$.

Longtail tuna in Omani waters attained a size of 28-30 cms fork length at the end of one year. Typical catches consisted of fish between 58 and 82 cms. Full recruitment into the fishery occurred at about 70 cms length (around 3 years). Yield per recruit analysis suggested that current fishing intensity of longtail tuna should be stabilized. It could be possible that gillnet selectivity is a confounding factor in length frequency analysis of this species in Oman.

3.10 Biological status of Thunnus albacares in the Gulf of Aden.

Yellowfin tuna landed during October 1988 at the cannery in Shugra were examined for length, weight, maturity, condition factor (liver) and stomach contents. Two size groups of fish were measured; smaller fish with mode at 68 cm and larger fish with mode at 92 cm. All fish were immature.

3.11 Marketing and consumption of tuna and seerfish in the Gulf Arab countries.

Though tuna and seerfish are landed in almost all the Gulf Arab countries, the favoured item in fresh or chilled form is seerfish, followed by yellowfin tuna, longtail, skipjack and bonito in that order. These are consumed usually in four product forms namely fresh/chilled, frozen, dried and canned. Of these, canned products are imported in the Arabian Peninsula except for the PDRY where there are two canning plants for tuna and mackerel in operation. Marketing channels especially in the six G.C.C. States comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the UAE are broadly of two kinds, one for the local products and the other for imports. Auctioning is common for fresh tuna and seerfish and is handled by fishermen, auctioneers and wholesalers. Imports are handled by the major fishery companies, small-scale traders and supermarkets. Canned tuna is imported from several sources like Thailand, Japan, and Fiji whereas frozen tuna is exported to countries in Europe as well as Australia and Thailand. Similarly, seerfish is imported into the region from India, Taiwan, etc., and also exported - either in frozen or fresh form. Considering the present consumption of these

fishes in the region at a total of 81,000 M.T., it is estimated that by the year 2000 A.D., an additional quantity of some 3,000 to 4,000 M.T canned tuna, 16,000 to 17,000 M.T seerfish and 10,000 to 12,000 M.T of fresh tuna would be required to sustain the present level of consumption. With such increase in demand, it is obvious that there is need to enhance production of these species by addition of industrial vessels to the present artisanal fleet without harming the interests of the artisanal sector. So also the scope for establishing modern canneries for tuna and other pelagic species available in the area is highlighted together with the need for better data collection system in these States. The suggested measures are directed towards stimulating investment, generating employment and ameliorating the condition of the fishermen. Above all food security which is of vital concern to the region is expected to be strengthened through such measures.

3.12 Research activities of the Marine Science and Fisheries Center.

A brief history, objectives and current staffing of the Marine Science and Fisheries Center were outlined. The Center has 8 sections including large pelagics, small pelagics, shellfish, demersal fish, seafood technology, library, aquarium, oceanography and marine ecology. The activities of these sections were reviewed.

3.13 An overview of the tuna fisheries development and management plan of the Sultanate of Oman.

The small-scale fisheries sector is given priority in the plan for the development of the tuna and seerfish fisheries. Various strategies to improve the lot of the small-scale fishermen, to increase the value of the landed catch and to proportion fishing areas for management purposes were explained.

4. Discussion topics

4.1 Mechanisms for the continuation and improvement of collaborative scientific investigation of the tuna and seerfish fisheries of the region.

IPTP is scheduled to be terminated at the end of 1989. However, a permanent organization, within the framework of FAO, is being organized to continue the work of IPTP. The general concern of the participants was the need to impress upon the new organization the unique conditions of the North Arabian Sea, with its large stocks of narrow-barred king mackerel and longtail tuna. These stocks are extremely important to the region, but in the context of the Indian Ocean are of secondary significance. Several recommendations were proposed to ensure the new organizations would give due attention to the stocks in this region .

4.2 State of stock assessment of small tuna and seerfish populations.

The Expert Consultation on Stock Assessment of Tuna and Tuna-like Species in the Indian Ocean held in Mauritius during June 1988 concluded that information is insufficient for assessment of small tuna and seerfish stocks. Since this consultation, additional information for the small tuna stocks in the South China Sea region and for the small tuna and seerfish stocks in the North Arabian Sea region have become available. With this additional information, first approximate stock assessments can now be made. Caution should be exercised however, as age and growth of small tuna and seerfish have not yet been resolved. Also, natural mortality rates derived for small tunas from growth parameters and mean annual temperatures may not be appropriate.

5. Recommendations

The Workshop recognised:

- the growing value and potential of the tuna and seerfish fisheries of the Indian Ocean, particularly in the North Arabian Sea Region;
- the relevance and value of undertaking research on a sub-regional basis, particularly since many of the coastal tuna and seerfish stocks appear to have limited ranges;
- and the importance of the assistance of the Indo-Pacific Tuna Programme with the management of tuna and seerfishes, particularly in the fields of data collection, research and the facilitation of regional collaboration.

The workshop recognized the tremendous service which the Indo-Pacific Tuna Programme has provided to the region over the past seven years and therefore regrets the forthcoming termination of the Indo-Pacific Tuna Programme while recognising that the issue of the replacement mechanism for future cooperation in tuna fisheries research and management is currently under discussion.

The workshop recommended that any new mechanism that is to be considered as a replacement of IPTP should, as a part of its general functions, ensure that it:

- supports improved and standardised data collection systems to obtain accurate catch, effort and biological information;
- supports working level cooperation and collaboration between fishery researchers through improved communications, through scientific personnel attachments and exchanges to work on regional problems and provides for regular and ad hoc regional and sub-regional meetings to consider:
 - regional research programme and implementation;
 - stock assessment and yield modelling;
 - and management and development recommendations

The Workshop also recommended that the participating countries

- improve the quality of catch statistics on tuna and seerfish with gear-wise breakdown;
- strengthen the present and/or initiate sampling programmes to obtain accurate catch/effort and biological information;
- and collect marketing information such as local prices, quantity and value of exports and imports on a more regular basis.

6. Adoption of the report

The report of the workshop was adopted by participants on 9 February 1989.

Appendix 1.

IPTP WORKSHOP ON TUNA AND SEERFISHES IN THE
NORTH ARABIAN SEA REGION

MUSCAT, 7 - 9 February, 1989

LIST OF PARTICIPANTS

<u>NAME</u>	<u>OFFICIAL TITLE</u>	<u>ADDRESS</u>
1. U.A.E.		
Mr. Ali Mohammed Dahmash	Deputy Director	Fisheries Department, Ministry of Agriculture and Fisheries, P.O.Box 509, Dubai, UAE
Mr. Mohmmed Ibrahim Al Zaadi	Fishery Office Manager	Same as above
2. SULTANATE OF OMAN		
Mr. Rashid Amour Al Barwani	Director of Fisheries Ministry of Development	Agriculture and Fisheries, P.O.Box 467, Muscat, Oman
Mr. Hussain Jawad Kabouri	In-charge of Computer Section	
Mr. Abdulla Mohammed Al Harthy	In-charge of Statistics	
Mr. David Evans	Advisor on Fisheries	
Mr. Eli Ibrahim Moussali	Fisheries Statistical/ Analyst	
Mr. Mahmood Bouhilal	Statistical Advisor	
Dr. Richard Dudley	Chief Scientist	Marine Science and Fisheries Center (MSFC), P.O.Box 467, Muscat, Oman
Mrs. Arundhati Prabhakar	Research Associate	
Mrs. Shama Zakiuddin	Research Assistant	
Mr. Juma Mohammed Al Mamry	" "	
Mr. Juma Mohammed Abdulla	" "	
Ms. Majida Abdul Amir	Laboratory Technician	

Appendix 1. Contd/

3. PAKISTAN

Mr. Jameel Ahmed	Principal Research Officer	Marine Fisheries Department, West Wharf, Karachi, Pakistan
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4. SOMALIA

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5. SRI LANKA

Dr. N M P Dayaratne	Senior Scientific Officer	National Aquatic Resources Agency (NARA), Crow Island, Colombo 15, Sri Lanka
Mr. Janaka De Silva	Scientific Officer	Same as above

6. PEOPLE DEMOCRATIC REPUBLIC OF YEMEN

Mr. Ali Abdulla Mahfod Ba-Kurausa	Head, Department of Fisheries Biology	Ministry of Fisheries and wealth, P.O.Box 1231 Aden, Yemen
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7. INFOSAMAK

Dr. K P P Nambiar	International Marketing and Trade Promotion Expert	INFOSAMAK UNDP/FAO P.O.Box 26629 Manama, Bahrain
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8. UNDP

Mr. M P Hyland	Resident Representative	P.O.Box 5287, UNDP, Muscat, Oman
Mrs. B Al Bakry	Programme Officer	Same as above

9. IPTP

Mr. T Sakurai	Programme Leader	IPTP, P.O.Box 2004, Colombo, Sri Lanka
Mr. M Yesaki	Tuna Biologist	Same as above

Appendix 2.

Opening Address by Mr. Abdulla Bin Ali Bakatheer, Director-General of Fisheries, Sultanate of Oman.

In the Name of God ,
Most Gracious, Most Merciful

Dear - Director of
Indo-Pacific Tuna
Development and Management
Programme

Our Dear Guests,

Assalam Alaikum A Rahmathulla
Wa Barakathuhu

On behalf of H.E. Sheikh
Mohammed Bin Abdulla Bin
Zahor Al Hinai, the Minister
of Agriculture and
Fisheries, I have the
pleasure to welcome and
thank you all for coming to
the Sultanate of Oman to
participate in this
workshop, and in the name of
God and with His blessings
we open this workshop hoping
it every success in
discussing the topics on its
agenda.

Tuna species, being highly
migratory species cannot be
studied by each country
individually, as this calls
for joint efforts like those
extended by IPTP and through
workshops such as this one
which will guide us all to
reach a realistic statistics
on the catch landings of
such important species.

Scientific works and efforts
carried out by each of our
countries is indeed
extremely added knowledge and
no doubt need to be linked
and discussed by this
neighbouring countries of
the region.

We in the Sultanate of Oman
give our special attention
to the Indo-Pacific Tuna

بسم الله الرحمن الرحيم

الفاضل \ مدير برنامج تنمية
وادارة اسماك التونة في المحيط
الهندي والباسيفيكي

هيووفنا الافاصل \

السلام عليكم ورحمة الله
وببركاته

يسنى نيابة عن معالي الشيخ \
محمد بن عبدالله بن زايد
الهنائى وزير الزراعة والاسماك
ان ارجو بمحظوركم جميعا فى
رحاكم سلطنة عمان خالل انعقاد
ندوتكم هذه وباسم الله
وبتوفيقه تعالى نفتح اعمال
هذه الندوة التي تمنى لها
التوفيق والنجاح فيما سنناقش
من موضوعات

هيووفنا الافاصل

نظرا لأن اسماك التونة تعتبر من
الاصناف عالية الهمزة فانه لا
يمكن دراستها بواسطة كل قطر
على حده حيث ان دراستها
تستلزم بذل الجهود المشتركة
كل الجهود التي يبذلها برنامج
التونة بالالمحيط الهندي
والباسيفيكي وذلك غير ورقة
العمل مثل ندوتكم هذه والتي
سوف تحاولون الحصول فيها على
احصاءات حقيقية عن المصيد
المتزر من تلك الاصناف الهامة

ان الجهود العلمية التي تقوم
بها كل دولة من دولنا لهي في
الحقيقة اهافة هامة وليس
هناك من شك من الحاجة الى
ربطها مع بعضها ودراستها
بواسطة الدول المجاورة
بالمنطقة . انتا في سلطنة
عمان نولي ادارة اسماك التونة

Appendix 2. Contd/

Development and Management Programme and we are following with full appreciation of its activities. The Sultanate of Oman is extending great efforts to benefit from its marine resources and as we consider the tunas as one of the good quality species and of high economical value, we are looking forward to have vessels and specialized cadres in the future to enable us benefitting from the tuna species passing our territory waters and EEZ in their migratory route.

On behalf of the Ministry of Agriculture and Fisheries, I would like to put on the record of your workshop our heartfelt thanks to Mr. Sakurai, the Leader - IPTP and Dr. Yesaki for the efforts they extended on behalf of IPTP to make this workshop possible. I would like also to extend the thanks to the UNDP office in Muscat for the coordination they extended.

At the end, I would like to congratulate you all for the confidence placed upon you by your countries to participate in this workshop and I hope you good stay and great success in reaching the conclusions that would emanate from the debate of this workshop. I would like also to add that with our joint cooperation we will achieve our target goals and learn much about this resources.

Assalm Aleykum Wa Rahmathulla Wa Barakathuhu

بالمحيط الهندي والباسفيكي اهتماماً خاصاً ونتابع نشاطاتها بكل تقدير وتبذل السلطنة جهوداً كبيرة في الاستفادة من ثرواتها البحرية بحيث إننا نعتبر أن إسماك التونة من الأصناف الجديدة ذات القيمة الاقتصادية غاترها تسعى جاهدين إلى أن يكون لدينا في المستقبل سفن وكميات متخصصة للاستفادة من كميات التونة التي تمر همن مسارها في مياهنا الإقليمية والاقتصادية .

**الإخوة الكرام
هيوفنا الأفاضل**

نزيابة عن وزارة الزراعة والإسماك أود أن أسجل في مهابط ورشة عملكم هذه شكرنا العميق إلى ساكوري مديري برنامج إدارة

التونة في المحيطين الهندي والباسفيكي والى الدكتور إيزاكى الجهد الذى بذلها نزيابة عن برنامج إدارة التونة لقيام ندوتكم هذه أرجو أن أشير كذلك شكرنا الجزيل لمكتب برنامج الأمم المتحدة الإنمائي فى مسقط لجهوده فى تنسيق أعمال الورشة . وفي الختام أود أن أثني على مديريكم جميعاً على الثقة التى وهبتموها على عاتقكم دولكم للمشاركة فى أعمال هذه الورشة متمنين لكم طيب الإقامة والتوفيق والنجاح فى الشتاء الذى ستتشقق من مداولات هذه الورشة . وبتعاوننا جميعاً فاترنا سوف نصل فى النهاية إلى تحقيق أهدافنا المنشودة وفهم الكثير عن هذه الشروة .

**والسلام عليكم ورحمة الله
وبركاته**

Appendix 3.

INDO-PACIFIC TUNA PROGRAMME
WORKSHOP ON TUNA AND
SEERFISHES
IN THE NORTH ARABIAN SEA
REGION
FEBRUARY 7-8-9, 1989

PROPOSED AGENDA

Tuesday February 7

8:30 Opening Address by H.E.
The Director General of
Fisheries

Welcome Address by IPTP
Programme Leader

Break (Coffe/Tea)

9:30 Start of Meeting,
Selection of Chairman Adoption
of Agenda

9:45 Country Status Reports

Break (Coffee/tea)
(15 minutes)

Pakistan
Somalia
Sri Lanka
United Arab Emirates
Yemen, PDR
Oman

13:00 - 14:30 Lunch Break
14:30 Review and
Research Papers

1. Trends of tuna and seerfish
landings in the Indian
Ocean.

ورشة عمل اسماك التونة والكنعد
في منطقة شمال البحر العربي
مسقط ٧ - ٩ فبراير ١٩٨٩ م

جدول الاعمال المقترن

* الثلاثاء : ٨٩٨٢٧ *

* ٣٠ : * خطاب الافتتاح يلقيه
الفاصل مدير عام الاسماك
* كلمة ترحيب يلقيها
مدير برنامج التونة بالمحيطين
الهندي والهادئ

* استراحة

* ٣٠ : * بداية الاجتماعات
* اختيار الرئيس
* اعتماد جدول الاعمال

* ٤٥ : * تقارير الواقع في
الدول المشاركة

* باكستان
* الصومال
* سريلانكا

* استراحة
١٥ دقيقة

* دولة الامارات
العربية المتحدة
* جمهورية اليمن
الديمقراطية الشعبية
* سلطنة عمان
* دول اخرى (لم تتوارد
بعد)

١٣ : ٣٠ - ١٤ : * فترة
تناول الغداء

١٤ : ٣٠ - * اوراق البحوث
وتجارب الدول

١- استعراض الكميات المنزعة
من اسماك التونة والكنعد في
منطقة المحيط الهندي

Appendix 3. Contd/

2. Tuna fisheries of the Gulf of Thailand and the East coast of Peninsular Malaysia.

3. Gillraker counts of *Thunnus tonggol* in Oman.

4. Beliefs of traditional fishermen about tuna and seerfish fisheries in Sur, Oman.

5. Underestimates of growth of small tunas by length frequency analyses.

16:30 Adjourn for the day.

Wednesday February 8

8:30 Resume Meeting

6. Growth of *Scomberomorus commerson* based on length frequency data in Oman.

7. Growth of *Scomberomorus commerson* based on length frequency data and otolith increment counts in Sri Lanka.

8. Biological parameters and stock assessment for *Thunnus tonggol* and *Euthynnus affinis* in the western Gulf of Aden.

9. Growth of *Thunnus tonggol* from Oman based on length frequency data.

٢- مصايد التونة في خليج تايلاند والساحل الشرقي لمالزيا

٣- عدد عينات خيشيش سمك السهوة بعمان

٤- مصايد تونا في التقليديين على مصايد التونة والكتنعد في منطقة هور سلطنة عمان

٥- التقليدات التقليدية لنمو التونة الصخريه بسواسطة تحليبات تكرار الطول

٦- انتهاء الاجتماع

* الاربعاء : ٨ فبراير

٧- استئناف الاجتماع

٦- قسمو اسماك الكتندع المبني على اساس بيانات تكرارات الطول بسلطنة عمان

٧- قسمو اسماك الكتندع المبني على اساس بيانات تكرارات الطول وعدد الزيارة في الدمية الاندية في سريلانكا

٨- معلومات بيولوجيه وطرق تقدير المفترضين للسهوة والشروع في غرب خليج عدن

٩- قسمو اسماك السهوة في عمان المبني على اساس تكرارات الطول

١٠- الحاله البيولوجيه لعمرها في التونة في خليج عدن

١٠- استئناف

١١- استئناف الاجتماع

١١- تسويق واستهلاك اسماك التونة والكتندع في دول الخليج

Appendix 3. Contd/

10. Biological status of Thunnus albacares in the Gulf of Aden.

10:30 Coffee/tea break

11:00 Resume Meeting

11. Marketing and consumption of tuna and seerfish in the Gulf countries.

12. Research activities of the Marine Science and Fisheries Center.

13. Tuna fisheries development plan for Oman.

13:00 - 14:30 Lunch Break

14:30 Discussions

1. Mechanisms for the continuation of collaborative scientific investigations.
2. State of stock assessment for tuna and seerfish populations.

Dinner at Oman Sheraton.

Thursday February 9

6:30 Trip to Muttrah Fish Market

8:30 Breakfast at Hotel

9:30 Tour to Marine Science and Fisheries Center.

13:00 Lunch break.

15:00 Adoption of Report

١٢ - انشطة الابحاث بمركز العلوم البحرية والسمكية

١٣ - خطة تنمية مصايد اسماك التونة بسلطنة عمان

١٤ : ٣٠ * فقرة الغذاء

١٥ : ٣٠ * تفاصيل وسائل اتصال التعاون في حقل الابحاث العلمية .

١٦ - الوظائف المختلطة لدراسات المفنون لاسماك التونة والكتنعد

١٧ - ٣٠ : ١٩ * مكملة عشاء بفندق الشيراتون

* الخميس : ٩ فبراير

٢ - ٦ : * زيارة الى سوق السمك بمطرح

٣ - ٨ : * تناول الافطار بالفندق

٤ - ٩ : * زيارة الى مركز العلوم البحرية والسمكية

٥ - ١٣ : * فقرة الغذاء

٦ - ١٥ : * اعتماد التقرير النهائي

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١١

Appendix 4.

Information being collected in countries of the north Arabian Sea region

Species *Scomberomorus commerson*

	<u>c/e</u>	<u>If</u>	<u>growth</u>	<u>mortality</u>	<u>maturity</u>	<u>electro</u>	<u>meristic</u>
			If otolith	If			
1. UAE	-	start	-	-	-	-	-
2. Oman	yes	yes	yes	start	yes	start	yes
3. Pakistan	yes	start	-	-	-	-	-
4. Somalia	-	-	-	-	-	-	-
5. Sri Lanka	yes	yes	yes	yes	yes	-	-
6. PDRY	-	-	-	-	-	-	-

Species *Thunnus tonggol*

	<u>c/e</u>	<u>If</u>	<u>growth</u>	<u>mortality</u>	<u>maturity</u>	<u>electro</u>	<u>meristic</u>
			If otolith	If			
1. UAE	-	start	-	-	-	-	-
2. Oman	yes	yes	yes	start	yes	start	- yes ^{1/}
3. Pakistan	yes	start	-	-	-	-	-
4. Somalia	-	-	-	-	-	-	-
5. Sri Lanka	-	-	-	-	-	-	-
6. PDRY	-	-	-	-	-	-	-

^{1/} - gill raker counts

Species *Euthynnus affinis*

	<u>c/e</u>	<u>If</u>	<u>growth</u>	<u>mortality</u>	<u>maturity</u>	<u>electro</u>	<u>meristic</u>
			If otolith	If			
1. UAE	-	start	-	-	-	-	-
2. Oman	yes	yes	start	-	start	-	-
3. Pakistan	yes	start	-	-	-	-	-
4. Somalia	-	-	-	-	-	-	-
5. Sri Lanka	yes	yes	yes	yes	yes	-	-
6. PDRY	-	-	-	-	-	-	-

Species *Thunnus albacares*

	<u>c/e</u>	<u>If</u>	<u>growth</u>	<u>mortality</u>	<u>maturity</u>	<u>electro</u>	<u>meristic</u>
			If otolith	If			
1. UAE	-	-	-	-	-	-	-
2. Oman	yes	start	^{2/}	-	-	-	-
3. Pakistan	yes	start	-	-	-	-	-
4. Somalia	-	-	-	-	-	-	-
5. Sri Lanka	yes	yes	yes	-	-	-	-
6. PDRY	-	-	-	-	start	-	-

^{2/} - some weight frequency data is collected.

AN OVERVIEW OF TUNA FISHERY OF PAKISTAN

All these landings are then transferred to curing yards where it is cured and sun dried before exporting to foreign countries.

By

JAMEEL AHMED
Marine Fisheries Department
Karachi, Pakistan.

INTRODUCTION

Tuna is one of the least exploited resources of the Pakistan's EEZ hardly contributing 5% to marine fish landings at 1986 level. There is no aimed fishery for tunas in Pakistan. These fishes are incidentally caught by pelagic gillnetters, targeting on a number of mixed species, especially the more lucrative ones such as mackerels and sharks which fetch better prices in local market. Therefore the fishery is generally confined to the areas where most of these fishes occur and not specifically in areas where only tunas are abundant. It is exclusively a small scale artisanal activity with traditional mechanised gillnetters using drift gillnet, the only gear in vogue for tunas in Pakistan.

There is no local demand for tunas as there exists a sort of aversion to red meat in local populations. Therefore tuna fishery in Pakistan is export oriented. Almost the entire catch is exported in dried salted form mainly to Sri Lanka. There is no tuna cannery in Pakistan nor it is produced in frozen and other acceptable forms familiar to the world.

The vessels do not carry ice. The catches are gutted and salted on board and landed in wet salted condition. Only the last day's catch of the trip of a vessel is landed in fresh form.

Contd:.....P/2.

The percentage contribution of tuna landing in marine fish production as depicted in national statistics of Pakistan ranged from 1.07% to 4.71% during the last decade. However these figures are not reliable as there exists no proper fisheries statistical collection system in Pakistan.

Fishing Craft and Gear:

The fishing craft engaged in tuna fishing are mainly the mechanised gillnetters. At present the number of mechanised gillnetters actually operating in Pakistan waters is 394. Out of these 185 are operating along Sind Coast and 209 operating along Baluchistan Coast (Anonymous, 1986).

These gillnetters are usually of 15 to 20 meters keel length, 5 to 7 meters beam, fitted with 88-135 HP marine diesel engines. Their gross registered tonnage varies between 35 to 45. The vessels are fishing upto a depth of 100 meters.

The only fishing gear used in tuna fisheries in Pakistan is the drift gillnet. The net is made from nylon twine. It is usually 2500 m long with a stretched mesh size of 15 cm and having a depth of about 80 meshes. Plastic floats are used for buoyancy while stones weighing 4 to 7 Kg each are used as sinkers (Imad, 1987).

Fishing Areas and Operations:

There are two maritime provinces in Pakistan viz (i) Sind ii) Baluchistan (Fig.I). The vessels registered in Sind Province are supposed to fish in waters along Sind Coast and land their catches at Karachi, the only major fisheries harbour of Sind province and the biggest in whole Pakistan. However quite a

Contd:.....P/3.

number of the Karachi based vessels do operate in waters along Baluchistan Coast and land their catches at Karachi Fish Harbour. The Vessels registered in Baluchistan Province operate in waters along Baluchistan Coast only and land their catches at five important landing centres viz. Gaddani, Sonmiani, Ormara, Pasni and Gawadar.

The fishing trips along Sind Coast are relatively of shorter duration varying between 12 to 15 days while along Baluchistan Coast the duration of the trips varies between 15 to 25 days. The crew usually consists of 12 to 18 persons on a fishing vessel. Usually the net is shot in the evening and hauled up in the morning. All these operations are done manually as these vessels are not fitted with powered winches or net haulers.

Tuna Sampling Programme:

Available national statistics for fisheries are not reliable as there is no proper system of data collection at Karachi Fish Harbour. Specieswise landings are not recorded in the published national statistics. Therefore, to have a reliable estimate of tuna landings, a tuna sampling programme was initiated in 1986 at Karachi Fish Harbour with the assistance of ITPP. After examining the situation at Karachi Fish Harbour a stratified random sampling programme was introduced. Karachi Harbour was visited for 3 days in a week for collecting information and recording tuna landings data by interviewing the skippers of incoming pelagic gillnetters unloading their catches at Karachi Harbour. This programme is being carried out under the supervision of the author.

METHODOLOGY:

Effort Assessment:

Effort information is extracted from Port Custom register. All vessels operating from Karachi Fish Harbour obtain clearance

from the Port Customs authorities who maintain a register in which the entries regarding registration number, area of fishing and duration of the trip of the vessel are recorded. Unfortunately information about the status of the vessel, whether trawler or gillnetters, is not recorded in these registers. Therefore a random sampling technique was devised to determine the status of various categories. The vessels off-loading at Karachi port have also been monitored to determine the trawler to gillnetter ratio. The ratios between pelagic to demersal gillnetter is also recorded by counting the actual number of the each type of vessels off-loading at the time of visit to the Harbour.

There are a few purse seiners operating from Karachi Fish Harbour and unloading by-catch. These are also entered in port custom register. Their approximate number is obtained from the auctioneer dealing with by-catch.

In this way the total monthly effort for pelagics is determined by subtracting the number of trawlers, purse seiners and demersal gillnetters from the total number of vessels operated from the harbour in a month as recorded in Port Custom register. Catch and effort data were collected from the boats interviewed on the sampling days. These were then pooled to obtain mean catch per unit effort (catch/boat/day) values for the whole month.

Estimation of Landings:

Karachi Fish Harbour was visited at least 3 days in a week. The samplers obtained information by interviewing the skippers of incoming pelagic gillnetters in respect of fishing ground, fishing days and catch composition. In addition length frequencies were measured of as many individuals and species as possible from the catch landed in tact.

Generally the skippers maintain a complete list by number of the species caught. All the transaction at harbour are done

on the basis of this list. Some of the skipper were cooperative enough to hand over the list of their catch to the samplers. Such information was rated as "good". Others gave the information of their catch by dictating verbally and if the samplers were satisfied with the accuracy of the information it was rated as "fair". While some of them did not cooperate or not available on the vessel and the information was gathered from other crew members and if samplers were doubtful about the authenticity of the data, such informations were rated as "poor".

The data rated as poor were not taken into account while computing the total landings for a month. Monthly landings were estimated by the formula :

$$L = \frac{C_o}{E_o} \times Et$$

Where :

L = Monthly total landings.

C_o = Catch for observed units in a month.

E_o = No. of units observed in a month.

Et = Total No. of units operated in a month.

Collection of length frequency data:

Length frequency data were taken randomly from landings of tuna species at harbour. Fork lengths were measured to the nearest centimeter using a measuring board. These data were then grouped into 5 cm classes and pooled to obtain length frequency distribution for the different species of tuna.

RESULTS AND ANALYSIS:

Species Composition:

The common species of tuna and tuna like fishes observed

at the Karachi landing centre were :-

1. *Thunnus tonggol* (Longtail) LOT
2. *Thunnus albacare* (Yellowfin) YFT
3. *Euthynnus affinis* (Kawa Kawa) KAW
4. *Katsuwonus pelamis* (Skipjack) SKJ
5. *Axis thazard* (Frigate) FRG
6. *Istiophorus platypterus* (Indo-Pacific sail fish) BIL
7. *Makaira mazara* (Indo-Pacific blue marlin) BUM
8. *Scomberorus commersonii* (Narrow-barred spanish mackerel) COM
9. *S. guttatus* (Indo-Pacific King Mackrel) GUT

Percentage composition of tuna species in total tuna landings is given in Fig. 2, which shows that T. tonggol constituted 54.97% T. albacares 21.49% E. affinis 17.24% K. pelamis 5.22% and A. thazard 1.03% of the total tuna landings.

T. tonggol was the major species contributing about 54.9% to the total tuna landings. It was observed almost the year round. Its peak landings were recorded in the month of April, May and June when its percentage was 76.45%, 87.38% and 96.15% respectively. Then again in the period from August to November it was well represented.

T. albacare is the second important species contributing 21.49% to the total tuna landing at Karachi Harbour. It was also observed throughout the year except in the months of July and August during South-West monsoon period. It contributed 72.81% and 33.36% in the months of January and December, respectively.

E. affinis contributed about 17.24% to the tuna landings. It was also observed round the year. Its main landing were recorded from September to January, representing 48.70%, 19.56%, 23.68%, 25.46% and 24.21% respectively.

The occurrence of A. thazard was sporadic. Its total percentage contribution during the year was recorded 1.03%. It was observed in the months of April and May and then again in the months of August, September and October, while for the rest of the year it was totally absent from the landings.

Landings:

The data generated from Karachi Fish Harbour for the year 1987 were computed and the total landings of all tuna species combined were estimated to be 6185 m. tonnes at Karachi Fish Harbour only. Of which 3402 m. tonnes was contributed by longtail (T. tonggeli), 1067 m. tonnes by Kawakawa (E. affinis), 1330 m. tonnes by yellowfin (T. albacares), 325 m. tonnes by skipjack (K. pelamis) and 64 m. tonnes by frigate tuna (A. thazard). (Tab.III)

The seasonal variation in tuna landings is given in Fig. 3 which show two distinct seasons, one from March to May and the other from September to January. The South-West monsoon period was lean period due to reduction in effort level because of the prevailing rough weather conditions.

Species-wise seasonal variation in landings of four important tuna species is given in Fig.4. The contribution of various species to tuna landings in different months revealed that peak landings in the season from March to May can be attributed to longtail tuna alone, while the second season starting from September and persisting till January was of mixed catch composition where all the four most important species of tuna contributed considerably. However the dominant species were yellowfin and longtail which took the major share of the tuna landings.

Fisheries statistical collection system in Baluchistan is far better than Sind. The statistics collected by provincial Fisheries Department for Baluchistan are quite reliable (Moazzam, personal communication). The landing statistics received for

1987 from Baluchistan has shown that tuna contributed 8,387 m. tonnes to the marine landings, while contribution of seerfish was 5394 m. tonnes and that of billfishes was recorded as 226 m. tonnes. Taking into account the tuna landings in Baluchistan, the total tuna landings for whole of Pakistan come to 14,572 m. tonnes for the year, 1987.

Variation in catch per unit effort (CPUE):

The mean monthly catch per unit effort (catch/boat/day and catch/boat/trip) values estimated for the year 1987 are shown in Fig.5 and 6 respectively. Both have followed almost the same pattern except in April when catch/boat/day has declined as compared to March, whereas catch/boat/trip is on the increase in the same period i.e. from March, through May. Relatively high CPUE values have been realised in the month of December. However from these data it is quite clear that there are two distinct seasons for tuna fishery, one from March to April and the other from October to January, the later being the peak season. The South-West monsoon is the lean period when tuna fishery almost comes to a stand still due to prevailing rough weather conditions. Variation in CPUE values when compared with the variation¹/Total monthly effort showed that the variation in monthly effort had not influenced the variation in CPUE.

These observations indicate that variation in CPUE values can serve as an indicator of the relative abundance of tuna along the entire coast in different months.

Length frequency distribution:

Since tuna catches are landed mostly in wet salted condition, sufficient length frequency data could not be obtained on monthly basis, therefore definite conclusion regarding growth rates could not be derived from the scanty data. However the data collected during 1987 have been pooled on yearly basis and

have been plotted in figures 7, 8, 9 & 10 for T. tonggal, T. albacares, K. pelamis and E. affinis respectively.

Length frequencies for T. tonggal have been plotted in Fig. 7 which show that longtail ranged from 41 cm to 100 cm in fork length. Major modes were observed at 65 - 68 and 73 - 76 centimeter classes.

Length frequencies for T. albacares have been shown in Fig. 8. It ranged from 47 cm to 190 cm in fork length showing different modes at 75 - 78, 91 - 94, 100 - 103, 107 - 110, 116 - 119 and 123 - 126 cm classes, major modes being in between 100 to 126 cm fork lengths.

Length frequency data for K. pelamis have been plotted in figure 9. This species ranged between 47 to 78 cm in fork length, major modes being in between 55 to 74 cm fork lengths.

Length frequency data for E. affinis is given in Fig. 10. Its range was noticed between 31 to 82 cm fork length. The major modes were observed in between 50 to 60 cm fork length.

DISCUSSION:

The estimated annual landings as computed through the stratified tuna sampling programme has come to manifold to what we have been depicting in the national statistics during the last decade. This is indicative of the fact that tuna resources are far greater than what we have been reflecting so far. The role of reliable statistics in the development of fishery in a country needs no emphasis, without which no sound policy and planning can be done. In the absence of reliable statistics private entrepreneurs feel shy of investing in tuna business.

Species composition of the tuna catches has shown that considerable landings of oceanic species such as yellowfin and skipjack is taking place by the small scale sector, employing traditional craft and gear, whose effort are confined to the coastal

waters. This can perhaps be attributed to the fact that continental shelf along Baluchistan coast is very narrow (15 - 30 Km) and deep waters run very near to the ~~shallow~~ resulting in relatively high landings of the oceanic species from coastal waters. It can be interpreted that there must be big resources of oceanic species further offshore in our EEZ and contiguous high sea, which remain unexploited.

Yellowfin tuna is only a minor constituent in the Indian tuna fisheries where the landings are dominated by eastern little tuna (E. affinis, Auxis sp.), longtail tuna (T. tonggal) and skipjack (K. pelamis), together forming over 80% of the tuna catch (Silas and Pillai, 1984). But the pattern of tuna species composition in landings at Karachi is quite different from that of India. Yellowfin is the second most important species accounting for about 21.5% to the tuna landings at Karachi Harbour. Landings are dominated by longtail tuna contributing about 55% to the landings, whereas in India eastern little tuna (E. affinis) is the major constituent.

SUGGESTION FOR THE DEVELOPMENT OF TUNA FISHERY IN PAKISTAN:

The options for the development of tuna fishery in Pakistan can be placed under two major heads. These are (A) developing marketing system and post harvest technology (B) augmenting production.

(A) Marketing & Post Harvest Technology:

The lack of proper marketing system for the disposal of even present production is the major constraint in the development of tuna fishery in Pakistan. As mentioned earlier there is no local demand for red meat tunas in Pakistan, therefore the tuna fishery in Pakistan is export oriented. The entire catch is exported in dry salted form, a product of very low quality, to countries like

Sri Lanka on throw away prices, the only option of disposal available to the fishermen in Pakistan. There exists no cannery for tunas nor it is produced in frozen, chilled or other acceptable forms familiar to the world.

Development of a cannery which can handle 6,000 to 10,000 tonnes of tuna per annum is an area which requires immediate attention. Export markets for canned, frozen and chilled tunas will have to be explored. For that matter a major change in the pattern of tuna fishery will have to be brought especially in post harvest technology to produce fish of high quality to compete the international market. General method of handling of tuna fish practised in Pakistan is the gutting on board and applying salt. The product is thus mostly landed in wet salted condition. Such a product has very limited market. To produce high quality fish our vessels will have to have freezing facilities for storage of fish prior to processing and marketing. Salt water chilling would be an ideal method for the type of vessels used in Pakistan. For the trips of shorter duration of 3 to 4 days icing of the catch would be suitable method.

Another option would be to introduce a carrier boat system which could purchase the catch from fishermen right at the fishing grounds in fresh condition and then bringing it in chilled form at the landing centres. Such developments would have a profound impact on the tuna fishery by fetching better prices to the fishermen for their catch, thus alleviating their socio-economic conditions at one hand and by enhancing the export earnings of the country considerably, even at the present level of production, on the other.

Consequently the introduction of proper marketing system and improvement in post harvest technology would provide the necessary incentive to the fishermen, for increasing production of tuna fishes in the country.

- (B) Augmenting production:
- Resource information collected through this tuna landing programme indicates good potentials of coastal and oceanic species of tunas and allied species in the EEZ of Pakistan.

Although a resource survey is a pre-requisite for working out the feasibility to venture into tuna fishery, yet the considerable landings of oceanic species of tunas by small scale artisanal sector through traditional craft and gear is indicative of good potentials of these fishes in our EEZ which calls for an immediate entry into high sea tuna fishery without waiting for feasibility reports.

The prime steps in the development of high sea tuna fishery by Pakistan would be to utilize expertise of developed nations through joint chartering arrangements for harvesting tuna resources of the high seas. Introduction of purse seining for surface tunas like skipjack and young yellowfin would be another step forward in this direction.

For augmenting production of coastal species of tunas immediate attention will have to be paid for the development of small scale sector through improvement of craft and gear.

Possibilities of introducing other gears like live bait pole and line fishing and use of artificial fish aggregating devices should be looked into and tried in our waters.

Production areas for tuna fishery should be identified through mapping the special environmental features where tuna fishes tend to congregate. In this regard modern techniques like satellite imagery should also be employed.

ACKNOWLEDGEMENT

The author is grateful to Mr. Sakurai, IPTP Programme Leader for providing financial support to tuna sampling programme at Karachi. Many thanks to Mr. Yesaki, IPTP Tuna Biologist, who took the initiative and introduced the tuna sampling programme at Karachi Harbour. It was through his valuable technical assistance that the collection of these data were possible, on which this paper is based.

CAPTIONS OF FIGURES

Fig. 1. Map showing important landing centres and areawise distribution of tuna catching vessels along Pakistan coast.

Fig. 2. Percentage composition by species of tuna landings in 1987.

Fig. 3. Seasonal variation in tuna landings at Karachi Harbour by gillnet fishery (All species combined).

Fig. 4. Seasonal variation in landings of four important species of tuna at Karachi Harbour.

Fig. 5. Seasonal variation in total efforts and catch/boat/day of all tuna species combined in gillnet fishery.

Fig. 6. Seasonal variation in total effort and catch/boat/trip of tuna (All species combined).

Fig. 7. Length frequency distribution of longtail in 1987.

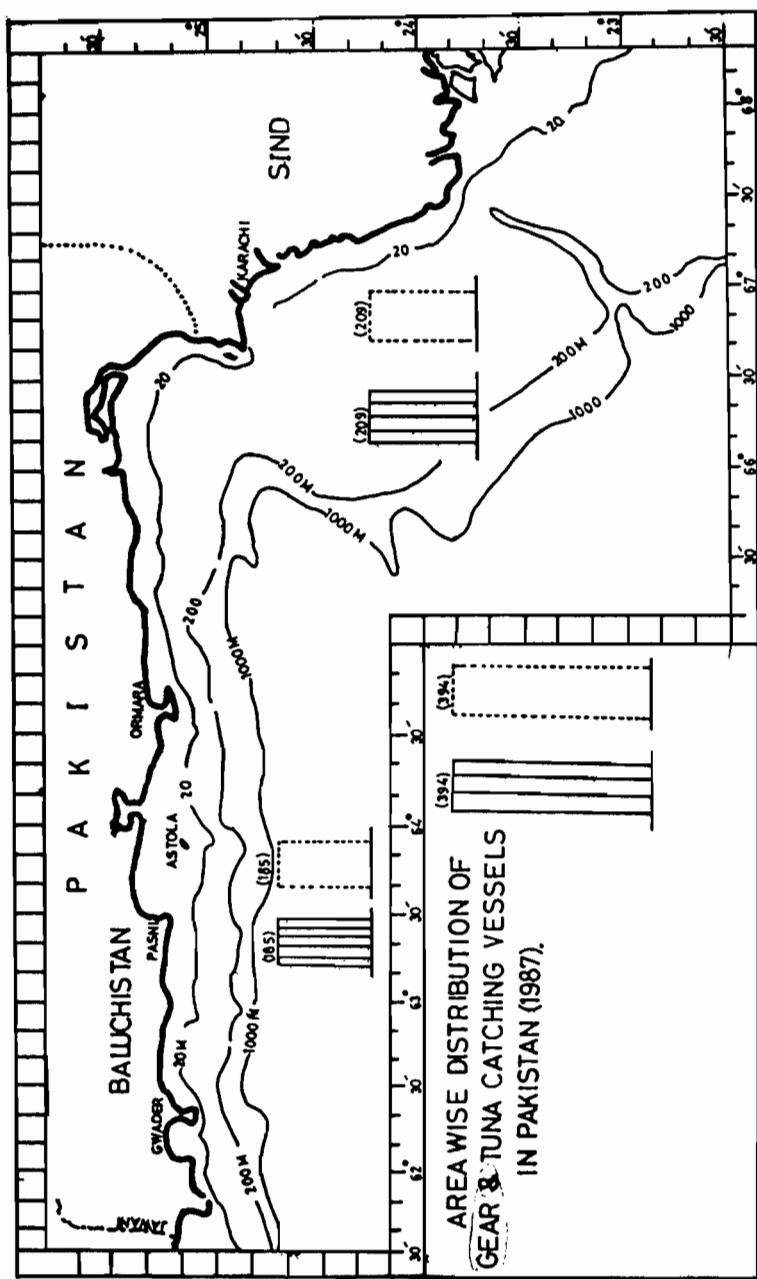
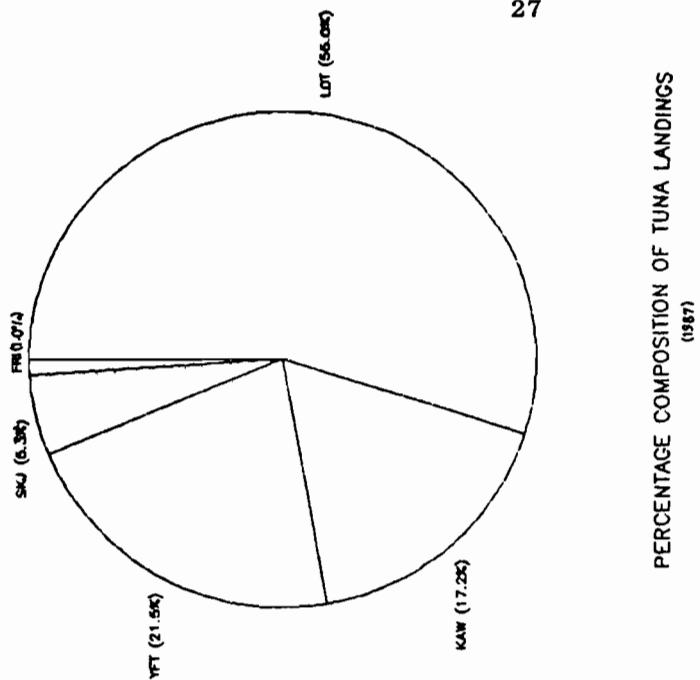
Fig. 8. Length frequency distribution of yellowfin in 1987.

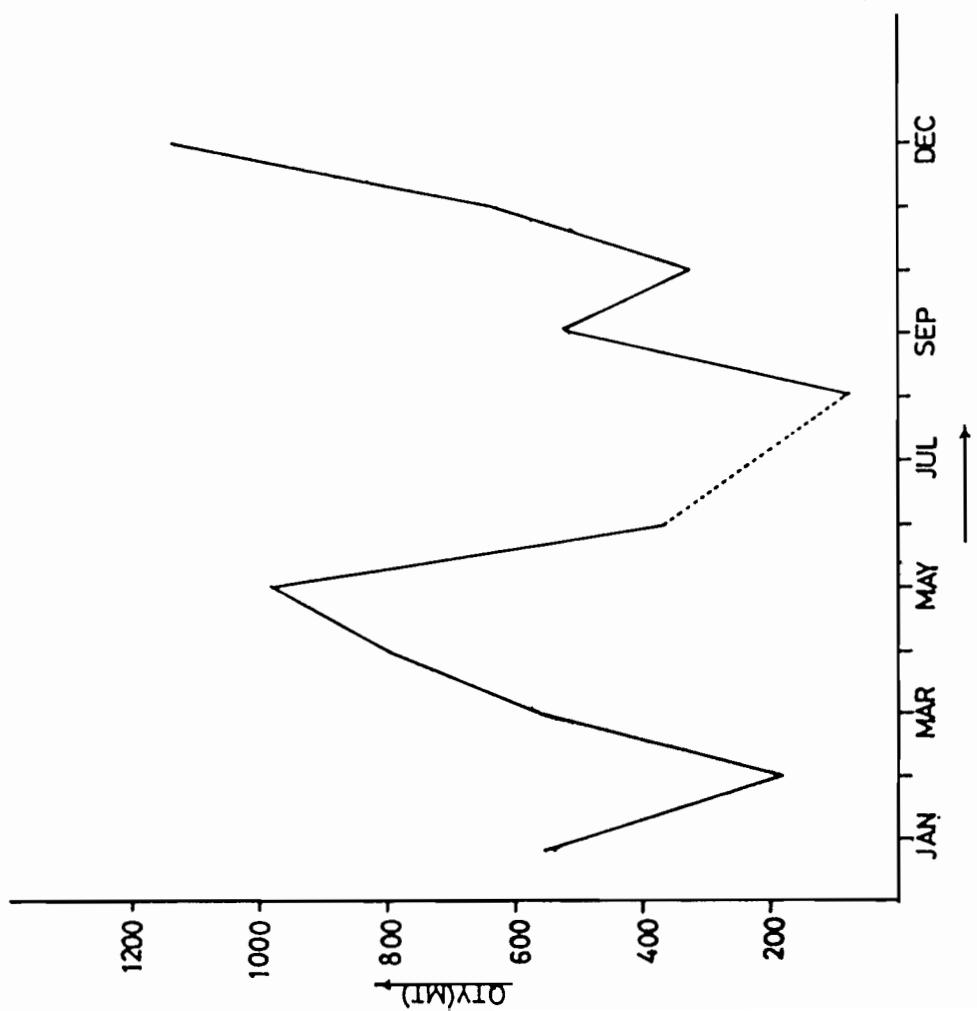
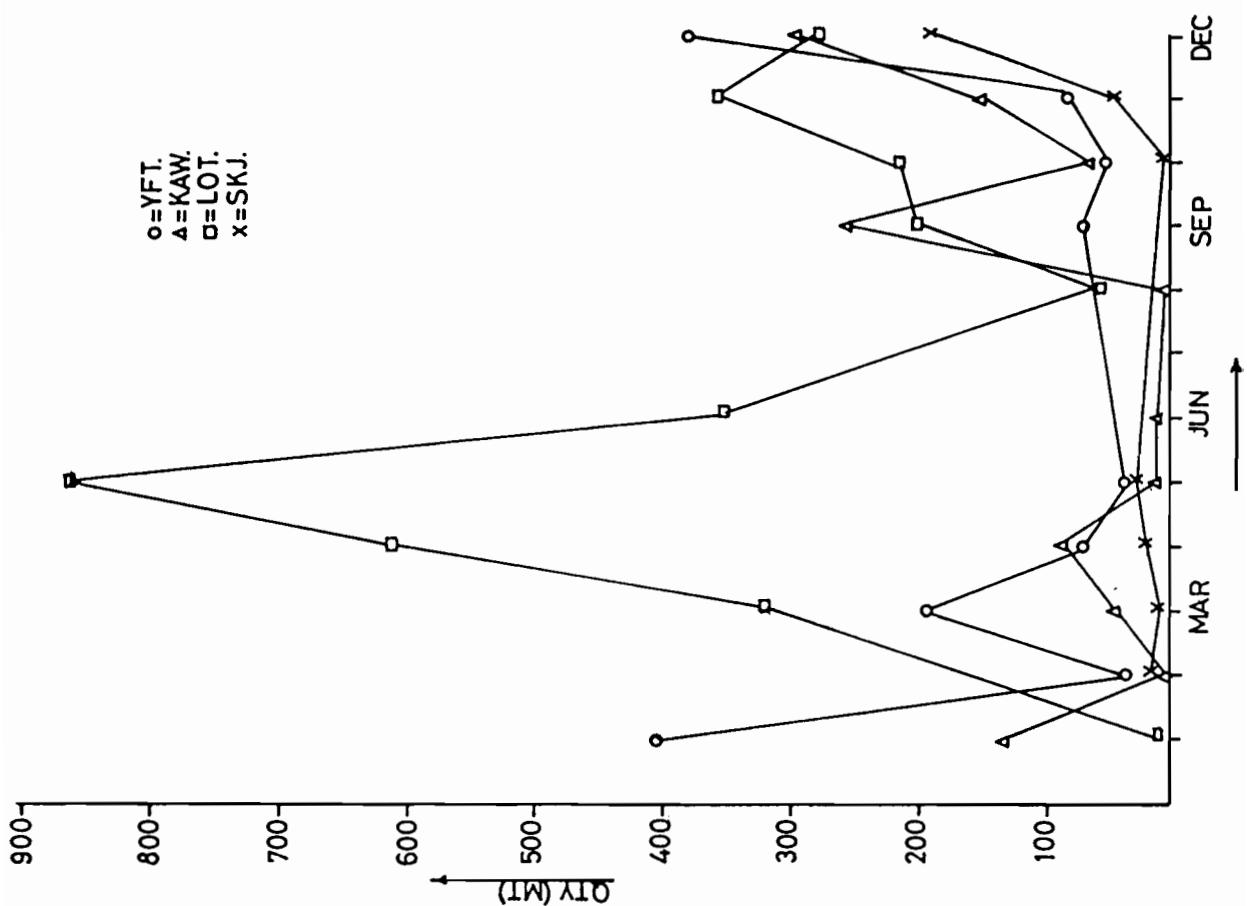
Fig. 9. Length frequency distribution of skipjack in 1987.

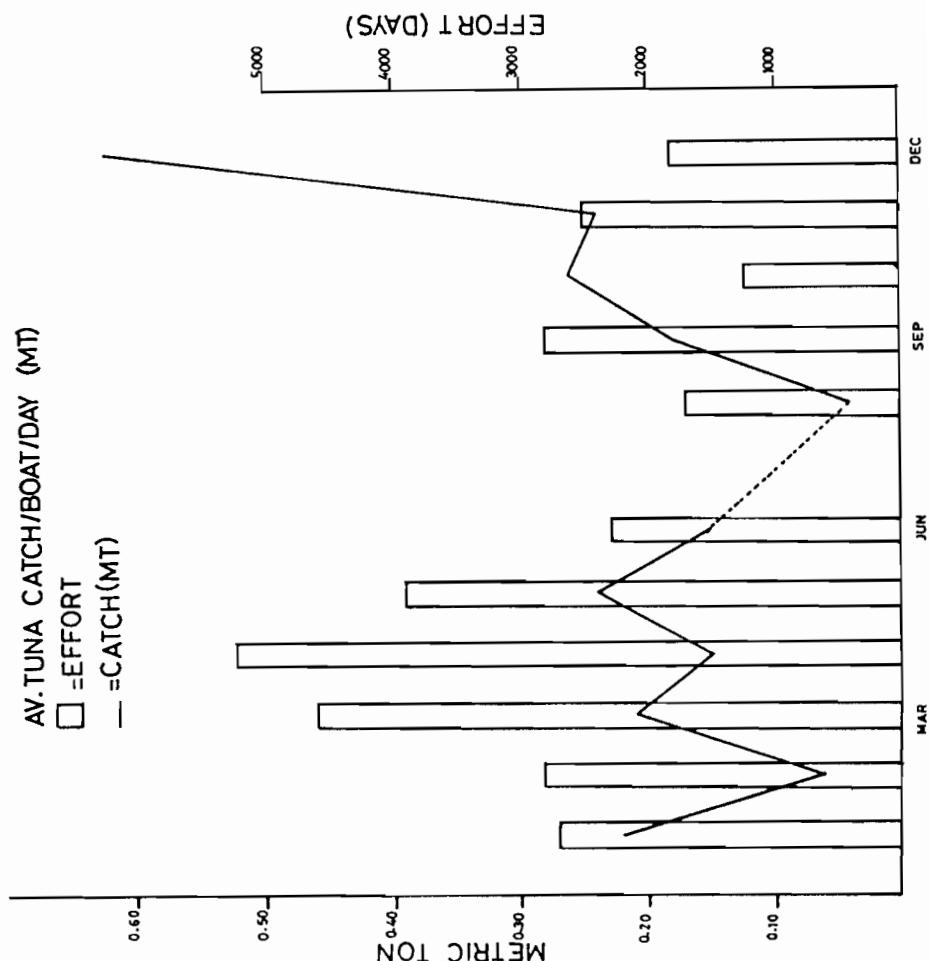
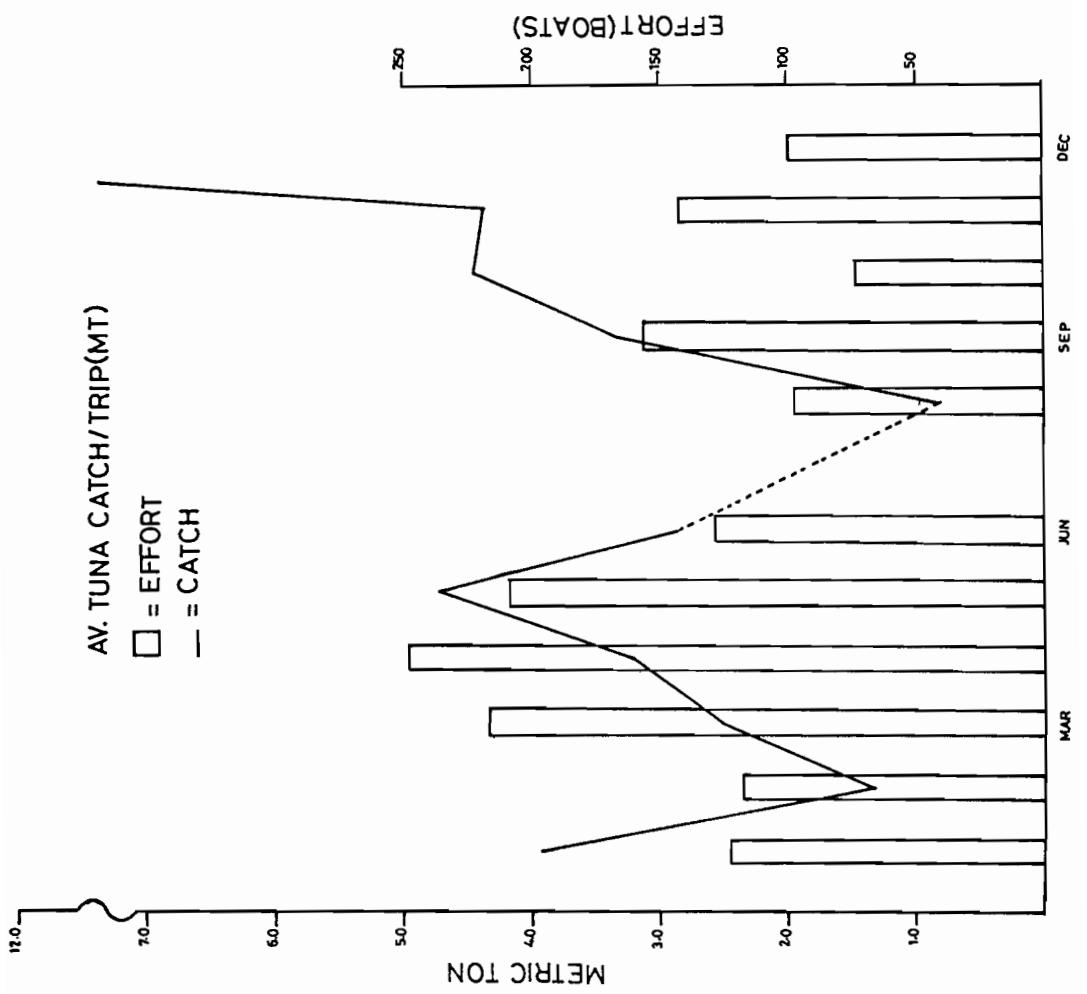
Fig. 10. Length frequency distribution of kawa kawa in 1987.

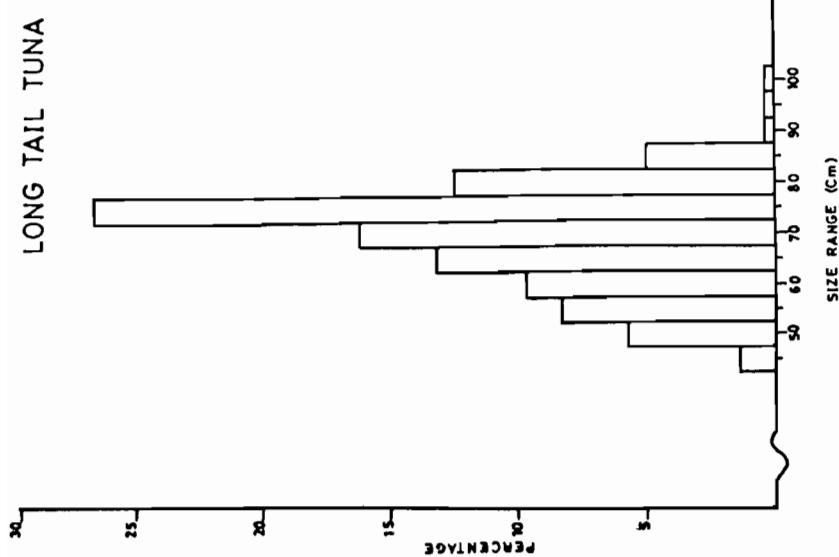
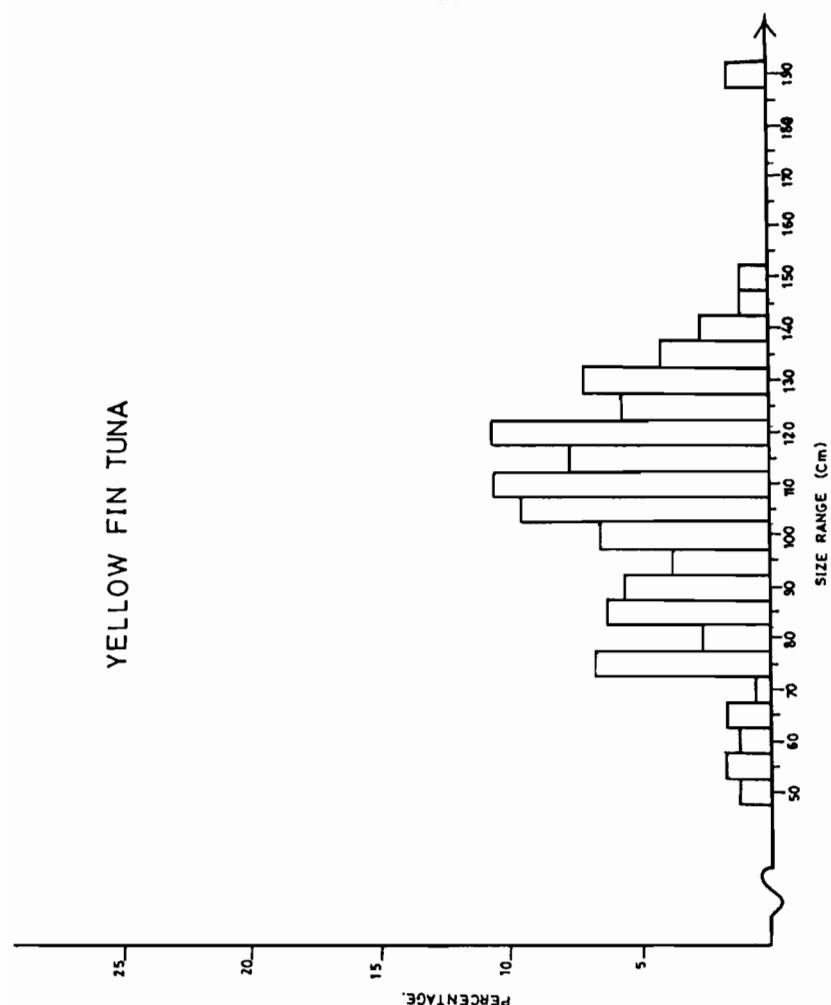
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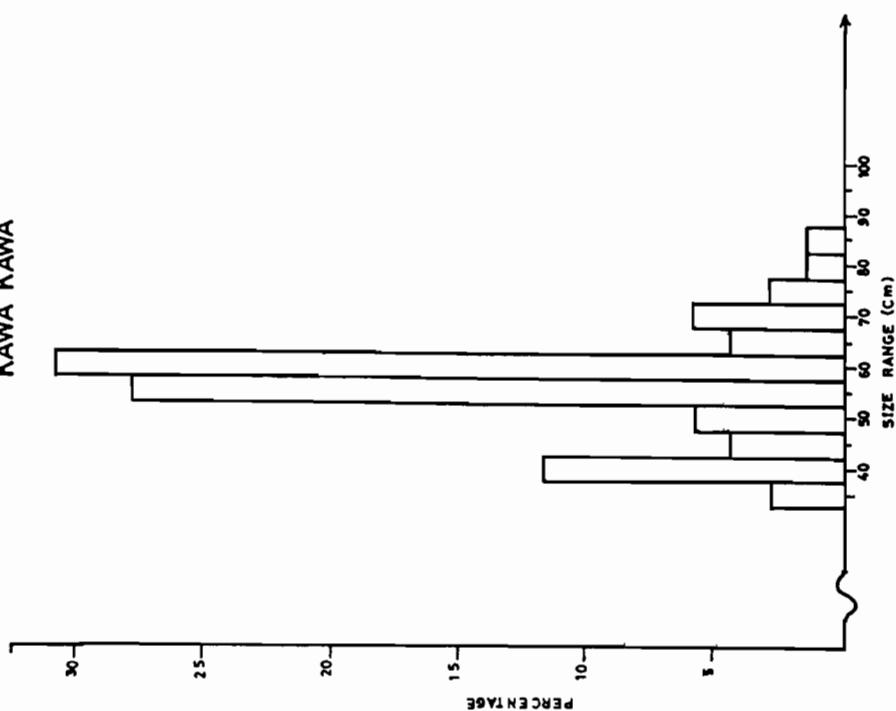








KAWA KAWA



SKIP JACK TUNA

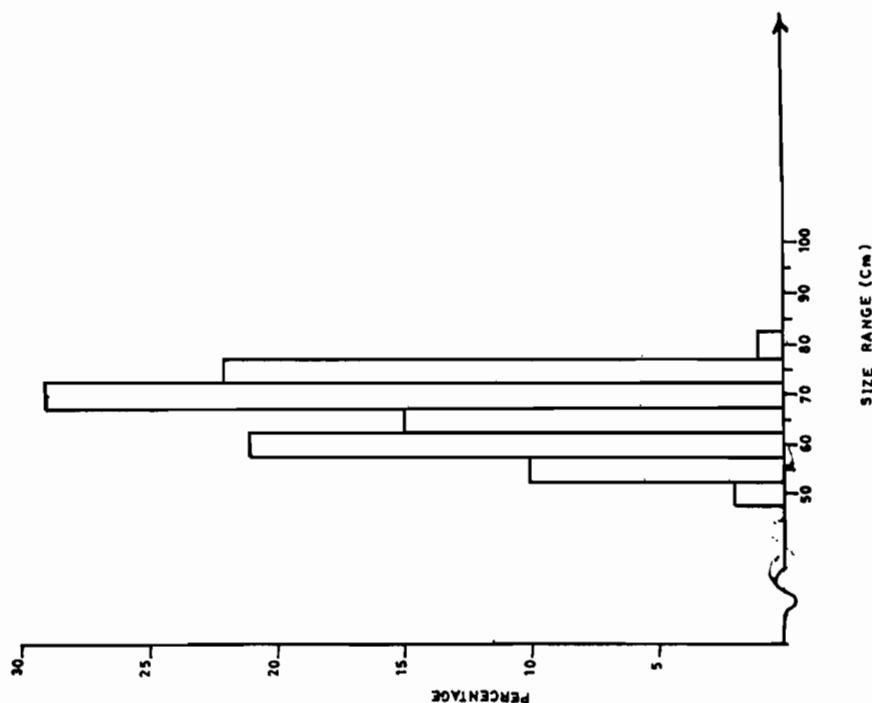


TABLE I

SEASONAL VARIATION AND PERCENTAGE COMPOSITION BY WEIGHT OF TUNA LANDINGS IN 1987

	LOT	KAW	YFT	SKJ	FRG						
MONTH	QTY	X	QTY	X	QTY	X	QTY	X	TOTAL		
JANUARY	16.68	2.96	136.00	24.21	409.00	72.81	-	-	561.68		
FEBRUARY	127.00	68.72	4.69	2.53	38.02	20.57	15.08	8.16	184.79		
MARCH	320.00	55.70	85.50	7.91	192.00	33.48	16.60	2.88	574.50		
APRIL	614.00	76.45	87.70	10.91	71.20	8.86	22.60	2.81	803.13		
MAY	862.40	87.39	11.80	1.15	36.70	3.71	36.30	3.67	986.80		
JUNE	354.00	96.15	13.50	3.66	0.66	0.17	-	-	368.16		
JULY	-	-	-	-	-	-	-	-	-		
AUGUST	60.00	74.07	7.00	8.64	-	-	-	14.00	17.28	81.00	
SEPTEMBER	201.00	37.94	258.00	48.70	68.60	12.95	-	-	2.10	0.39	529.70
OCTOBER	211.70	64.11	64.60	19.56	51.30	15.53	2.52	0.76	0.06	0.01	330.18
NOVEMBER	354.00	56.27	149.00	23.68	82.00	13.03	44.00	6.99	-	-	629.00
DECEMBER	281.00	24.67	290.00	25.46	380.00	33.36	188.00	16.50	-	-	1139.00
TOTAL	3401.78	1067.39		1329.88		325.10		63.79		6187.94	

Table II Seasonal variation and catch composition of gillnetters catching tuna in 1987

MONTH	LOT		KAW		YFT		SKJ		FRG		COM		BIL		SHRE		OTHERS		TOTAL
	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	QTY	%	
JANUARY	16.68	2.96	136.00	24.21	409.00	72.81	-	-	-	-	-	-	31.00	2.57	216.00	17.91	397.32	32.94	1206.00
FEBRUARY	127.00	68.72	4.69	2.53	38.02	20.57	15.08	8.16	-	-	-	-	90.62	26.34	68.59	19.93	144.00		
MARCH	320.00	55.70	85.50	7.91	192.00	33.48	16.60	2.88	-	-	-	-	57.47	3.71	937.00	54.17	76.00	4.91	1544.97
APRIL	614.00	76.45	87.70	10.91	71.20	8.86	22.60	2.81	7.63	0.75	-	-	24.29	1.71	275.10	19.38	316.40	22.30	1419.00
MAY	862.40	87.39	11.80	1.15	36.70	3.71	36.30	3.67	40.00	4.05	-	-	123.00	10.23	13.75	1.64	72.45	6.02	1202.00
JUNE	354.00	96.15	13.50	3.66	0.66	0.17	-	-	-	-	-	-	10.96	1.34	236.42	29.03	199.36	24.44	815.00
JULY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
AUGUST	60.00	74.07	7.00	8.64	-	-	-	-	14.00	17.28	6.00	3.57	2.06	1.22	20.50	12.20	58.44	34.70	168.00
SEPTEMBER	210.00	37.94	258.00	48.70	68.60	12.95	-	-	2.10	0.39	-	-	3.00	0.37	34.27	4.24	240.00	29.73	806.97
OCTOBER	211.70	64.11	64.60	19.56	51.30	15.53	2.52	0.76	0.06	0.01	2.52	0.37	64.50	9.60	171.20	25.70	98.00	14.71	646.34
NOVEMBER	354.00	56.27	149.00	23.68	82.00	13.03	44.00	6.39	-	-	64.00	5.22	52.00	4.24	39.00	3.18	442.00	36.05	1226.00
DECEMBER	281.00	24.67	290.00	25.46	380.00	33.36	188.00	16.50	-	-	22.50	1.50	86.00	5.76	215.00	14.41	29.50	1.97	1492.00
TOTAL	3401.78	1067.39		1329.88		325.10		63.79		95.02		456.28		2155.06		1948.04		10890.34	

TUNA AND SEERFISH STATUS OF SOMALIA

Prepared by

Yusuf Abdullahi Nur

1. Introduction

Tuna and seerfish common in Somalia are not so well identified. Tuna species commonly found are bigeye (*Thunnus obesus*), yellowfin (*T. albacares*) and albacore (*T. alalunga*). Three seerfish species have been observed, namely *Acanthocybium solandri*, *Scomberomorus commerson* and *Scomberomorus guttatus*. Where canneries, fresh fish markets or cold stores are not available, these fish salter. The total landed is not exactly known due to poor statistical recording, lack of trained personnel, remoteness of many fishing villages, and because fishermen directly sell their products. Trials were made to sample in Mogadishu free fish market but in vain. This is due to the fact that fishermen do not allow their catch to be counted or weighed. The fish record kept in the government fish markets use grouping method where the highly priced king fish and yellowfin are put together; bonito, skipjack, sailfish and swordfish are in the second grade. Therefore catch composition is not possible to be observed in our recording system.

Off shore tuna fishing in Somali waters have never been regularly carried out, despite the potential yield indicated by commercial and scientific sources. Licensing of Japanese longliners for test fishing in Somali waters began as far back as 1960. In 1983, ten Japanese vessels were licensed. In 1986 Korean longliners increased to 21 from 19 as in 1984. Japanese vessels were not available from 1984.

Licenses for longliners in Somalia are issued on a monthly basis for a fixed sum per vessel per month. The provision of daily catch and effort statistics is a condition for licensing. Also observers who are not trained for sampling are allowed on board as a part of the agreement. They record catch and perform gear inspection.

Table 1. Korean tuna longliners catch in Somali waters (1986)

No of vessels	March	April	Monthly catch (mt)	Total	Average
21	106	560	621	1,288.2	61.3

Table 2. Korean tuna longline catch in Somali waters (1987)

Month	No of vessels	Catch (mt)					Average
		BE	YP	AI	Mar	Others	
March	16	110.3	254.8	1.4	45.7	37.3	449.5
April	31	215.4	668.2	5.8	112.0	84.6	1086.0
May	26	218.1	476.1	2.6	71.4	81.4	849.6
June	1	0.7	1.8	-	0.3	0.3	3.1

Table 3. Korean tuna longline catch in Somali waters (1988)

Month	No. of vessels	Catch (mt)					Average
		BE	YP	BP	others	Total	
March	20	195.3	253.7	64.4	29.5	542.9	27.1
April	34	402.6	550.7	104.0	53.3	1110.6	32.7
May	22	247.5	303.6	48.9	42.6	642.6	29.2

Key

BE = Bigeye
YP = Yellowfin
BP = Billfish
Mar = Marlin
AI = Albacore

2. Catch statistics

The total fish production for Somalia is estimated at 18,000 mt per annum out of which 20% represents large pelagics mainly tuna and seerfish. Production by longliners represent 56% of all large pelagics produced in 1988. Catch rate for longline fishing vary from 276 mt to 2617 mt per annum between 1972 and 1977. During the years of 1986 to 1988 the range remains within the limits given in Tables 1 to 3.

3. Catch effort data

Various surveys conducted for large pelagic species in Somali waters indicate that multiple trolling averaged 26.6 kg/trolling hour and 212.8 kg/trolling day. Early longline surveys made during 1962-73 in the Gulf of Aden showed a high hook rate. A survey carried out in 1988 by North East Coast Enterprise showed that 29,595 m of Pelagic gillnet produced 15,867 kg. A similar study carried out with longlines in 1984 has shown 540 kg/day and 24 kg/100 hooks.

Reliable data for catch effort statistics in artisanal fisheries is not available but data recorded for Las Koreh Cannery in 1977-82 indicated catches per boat/day as 160 kg. Catch per day rates were 170kg during the peak months of October and December and around 130 - 140 kg for the other four months of the season. Daily average catch for Hobo and Kandala are about the same.

Hanid

This product is sold locally or exported to Jeddah. Price paid by consumer is Sh.2,000/kg and 18 - 20 riyals/kg. The product is prepared mainly from yellowfin tuna and sometimes from sailfish and marlin.

The procedure is to bury a 200 liter oil drum in the sand so that the open end stands just clear of the surface. Firewood is then placed in the bottom of the drum and the fire is lit and left to burn down until only hot embers are left. The fish is gutted, cut along the dorsal side, salted and is placed in the drum with the head facing downwards. The drum is then covered with the metal top and covered with a soaked sack and sand. The fish is removed from the drum and the bones, skin, dark meat and loose meat picked so that only firm blocks of flesh remain. The product is called "hanid" and is left to dry after resalting.

Pelagic gillnets

Twine size - used are standarized on 21.0d/36-45 ply. The preferred type is 45 due to it's greater service life. Nets are stated to last 3-4 seasons on average.

Mesh sizes - are usually 150 mm but a range of nets are in use at all fish centres and their mesh size and dimensions reflect the source of supply. 154 mm to 178 mm are usually obtained from the Gulf. Nets supplied by the Ministry range from 127 mm to 230 mm.

The length of nets most commonly used are 100 to 120 m stretched length which when mounted on rope gives nets of 70 to 90 m.

The depth of average net in use in some areas of the north is 6-8 m deep, while it is staked that 14 - 16 m depth is preferred.

Longlines are not commonly used except by boats that fish for the canneries. Pelagic (floating) longlines were used to catch yellowfin.

Hook and line and trolling are commonly used for tuna (yellowfin) and kingfish around Mogadishu and it's vicinity.

Fishing boats

Boats used for artisanal fishing are varied as they are obtained from various sources. They are imported from such countries as Sri Lanka, Italy, Greece. Locally made GRP boats are of 6.4 and 8.5 m length. Huris (canoes), baiden and sail boats are also used. The total number of fishing boats is as follows:

Motorized boats	354
Traditional canoes	891
Traditional sail boats	176

Processing

Most of the artisanal catch for tuna and seerfish are processed soon after landing or otherwise cold-stored. Processing includes canning salting and smoking (hanid a local product).

Myluux (salted kingfish)

The fish is split ventrally, salted and laid flat to dry. The flesh rarely achieves a hard dry, and after a few days of drying it may be resalted and stacked with the two halves folded back together. The product is sold to East Africa. The price of this product is low, ranging from 50 to 70 sh.price.

Canned tuna

Tuna caught in the north-east near the canneries are used for canning. Canned tuna is highly sought after in Somalia. Habo and Kandala use 200g, 1.0 kg and 2.5 kg cans while Las Koch use only 200 g cans. The production by these canneries from Oct. 1987 to April 1988 is as follows:

Input (mt)	Cans processed
Habo & Kandala	183
Las Koreh	118

Prices

Local prices for tuna and seerfish vary from region to region depending on supply and demand. The highest demand for yellowfin and kingfish is in Mogadishu and it's vicinity. The price paid for Kingfish in Mogadishu is as high as 400 sh. The following is a comparative price list to consumer at price regulated centres:

	Sh/kg
Mogadishu	120 - 200
Borasoo	35 - 50
Berber	35 - 55

References

1. Ministry of Fisheries and Marine Transport annual report for 1988
2. Task Force Report No. 3
3. Necfish Feasibility Study (final draft) - 1988.

Appendix 7.

FISHERIES FOR SEERFISH (*Scomberomorus* spp) IN WATERS AROUND SRI LANKA

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NATIONAL AQUATIC RESOURCES AGENCY
COLOMBO, SRI LANKA

PAPER PRESENTED AT THE WORKSHOP ON TUNA
AND SEERFISH IN THE NORTH ARABIAN SEA
REGION. MUSCAT - FEBRUARY 7 - 9 1989.

Introduction:

Seerfishes in Sri Lanka are economically important because of their high market value. However, there is no separate fishery for seerfish. As in many other tropical fisheries the majority of fisheries in Sri Lanka are multispecies and multi-gear.

Seerfish are caught right round the island by many varieties of gear that are used mainly for large pelagic fish species. Gillnets, troll lines and hand lines are the main contributors to the production of this variety. Combination gears are used by most of the fishing crafts and because of the high market value fishermen tend to put more effort in catching seerfish with additional gears. They use troll lines while sailing to and from the fishing grounds and hand lines while they are operating main fishing gears, usually gillnets and longlines.

The total seerfish production in Sri Lanka has remained around 3500 MT per annum during the past few years. This is about 2.5% of the total marine fish production. Though this species is an economically important one in Sri Lanka, the available literature on this species is very limited. Jiradassai (1980) described the species composition, size range and age and maturity of *Scomberomorus commerson* from the west coast. Some information on seerfish are also available in publications on fisheries for large pelagics and tuna-like species (De Bruin 1970, Joseph 1985 and Maldeniya et al 1987).

The present paper describes the different methods of exploitation, production trends, seasonal variation in catches, species composition and the size distribution of the important species of seerfish in the waters around Sri Lanka.

An approximate estimate of seerfish production by different gear types are as follows:

	<u>MT</u>	<u>Percentage</u>
Drift gill nets/ troll lines	2034	55
Hard line/troll lines	1072	29
Drift gillnets/handline	444	12
Beach seine, small mesh gillnets and other gears	148	4

Catch rates:

Catch data collected for 1987 by the NARA/IPTP sampling programme were analysed for the present study. These data were collected at three major fish landing sites on the northwest, west and southwest coasts. (Fig. 1). As the gillnets operated by the 9 meter class of boats are the major contributor to the seerfish production only these data are presented. Catch/boat/fishing night was considered as the catch per unit effort. Fig. 2 shows the monthly variation in catch per unit effort of seerfish in the three areas. Catch rates in Kandakuliya were very low ranging from 0.12 kg to 4.5 kg. Better catch rates were observed in Negombo and Beruwala with the values ranging from 0.23 to 12.4 and 0.8 to 10.3, respectively. In all the three areas, high catch rates were observed from July to October (Fig. 2). This period is the peak season for the total large pelagic production as well. An increase in catch rates were also observed in December. This is more prominent in Negombo. The average catch rate of seerfish were 1.28 kg, 4.41 kg, and 3.24 kg/boat night for Kandakuliya, Negombo and Beruwala, respectively.

In Sri Lanka drift gill netting conducted by the 9 meter and 11 meter class of boats is the major fishing method used in the exploitation of large pelagics. The number of net pieces depend on the type of crafts and the mesh sizes range from 10 to 15 cm. All the 11 meter and a majority of the 9 meter class of boats now operate as multiday boats carrying out fishing at relatively greater distances from the Sri Lankan coast (Dayaratne & Maldeniya 1987). A major part of the production of seerfish are from these drift gill nets. Small meshed gillnets (mesh size ranging from 3.2 cm to 6.0 cm) are operated by 5.5 - 6.1 m class of FRP boats in nearshore waters for small pelagics. During certain seasons, the juveniles of seerfish are caught by these gillnets. In the west, south-west and south coasts of Sri Lanka, a handline fishery is carried out along the reef edges of the continental shelf. 5.5 - 6.1 m FRP boats are mainly used for this purpose although a few 9 meter boats and dugout canoes are also used. Seerfish are also caught in the incidental handline fishery carried out by the purse seiners (9 meter boats) in the south-west coast of the island. Trolling is carried out by the drift gillnetters and handliners while sailing to and from the fishing ground. During certain seasons, troll lines are operated on the west coast specifically for seerfish. Sardines and squids are mainly used as bait in handline and troll line fisheries for seerfish.

Production trends:

The estimated seerfish production and its percentage contribution to the total marine fish production for the period 1978 to 1987 is given in Table 1. Table 2 gives the estimated seerfish production on a provincial basis for the years 1982 and 1984.

Not much fluctuations has occurred in seerfish production during the last decade, except in 1980 when the highest production of 6230 MT was obtained. The lowest production of 3385 MT was recorded in 1984 but there has since been a slight increase in production. Northern, western and eastern provinces are the areas with high production. The percentage contribution of seerfish to the total marine fish has remained around 2.5% although it was higher in 1980 (3.0%) and lower in 1982 and 1983 (1.9%).

Monthly variations in the total seerfish production in the three areas covered by the NARA/IPTP sampling programme is shown in Fig. 3. Highest production was observed during the post monsoonal months i.e July–October. This is also the peak period of total large pelagic fish production from these areas.

Species composition:

Four species of seerfish are found in the waters around Sri Lanka; Scomberomorus commerson, S. guttatus, S. lineolatus and Acanthocibium solandri. The most abundant among these is the narrow-barred king mackerel (S. commerson).

Table 3 gives the percentage species composition of the catches for 1987 at the three landing sites. S. commerson, the dominant species among seerfish caught in Sri Lanka, constitute 55–96% of seerfish landed. Acanthocibium solandri is the second dominant with a percentage contribution ranging from 3 to 4%. Contribution by the other two species S. guttatus and S. lineolatus are rather low.

Percentage contribution of S. commerson decreases from north to south while that of Acanthocibium solandri increases from north to south. This is probably related to the extent of the continental shelf off Sri Lanka. Based on experimental gillnet fishery conducted by 11 ton boats, De Bruin (1970) reported that S. commerson is distributed within the continental shelf area while A. solandri is an inhabitant of the offshore waters beyond the continental shelf.

The continental shelf is relatively wide in the northwest region and narrows to the south. Previous studies of the species composition of seerfish catches have also shown that S. commerson is the dominant species (Jinadasa, 1980 and Malediyya et al 1987). However, high contribution by A. solandri in Beruwala has not been reported in previous studies.

Size composition:

Fig. 4 shows the size frequency distribution of S. commerson caught by different gears. Smallest size group (9–48 cm PL) was caught by small mesh gillnets (1.2 – 3.6 cm mesh size) operated by 5.5 – 6.1 m FRP boats. These nets are operated for sardines and Indian mackerels at depths of about 25 meters. Seerfish caught by beach-seines had a length range of 28–60 cm fork length. Very small fish were not observed in the beach seine catches because they are probably not available in the nearshore area during the season when this gear is operated. Beach-seines are fished within 2–3 kilometer of the shore for sardines and anchovies mainly. Seerfish following schools of small pelagic fish are also captured. S. commerson caught by troll line/handline have a wider length range (48–116 cm) and mode at 72 cm. Troll line/handline are operated at about 30 m depth. S. commerson catch by large mesh gillnets/troll lines are larger, ranging from 52 to 134 cm and mode at 84 cm. Large-mesh gillnets are generally fished from the edge of the continental shelf to seaward.

The size frequency distribution of S. commerson caught by these gears therefore reflect their distribution at different life history stages. Juvenile fish smaller than about 60 cm are distributed in the inshore areas with other small pelagics, larger fish are found in offshore areas.

Size frequency distribution of A. solandri fished are all larger than 80 cm while S. guttatus are all smaller than 88 cm in fork length (Fig. 5).

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- The catch rates for seerfish in the gillnet fishery are very low when compared to the other large pelagic species. This may be due to the scattered distribution of the seerfish in the fishing area. The catch rates of seerfish (*S. commerson*) reach a peak at the end of the south-west monsoon period. This is also the peak season for sardines on the west coast (Dayarathne, 1984). Chisara (1986) found that the peak season for *S. levescaetus* is related to the availability of *Sardinella* spp in the Zanzibar channel. As *Sardinella* species is an important food item for seerfish it may be that seerfish concentrate to feed on schools of sardines during the peak season.
- Commercially exploited size range of seerfish from the west coast is 30 cm to 112 cm in FL. However fish below 30 cm are exploited to a lesser extent by the small-mesh gill netters. Small fish are caught during the July - September period indicating that spawning must have taken place a few months before. Fish larger than 102 cm FL were occasionally encountered in troll lines, hand lines and gill nets.
- Although there has been an increase in number of boats engaged in gillnet fishery during the last decade, the Sri Lankan seerfish production has remained saturated. The slight increase in production during the last 3 years could be due to the greater use of troll lines and harpoons in combination with gillnet/longlines.
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Table 1. Total seerfish production and their percentage contribution to the total marine fish production.

Year	Seerfish production (MT)	% contribution to the total
1978	3703	2.7
1979	4323	2.9
1980	6230	3.8
1981	4542	2.6
1982	3408	1.9
1983	3429	1.9
1984	3395	2.5
1985	3475	2.5
1986	3574	2.5
1987	3698	2.5

Source : Ministry of Fisheries.

Province	D.F.E.O. area	1982	1984
North	Jaffna	739	450
	Mannar	96	17
	Mullaitivu	100	273
North-west	Puttalam	315	294
	Chilaw	71	402
West	Negombo	260	400
	Colombo	154	85
South-west	Kalutara	237	98
	Galle	258	21
South	Matara	58	206
	Tangalle	108	50
South-east	Kalmunai	121	317
East	Batticaloa	311	342
North-east	Trincomalee	526	377

Source: Ministry of Fisheries
D.F.E.O. - District Fisheries Extension Office.

Table 2. Seerfish production in Sri Lanka 1982 and 1984
(Metric tonnes)

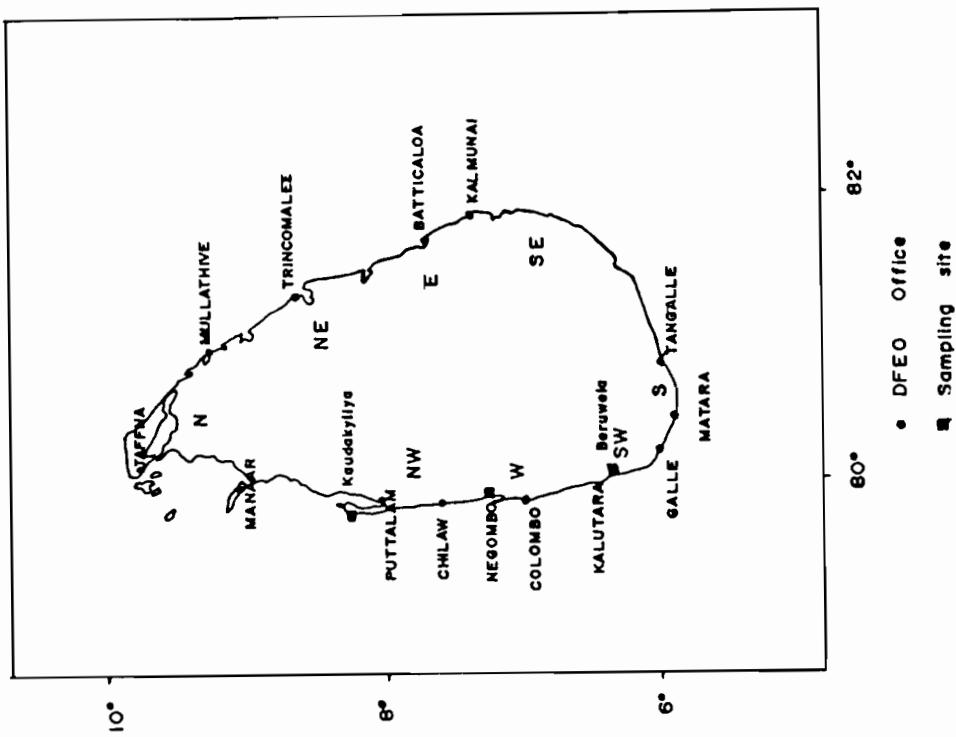


Table 3. Percentage species composition of seerfish for 1987 at different landing sites.

Species	Landing sites			Total
	Kandakuliyā	Negombo	Beruwala	
<i>S. commersoni</i>	96	86	55	79
<i>S. guttatus</i>	0	2	0	1
<i>S. lineolatus</i>	1	1	0	0
<i>A. sloanii</i>	3	11	45	20

FIG. 1. Map of Sri Lanka showing the District Fisheries Extension Office areas and sampling sites.

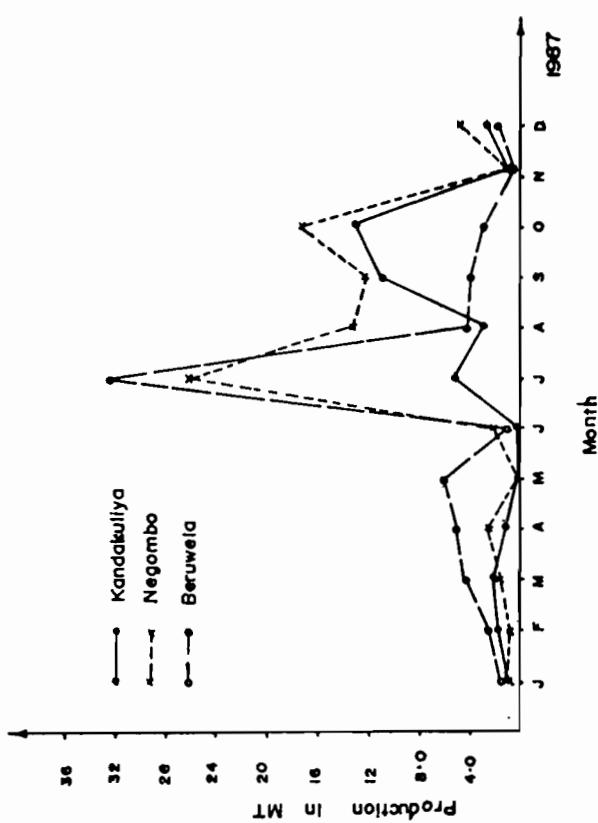


Fig. 3. Monthly variation in the total seerfish production.

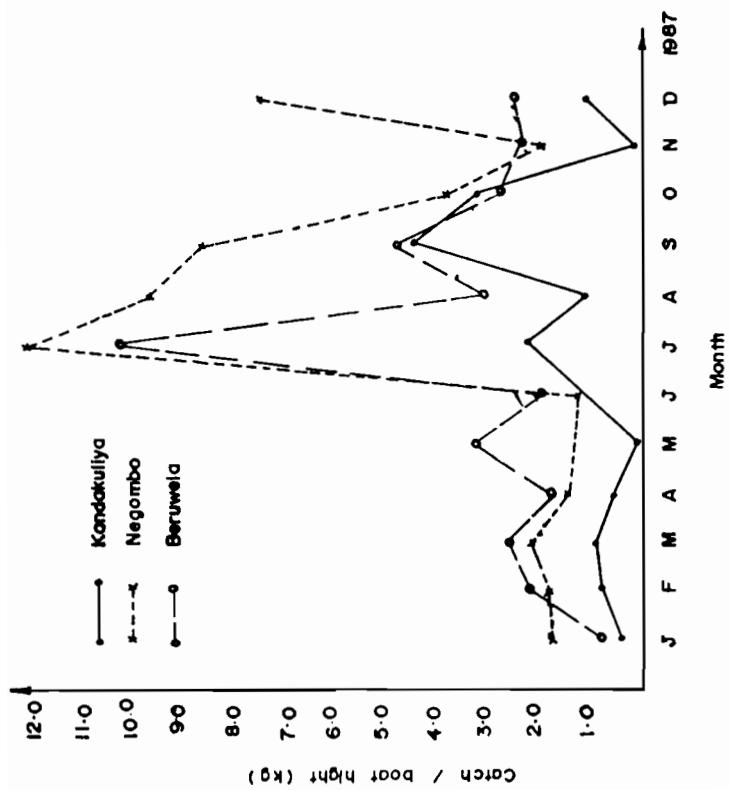


Fig. 2. Monthly variation in catch per unit effort of seerfish in the Gillnet fishery conducted by 9 meter boats.

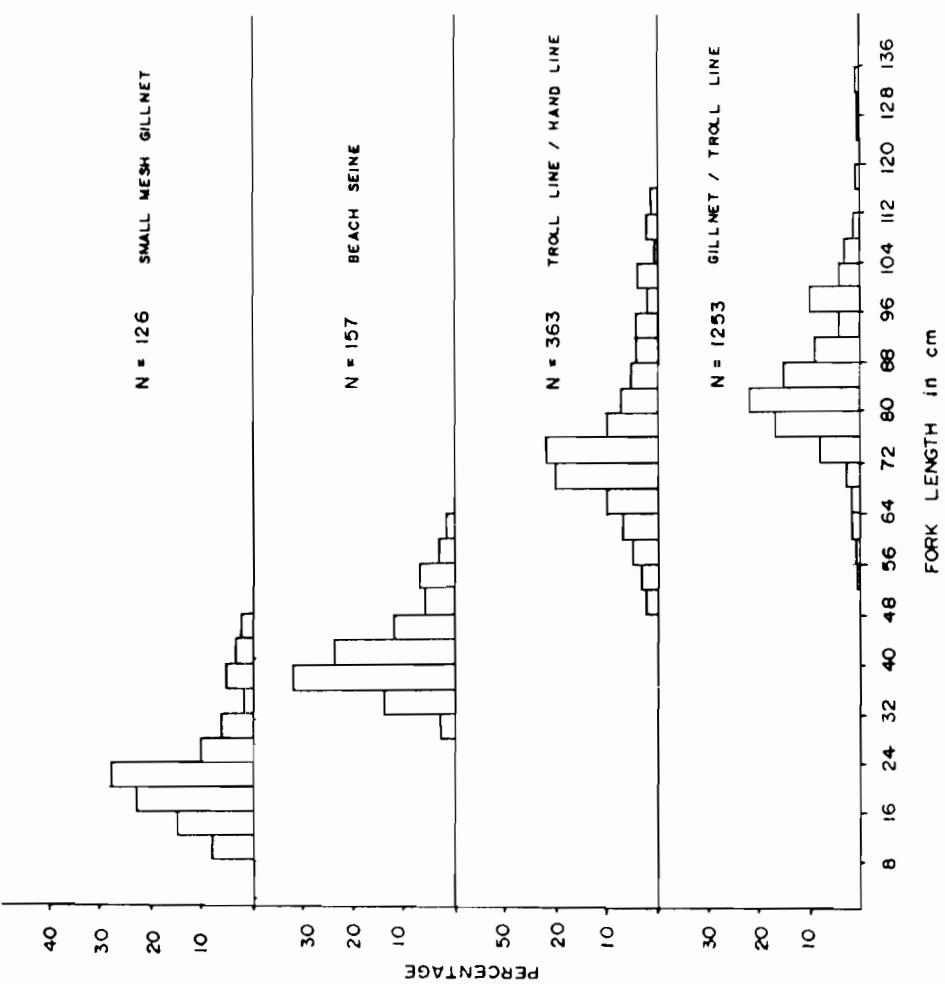


Fig. 4. Length frequency distribution of *S. commerson* from different gears.

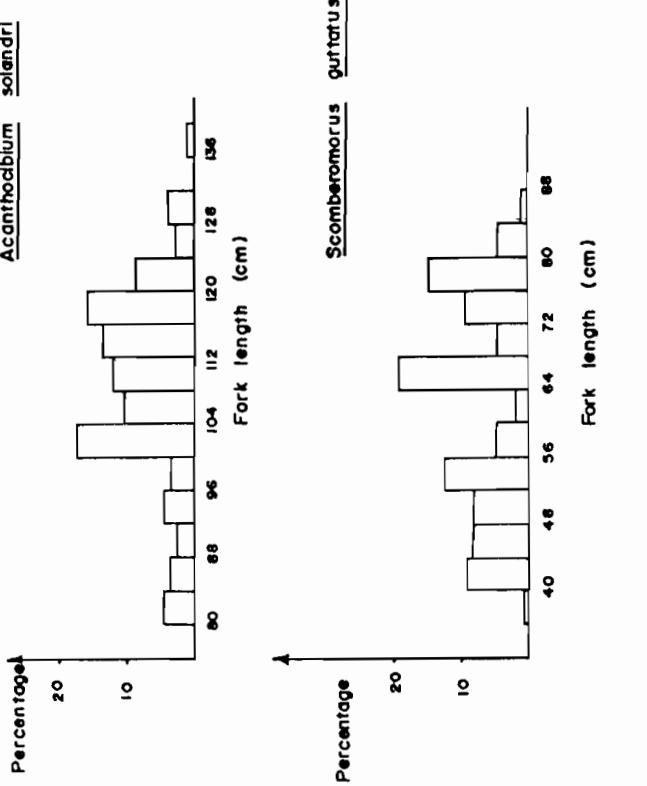


Fig. 5. Length frequency distribution of *A. solandri* and *S. guttatus* from gill nets and troll lines.

Appendix 8.

Report on the status of commercial catch of tuna and tuna-like fish and its biological characteristic in Aden Gulf, P. D. R. Yemen.

by Al Ba-Khraisa

Introduction

Previous studies of fish population in the Gulf of Aden included FAO, 1973 and Kesteven et al 1981. 1983 can be considered as M.S.R.C. OPERATIVE INDICATION. Dense scientific activities were carried out since 1983. All research at the sea were carried out by using R.V. "Ibn Hajid". Soviet research vessels and R.V. "Dr. P. Nansen" from 1975 through 1976. In 1984 R.V. of Marine Research Institute of Bergen in Norway was operated. In 1983 and 1988 dense shoals of small pelagic fish were observed, between our eastern sector and the border with the Oman Sultanate. Large pelagic such as S. commerson and tuna species were observed feeding on them. Upwelling affected the eastern sector from Magatin to the Yemen/Oman border (13° 24' N, 46° 17' E to 160°N, 52° 30' E). While the western sector (Aden area) was largely unaffected, this area is known as non upwelling area.

The pelagic fish stocks were scattered by the upwelling waters with concentration occurring more than 60 nautical miles out to the Gulf. An approximate pelagic fish biomass of 125,000 tonnes remained on the coastal shelf, while offshore biomass was around 145,000 tonnes. There were higher concentrations of pelagic fish over the coastal shelf around Aden area than elsewhere to the east. The first recorded echo integrated surveys of the pelagic fish stocks in P. D. R. Yemen were made in 1975/1976, by R.V. "Dr. P. Nansen" (Kesteven et al, 1981). The total stocks were calculated as 376x10³ tonnes. Concentrations of pelagic stocks were found in the eastern and western sectors of P. D. R. Yemen. Stocks in the non-upwelling seasons varied between 1 and 9t/km² depending on depth, but apparently declined during upwelling due to vertical and near shore migrations in response to a reduced oxycline. Deeper water species moved up the shelf at this time, while pelagic fish stocks migrated offshore. When conditions returned to normal demersal fish are distributed back down the shelf and pelagic fish returned to coastal waters.

1. Annual Catch Statistics By Species

Table (1) shows the annual catch of tuna and tuna-like species for the period extending from 1980 to 1987 in tons. Catch data statistics were collected from 12 cooperatives. For 1988 catch data statistics were collected from January to October from 12 cooperatives; private sector catch is not included. It is impossible to separate catch statistics by type and size class of boat. For collecting catch statistics regularly from the cooperatives along the coast (unloading centers), we face many difficulties such as:

- species reported together
- confusion in local names
- most of the fishermen along the coast of P. D. R. Yemen are uneducated so the consumed fish in many fishery villages are not reported.
- the statistical staff in the unloading centers along the coastal waters of P. D. R. Yemen report catch by using the grade system, according to the quality and price of the fish.

Example:	<u>T. albacares</u>	grade	excellent
	<u>S. commerson</u>	*	*
	<u>E. affinis</u>	1	1
	<u>K. pelamis</u>	1	1
	<u>A. thazard</u>	1	1
	<u>S. orientalis</u>	1	1
	<u>X. gladius</u>	2	2
	<u>Lethrinidae</u>	1	1
	<u>Caranx</u>	1	1
	<u>Carrangidae</u>	1	1
	<u>Sharks</u>	2	2
	<u>Sphyraenidae</u>	2	2
	<u>Nemipteridae</u>	2	2
	<u>Sparidae</u>	2	2
	<u>Pomadasysidae</u>	2	2
	<u>R. canthias</u>	1	1
	<u>Lutjanidae</u>	2	2
	<u>Siganidae</u>	2	2
	<u>Drepanidae</u>	3	3
	<u>Serranidae (Epinephelus sp.)</u>	3	3
	<u>Rays</u>	3	3

This grade system is used in the most governorates along the coast, but in the Hadramout governate, they place E: affinis in grade excellent, while other governorates place it in grade 1. Therefore, we face sometimes confusion, in using the grade system when collecting statistics from national cooperatives at unloading centers. Effort is being made with authorities of the Fish Marketing Corporation to encourage cooperatives to use familiar local names specially for the main species of pelagic and demersal fish.

2. Fishing Craft Statistics

Table 3 shows the fishing crafts which are operating along the coastal waters of P. D. R. Yemen, by the cooperatives only. These craft are used for multipurposes, based on the official statistical information. The total number of fishing craft is estimated as follows.

- (1) Wooden and Fibreglass boats (Hoori) = 156 boats. This type of boat is locally constructed and their main characteristics are as follows:

Length	3 - 11 meters
Beam	1.5 - 2 meters
Draft	0.8 - 1 meters

Most of them are mechanized with outboard benzine engine of power ranging from 8-15 HP. The crew of this boat type consists of 2 to 5 persons. They are mainly used for trolling, handlining, gillnetting, driftnetting and small purse-seining.

- (2) Fibreglass and wooden sambooks, are a traditional craft locally constructed. Their main characteristics are as follows:-

Length	12 - 14 meters
Beam	2 - 3 meters
Draft	1 - 1.5 meters

Table (1) shows the annual catch of tuna and tuna-like species for the period extending from 1980 to 1987 in tons. Catch data statistics were collected from 12 cooperatives. For 1988 catch data statistics were collected from January to October from 12 cooperatives; private sector catch is not included. It is impossible to separate catch statistics by type and size class of boat. For collecting catch statistics regularly from the cooperatives along the coast (unloading centers), we face many difficulties such as:

Most of them are mechanized with inboard diesel engine or outboard benzine engine of a power ranging from 15 to 45 HP. Their crew consists of 4 to 6 fishermen. They operate within 15-25 miles from the shore.

They are mainly used for surface gillnetting, hooking, trolling, small purse-seining and handlining. Fishing trips may take 4 to 6 days. The catch is preserved by salting and salt-drying.

3. Fishing Gear

The fishing are mainly traditional. They are somewhat found effective in the coastal waters. Synthetic fibres are used in the construction of fishing gears. Their use has increased over the last few years, and have almost entirely replaced natural fibres in fishing gears. The most common fishing gears and methods in the field of small-scale artisanal fishery, Cooperatives and private sector are:

- troll lines
- handlines
- longlines
- gillnets or driftnets
- small purse-seine
- ringnets
- bottom and pelagic nets

It has been reported that surface driftnetting and bottom gillnetting are seasonally profitable fishing methods for different type and size of mechanized fishing boats. The methods employed for fishing, in the coastal waters of P. D. R. Yemen are diversified enough for harvesting the available known resources. Therefore, future development work in the field of fishing gear technology, should be oriented towards upgrading the existing fishing gears and methods for reaching a higher degree of efficiency. Regarding our routine sampling programme, we were concerned only with sampling for size composition and catch and effort data. The sampling programme was carried out in region (Imran 12° 21' N - 44° 00' E), from January to November 1988. Biological studies, such as feeding, maturity, parasites were not included during our sampling programme.

By estimation we found the total catch, from the average of one boat (Boat) of 15HP, from gillnet set after sunset and 3 to 5 hours soaking was 74.8kg., in Aden area.

Most of the catch consist of S. commerson, R. canadus, E. affinis, and Catanz species.

S. commerson was observed as dominant species of the total catch, during our sampling programme performed on August 1988.

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Report on workshop on fish technology and quality control. Muanza, Tanzania 31 July to 19 August, 1983, FAO, Rome.

Table 1. Annual catch of tuna and tuna-like species in tons from 1980 to 1987 in P.D.R. Yemen.

catch of tuna and tuna-like species in tons from 1980 to 1987 in P.D.R. Yemen.

Year/species	1980	1981	1982	1983	1984	1985	1986	1987
<i>T. albacares</i>	11.989	9.116	3.542	34.446	170.581	1821.171	634.477	399.854
<i>T. t. congol</i>	64.974	1061.211	72.617	168.596	155.722	81.499	72.109	77.075
<i>T. t. affinis</i>	976.675	376.338	396.341	373.341	510.384	1221.340	699.000	130.524
<i>X. pelamis</i>	0.876	1.400	1.102	53.3	61.884	3.19	6.985	28.111
<i>S. orientalis</i>	0.395	10.650	6.559	0.044	0.458	7.075	16.249	7.724
<i>A. thazard</i>	-----	8.465	2.041	6.501	47.742	24.577	22.659	77.487
<i>X. gladius</i>	5.052	23.472	17.208	20.166	3.958	12.157	19.882	19.900
<i>S. commerson</i>	979.000	485.00	484.00	492.00	1062.00	893.00	897.00	500.00

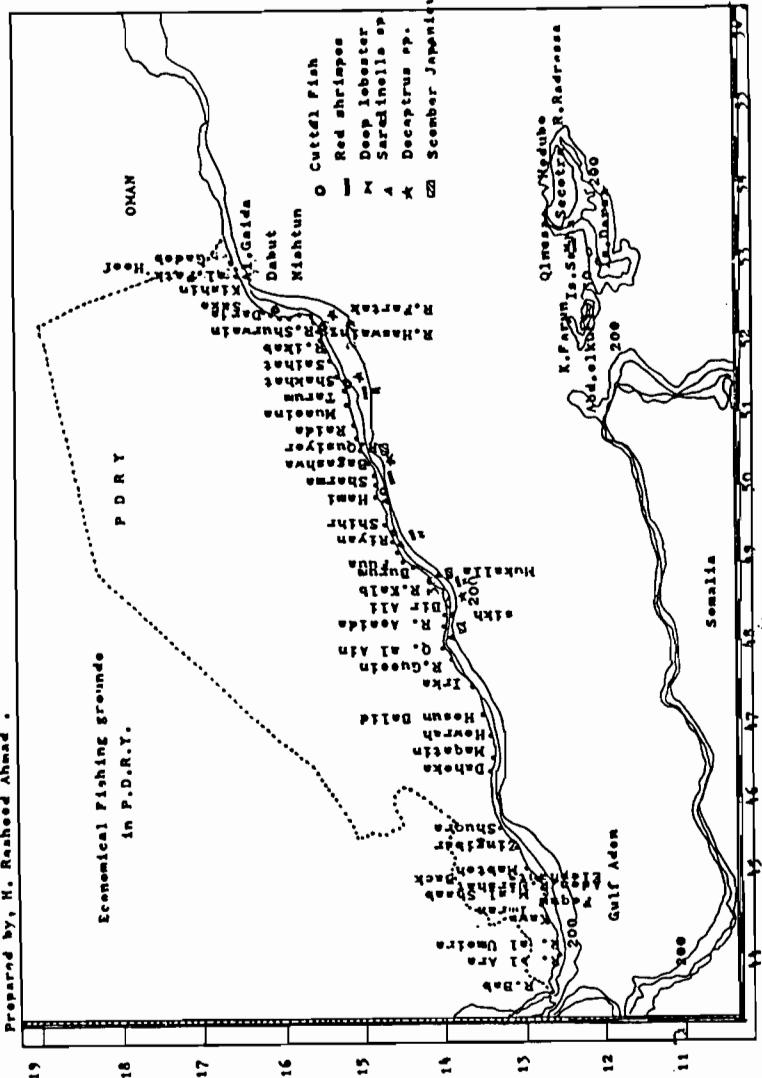
Table 2. Annual catch of tuna - like species during January - October 1988 in tons in P.R. Yemen.

Year/Species	<i>T. albocincta</i>	<i>T. tonggol</i>	<i>T. effinia</i>	<i>X. gladius</i>	<i>S. commersoni</i>	<i>K. pelorus</i>	<i>A. thazard</i>
January	116.971	13.357	114.222	8.395	16.245	1.052	-
February	170.636	8.288	55.575	2.376	69.823	0.791	-
March	169.159	10.469	39.457	7.571	4.467	0.035	-
April	76.530	15.490	134.420	24.187	0.461	-	0.210
May	50.615	9.091	114.195	14.972	0.495	-	-
June	52.241	3.156	127.769	0.360	0.040	-	-
July	0.398	1.059	90.180	0.058	6.418	-	-
August	96.682	3.189	98.413	0.190	21.942	-	-
September	155.717	12.489	88.590	1.328	15.150	-	-
October	-	-	-	-	-	-	-
November	-	-	-	-	-	-	-
December	-	-	-	-	-	-	-

Table 3. Fishing craft in 13 cooperatives which are operating along the coastal waters of P.D.R. Yemen

Governorate	Name of cooperatives	No. of members	No. of shooting boats	No. of hoari boats	Total
Aden (Lahj)	Aden Gulf	28	3	44	75
	Bas Alata	2	1	26	29
Ibbi	Shuqra	3	2	70	75
	Al-Sander	1	10	4	15
Shabwa	Bir-Ali	--	15	--	15
	Mukalla	17	18	12	47
Hadramouth	Al-Shithir	--	109	--	109
	Adia	20	42	--	62
Quaqish	Qaseef	29	34	--	63
	Qashan	--	61	--	61
Al-Mahra	Saihot	--	42	--	42
	Al-Chyda	3	107	--	110
Socotra Prov.	Socotra	3	31	--	34
		106	475	156	737

Prepared by, H. Ranhood Ahmad.



Prepared by: H. Rehshed Ahmad.

UNITED ARAB EMIRATES

MINISTRY OF AGRICULTURE AND FISHERIES
DEPARTMENT OF FISHERIES

The United Arab Emirates [U.A.E.] is a federation of seven emirates, it is located on the south eastern coast of the Arabian Gulf. The total area is estimated to be 77,700 square kilometres, at the December 1985 census the population was estimated to be about 1.6 million.

The Fisheries in U.A.E. is considered to be the natural wealth after the oil.

The total fish production ranged between 64,68,70,73,72.2, 79.0, 85 metric tons for the years 1979, 1980, 1982, 1983, 1985, 1986, 1987 respectively. The per capita consumption of fish is around 30-33 Kg per annum.

Tuna and Seefish Status in U.A.E.
1 - Tuna species in U.A.E.

Longtail tuna
Kawakawa
Frigate
Seefish

-Ghunnus tonqrol -
-Euthynnus affinis -
-Auxis thazard -
-Scomberomorus commerson-

Tuna And Seefish
Fisheries In U.A.E.
January, 1989

2 - Tuna and Seefish Production

Species	1982	1985	1987
Longtail tuna	4000 mt	2830 mt	3654 mt
Kawakawa	2000 mt	0980 mt	2108 mt
Frigate	1000 mt	0470 mt	0576 mt
Seefish	6580 mt	5000 mt	6630 mt

Note:

3 - Fishing vessels:

There are two basic types of mechanized fish vessels in U.A.E. smaller outboard and larger inboard - powered vessels, the outboard vessels are either wood-planked or fiberglass and the in board vessels are wood-planked hulls.

The fiberglass vessels range in length from 14 - 22 feet and between 18-30 feet for the outboard wooden vessels, the outboard motors used in U.A.F. range in power from 25 - 120 H.P. and many of the outboard vessels have two motors.

The inboard vessels range in length from 30 - 50 or 50 - 80 feet, also their motors range in size from 33 - 240 H.P.

The total numbers of fishing vessels in U.A.E. have increased since the last five years, the currently numbers about 3050 vessels, 2266 for the outboard vessels and 784 for the inboard vessels, this number increased 49% since 1982 with higher increase in the numbers of outboard - powered vessels [In 1982 the numbers of outboard vessels was 1411 and 638 for the inboard vessels].

4 - Fishing gears for tuna in U.A.E.:

The most important fishing gear for tuna in U.A.E. is the gillnet which is fished primarily with the outboard - powered circle-setting, surface schools during the day. These nets are 1,000 m to 1,700 m long and approximately 42 m deep. Gillnets with 1,000 m long and 22m deep are also used for beach-seining surface schools with one or two boats. Mesh size are usually range from 10 cm to 14 cm stretch-mesh for tuna and king-mackerel.

A secondary fishing gear for tuna and seerfish is troll lines which are generally used by inboard and outboard vessels while steaming to and from the fishing ground.

5 - Tuna Fishing seasons in U.A.E.:

There is no current data about tuna fishing season in U.A.E. In general tables [1] and [2] shows the monthly landings of tuna and seerfish at Khorfakkan which is a small town at the east coast of the U.A.E. over-lookig at the gulf of Oman.

Four species were discriminated during the survey of the site. In terms of weight, the most important species was narrow-barred mackerel followed by longtail tuna, frigate and kawakawa.

The highest landings of narrow-barred king mackerel are made from February to June.

There appears to be 2 peaks of abundance for longtail tuna from April to July and from September to November. Landings of kawakawa were highest in September - October during sampling period, in February - May, during the other period Frigate tuna were most abundant in March, April and November.

6 - Size composition:

Length frequency samples of longtail tuna and kawakawa were taken from April through September 1987 at Ras Al Khaimah fish market which consider to be one of ten major fish markets in U.A.E.

The number of samples taken each month ranged from 9 to 12 for longtail and 3 to 4 for kawakawa fish counts at Ras Al Khaimah fishmarket whos numbers of longtail tuna peaked in August and of kawakawa in June. The number of Frigate tuna were not recorded, the ratio of total counts of these two species for the sampling period was approximately 10 longtail to 1 kawakawa, 15% of the longtail and 2% of the kawakawa were less than 50 cm, small longtail ranged from 27 cm to 4 cm, a large one from 65 cm to 85 cm, the smallest longtail of 27 cm was found in September and the largest in June.

Length frequency distribution of longtail tuna taken in 1982, mostly at Dubai fish market which consider to be the biggest in the country, also showed two size classes, one in the 40 to 54cm interval and the other in the 60 cm to 70 cm interval.

Kawakawa were measured in April, June and July 1982. Small fish record in April, June and the large one [70-84cm] in July, the measured Kawakawa ranged from 30 to 89 cm with highest proportion in the 40-59 cm interval

King fish with 25 cm usually record during September and with 50 to 70 cm during Jan, and Feb., the big kingfish with more than 70 cm upto 150 cm usually found during March, April and May every year.

7 - Tuna and Seerfish Commercial Value:

Tuna and Seerfish have a very important value in the local fish markets, the selling prices vary according to the freshness and to the quantity displayed in the markets. In general the highest and lowest retail prices range between 2.8 - 0.78 US \$ for one kilogram usually the highest prices recorded at the beginning of the season.

R - Fisheries Research in U.A.E.:

a. Ministry of Agriculture and Fisheries Department of Fisheries. Technical Report No. R - 1984.
b. Marine Resources Research and Culture Centre

Table [1] Monthly landings - Kg - of Scombrid species
at Khorfakkan during Nov. 1976 to Oct. 1977

Species	S. commerson	T. tonnoi	F. affinis	Total
Month				
Nov.	1976	479	487	966
Dec.	-	336	24	360
Jan.	1977	75	131	212
Feb.	-	196	70	270
March	-	510	338	5459
April	-	18760	2,340	21110
May	-	787	2,274	3096
June	-	3,565	1,152	4717
July	-	26	865	891
Aug.	-	26	83	109
Sept.	-	105	654	1329
Oct.	-	-	622	1597
Total	29445	9040	1631	40116

Source: Ministry of Agriculture and Fisheries
Technical report no. 3.

Table [2] Monthly landings - Kg - of Scombrid Species
at Khorfakkan during May 1978 - April 1979

Species	S. commerson	T. tonnoi	F. affinis	A. thazard	Total
Month					
May	1978	1,847	131	109	2275
June	-	1,993	994	70	3149
July	-	442	653	38	1141
Aug.	-	22	168	29	222
Sept.	-	36	318	126	498
Oct.	-	408	923	15	1439
Nov.	-	270	221	240	731
Dec.	-	548	403	-	951
Jan.	1979	1,028	191	-	1215
Feb.	-	2,781	-	282	3093
March	-	3,012	-	580	3828
April	-	24,140	15	190	2505
Total	36,527	4,017	1,454	1,603	43,60

Source: Ministry of Agriculture and Fisheries
Technical report no. 5.

Appendix 10.

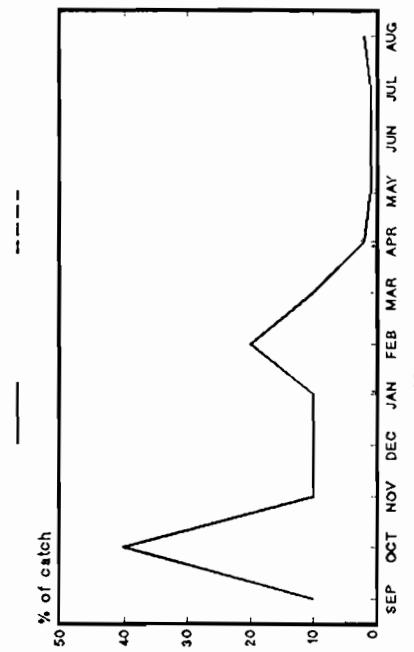
Indo-Pacific Tuna Programme
Workshop on Tuna and Seerfishes
in the
North Arabian Sea Region
February 7-8-9, 1989

ABSTRACT

A summary of recent landings for Kingfish and Tunas is presented for the Sultanate of Oman. The system for data collection, entry and analysis is also presented. Problem areas are discussed.

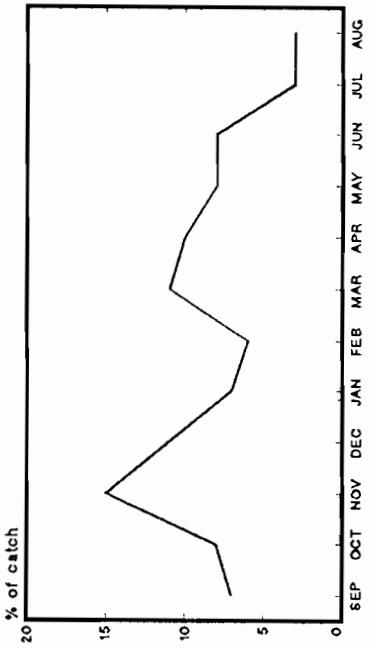
Country Status Report
for the
Sultanate of Oman

SEASONALITY OF CATCH KINGFISH



87 and 88 mean

SEASONALITY OF CATCH TUNAS



87 and 88 mean

Ministry of Agriculture and Fisheries
Directorate General of Fisheries
Statistics and Data Processing

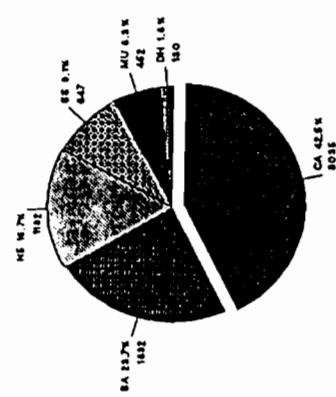
Elie I. Moussalli
RDA International, Inc.

Recent Landings of Seerfish and Tuna in Oman (Metric Tonnes)

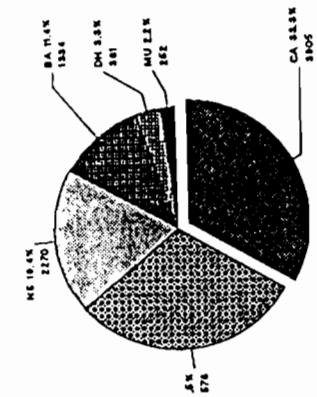
COM	85	86	87	88
S. commerson	18,382	14,201	26,205	30,227
T. albacares	22.9	17.5	25.8	25.9
YFT				
T. albacares				
KAW	6,696	11,486	2,544	3,427
E. affinis	8.4	14	2.5	2.9
LOT				
T. tongol				
	17,438	15,994	17,2	13,7
	85	86	87	88

Figures with decimals are percentages of total landings.

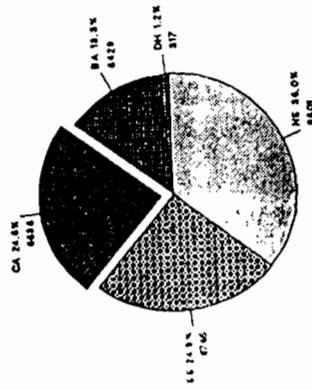
TUN85



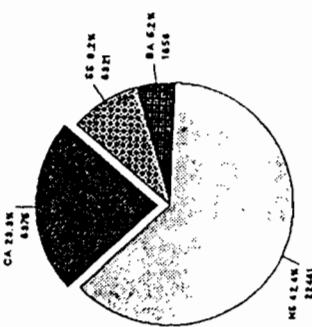
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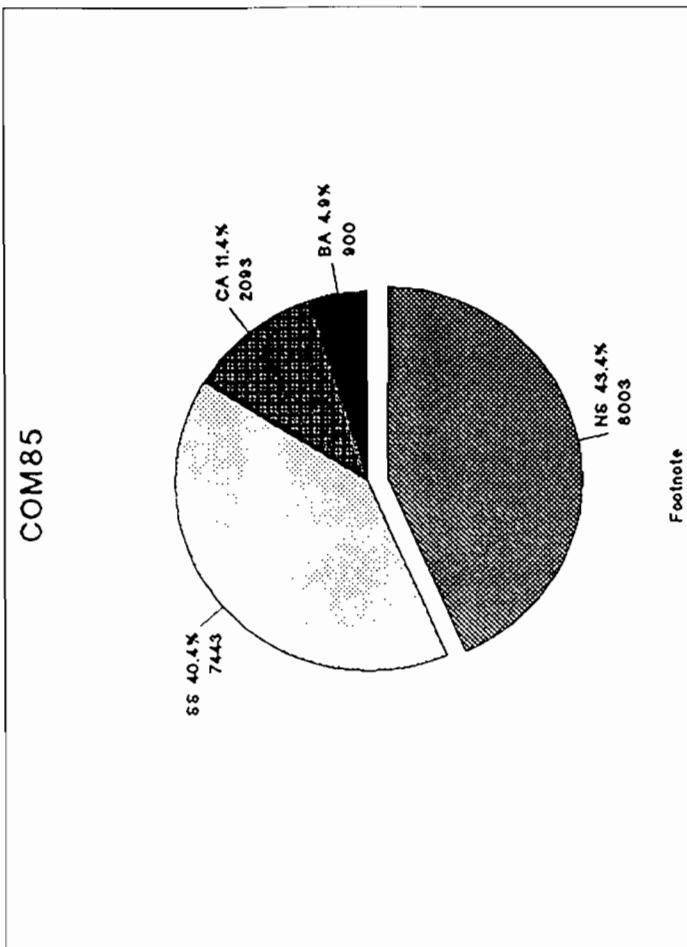
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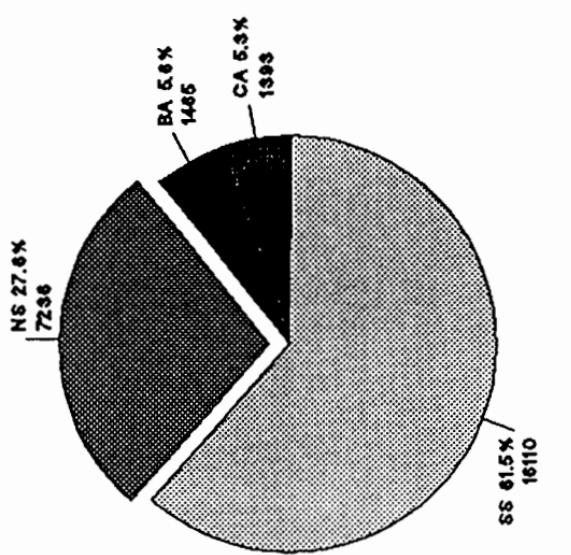
TUN88



Footnote

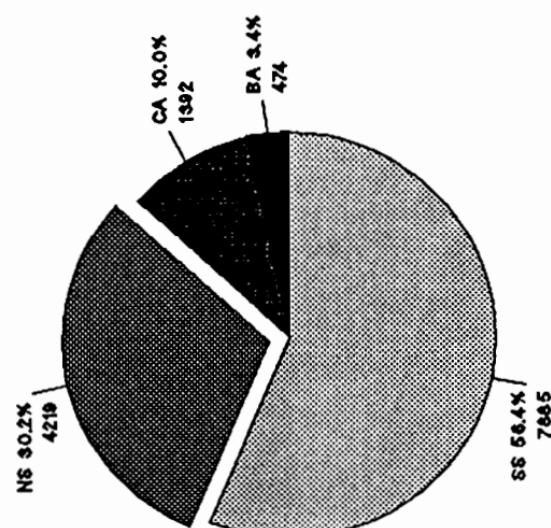


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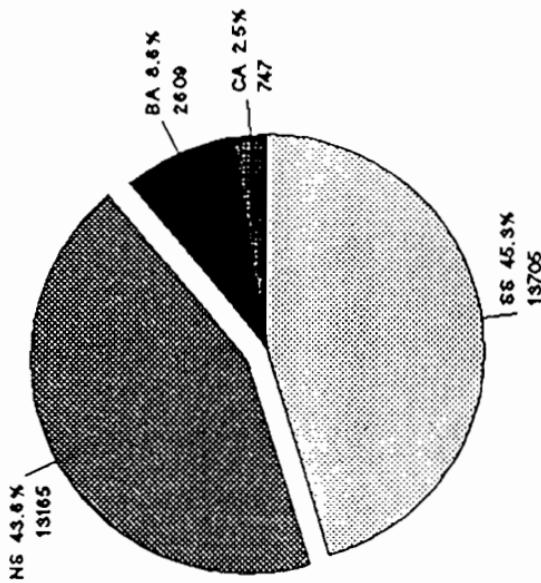
Footnote

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Footnote

1. Trend of catch of Tuna and Tuna-like Species in the world

PAO statistics shows that the total catch in marine fishing area, for all species, was 80 million metric tons (mt) for 1986. This was an increase of 25% over 1980. The total catch of tuna and tuna-like species including seerfish and billfish in the world was 3,418 thousand mt for 1986. This was an increase of 30% over 1980. The total catch of tuna and tuna-like species in the Indian Ocean for 1986 was 547 thousand mt. This was an increase of 98% over 1980. In the Atlantic and Pacific Oceans, the catches of tuna and tuna-like species increased 5% and 26% respectively over 1980. It shows that the highest increase in the catch of tuna and tuna-like species was in the Indian Ocean (Table 1).

Table 1 Catch of Tuna and Tuna-like Species in the world

Ocean	1980	1981	1982	1983	1984	1985	1986
Indian Ocean	276	285	359	385	424	506	547
100	103	130	139	154	183	198	
Atlantic Ocean	520	563	647	619	564	589	546
100	108	124	119	108	113	105	
Pacific Ocean	1843	1805	1797	1957	2140	2075	2324
100	98	98	106	116	113	126	
Total	2638	2654	2802	2961	3128	3170	3418
100	101	106	112	119	120	130	

Unit: 1000 MT

2. Major Tuna Species in the Indian Ocean

In the Indian Ocean, there are 20 species of tuna and tuna-like species including 11 species of tunas, 4 species of seerfish and 5 species of billfish (Table 2).

Indo-Pacific bonito and also unclassified tunas consists of 20.9% out of the total. Seerfish consisting of narrow-banded king mackerel, Indo-Pacific mackerel and streaked seerfish shares 17.2% of the total. Billfish consisting of blue marlin, black marlin, striped marlin, sailfish and swordfish are only 2.3% of the total. Compared with the catches between 1975 and 1987, there have been percentage increases in skipjack, yellowfin tuna and albacore and percentage decreases in southern bluefin tuna, bigeye tuna and small tunas. These changes resulted from increased catch of purse-seiners which have started their operation since around 1980 and of gill netters which have started in 1984.

3. Development of Tuna Fisheries in the Indian Ocean

The industrial fishery in the Indian Ocean started in the early 1950's by Japanese longliners to catch tunas and billfishes. Thereafter, Taiwanese and Korean longliners followed their operation. In 1975 the total catch of longliners from these three countries was 75 thousand mt and shared 35% of the total catch of tuna and tuna-like species. In 1981, the catch of longliners increased to 109 thousand mt. But, its percentage decreased to 17% out of the total (Fig. 2). The industrial fishery of tuna purse seiners, which was initiated by 'Lady Sushii', a joint venture fishing vessel in Mauritius with a Japanese company in 1979, has expanded its fishing efforts rapidly in the western Indian Ocean. The total catch of industrial purse seiners reached 184 thousand mt for 1987 and its percentage was 25% out of the total. As of September 1988, 46 purse seiners are active in the Indian Ocean, 20 vessels from France, 17 vessels from Spain, 3 from Mauritius, 3 from USSR and one each from Panama, Japan and India.

In the Indian Ocean, there are many types of artisanal fisheries using small-scale fishing boats to catch tuna and tuna-like species in coastal countries. Fig. 4 shows the major tuna fishing countries in the Indian Ocean. France topped the total catch for 1987 followed by India, Spain, China (Taiwan), Oman, Maldives, Indonesia, Japan, Korea, Sri Lanka, Pakistan, Thailand, Iran, UAE and Australia. The total catch of these countries amounted to about 90% out of the total. In 1975, catch by artisanal fisheries was 140 thousand mt or 65% of the total and in 1987 it increased to 360 thousand mt; about more than double the catch in 1975 (Fig. 3). But the percentage of the catch in 1987 which was 57% dropped by 7% between 1974 and 1987. The major types of gear used in the artisanal fisheries are gill net, pole and line, troll line, purse seine, hand line, etc. The increase in the catch of artisanal fisheries is primarily attributed to the intensified fishing effort and also technological improvement in fishing in many coastal countries but also there is another factor which could increase catch that is the development of data collection system in some countries.

The major development in tuna fishing in the Indian Ocean for recent years is the gill net fleet from Taiwan which started operations in 1984. The catch of the fleet was 15,972 and 10,145 mt in 1986 and 1987 respectively. The target species of this fleet is albacore.

4. Tuna Landings by Species

4.1 Skipjack tuna

Skipjack tuna is the most dominant species in the Indian Ocean in terms of the catch in weight. The catch of skipjack tuna has been increasing during the past several years and reached 163 thousand mt in 1987. Skipjack tuna is known as a species of widespread distribution in the Indian Ocean. The traditional fishing grounds by artisanal fishermen are the waters off Maldives, Sri Lanka, North and Western Sumatra and Laccadive Islands. The fishing gears used in these areas differ from country to country; pole and line in Maldives, mostly gill net and partly pole and line and troll line in Sri Lanka, purse seine, gill net and troll line in North and Western Sumatra and pole and line in Laccadive Islands. The catch level of these artisanal fisheries in the Indian Ocean averaged from 30 - 40 thousand mt per year up to 1983 (Fig. 5). The catch has increased since 1984 and peaked 75 thousand mt in 1986 which is almost double the catch in 1972. This is mainly due to increased catch in Maldives.

The industrial purse seiner's operation started in the western Indian Ocean around 1980. The catch level has increased in accordance with the increased efforts. Their target is two species skipjack and yellowfin tunas. The catch of skipjack tuna by purse seiners in 1987 was almost 91 thousand mt, 56% of the total. Good catch rates were continuing in 1988.

Few catches of skipjack tuna are reported from longliners. The catch records from China (Taiwan), Japan and Korea shows that the catch are less than 100 mt on the average per year.

4.2 Yellowfin tuna

Yellowfin tuna is also one of the dominant species together with skipjack tuna in the Indian Ocean.

Fig. 7 shows the fishing grounds of yellowfin tuna for longliners, purse seiners and artisanal fisheries. This fishing ground distributes widely to the whole of the Indian Ocean for longline fishery and only in the western Indian Ocean for purse seine fishery and coastal areas such as the north and western Sumatra, Sri Lanka, Maldives, Laccadive Islands, Pakistan, Iran, Oman, Yemen and Somalian waters for artisanal fishery.

Longline fishery started in the early 1950's by the Japanese fisherman followed by Korean and Taiwanese fishermen. The highest catch of yellowfin by longliners was reported in 1968 as 77 thousand mt. The catch level fluctuated at an average of between 20-30 thousand mt in the past 10 years (Fig. 6). The present price of yellowfin tuna is comparatively lower than that of bigeye tuna. Longliners therefore are aiming to catch more bigeye tuna than yellowfin tuna.

The present catch of artisanal fishery are mainly reported from Sri Lanka, Maldives, Indonesia, Pakistan and Oman. Fishing gears used are gill net, longline and pole and line for Sri Lanka, pole and line for Maldives, trolling line, purse seine for India and gill net for Pakistan and Oman. Although some catches occurred in India, Iran and Somalia, few data have been reported from these countries. The catch level of the artisanal fishery was 10-20 thousand mt in the past 10 years. Following the introduction of purse seiners in the Indian Ocean, the catch of yellowfin has remarkably increased as shown in Fig. 6 and reached 129 thousand mt in 1987 52% of which was by purse seiners.

4.3 Southern bluefin tuna

Southern bluefin tuna resources was exploited by Japanese longliners in the early 1950's. Southern bluefin tuna are known as one of the most expensive fish which can be sold at the highest price among tunas at Tsukiji Fish market in Tokyo. The recent price of the fish at the market is US\$ 25,000 - 59,000 per ton. Australian fishermen use purse seine and pole and line to catch the fish in their coastal waters. The spawning ground of this fish is located in the area of north western Australia. The fishing ground for Japanese longliners are mostly located between south 40° and 50° latitude (Fig. 9).

The catch trend of this fish in the Indian Ocean indicated that the highest catch of 70 thousand mt was in 1960. Since then, the catch dropped and was only 18 thousand mt in 1986.

It was revealed by scientists that the southern bluefin tuna was heavily exploited and management measures were necessary to conserve this resource. At present, three fishing countries, i.e., Australia, Japan and New Zealand hold an annual meeting to discuss the stock status and the management measures. The fishing for each country is currently under control based on the suggestions made by scientists.

4.4 Bigeye tuna

The bigeye tuna is mostly caught by longliners. There are two fishing grounds for bigeye tuna in the Indian Ocean i.e., northern Indian Ocean and southern Indian Ocean (Fig. 10). The northern fishing ground is located between 50° N and 10° S and the southern fishing ground between 30° S and 35° S. A very few catch are reported by other gears i.e., gill netters and purse seiners.

It seems that the catch of bigeye tuna is on an upward trend from the inception of longline fishery up to the present with some fluctuations (Fig. 11).

The present price of bigeye tuna is higher than yellowfin at Japanese markets for 'sashimi'. Japanese and Korean longliners are presently aiming their catches at bigeye tuna rather than yellowfin tuna. A deep water longline fishing technique was

adapted to increase the catch of bigeye tuna in the late 1970's in the Indian Ocean. Recently, Taiwanese have also intensified their catch on bigeye tuna.

4.5 Albacore

The fishing ground of albacore in the Indian Ocean (Fig. 10) is located in the southern part of the Indian Ocean between 10° S and 40° S.

Albacore is mostly marketed as 'white meat tuna' in canning. Skipjack tuna is also used as material for canning but can only be marketed as 'light meat tuna' and is sold at a lower price than albacore.

Albacore were mostly caught by longliners up to 1984 (Fig. 12). In 1984 gill netting fleet from China (Taiwan) has started concentrating its target on albacore in the Indian Ocean. The catch by gill netters was 15,176 mt in 1986 which was more than the longliner catch. However, the catch has decreased to 8,651 mt in 1987. There were some minor catches by purse seiners.

Many of Taiwanese longliners were operating in the Indian Ocean aiming their catches at albacore. Their fishing ports are Reunion and Port Louis. Japanese and Korean longliners catch of albacore were very low - only 7% of the total in 1987 and their target species are southern bluefin tuna, bigeye tuna and yellowfin tuna instead.

4.6 Small tunas

Longtail tuna, kawakawa and frigate tuna are major species under the category of 'small tunas'. These are neritic species and are caught by artisanal fisheries. Longtail tuna is mainly caught in Iran, Pakistan, UAE, India and Thailand. The total catch of longtail tuna was 41 thousand mt in 1987 showing an increasing tendency in catch in these countries. This was partly attributed to the improvement in data collection systems. Oman revealed for the first time the catch of longtail tuna being 17,257 mt in 1987.

Kawakawa is very common in the Indian Ocean. Major producing countries are India, Iran, Maldives, Pakistan, Sri Lanka, UAE, Yemen, Oman, Comoros and Seychelles. The total catch in these countries was 31 thousand mt in 1987. Catch levels have fluctuated from year to year and it is uncertain whether the catch tendency is for an increase or decrease. A problem with this species in catch statistics is in the inclusion of landings as 'frigate tuna' in some cases and as 'unclassified tuna' in other cases.

Frigate tuna are also very common and can be seen more or less in every coastal country in the Indian Ocean. There is also a statistical problem as mentioned in the section of kawakawa. Due to the above reason, it is difficult to detect the catch tendency of this species.

As a whole for small tunas, it can be said that the catch has been on an upward trend (Fig. 13). But it should be noted that the upward trend was partly attributed to the development and improvement of the statistical data collection system in some countries.

4.7 Seerfish

Under seerfish, there are two popular species, narrow-barred king mackerel, (*Scomberomorus commerson*) and Indo-Pacific king mackerel (*S. guttatus*). In some countries, these are classified under one category as 'seerfish' in the statistics.

The major producing countries of these species are Australia, India, Indonesia, Oman, Pakistan, U.A.E., Yemen, Sri Lanka, Saudi Arabia, Tanzania and Thailand. The catch of seerfish has been on an upward trend as a whole (Fig. 13). An improvement in statistical data collection system contributed partly to the increased catch.

4.8 Billfish

Under billfish, there are 5 popular species in the Indian Ocean, i.e., blue marlin, black marlin, striped marlin, sailfish and sword fish. Although these are caught by artisanal fisheries in coastal areas, many of them are caught by longliners from China (Taiwan), Japan and Korea. There are also sport fishermen to catch these species in Kenya, Mauritius and Seychelles.

According to the statistics collected by IPTP, the catch of billfish, all species combined, did not fluctuate but increased slightly during the past 10 years (Fig. 13).

Many coastal countries reported the catch of billfish as combined species of billfish due to difficulty of species identification.

5. Present status of tuna resources

The present status of resources of tuna and tuna-like species were discussed at the Expert Consultation on Stock Assessment of Tunas in the Indian Ocean held in Mauritius in June 1988. Following are the summaries of discussions at the Expert Consultation on the status of the resources.

Southern bluefin tuna : This species is currently under control by three countries i.e., Australia, Japan and New Zealand on the basis of the recommendation made by scientists from these three countries. There is a fear that the parental biomass is likely to decline further in coming years and that there would be a risk of recruitment decline if the current catch limits were maintained.

Skipjack tuna : It is presumed that there is a large population of skipjack tuna in the Indian Ocean. This fish is likely to be able to yield more production since the stock of this resource seems to be healthy with the fact that catch per unit effort (CPUE) shows a

tendency of increasing. However, a thorough analysis of the data should be conducted to verify this observation.

Bigeye tuna : The resources were highly exploited by longline fishery with the deep longline technique. It appears that without a new break-through in fishing technology that can target on an un-exploited part of the stock, further increase in fishing effort will not result in a corresponding substantial increase in catch.

Albacore : The fishery for albacore in the Indian Ocean has been operated at a level of effort but with a high variability in catch and with effective catch rate remaining at the same level in recent years. The size frequency of fish caught by the longline fishery has also remained constant in recent years. The stock thus appears to be in good condition. With the existing fishery pattern, it does not appear that further increase in fishing effort will result in a corresponding substantial increase in catch. However, the increased fishing effort by gill netters, which has been introduced in the Indian Ocean since 1984, might have had some impact on the stock status. This requires close monitoring to assess the status of the resources.

Yellowfin tuna are currently captured by longline, purse seine and artisanal fisheries in the Indian Ocean. The Expert Consultation could not conclude any definite status for this species. However, the examination of catch and cpue indicate that the stock is currently producing higher level of catch than in past years when there were only longline and artisanal fisheries. CPUE for the longline and purse seine fisheries suggests that the stock is either not effected by the current level of exploitation or is increasing in size. An in-depth study of the condition of the stock is clearly needed because the recent fishing may be well above the equilibrium level of productivity as a consequence of the very fast increase in purse seine fishing effort.

Small tunas : The stock assessment study for each species under this category is an extremely difficult task because of lack of information on stock structure for each of these species.

Seerfish : Although seerfish fisheries are so important in the region, potential of seerfish catch is unknown and considerable effort is required to evaluate these resources.

Billfish : Due to incomplete statistical information, the potentiality for these species is far from a point of discussion.

6. Conclusion

Tuna and tuna-like species are currently utilized widely not only as table fish to local people but also as export items to international markets of 'sashimi' and cannning. This demand will be further increased with the increasing population and a good reputation that sea food is favourable for the health of human beings.

TABLE 2 CATCH BY SPECIES

UNIT : MT

In order to meet such increasing demands, tuna fisheries will be further developed in the Indian Ocean in both industrial and artisanal fisheries. However, owing to the nature of highly migratory species, these resources need to be closely monitored on a global basis to prevent over exploitation. Further improvement and development of data collection on catch/effort and biological parameters is highly recommended to attain more accurate stock analyses.

SPECIES	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
TFT	28370	38670	50870	44683	36982	3664	3645	46820	60665	73503	189766	114221	128874	
BEL	39570	21650	31511	47379	31127	31383	32378	39144	44168	35684	41949	42494	44643	
ALB	5361	6176	9713	16653	16211	11637	13223	17190	15111	9420	25585	24917		
BKF	21273	24866	24359	17122	16744	24293	26965	29136	36781	31813	28982	21998	18139	
SKJ	35165	38612	38629	38461	33916	5187	45792	61594	19122	163345	168119	161692	141491	
LGT	2421	3846	5649	5127	6613	7916	6342	17839	19845	21111	25587	21322	22343	
KAN	19345	18241	13819	9468	14089	8352	2111	25587	21322	22343	28347	31683		
FRI	0	0	0	0	0	0	0	0	0	0	0	2921	2164	
BLT	0	0	0	0	0	0	0	0	0	0	0	617	67	
FZ2	4937	2766	3986	1461	1761	1595	2980	4967	5675	9357	1418	18432	14817	
SIP	0	0	0	0	0	0	0	0	0	0	0	0	254	
TUN	28616	38578	39739	38431	41965	55559	34367	46884	42818	313232	58976	53374	4393	
Sub total	175587	187979	212267	211177	199339	222635	284565	388789	367365	442978	488698	515379		
CDD	11557	14364	17063	17914	28491	16816	14974	43334	47426	43359	52779	58217	55183	
GUT	496	115	181	157	245	182	1361	1557	1525	1525	14479	13434	14184	
SIS	0	0	0	0	0	0	0	2779	185	238	225	76	2375	
MAN	0	0	0	0	0	0	0	0	1	713	57	57	3	
KGZ	23981	26531	27419	25778	36173	37069	98682	14865	10575	71811	28118	21682	38726	
Sub total	35956	43210	46582	43849	56899	52267	58598	73597	73597	73594	73597	73594	118193	
BUN	22986	1550	1427	2865	2578	2449	2741	2492	3266	47114	3577	3638	2494	
MLN	1161	13	92	49	87	188	147	125	174	438	1344	1344		
SAI	438	384	148	281	2668	1875	1712	1359	1841	2149	4156	2959		
SMU	983	774	923	1641	2119	244	311	147	126	126	126	126	1825	
GIL	652	1240	1433	2214	1624	1197	1597	1021	1021	294	2489	2228		
Sub total	5754	4794	3089	9548	18161	9817	10741	10912	1627	11155	17191	17198	14738	
Gear total LL	75309	71089	182292	116763	89420	93455	10353	10434	11633	Y4518	78916	184543	16273	
Gear total M	22154	26694	21131	18451	2892	26397	21957	26321	14180	34849	51814	149756	149756	
Gear total FG	2898	1877	3437	5769	3953	6481	5161	18382	34641	115473	149757	149757	149757	
Gear total TILL	1374	1931	6126	5748	5525	6749	6749	6749	6749	6749	73375	149758	149758	
Gear total UNCL	115548	14483	124971	128814	144431	159863	164431	164431	164431	164431	164431	188598	184498	184498
TOTAL	217193	215974	262589	264556	268694	255205	193465	216164	15151	442457	526457	526457	649382	

Fig. 1 CATCH COMPOSITION BY SPECIES

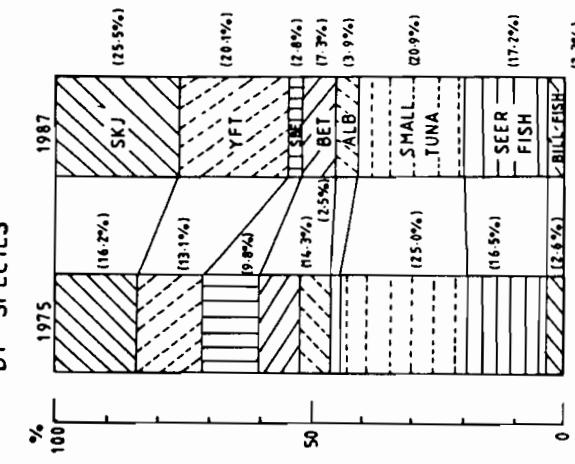


Fig. 3 CATCH COMPOSITION BY TYPE OF FISHERIES

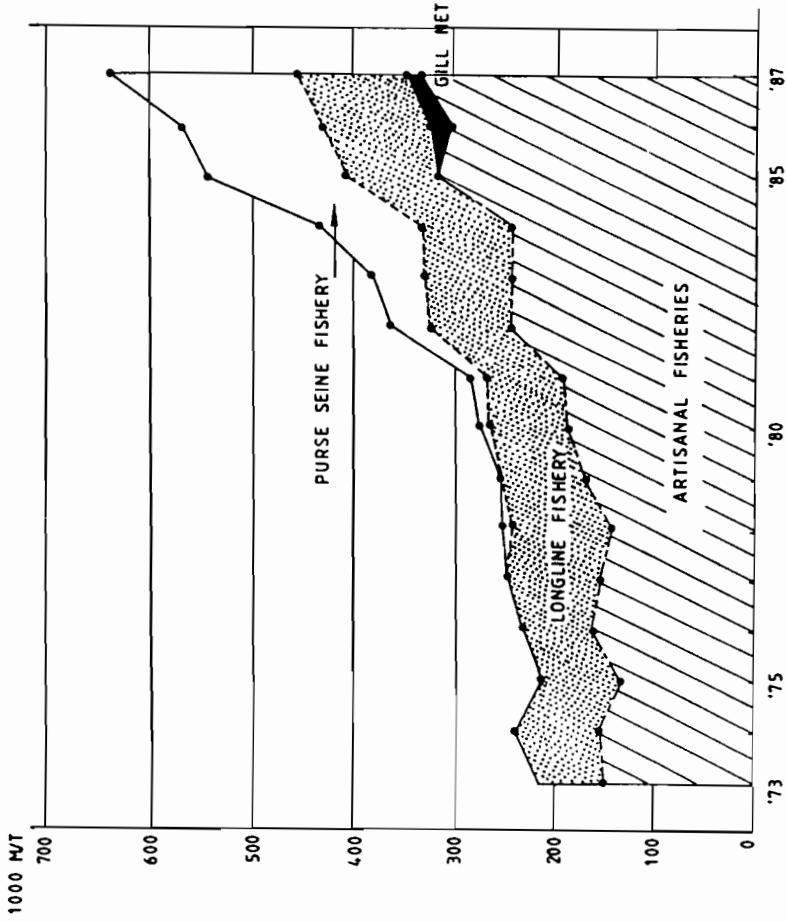


Fig. 2 CATCH COMPOSITION BY GEAR

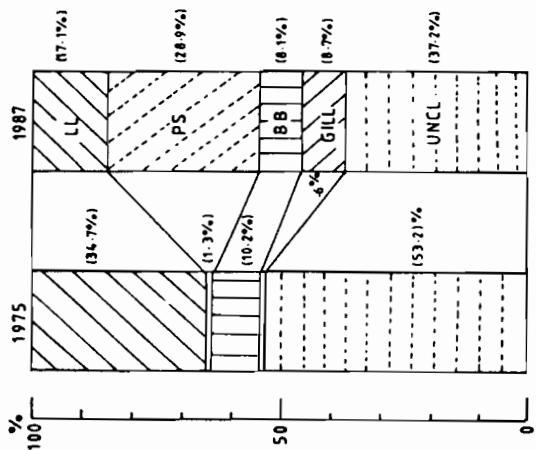


Fig. 4 MAJOR TUNA FISHING COUNTRIES IN THE INDIAN OCEAN

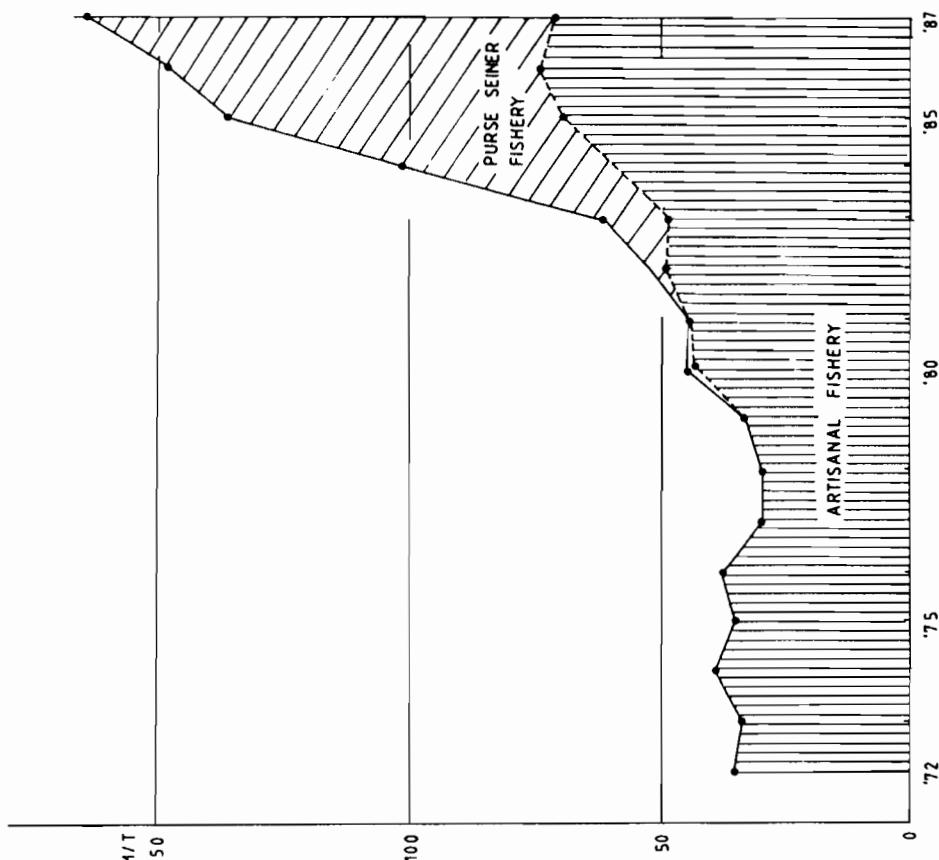
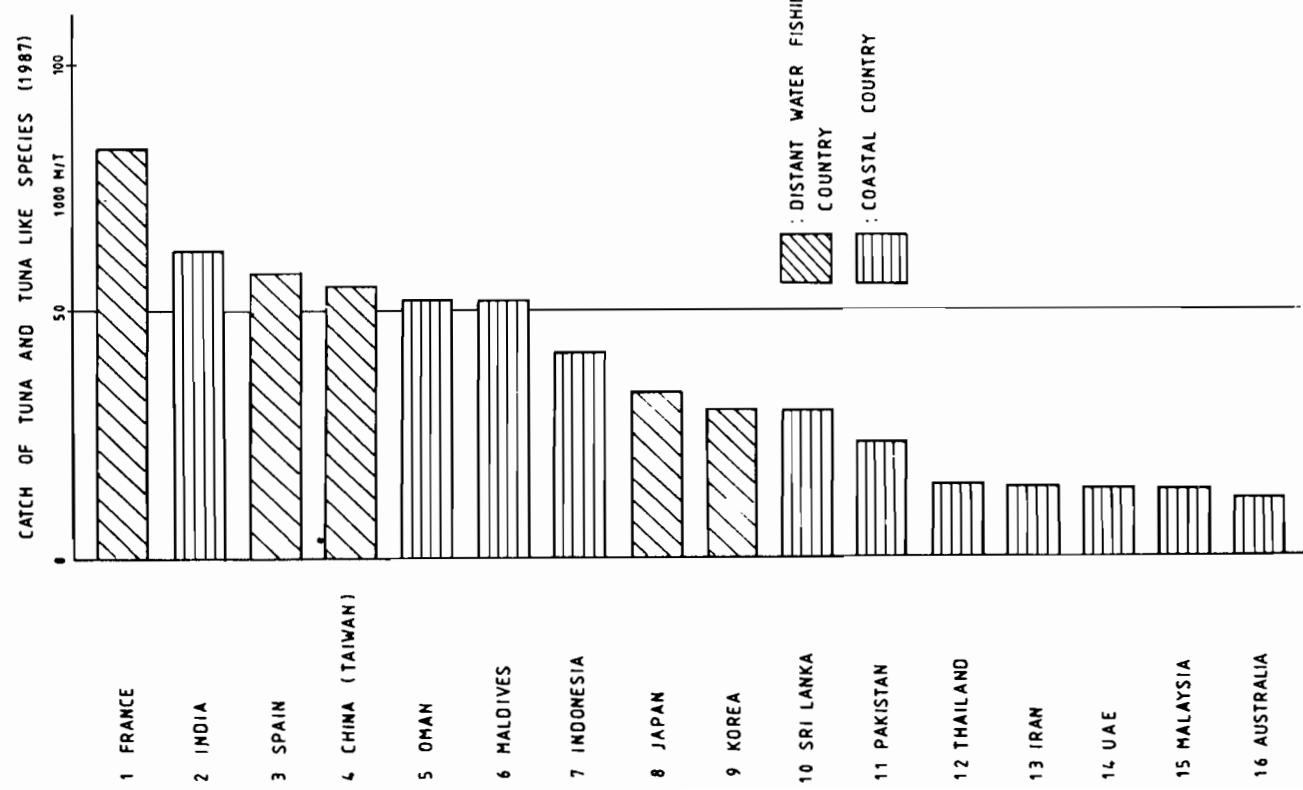
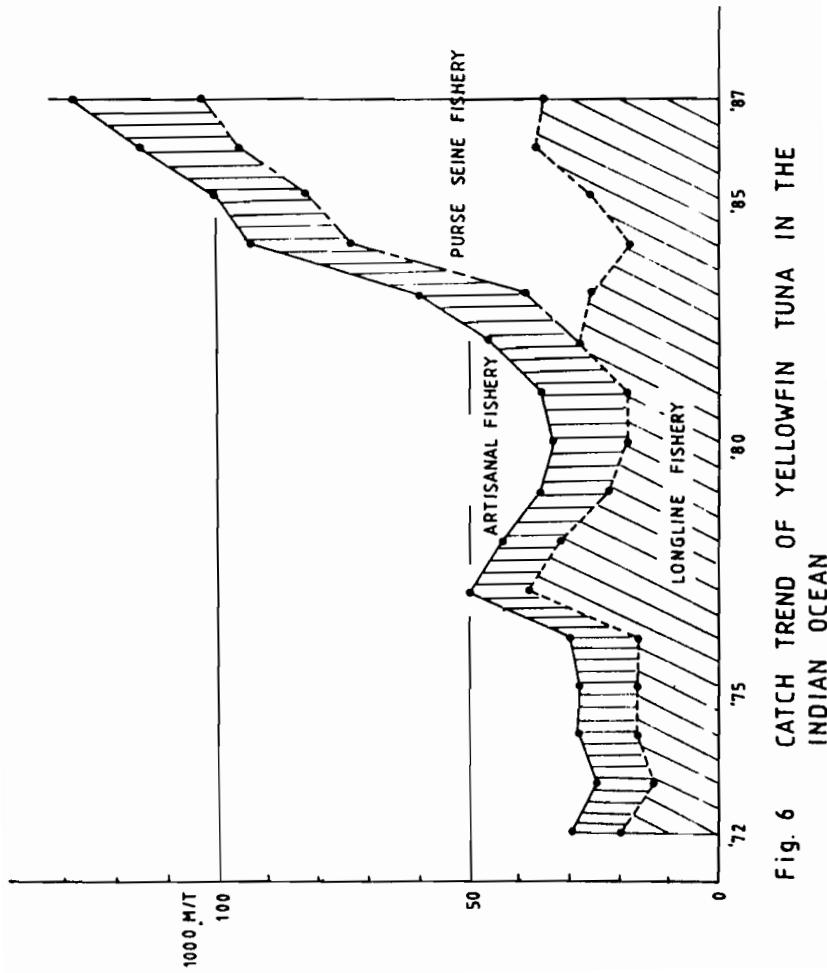
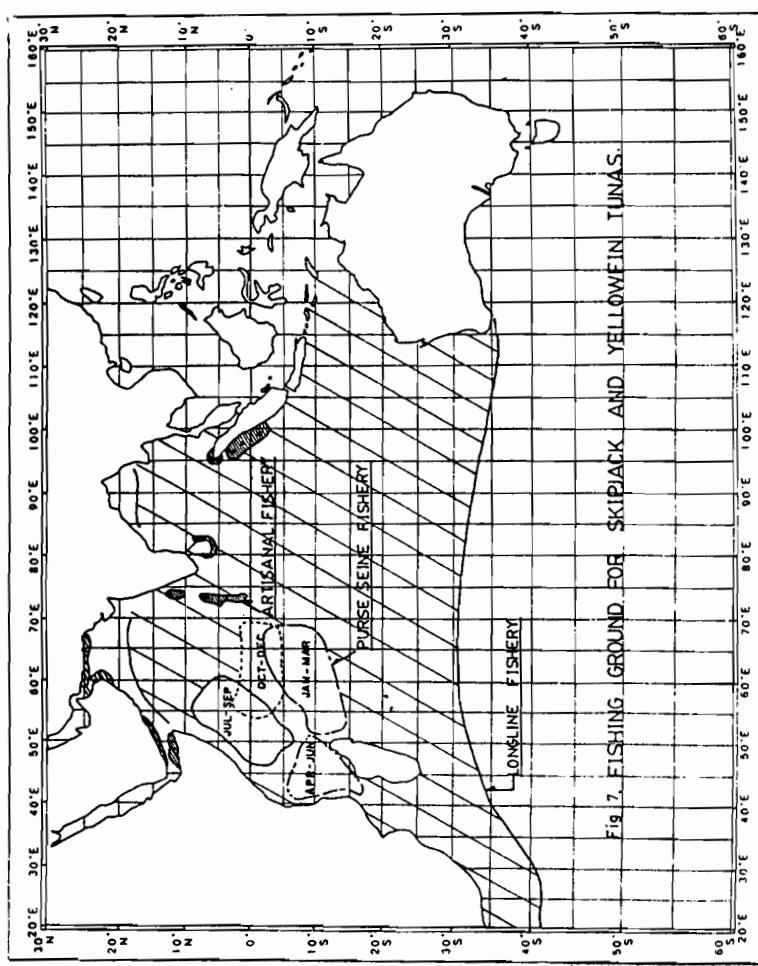


Fig. 5 CATCH TREND OF SKIPJACK TUNA IN THE INDIAN OCEAN



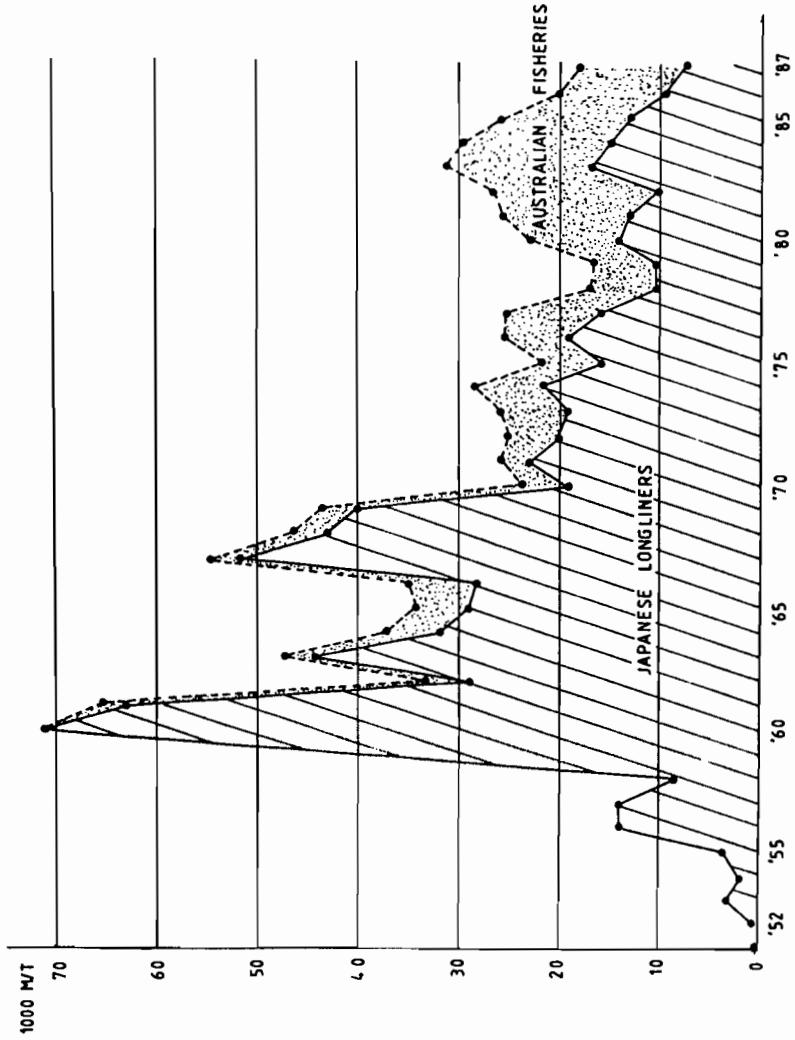
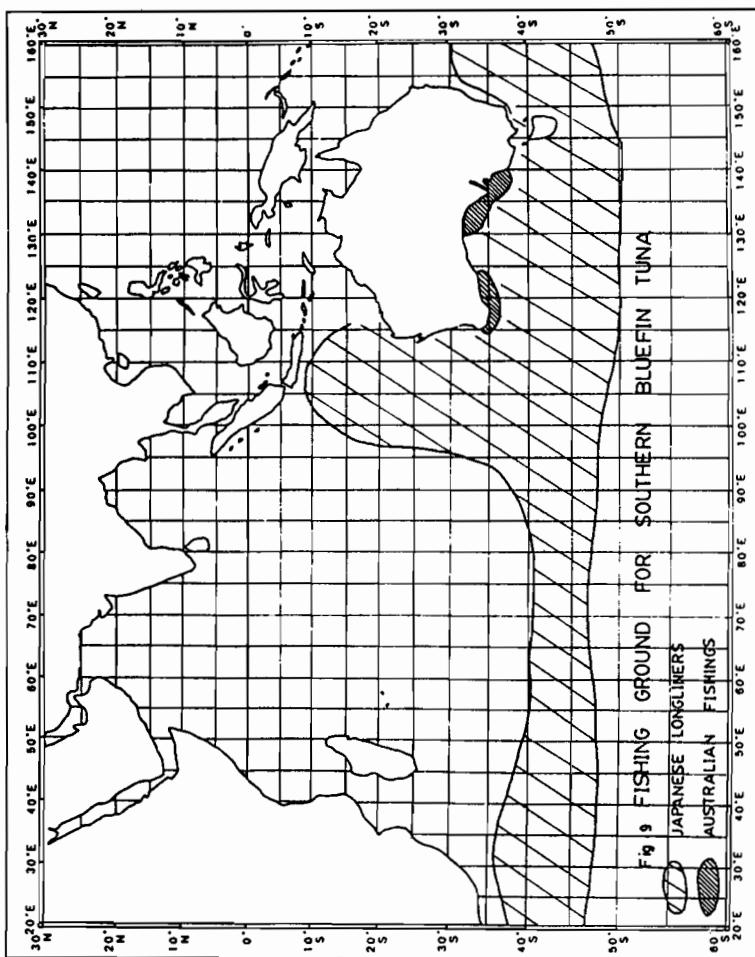


Fig. 8 CATCH TREND OF SOUTHERN BLUEFIN TUNA
IN THE INDIAN OCEAN

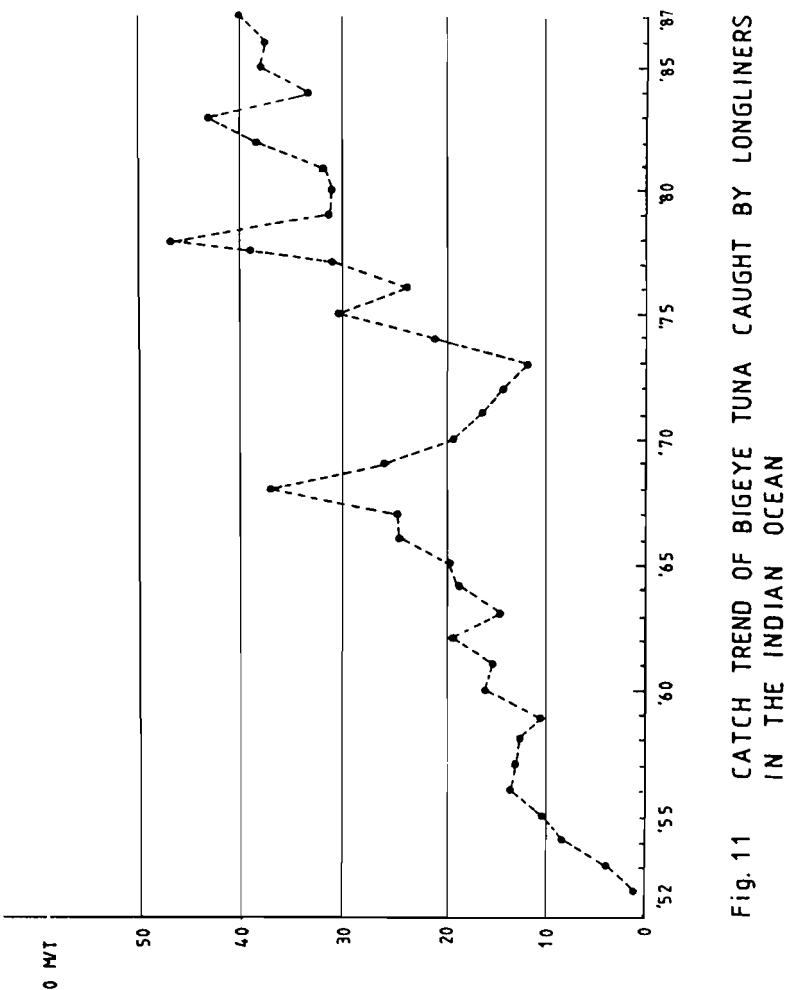
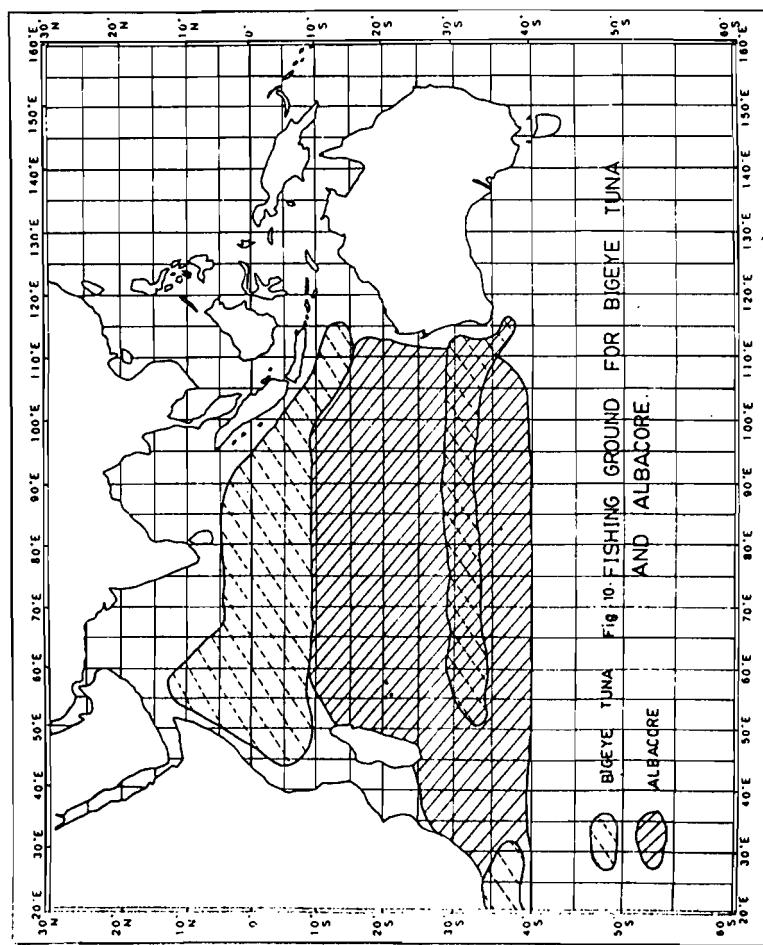


Fig. 11 CATCH TREND OF BIGEYE TUNA CAUGHT BY LONGLINERS IN THE INDIAN OCEAN



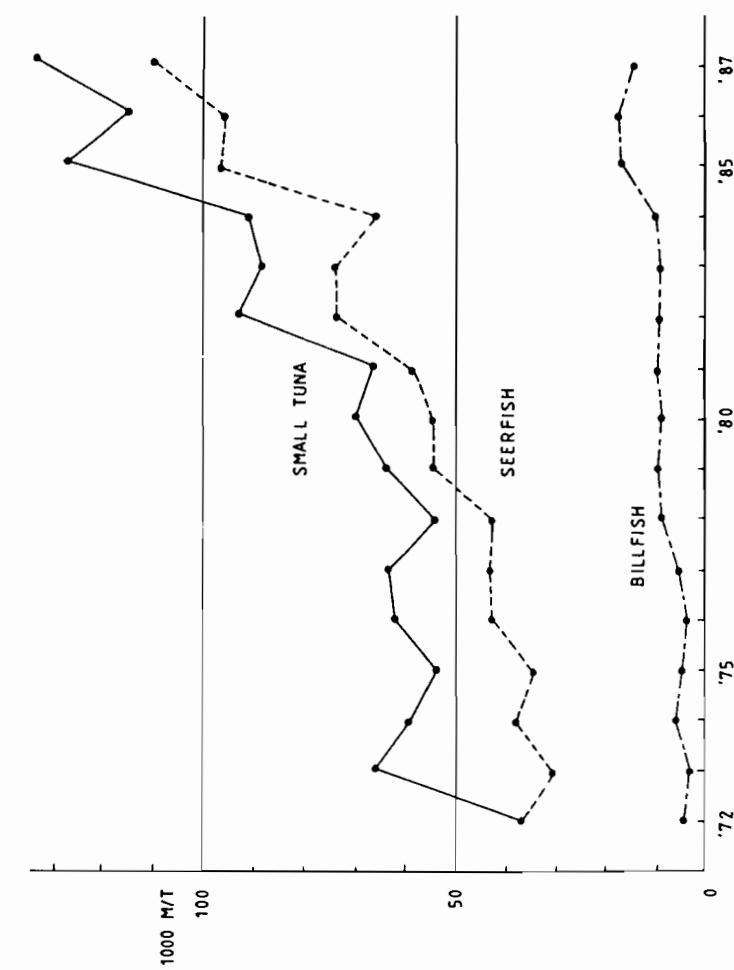


Fig. 13 CATCH TREND OF SMALL TUNAS, SEERFISHES AND BILLFISHES IN THE INDIAN OCEAN

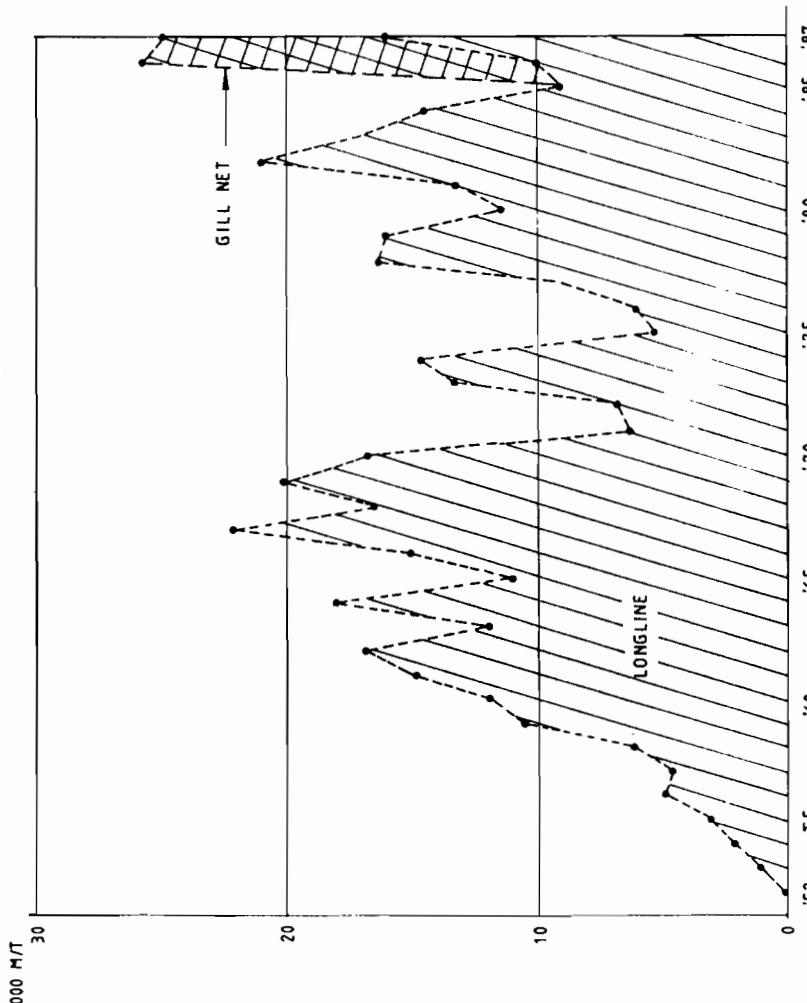


Fig. 12 CATCH TREND OF ALBACORE IN THE INDIAN OCEAN

**GILL RAKER COUNTS: A POSSIBLE MEANS OF STOCK SEPARATION
FOR LONGTAIL TUNA (*THUNNUS TONGGOL*) IN THE INDIAN OCEAN**

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ABSTRACT

Gill raker counts from longtail tuna (*Thunnus tonggol*) in Oman were compared with those reported in the literature. Significant differences were found in the number of gill rakers in Oman, as compared to those from Gulf of Mannar, in the southeastern part of India. This is an indication that these stocks of longtail tuna do not mix.

INTRODUCTION

The purpose of this study is to investigate possibilities of using gill raker counts as a possible method of separating stocks of longtail tuna in the Indian Ocean. It is usually assumed that the stocks of longtail tuna are somewhat migratory. To have a well managed fishery it is important to identify possible sub-stocks. While monitoring the status of fisheries it is equally important to determine the existing locations of various sub-stocks. One possible comparison based on gill raker counts can be made between fish from the Mannar coast (Sillas 67), and those collected in Oman.

If we observe that the counts of gill rakers are not significantly different then the two populations may mix. On

MATERIALS AND METHODS

Heads of longtail tuna were collected from the capital fish market located in Mutrah, Oman, from June to December 1988. These heads were kept frozen until examined. Prior to the examination heads were left to thaw for about three to four hours. The different head measurements such as, upper jaw length, snout length, opercle and pre-opercle lengths were taken. Each first right and left branchial gill arch were removed from the fish.

The number of gill rakers on the upper limb and the lower limb of the gill arch were counted. Both branchial gill arches were examined. The gill raker counts were done with all size ranges of longtail tuna, the smallest being 22 cm. Regardless of length the counts were the same. It was also found that there was no difference between the right and the left gill raker counts (Figure 2). Mean gill raker counts from Oman were compared with those from the Gulf of Mannar using a T test with unequal variances.

The number of specimens used for analysis in Oman was 162 for both upper and lower limbs. For Gulf of Mannar Silas (1967) reported data 34 specimens for upper limb and 37 for lower limb. Means were calculated separately for the upper and lower limb, and those from Oman were compared to those from the Gulf of Mannar. The means for the upper limb were significantly different ($t = 9.982$, $P < .001$). This indicates a significant difference in the upper gill raker counts between Oman and Gulf of Mannar. Means for the lower limb were not different, ($t = -.369$, $P = 0.0606$). (Table 1).

In Oman the total number of gill raker count is 24 to 28. The modal formula is 8 + 18 = 26. For Gulf of Mannar the range is from 22 to 27. The modal formula is 7 + 18 = 25. (Figure 3). After comparing the data from Oman and Gulf of Mannar, we see that the lower limb gill raker counts are the same. However, a significant difference is found in the upper limb.

DISCUSSION

This study was initiated as an attempt to identify possible sub-stocks of longtail tuna in the Indian Ocean. Besides gill raker count, there are several other possible methods of stock identification. For example one method uses unique parasite fauna found in a specific area, which can be compared to parasite from fish in other areas. Meristic counts

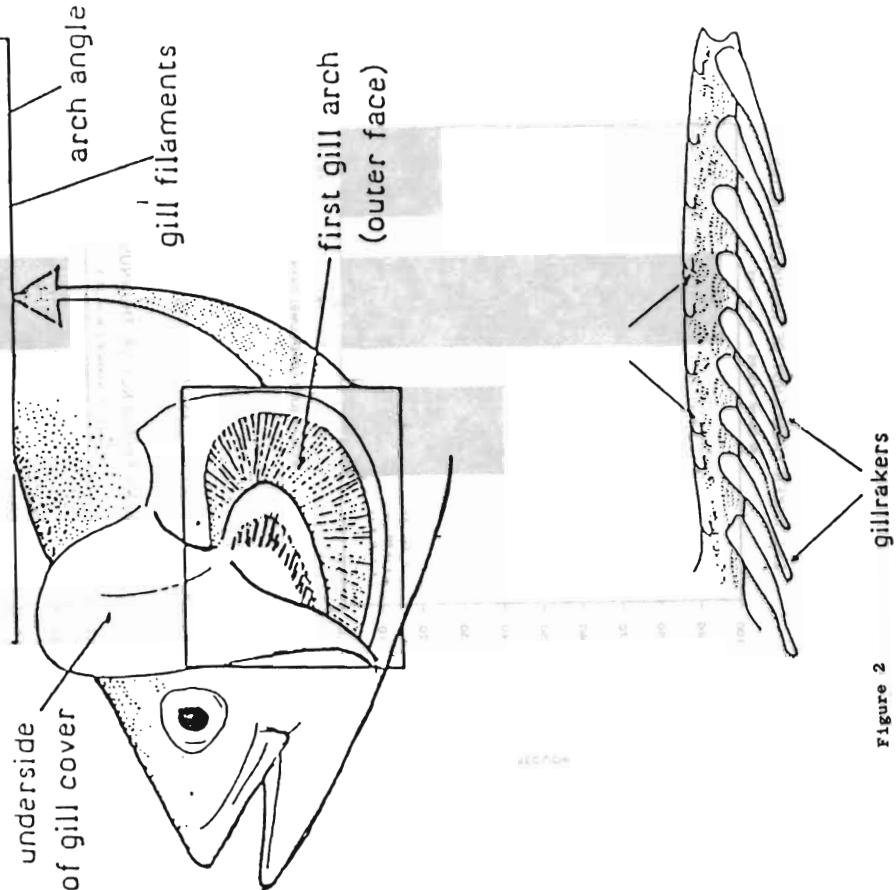
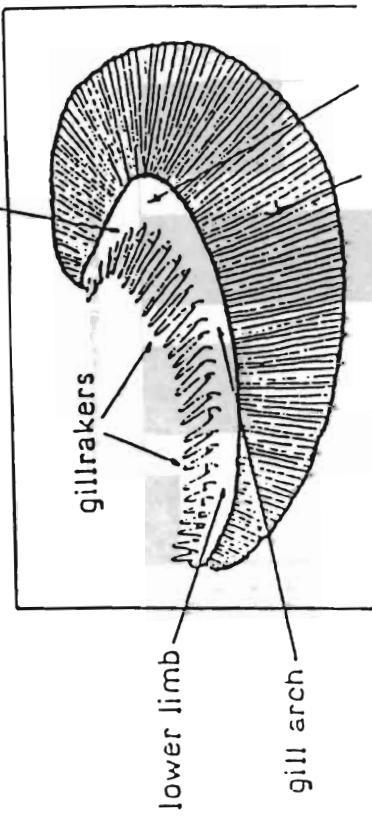
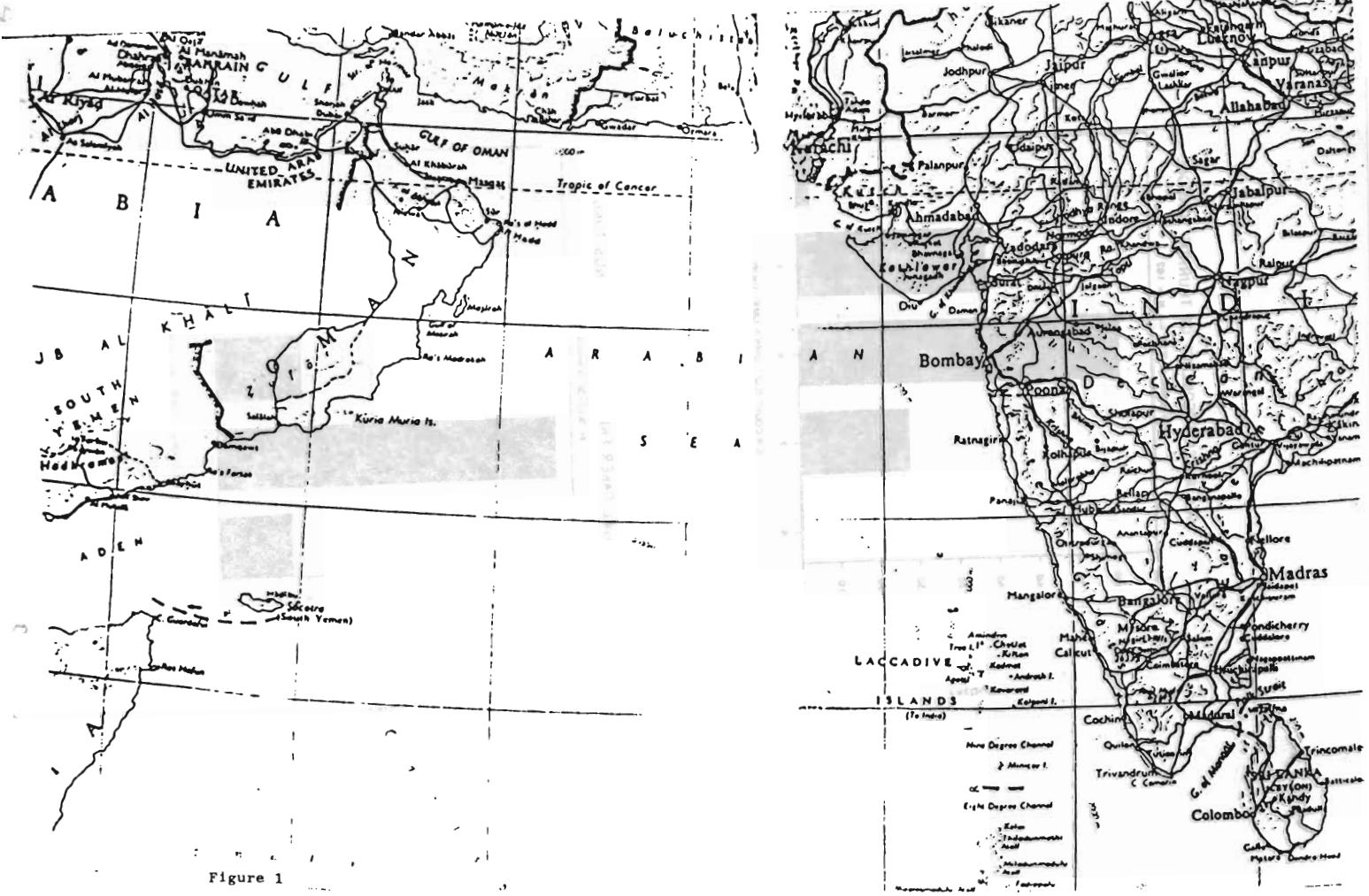
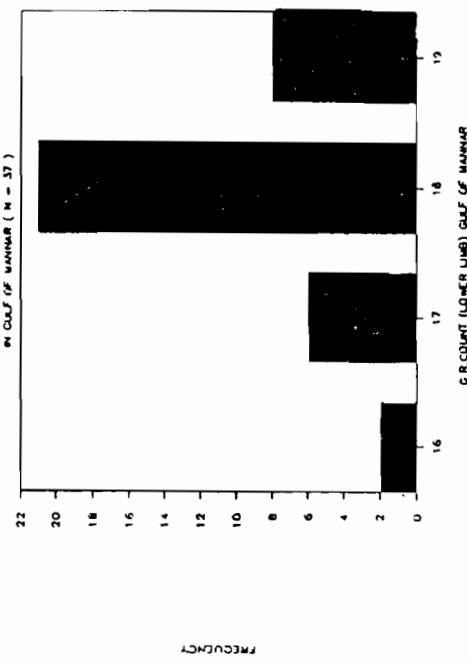
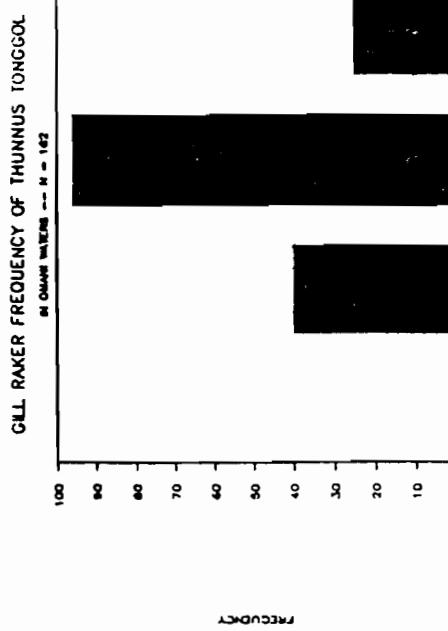
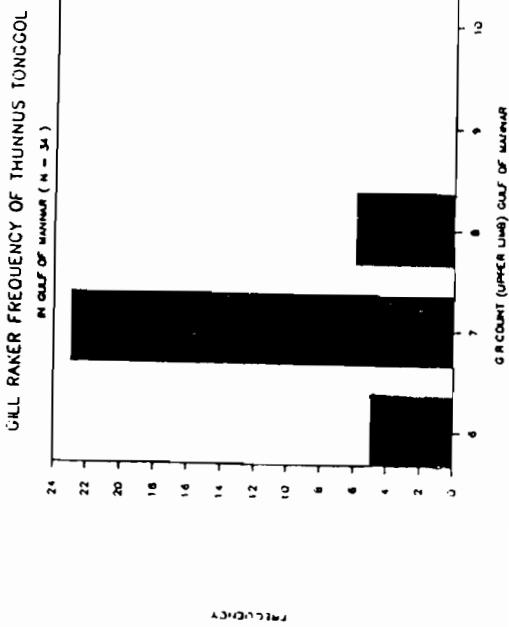
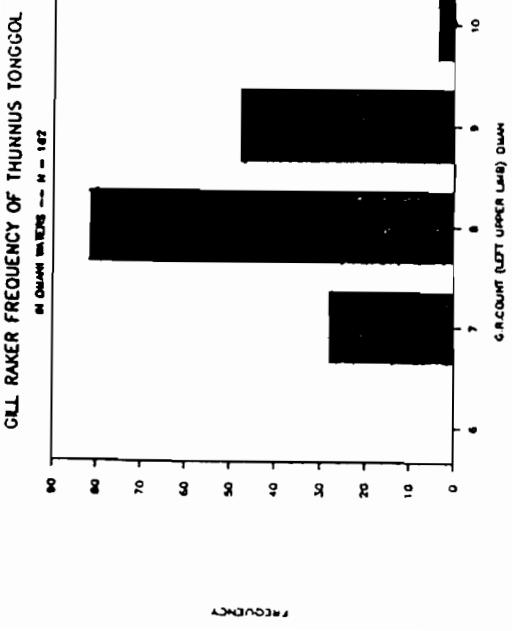


Figure 2





INTERVIEWS WITH TRADITIONAL FISHERMEN NEAR SUR, OMAN

Traditional Fishermen in Oman

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ABSTRACT

Taped, open ended interviews with twenty local fishermen in the area of Sur, Sultanate of Oman, indicate that artisanal fishermen of the area have significant knowledge of importance to fishery managers. Information about fish migrations, and about factors affecting fishing success were among the items fishermen provided.

INTRODUCTION:

Indigenous knowledge of artisanal fishermen has great potential for improving and enriching fisheries research work in Oman. This has special importance for the management of tunas and seerfishes since these species are among the most sought after fishes in the region. A program to interview local fishermen in Sur and its surrounding villages in the area between Sur and Qalhat, was carried out in order to incorporate useful knowledge into the research activities of the Marine Science and Fisheries Center. Fishing in the area of study is practiced mainly in the area extending from Ras al Hadd to Ras Al Shajair, but the findings of the study may have wider application.

RESEARCH PROCEDURES:

This study was carried out in two phases of four days each, one in early August and the other in early October of 1988. During each phase I interviewed 10 fishermen who I had known for a long time, and who I felt had a lot of experience in fishing and fishing methods. I visited and interviewed these fishermen in their boats and houses, and gave them every opportunity to say whatever they wanted to about their fishing activities with minimal interruption from me. When necessary I asked simple questions to encourage comments from the fishermen. In these

cases I usually asked about their name, age, and period of experience. Then I proceeded to ask about type of boats, types of nets, extent of development, and types of fishes caught with stress on seasons, distinctive characteristics, abundance and reproduction. I also asked about factors affecting abundance of specific fishes and factors affecting success of fishing in the area.²

I recorded all interviews and later replayed the tapes while taking notes for this paper.

FINDINGS

In covering the wide range of these points mentioned above two problems were encountered. The first involves the question of how to describe and interpret fishermen's opinions and beliefs in a brief and orderly fashion. The other, related problem, is the contradiction among these opinions which took considerable time and effort to examine in order to extract the relevant ideas. I hope that the following summary accurately reflects the beliefs of these fishermen.

Fishing Activities in the Region

The prevalent large pelagic fishes in the Sur market are Kingfish *Scomberomorus commerson*, Sahaia *Thunnus tonggol*, Gaydhar *Thunnus albacares*, Suda *Euthynnus affinis*, Sagana, *Sarda orientalis* Sharks, various demersal fishes and small pelagic fishes.

Methods of fishing experienced considerable improvement over the past several years from 'Albee' nets to nylon imported ones e.g. drift gillnets and gill nets. For sardine, fishermen used to use different kinds of nets made from spun twine which differed primarily in mesh size. For example: Magdawas used for types of sardines (*safí*, *badih*, *biyah*). Gal for *Sardinella longiceps* (*Auma*). Shabaka for a sardine called Baria. These nets are now made from nylon. Also you can find traps made of palm leaves in certain geometrical shapes for demersals and recently 'Dwabee' for Demersals

Also hook and line of different types are used: string used for demersals, 'royiad' for large pelagics, and other spun lines

*This paper was originally written in Arabic, was translated by Somaya Adam Eisa, and was then edited by Richard Dudley.

² Two anthropologists, Dr. Carol J. Pierce Colfer and Dr. Dawn Chatty, kindly provided training on open ended interview techniques.

Boats used in fishing have improved over the years from wooden ones operated by oars and sails (e.g. 'baden') to diesel powered ships which are manufactured in Sur. Recently the Government assisted fishermen by introducing fiberglass boats which are operated by petrol engines.

Traditional beliefs about Large Pelagic Fishes

Most fishermen stressed that large pelagic fishes are migrant fishes appearing in large schools in certain seasons. Also they mentioned that there are factors which affect fishing and there are many indicators used by them to identify periods when fish are abundant.

Large Pelagics and their seasons

Kingfish *Scomberomorus commerson*: One of the most important Omani fishes attract the attention of fishermen as well as researchers due to the high catches and value. Most fishermen agreed that kingfish have 'seera' or movement away in schools as well as 'Rajaiya' or coming back in schools

The "Seera season" starts with the beginning of the spring when kingfish schools move from eastern Arabian sea and Indian Ocean into the Gulf. This season lasts for a period of one to four months. Fishermen noticed this migration long time ago and they believed that the reason for such movement is that the *S. commerson* are looking for temperate, stagnant waters in shores and bays of the Gulf because warm temperatures lead to early maturation of eggs.

The return migration 'Rajaiya' which takes place by the end of Summer forms the return of these schools from the Gulf to the Arabian Sea. During this period they are emaciated, spent, and moving faster than before. They usually spend about three months near the shores of Sur but they may stay there longer if there is abundance of sardine and cool currents.

Fishermen believe there is also another form of migration (called Hadfai) in which large *S. commerson* come from offshore and move to nearshore areas, perhaps 500 to 1000 m from shore. These fish are usually of an extra large size and move as individuals rather than in schools. This Hadfai season precedes the Seera season by a short time.

Fishermen also state that they never noticed small size kingfish (30 cm or smaller) but they added that these fishes may be found in Iraq and the Gulf.

Catch rates of *S. commerson* are usually quite high, sometimes reaching 200 fish per boat per night. Kingfish are caught by means of nets or trolling lines pulled behind boats.

Sahwa *Thunnus tongol*: This is the most important tuna species in the area and is an important source of food for people in Sur. The fishermen believe there is some sort of migration during different seasons, but I was unable to verify the direction and timing of these movements because the fishermen contradicted each other when speaking about this subject. I believe part of this situation is due to the fact that Sahwa are present in Sur waters all year. However, most fishermen agreed that Sahwa accompany kingfish from the east in winter and were available until summer when they carry eggs. They then return from the Gulf by the end of summer moving towards the Arabian Sea in large schools. The numbers also increase when sardine are abundant.

Fishermen believe that Sahwa have no real migration. They inhabit the region, but it is noticed that Sahwa disappear in the presence of eastern currents and increase in sea temperature.

Sahwa can be seen during day time jumping in schools, and also at night. They move faster than kingfish and are caught by nets or trolling lines. Catch rates are very high, sometimes reaching 650 fish per boat per day. Sahwa found sub-surface waters whereas kingfish are found deeper.

Suda - *Euthynnus affinis*: Fishermen believe that these fish move with kingfish, but tend to stay near shore. All sizes move near shore, where they can be seen clearly by fishermen at sunset. Catch rates can reach 600 fish per boat. Caught primarily by nets they disappear during some months of the year.

Gaydhar - *Thunnus albacares*: This species disappear in certain years. Fishermen say that it may enter their waters for up to ten years continuously and then disappear for perhaps the next seven years. Fishermen think that availability of Gaydhar now-a-days is due mainly to availability of Sardine in the Gulf and Arabian Sea.

Fishermen state that certain disease (red spots) which infect the frontal month parts of Gaydhar makes them unable to swallow bait. This species is usually caught by gill nets or trolling lines.

Other important fishes are *Sagatana (Sarda orientalis)* which are more abundant in winter and when sardine are abundant. Various Carangidae (e.g. Gashran, Golani, Salan, etc.) are abundant in Summer and also increase with the availability of Sardine

Other Fishes

Demersal fishes: The Sultanate shores especially eastern shores are rich of different types of demersal fishes in large populations that you will never miss any kind of them in Sur market. Fishermen could identify great numbers of Demersal fishes and their locations, demersal fishes differ according to the depth of the coral reefs and rocks of the region.

Sardine (Sardinella species) are and important food item for larger fishes, especially large pelagics. They are also caught for food for animals and as a manure on farms. Fishermen have the following beliefs about sardine:

"Auma" come from the Arabian sea late in the year when they are relatively small and leave the area at the beginning of summer when they are bigger in size. They stay for a short period in the Sur area.

"Bana" migrate to the Gulf in Winter, sometimes mixed with Auma, and return at the end of summer.

"Samoka", a third type of sardine lives in the Sur area throughout the year and is used as a bait for bigger fishes.

Factors affecting fishing in the region.

The sea turns green when cool currents come from Arabian Sea. This is used as indicator of the availability of large pelagic species. High temperature result in darker color and fishing success decreases.

Fishermen believe that the moon negatively affects fishing for large pelagics with the exception of Kingfish. The dark of the moon is best for fishing Tuna and Sharks.

Presence of bio-luminescent plankton decreases chances of catching fishes because of the light given off when these organisms hit the nets. This light allows the fish to see the nets.

Rough sea conditions during the winter are caused by northerly winds which blow in the eastern part of Oman. These winds raise the height of waves which decreases fishing opportunities.

Fishermen believe that tides don't affect net fishing directly, but some fishermen do make use of tides by setting their nets or traps on shore and waiting for the tide to drop to collect the fishes which are caught.

Fishes are believed to be most active before sunrise and also at sunset. The daytime is not suitable for fishing for large pelagics. Tuna are always found off shore whereas Kingfish can be caught near shores.

Other factors affecting fishing

- strong currents decrease fishing possibilities.
- availability of large quantities of sardines attract large pelagic fishes, especially Kingfish.
- oil spots on the water surface indicate the presence of Kingfish in the region.
- black birds indicate large populations of fish are present.
- Eastern Winds, lower sea temperatures and increase chances of catching fish.
- Northern 'Azeeb', winds raise sea temperature.
- Sahwa pull nets up where as Kingfish pulled them down.

CONCLUSIONS

Indigenous knowledge of fishermen in this region is significant and has great importance especially with regard to management of and research about large pelagic species.

This type of information is difficult to interpret due to the considerable contradiction among fishermen. Nevertheless, I have attempted to make this report a concise summary which reflects the primary ideas discovered in talking to these fishermen.

ACKNOWLEDGMENTS

I would like to thank the Fishermen of the Sur area who so kindly and enthusiastically participated in these interviews. I would also like to thank my co-workers at Oman's Marine Science and Fishery Center who supported me in this work. Special thanks go to the Center's Director, Mohamed Amor Al-Barwani.

GROWTH OF *Scomberomorus commerson* IN OMAN BASED ON LENGTH DATA

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ABSTRACT

Length data from *Scomberomorus commerson* collected monthly from February 1987 through January of 1989 were analyzed to determine basic growth and population parameters. The growth curve which fit the data best had the following parameters: $L_{\text{inf}}=164$, $k=0.340$, $C=0.360$ and $WP=0.100$. The estimated value of total mortality based on a length converted catch curve using these growth parameters is $Z=1.151$. Natural mortality based on the growth parameters and mean environmental temperature ($T=25.5^{\circ}\text{C}$) is $M=0.526$. Fishing mortality is $F=0.625$. These values indicate that current fishing effort should be stabilized. However, the analysis also indicates that several other combinations of growth parameters fit the data almost as well. Some of the other combinations indicate that fishing effort should be decreased. Thus, caution is suggested in managing the fishery for the present.

INTRODUCTION

Scomberomorus commerson (Lacepede) (the narrow barred or Indopacific Spanish mackerel) is extremely important commercially both in Oman and in the Gulf of Oman and Arabian Sea in general. Annual catch estimates of this species in Oman have been between 14 and 25 thousand tons over the last three years. This species accounts for about one third the value of Oman's fish catch.

In spite of the extreme importance of *S. commerson* there is relatively little information about the species in this region. Preliminary information on this species in Oman fishery was supplied by Dudley and Arundhati (1988). From adjacent areas information on growth and survivorship of *S. commerson* is available from Djibouti (Bouhlel 1985); and Deveraj studied growth (1981) and reproduction (1983) of *S. commerson* in southeastern India.

There are several significant questions regarding the *S. commerson* fishery in Oman which should be answered if the fishery is to be managed properly.

Analysis of *Scomberomorus commerson* Length Data

Many small (40 to 60 cm) *S. commerson* are caught in Oman. In Dubai and other parts of the Gulf even smaller (20 to 30 cm) *S. commerson* are commonly caught. The ages of these fish and the potential contribution they could make to the fisheries needs to be assessed. While it is known that *S. commerson* in Oman can reach a size in excess of 200 cm, very few fish of this size are caught. It is essential to determine what protection is needed for young *S. commerson*.

The migration pattern of *S. commerson* is not known, yet the movements of the fish are an important management consideration. It is quite possible that *S. commerson* stocks are shared with Iran, Pakistan and the United Arab Emirates.

Also, the proportion of fish being taken from the population is not known.

A first step toward answering these questions is to determine growth and survival rates for *S. commerson* found in Oman. This information, in conjunction with available data from surrounding areas can provide a basis for a preliminary understanding of *S. commerson* stocks in the area. This information can then be improved as additional information is collected to answer specific questions.

In this paper we describe our work with *S. commerson* which attempts to answer some of the above questions pertaining to growth, mortality and management of *S. commerson* in Omani and regional waters.

METHODS

Our research is based primarily on length frequency data supplemented by occasional data from other sources.

Standard sampling was conducted during the first 10 days of each month at the Muttrah fish market near Muscat, Oman. Fish sold at the Muttrah market include those caught in other parts of the country and brought to Muttrah by vehicle. For this reason *S. commerson* sampled at Muttrah provide a reasonable, though not perfect, sample of the fishery as a whole. The fork length of fish were measured to the nearest cm with large calipers. Data was collected each month over the two years between February 1987 and January 1989. Supplemental length data was collected from Masirah Island, Sur, Musandam, Dugm, and the Batinah Coast.

On some occasions it was possible to determine the sex of the specimens measured. Usually this was not possible since the fish are generally marketed whole. In cases where gonads could be examined the stage of maturity was also determined. Otoliths of several hundred S. commerson have been collected during 1987 and 1988, but these have not yet been examined in detail.

We analyzed length data using the Complete Elefan package (Gayaniello et al. 1988). This computer package provides a curve fitting routine which allows one to examine the goodness of fit of a growth function for many different sets of parameters. The package allows one to fit both the standard and the seasonally oscillating version of the Von-Bertalanffy growth function to the data (Pauly 1987).

In carrying out analysis of this data we fit both a oscillating and standard version of the growth function to data collected during the full two year period. We also fit a growth function to data derived from modal progression analysis (as implemented in the above computer package). This approach uses the Bhattacharya (1967) method to fit normal distributions to the different modal groups making up the length frequency distribution. A growth curve can then be fitted to growth increments derived from the means and standard deviations of these groups.

Total mortality was estimated from a length converted catch curve which makes use of growth parameters and length frequency data. Natural mortality was estimated by Pauley's (1980) method using growth parameters and mean environmental temperature. The latter, derived from recorded oceanographic data for the region (Anon. 1967), was estimated as 25.5.

RESULTS

Length Frequency Data

General trends

Length frequency data from S. commerson shows very distinct modes and a very clear progression of these modes over time. Young fish first appear in the catches in September (1988) or October (1987) at a size of 40 to 50 cm. This mode progresses over the year to between 80 and 90 cm one year later. From October through April two and sometime three clear modes are visible (Table 1, Figure 1).

Data Comparisons Within Oman

Although most of our data was collected at the Muttrah fish market the analysis assumes that these samples are representative of the Omani fishery as a whole. Supplemental samples from other locations in Oman indicate that this is probably the case although some regional differences do exist.

Data collected at Sur and Masirah Island usually exhibit the same modes as those from Muttrah with the exception that the smaller fish (40 to 60 cm) in September through December are less abundant in the Masirah/Sur fisheries. A comparison of this type is illustrated in Fig. 2.

Our relatively limited data from Musandam, starting late in 1988, indicated that there were some fish there between 60 and 80 cm. No fish of this size were found in Muttrah during this period. Also, some fish smaller than the smallest found at Muttrah were measured in Musandam. It is possible that at least some fish the Musandam area are from different sources compared to S. commerson found at Muttrah. Not also that fish from Musandam are rarely, if ever, marketed in Muttrah. This comparison is illustrated in Fig. 3.

Some regional differences within the rest of Oman are important. For example, small fish tend to be abundant on the North (Batinah) coast earlier than at Sur and Masirah. We also examined the possibility that male and female fish grow at different rates. From samples where the sex of fish was known, there was no strong indication that this was the case. Modal groups were composed of both male and female fish. However, there is a slight tendency for more large fish to be female. (Fig. 4).

Data Comparisons Between Years

Sampling over a two year period has given some indication that significant fluctuations in yearclass abundance may occur. A comparison of data from November 1987 through January 1988 with data from November 1988 through January 1989 indicate that significantly more small Kingfish (40 to 70 cm) were present during the latter period. (Fig. 5).

Although our current sampling program does not allow a precise measure of yearclass strength, it is fairly obvious that the 1987 yearclass was significantly larger than that from 1986. It is quite possible that in the future a relatively straightforward sampling program to estimate yearclass strength can be established.

Comparison with locations outside Oman

A comparison with *S. commerson* length frequency data from Djibouti (Bouhlel 1985) reveals that the Djibouti population has a significantly different structure. In Djibouti small fish (40 to 50 cm) are most abundant in January through April while in Oman this size is found only during September through December. In February, March and April of 1987 and 1988 virtually no fish smaller than 50 cm were found in Omani catches. Since these fish are growing it is unlikely that the fish in Oman during September through December are the same as those which appear later in Djibouti.

Small *S. commerson* (20 to 40 cm) are regularly reported from the United Arab Emirates, but do not seem to occur in Oman.

Growth Curves

The seasonally oscillating growth curve which best fits our data has the following parameters: $L_{inr}=164$, $k=0.340$, $C=0.360$ and $WP=0.100$. Length at age data using these parameters is presented in Table 2. This curve predicts that fish would be zero length in mid-August.

Although these parameters produced the best fitting curve, several other sets of parameters also produced curves which fit the data well. A possible alternate set of "correct" parameters is: $L_{inr}=203$, $k=0.230$, $C=0.280$, $WP=0.130$. Lengths at age for this set are given in Table 3. Fish following this growth curve would have a length of zero in mid-July. The occasional occurrence in the catches of *S. commerson* 200 cm long gives credence to this alternate set of parameters. This set of parameters results in significantly different management recommendations (see below).

Although the oscillating growth function provided a better fit to the data, the standard von Bertalanffy growth function was also fitted to allow comparison with other studies. The best fitting curve had the following parameters: $L_{inr}=170$, $k=0.301$, $t_0=0.0374$.

A growth curve based on modal progression (using means of the modal groups assuming a normal distribution) yielded approximately the same parameters as the first curve ($L_{inr}=164$) listed above.

Estimates of Mortality

Estimates of total mortality Z using length converted catch curves is dependent on values of the growth parameters L_{inr} and k . Thus, different growth parameters will yield different Z values. Also, the only method available for estimating natural mortality M (Pauly 1980) also makes use of these two growth parameters. For this reason our estimates of fishing mortality, $F=Z-M$, are heavily dependent on our estimates L_{inr} and k . As a consequence it is important to examine all possible growth functions in determining possible mortality rates and their management implications.

Using the most likely oscillating growth function parameters these mortality rates are: $Z=1.151$, $M=0.526$, $F=0.625$. The exploitation rate $E=F/Z=0.543$. Relative yield per recruit (using these growth parameters) is maximum at $E=0.51$, indicating that the fishery is fully exploited at present, given the current sizes at capture. Some increase in effort might be possible if size at first capture were increased. Use of a likely alternate oscillating growth function ($L_{inr}=203$, $k=0.230$, $C=0.280$, $WP=0.130$) produces a very different result. In this case $Z=1.780$, $M=0.384$, $F=1.396$ and $E=0.784$. Relative yield per recruit would be maximum, in this case at, $E=0.6533$. If one accepts this as the correct group of parameters then fishing for this species should be curtailed somewhat.

DISCUSSIONLength Based Analysis

The use of LF data for growth analysis has received renewed interest in recent years (Pauly and Morgan 1987), especially with the implementation of computerized analysis packages (e.g. Gavailo et al 1988, Sparre 1987). The primary benefits of this type of analysis are the relative ease with which necessary data can be obtained over a short period. The data is also relatively inexpensive to collect. The computerization such analysis has brought several other benefits as well, the most important being the ease and speed of analysis.

Some possible problems associated with computerized stock analysis packages of this sort might also occur. The ease of computational analysis makes it more likely that numbers can be generated with little understanding of their meaning or reliability. However, this possibility is offset by the ability to rapidly and easily examine the consequences of variations in input parameters.

More important than these are the real problems inherent in length frequency analysis. Any factor affecting the modes in a length frequency distribution will affect the outcome. Such factors include gillnet selectivity and size selective migration of fishes.

Suitability of Data

Because of its long narrow shape, *S. commerson* of a given size are likely to be caught in meshes of several sizes. This limits the likelihood that mesh selectivity confounds the analysis. Although *S. commerson* are migratory, the clear progression of the modes indicates that fish of various sizes are regularly captured in Omani waters. It is possible, however, that the absolute abundance of fish in the different modal groups may be affected by migration. This possibility would significantly affect mortality estimates. For example, more small fish are landed in northern Oman and thus may contribute more to our samples than to the overall fishery.

Fluctuations in yearclass strength occur in the Omani *S. commerson* population and could confound survival estimation. However, since the survival estimation technique uses all data collected over a two year period these fluctuations will have less effect.

In general, however, we feel that the length data collected over the past two years is very good for length based growth analysis and is reasonably good for derivation of mortality rates.

Findings in relation to management of *S. commerson*

We feel it is important to report two sets of growth parameters for several reasons. Fish which are larger than the best fit L_{∞} of 164 cm, and occasionally larger than 200 cm, occur in the catches. Although these fish are not abundant (only one fish in 10,000 examined was over 200 cm, and only two were larger than 165 cm), they can grow to this size, and present mortality rates could remove these fish from the population.

We also believe this approach emphasizes the fact that the parameter values presented are estimates, and that different values of these estimates yield different management recommendations.

Another consideration is the possibility that these growth parameters actually change under the influence of environmental (including fishing) factors. We certainly don't know that this is the case, but it is possible that a few large fish are an indicator of different growth conditions during past years. For example, Stromme (1986) reported that the small pelagic fish *Trachurus indicus*, a probable food of *S. commerson*, constituted 50 percent of the biomass of small pelagic fishes in 1983 and 1984 but was only of minor importance in earlier surveys in 1975 and 76. Such fluctuations in abundance of prey fishes are a characteristic of up-welling systems like that found off Oman's south east coast, and could effect growth, and growth parameters, of *S. commerson*.

Our analysis, using the best fitting growth curve, provides reasonable estimates of growth and population parameters. These estimates suggest that current levels of fishing are reasonable, but that no expansion is possible. We believe that it is prudent to be careful in managing Oman's (and the region's) *S. commerson* fishery. We therefore suggest that the fishery be stabilized at present fishing levels.

Future research needs

Several lines of research, of benefit to the management of the fishery, should be pursued in the near future. These suggestions would lead to more accurate information of the type presented here, and to the development of new information.

Growth analysis should be refined by detailed examination of otoliths from this species. Data from older fish is needed to better define the growth function, and data from small fish would also be useful.

Additional length data from adjacent regions is needed. Data from the United Arab Emirates, Iran, Pakistan, and Yemen (PDRY) would be particularly useful for comparison with data from Oman.

In order to provide improved estimates of mortality rates based on length frequency data, length data which accurately reflects the number of fish within the modal groups is needed.

The question of stock identification needs to be addressed as well. This can be done via two approaches: genetic and tagging studies. Electrophoretic studies of samples from different areas will give some indication of different stocks in the region. Tagging studies, although difficult and expensive to carry out, would also provide information about migratory behavior and could provide estimates of F independent of length data.

There is currently evidence to suggest that this species is being caught at a sub-optimum size. Thus, mesh selection studies could provide valuable information for formulation of management regulations and also for more accurate analysis of length data.

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Table 1. Length frequency data for narrow barred Spanish mackerel (*Scomberoides* commerson) collected monthly from February 1987 through January 1989 at the Nutriart fish market in Ocean. Fish were originally measured in one ca. 4 m.

FIGURES

Figure 1. Length data of *Scomberomorus commerson* collected during February 1987 through January 1988.

Figure 2. A comparison of lengths of *S. commersoni* from Misrah Island and Muttrah fish market in October of 1987.

Figure 3. A comparison of lengths of *S. commersoni* from Musandam and the Muttrah fish market in

Figure 4. A comparison of lengths of male and female S. commerson caught at Masirah Island in November through December of 1988

Figure 5. A comparison of relative numbers of fish in different year classes in December of 1987 and 1988. The 1986 yearclass appears less abundant than that produced in 1987

Table 2 Calculated length at age for *S. commerson* using growth parameters: $Linf=164$, $k=0.340$, $C=0.360$, $W=0.100$

Year	1	2	3	4	5	6	7	8	9	10	11	12
Length (cm) on 15th of Each Month												

Length (cm) on 15th of Each Month

Month	Sep	0.85	47.88	81.35	105.17	122.13	134.20	142.79	148.90	153.26	156.36	158.56	160.13
Oct	6.29	51.75	84.10	107.13	123.53	135.19	143.50	149.40	153.62	156.61	158.74	160.26	
Nov	10.96	55.07	86.47	108.82	124.72	136.05	144.10	149.84	153.92	156.83	158.90	160.73	
Dec	14.59	57.65	88.31	110.13	125.66	136.71	144.58	150.18	154.16	157.00	159.02	160.46	
Jan	17.64	59.82	89.85	111.23	126.44	137.27	144.97	150.46	154.36	157.14	159.12	160.53	
Feb	20.34	61.75	91.22	112.20	127.13	137.76	145.32	150.71	154.56	157.27	159.21	160.59	
Mar	22.84	63.53	92.49	113.10	127.77	138.22	145.65	150.94	154.71	157.39	159.29	160.65	
Apr	25.99	65.77	94.09	114.24	128.58	138.79	146.06	151.23	154.91	157.53	159.40	160.73	
May	29.62	68.35	95.92	115.55	129.51	139.45	146.53	151.57	155.15	157.70	159.52	160.81	
Jun	33.95	71.44	98.12	117.11	130.63	140.25	147.09	151.95	155.44	157.91	159.66	160.92	
Jul	38.35	74.70	100.44	118.76	131.80	141.08	147.69	152.39	155.74	158.12	159.82		
Aug	43.34	78.12	102.87	120.49	133.03	141.96	148.32	152.84	156.06	158.35	159.98		

Table 3 Calculated length at age for *S. commerson* using growth curve parameters: $Linf=203$, $k=0.230$, $C=0.280$, $W=0.130$

Year	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	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
Month	Length (cm) on 15th of Each Month	3.25	44.29	76.90	102.81	122.40	139.75	152.75	169.99	187.21	205.35	223.41	241.30	259.98	278.14	296.18	314.99	332.21	350.35	368.41	386.46	404.50	422.55	440.59	458.63	476.67	494.71	512.75	530.79	548.83	566.87	584.91	602.95	620.99	638.03	655.07	672.11	689.15	706.19	723.13	740.17	757.11	774.15	791.19	808.13	825.17	842.21	859.25	876.29	893.33	910.37	927.41	944.45	961.49	978.53	995.57	1012.61	1029.65	1046.69	1063.73	1080.77	1097.81	1114.85	1131.89	1148.93	1165.97	1182.01	1200.05	1217.09	1234.13	1251.17	1268.21	1285.25	1302.29	1319.33	1336.37	1353.41	1370.45	1387.49	1404.53	1421.57	1438.61	1455.65	1472.69	1489.73	1506.77	1523.81	1540.85	1557.89	1574.93	1591.97	1608.01	1625.05	1642.09	1659.13	1676.17	1693.21	1710.25	1727.29	1744.33	1761.37	1778.41	1795.45	1812.49	1829.53	1846.57	1863.61	1880.65	1897.69	1914.73	1931.77	1948.81	1965.85	1982.89	2000.93	2017.97	2034.01	2051.05	2068.09	2085.13	2102.17	2119.21	2136.25	2153.29	2170.33	2187.37	2204.41	2221.45	2238.49	2255.53	2272.57	2289.61	2306.65	2323.69	2340.73	2357.77	2374.81	2391.85	2408.89	2425.93	2442.97	2459.01	2476.05	2493.09	2510.13	2527.17	2544.21	2561.25	2578.29	2595.33	2612.37	2629.41	2646.45	2663.49	2680.53	2697.57	2714.61	2731.65	2748.69	2765.73	2782.77	2800.81	2817.85	2834.89	2851.93	2868.97	2885.01	2902.05	2919.09	2936.13	2953.17	2970.21	2987.25	3004.29	3021.33	3038.37	3055.41	3072.45	3089.49	3106.53	3123.57	3140.61	3157.65	3174.69	3191.73	3208.77	3225.81	3242.85	3259.89	3276.93	3293.97	3310.01	3327.05	3344.09	3361.13	3378.17	3395.21	3412.25	3429.29	3446.33	3463.37	3480.41	3497.45	3514.49	3531.53	3548.57	3565.61	3582.65	3600.69	3617.73	3634.77	3651.81	3668.85	3685.89	3702.93	3719.97	3736.01	3753.05	3770.09	3787.13	3804.17	3821.21	3838.25	3855.29	3872.33	3889.37	3906.41	3923.45	3940.49	3957.53	3974.57	3991.61	4008.65	4025.69	4042.73	4059.77	4076.81	4093.85	4110.89	4127.93	4144.97	4161.01	4178.05	4195.09	4212.13	4229.17	4246.21	4263.25	4280.29	4297.33	4314.37	4331.41	4348.45	4365.49	4382.53	4400.57	4417.61	4434.65	4451.69	4468.73	4485.77	4502.81	4519.85	4536.89	4553.93	4570.97	4587.01	4604.05	4621.09	4638.13	4655.17	4672.21	4689.25	4706.29	4723.33	4740.37	4757.41	4774.45	4791.49	4808.53	4825.57	4842.61	4859.65	4876.69	4893.73	4910.77	4927.81	4944.85	4961.89	4978.93	4995.97	5012.01	5029.05	5046.09	5063.13	5080.17	5097.21	5114.25	5131.29	5148.33	5165.37	5182.41	5200.45	5217.49	5234.53	5251.57	5268.61	5285.65	5302.69	5319.73	5336.77	5353.81	5370.85	5387.89	5404.93	5421.97	5438.01	5455.05	5472.09	5489.13	5506.17	5523.21	5540.25	5557.29	5574.33	5591.37	5608.41	5625.45	5642.49	5659.53	5676.57	5693.61	5710.65	5727.69	5744.73	5761.77	5778.81	5795.85	5812.89	5829.93	5846.97	5863.01	5880.05	5897.09	5914.13	5931.17	5948.21	5965.25	5982.29	5999.33	6016.37	6033.41	6050.45	6067.49	6084.53	6101.57	6118.61	6135.65	6152.69	6169.73	6186.77	6203.81	6220.85	6237.89	6254.93	6271.97	6288.01	6305.05	6322.09	6339.13	6356.17	6373.21	6390.25	6407.29	6424.33	6441.37	6458.41	6475.45	6492.49	6509.53	6526.57	6543.61	6560.65	6577.69	6594.73	6611.77	6628.81	6645.85	6662.89	6679.93	6696.97	6713.01	6730.05	6747.09	6764.13	6781.17	6798.21	6815.25	6832.29	6849.33	6866.37	6883.41	6900.45	6917.49	6934.53	6951.57	6968.61	6985.65	7002.69	7019.73	7036.77	7053.81	7070.85	7087.89	7104.93	7121.97	7138.01	7155.05	7172.09	7189.13	7206.17	7223.21	7240.25	7257.29	7274.33	7291.37	7308.41	7325.45	7342.49	7359.53	7376.57	7393.61	7410.65	7427.69	7444.73	7461.77	7478.81	7495.85	7512.89	7529.93	7546.97	7563.01	7580.05	7597.09	7614.13	7631.17	7648.21	7665.25	7682.29	7699.33	7716.37	7733.41	7750.45	7767.49	7784.53	7801.57	7818.61	7835.65	7852.69	7869.73	7886.77	7903.81	7920.85	7937.89	7954.93	7971.97	7988.01	7995.05	8012.09	8029.13	8046.17	8063.21	8080.25	8097.29	8114.33	8131.37	8148.41	8165.45	8182.49	8199.53	8216.57	8233.61	8250.65	8267.69	8284.73	8301.77	8318.81	8335.85	8352.89	8369.93	8386.97	8403.01	8420.05	8437.09	8454.13	8471.17	8488.21	8505.25	8522.29	8539.33	8556.37	8573.41	8590.45	8607.49	8624.53	8641.57	8658.61	8675.65	8692.69	8709.73	8726.77	8743.81	8760.85	8777.89	8794.93	8811.97	8828.01	8845.05	8862.09	8879.13	8896.17	8913.21	8930.25	8947.29	8964.33	8981.37	8998.41	9015.45	9032.49	9049.53	9066.57	9083.61	9100.65	9117.69	9134.73	9151.77	9168.81	9185.85	9202.89	9219.93	9236.97	9253.01	9270.05	9287.09	9304.13	9321.17	9338.21	9355.25	9372.29	9389.33	9406.37	9423.41	9440.45	9457.49	9474.53	9491.57	9508.61	9525.65	9542.69	9559.73	9576.77	9593.81	9610.85	9627.89	9644.93	9661.97	9678.01	9695.05	9712.09	9729.13	9746.17	9763.21	9780.25	9797.29	9814.33	9831.37	9848.41	9865.45	9882.49	9900.53	9917.57	9934.61	9951.65	9968.69	9985.73	9998.77	10015.81	10032.85	10049.89	10066.93	10083.97	10096.01	10113.05	10130.09	10147.13	10164.17	10181.21	10198.25	10215.29	10232.33	10249.37	10266.41	10283.45	10299.49	10316.53	10333.57	10350.61	10367.65	10384.69	10399.73	10416.77	10433.81	10450.85	10467.89	10484.93	10501.97	10518.01	10535.05	10552.09	10569.13	10586.17	10603.21	10620.25	10637.29	10654.33	10671.37	10688.41	10705.45	10722.49	10739.53	10756.57	10773.61	10790.65	10807.69	10824.73	10841.77	10858.81	10875.85	10892.89	10909.93	10926.97	10943.01	10960.05	10977.09	10994.13	11011.17	11028.21	11045.25	11062.29	11079.33	11096.37	11113.41	11130.45	11147.49	11164.53	11181.57	11198.61	11215.65	11232.69	1

SCOMBEROMORUS COMMERSON

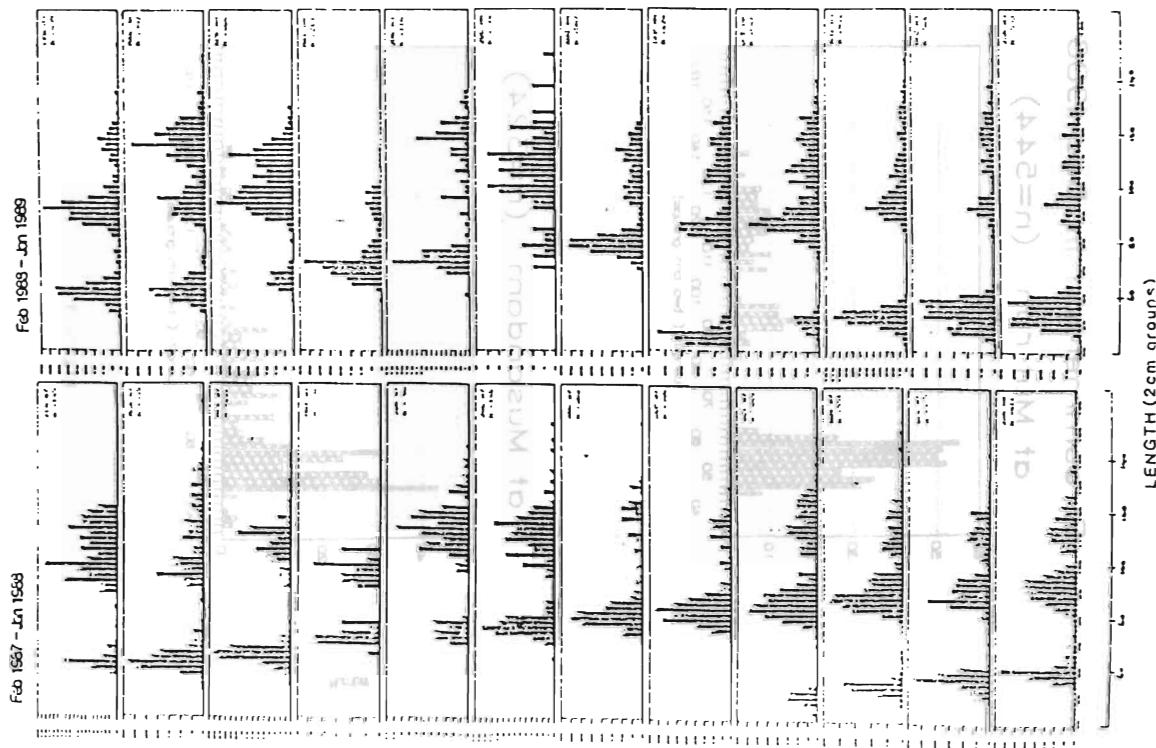
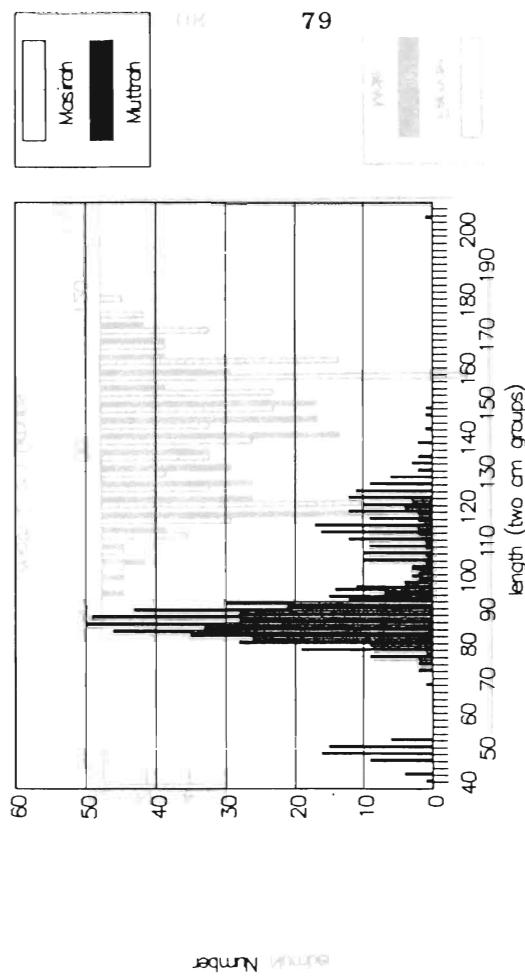
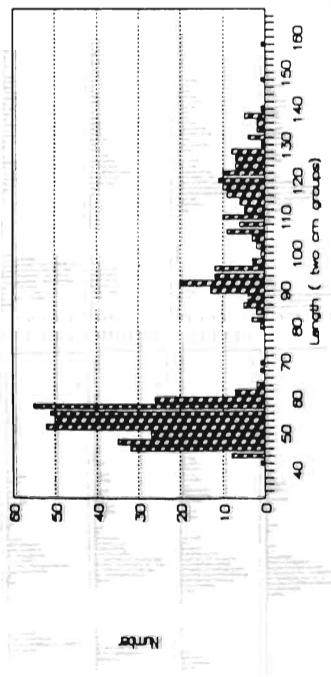


Figure 1.

S. commerson at Masirah and Muttrah
October 1987 n=315, n=449



S. commerson in Dec 1988
at Muttrah (n=544)



Male and Female *S. commerson*
Masirah Island Nov.-Dec. 1988

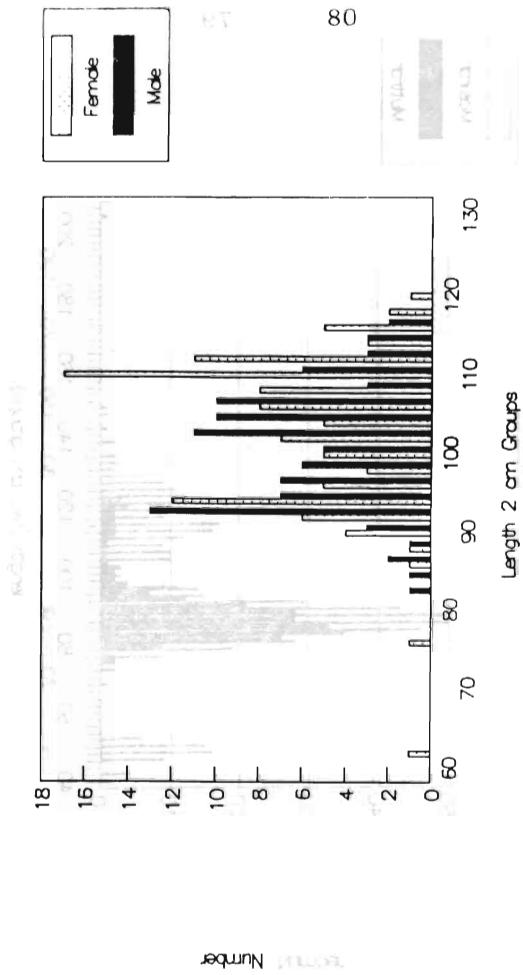
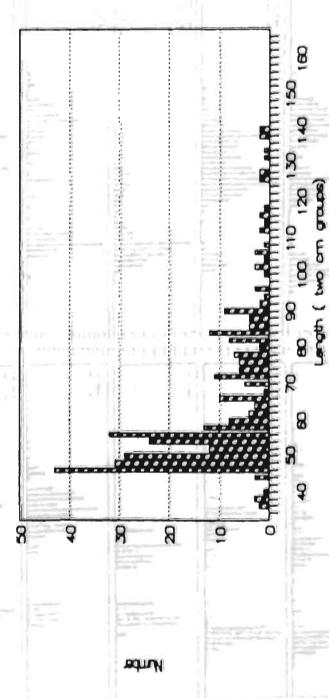


Figure 4. *S. commerson* at Masirah Island Nov.-Dec. 1988

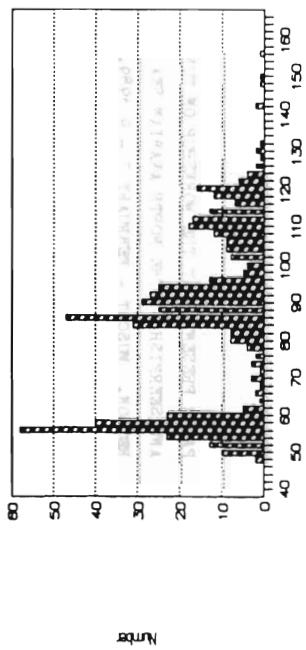
2. comparison at Musandam and Muscat



at Musandam (n=324)

Figure 3.

S. commersonn at Muttrah
Dec 1987 (n=555)



Dec 1988 (n=544)

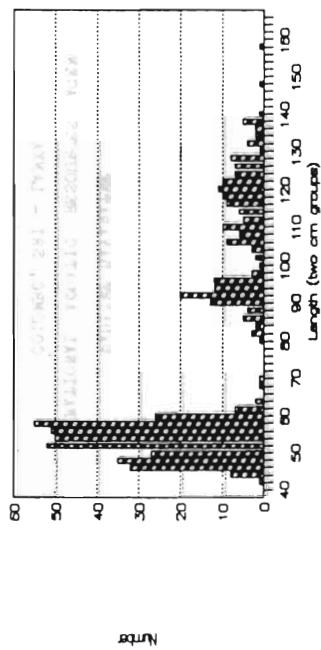


Figure 5. Scoring according to RITZEL, 1984. Total length of 555 individuals of *S. commersonn* at Muttrah in December 1987 (a) and 544 individuals in December 1988 (b).

1987

1988

Appendix 15.

AGE, GROWTH AND MORTALITY ESTIMATES OF
SCOMBEROMORUS COMMERSON (Seerfish) FROM THE
 WEST COAST OF SRI-LANKA.

PAULINE DAYARATNE
 NATIONAL AQUATIC RESOURCES AGENCY
 COLOMBO, SRI - LANKA.

Introduction:

In Sri Lanka, *Scomberomorus commerson* (seerfish) is an economically important species because of its high market value. The total annual production of seerfish in 1987 was around 3500 MT.

Principal gears involved in the exploitation of the mackerel are gillnets, troll lines and hand lines. This species is also occasionally caught by beach seines. A detail description on the fisheries for seerfish in Sri Lanka is given by Devaratne (1969).

This species is widely distributed in the Indo-pacific region and is a commercially important species in many countries. Several age and growth studies have been completed for this species from the Indian Ocean based on length frequency data and annual rings in otoliths. However, there are high discrepancies between these estimates. The size at age one ranging from 12.3 to 48.3 cm, the growth constant (K) from 0.1 to 0.7 and the length infinity from 49 to 230 cm. The average size at first maturity is around 85 cm (Bouhlel, 1985 and Devaratne, 1983). Spawning season of *S. commerson* has been reported to be in May - June period (Devera, 1983 and Bouhlel 1985).

The present study provide information concerning length composition and age and growth of the *S. commerson* stock on the west coast of Sri Lanka. The estimates are based on length frequency data. The mortality coefficient are estimated in order to investigate the present level of exploitation. An attempt was also made to age a few juvenile fish (with a length range 9 cm to 45 cm fork length) by counting the primary growth rings in the otoliths. A verification study on daily growth ring formation was carried out by following the same population over a period of about 3 months.

PAPER PRESENTED AT THE WORKSHOP ON TUNA
 AND SEERFISH IN THE NORTH ARABIAN SEA
 REGION. MUSCAT - FEBRUARY 7 - 9 1989.

Material and Methods:

The length frequency data for the present study were collected at the main fish landing centre (Mekomo) on the west coast of Sri Lanka from August 1986 to December 1987. Fish caught by gill nets and troll lines were sampled at the landing centre about 8 days during a month.

Length measurements (fork length) were taken at the landing site to the nearest centimeter. These data were grouped into 4 cm class intervals and were then used to estimate the growth parameters of the Von Bertalanffy growth equation

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

BIEPAN II Programme (Brey and Pauly, 1986) was employed in extracting the growth parameters K and L_{∞} . As the majority of the samples were from gill nets, a correction for selectivity was made. The values of probability of capture at different lengths, estimated by EIEPAN II, was used for this purpose. Estimates of the instantaneous rate of total mortality (Z) was obtained by using the length converted catch curve and the Neteralni method (1986). Both these analyses were performed by using the EIEPAN II Programme (Brey & Pauly, 1986). The natural mortality (M) was computed from the empirical equation of Pauly (1980) relating K , L_{∞} , K and mean environmental temperature. An estimate of the fishing mortality (F) was obtained by subtracting natural mortality (M) from the estimate of Z calculated above. The exploitation rate E (neverton and Holt 1966), was then computed from the expression $E = F/Z$.

Juveniles of *S. commerson* (9.0 – 45.0 cm TL) caught by small mesh gillnets (stretched mesh size 3.2 cm – 5.7 cm) were collected from the same landing site during the period July – August 1988. These were brought to the laboratory for length measurements and otolith extraction. The otoliths were then preserved dry in paper envelopes, and later prepared for counting of primary growth rings. The terminology and the methodology used in preparing otoliths were the same as described for *Sardinella* spp. by Dayarathne & Giddeaser (1985).

The primary growth rings were counted from the centre of the otolith (*molesus*) towards the outer edge along the antiretro direction (posterior). The correlation between the increase in the number of rings between sampling date and the number of days lapsed between samplings was used for verification of the ageing method. Age of these juvenile fish were then estimated by using the primary ring counts. These age estimates were used to compare the growth estimates based on length frequency data.

Results:

The length frequency distribution of *S. commerson* and the estimated growth curve are shown in Fig. 1. The length of the fish exploited by the troll lines and gillnets range from about 40 cm to 130 cm in fork length. The growth parameters estimated are as follows:

1. Without correction for selectivity
 $K = 0.25$ $L_{\infty} = 153$ cm
2. After correction for selectivity
 $K = 0.37$ $L_{\infty} = 146$ cm

In both instances the growth parameter estimates of *S. commerson* produced reasonably good fit to the length frequency distribution and restructured frequencies. The growth parameters obtained after correcting for selectivity were used in computing the growth curve (Fig. 2) and in mortality estimates.

The natural mortality coefficient (M) estimated by using the above growth parameters and taking mean environmental temperature as 28°C was 0.605. The value of the total mortality estimated by the catch curve analysis is 1.59 with the correlation coefficient of the regression analysis $r = 0.986$ (Fig. 3). Z value estimated by weberall was 4.54. The value of K estimated by EIEPAN II was then used to calculate Z . The value estimated for Z by this method was 1.67.

By taking the average of the two Z value thus estimated i.e. 1.03, the fishing mortality F was estimated at 1.03. The present exploitation rate was then calculated to be around 0.63.

The age estimated by counting the primary growth rings are shown in Fig. 2. Only a few juvenile fish were aged by this method. According to these estimates juvenile fish of 10 cm, 20 cm and 40 cm fork length are around 30 days, 60 days and 140 days old respectively.

Fig. 4 shows the relation between the number of increment counts and the fork length of the samples collected from Negombo. The slope of the linear regression including all the samples from Negombo was compared with the slope of the linear regression excluding the sample collected on 28th Nov. 1988, by carrying out student's t test. The results ($t = 0.76$) showed that the slope of the two regressions are not significantly different. This indicate that the length at age data for all Negombo samples (Fig. 4) are consistent and that the sample collected on 28th Nov. 1988 (with a mean fork length of 26.5 cm) has a mean age of 90 days. The back calculated spawning time of these fish was in mid August 1988. All the other samples collected from Negombo had the same spawning time in late June 1988 (Fig. 5). This conclude that the sample taken on 28th Nov. 1988 is from a different spawning. Therefore this sample was not included in the following analysis.

The linear regression used to determine the relationship between the increase in ring counts and the number of days between the two sampling is shown in Fig. 5. The origin in the x- axis was set at 1st June 1988. Sample taken on 28th Nov. was not included in the analysis as it is from a different spawning. Two regression analysis were performed one by using the samples from Negombo and Beruwala, the other by using only the Negombo samples. The result are as follows:

	<u>Regression 1</u>	<u>Regression 2</u>
<u>Negombo & Beruwala</u>		<u>Only Negombo</u>
Coefficient of determination R ²	0.927	0.921
Slope with 95% confident limits	1.19 ± 0.069	1.004 ± 0.094
Intercept	-32.00	-19.58
Number of Observation	92	70

Discussion:

Table 1 gives the summary of the available information on growth parameters of *S. commerson* from different regions of the Indian Ocean. The present estimates are more similar to those estimated by Kedidi and Abuabusha (1987) from the Southern Saudi Arabian Red Sea coast. The previous parameter estimates showed a wide variation with the growth constant K varying from 0.1 to 0.7 and L₀ varying from 49.0 to 230 cm. According to the present estimates *S. commerson* grow to a length of 45.2 cm, 76.3 and 97.9 cm at the end of 1st, 2nd and 3rd year respectively. The available information revealed that *S. commerson* of Saudi Arabian and Oman in the North Arabian Sea region grow faster than that in other parts of the Indian Ocean.

Based on the growth parameters estimated by the length frequency analysis, the mortality coefficients were determined. Natural mortality was estimated at 0.605 and the total mortality at 1.66. Accordingly, the present exploitation rate is around 0.63 indicating that *S. commerson* on the west coast of Sri Lanka is actively exploited.

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On the other hand, the age estimates made by counting primary growth increments in otoliths revealed a much faster growth at least up to 45 cm in fork length. According to this ageing method S. commerson grows to a length of 45 cm in 5.5 months. This ageing technique has been used in studying growth parameters of other scombrids such as yellowfin tuna, skipjack tuna and kawakawa (Hild & Foreman, 1980; Uohiyama, 1980 and Uohiyama & Struhaker 1981). For skipjack and kawakawa the growth estimated from increment counts were higher than that estimated from the progression of length frequency modes.

The results of the verification study shows that when the same spawning population was followed, the time difference between the sampling dates correspond to the size difference when only Negombo samples of the same cohort was analysed a slope of 1.004 ± 0.094 was obtained. Thus the slope is not significantly different from 1. This indicates that the increments observed and interpreted as daily growth rings in the otolith of S. commerson within the size range 9.0 - 42.0 cm are formed daily.

As indicated by the daily increment counts, the growth of S. commerson is actually faster than estimated by length frequency data. The mortality rates also would be higher than estimated from length frequency data. With high growth rates in S. commerson high turnover rates could be expected which allow high fishing pressure to be maintained.

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Table 1 Summary of the growth parameter estimates of
S. commerson from Indian Ocean.

Study area	L	K	Length at age 1 *	Method used	Source
Indian Waters	208	0.18	40.2	Otolith reading (annual rings)	Davros (1981)
Philippine Waters	49	0.70	24.7	ELEPAN	Truelin and Pauly (1984)
Waters of Djibouti	151	0.21	28.6	FORD-WALFORD PLOT	Bonhag (1985)
Republic Gulf of Aden Southern	230	0.12	25.8	?	Edwards et al (1985)
Saudi Arabian Red Sea coast 153	0.38	48.3	ELEPAN	Kedidi and Abusmasha (1987)	
Gulf of Thailand	130	0.10	12.3	FORD-WALFORD PLOT	Chantman (1987)
Oman Waters	200	0.27	47.9	FORD-WALFORD PLOT	Daddler (unpublished 1988)
Sri Lankan Waters	146	0.37	45.2	ELEPAN	Present analysis

* Length at age 1 values were calculated by using the K and L estimates available and taking to as zero.

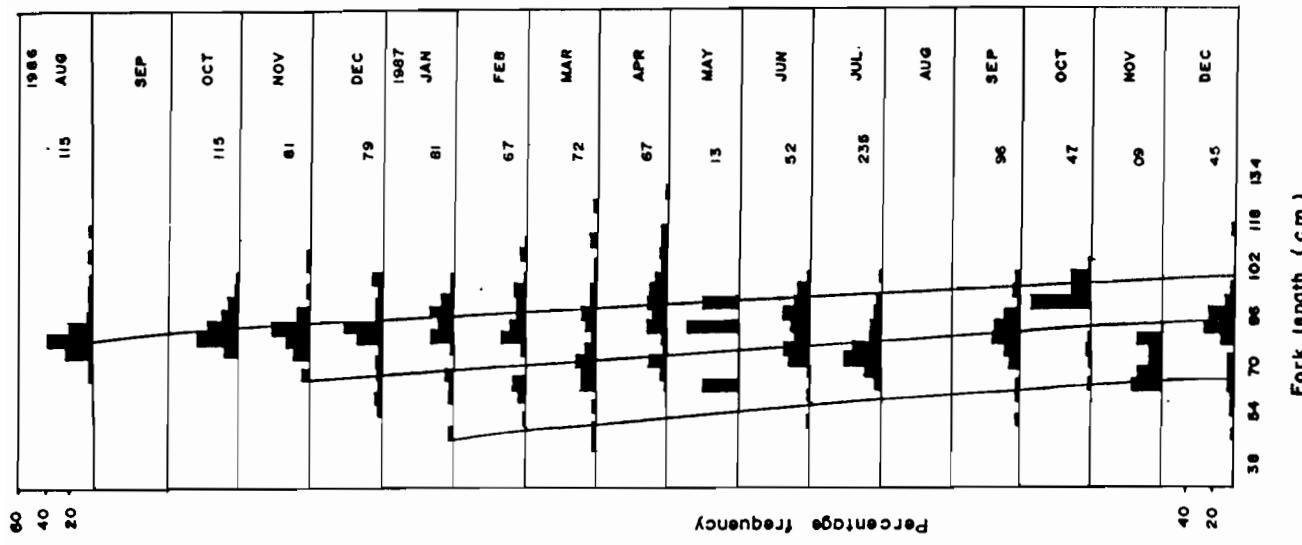


Fig. 1 Length frequency distribution of *Scomberosomus commerson* with the growth curve fitted by using the ELEPAN I Programme.

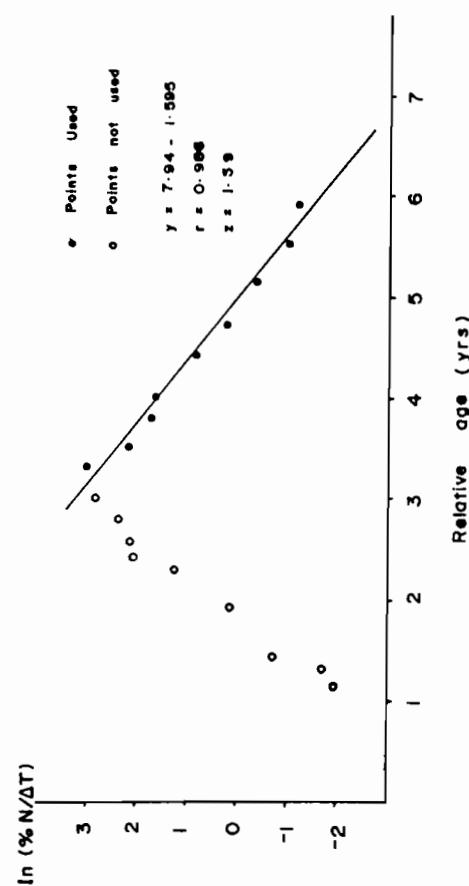


Fig. 3 Catch curve analysis of *S. commerson* by using the ELEFAN II programme.

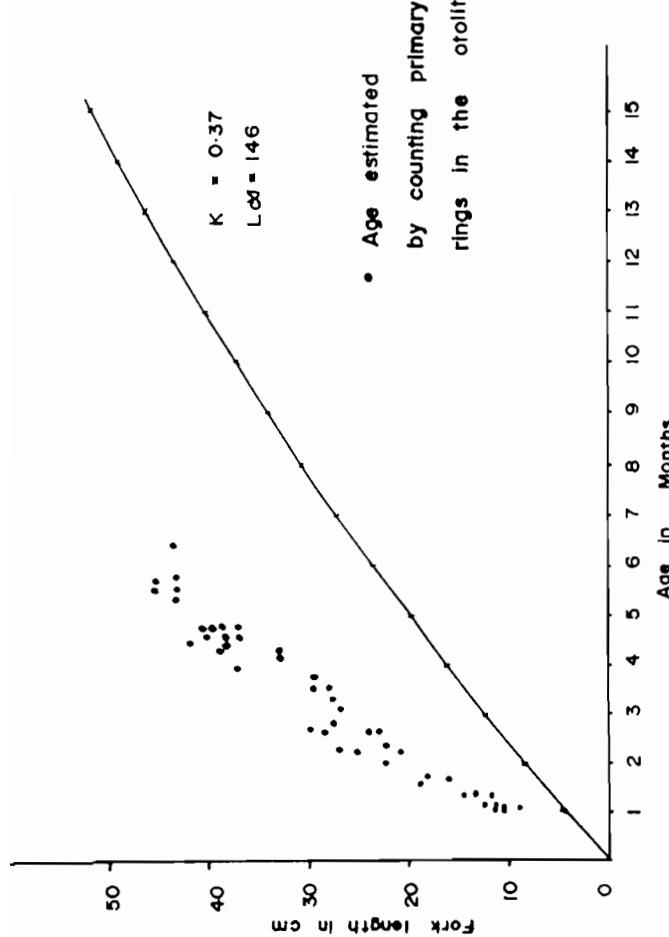


Fig. 2 A comparison of length at age data of *S. commerson* obtained by length frequency analysis and by counting primary rings in the otoliths.

CROSS

1986-1987 cutting long axis and gloromai technique to obtain
 917 one year old tree girth measurements. Counting age was
 determined by the following technique. The technique used
 consisted of two parts long axis of the technique. The first
 concerned the measurement of the length of the stem, the second
 concerned the measurement of the stem diameter. This tech-
 nique was developed by the Forest Research Institute
 and University of Malaya and has been used in
 several areas. Horizontal timber was measured at
 height of 1.3 m from the ground. Quadrat Q1000 was
 used to obtain the stem girth and height measurements.
 Cross sections were cut at 10 cm intervals along the stem.

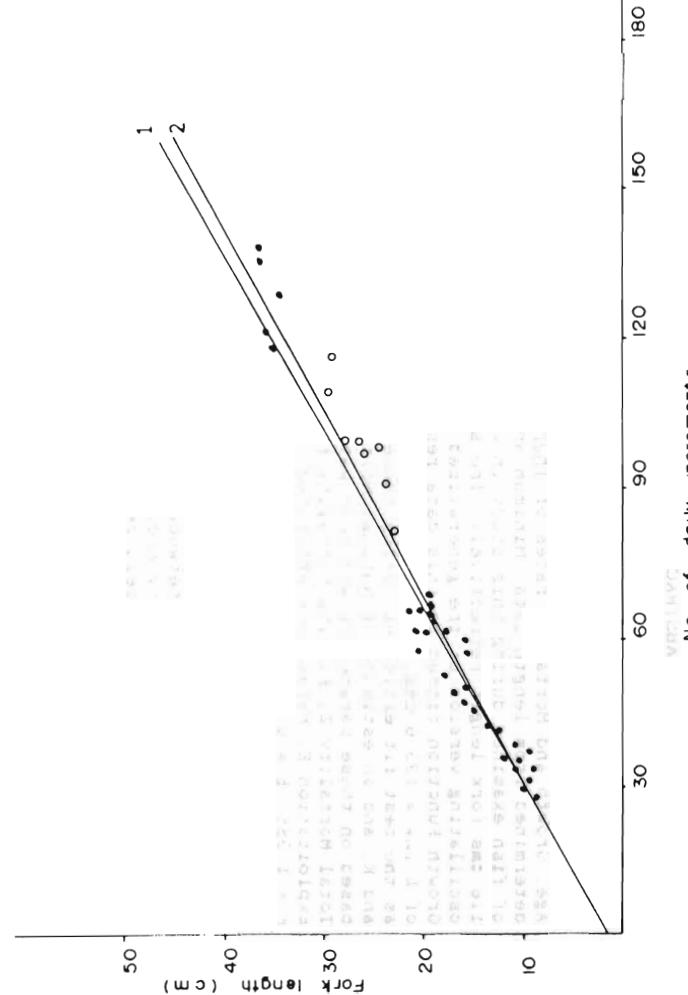


Fig. 4 A plot of the number of daily increment counts versus fork length of *S. commerson* collected during Oct. 1987 to Nov. 1988, at the Negeri Sembilan State Reserve, Negeri Sembilan, Malaysia. Regression line 1. Including all the samples on 28 Nov. 1988 (o)
 Regression line 2. Excluding the sample collected

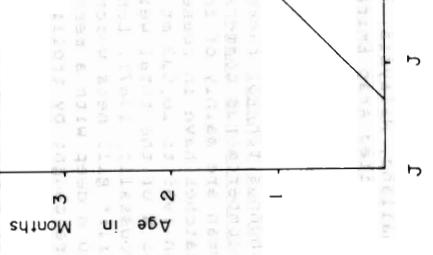


Fig. 5 Scatter correlation between the estimated age and time of capture of *S. commerson* both including the sample for food consumption and excluding the sample for food consumption. No correlation was found between the estimated age and time of capture.

ANALYSIS OF THE INFLUENCE OF THE VARIOUS FACTORS ON THE GROWTH AND MORTALITY RATE OF *S. COMMERSON* IN NEGERI SEMBILAN STATE, MALAYSIA

WILSONGARIP

AGE, GROWTH AND MORTALITY RATES OF LONGBEAK TUNA
Thunnus tonggol (Bleeker) IN OMANI WATERS
 BASED ON LENGTH DATA

INTRODUCTION

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ABSTRACT

Age, Growth and Mortality rates of *Thunnus tonggol* were determined from length data. Minimum and maximum sizes of fish examined during this study in Oman were 22 and 116 cms fork length respectively. The seasonally oscillating version of the Generalised von Bertalanffy Growth Function fitted to this data resulted in values of $L_{\infty} = 133.6$ cms, $K = 0.228$, $C = 0.12$ and $WP = 0.2$ as the best fit estimates. Using these values of L_{∞} , K and C , and an estimate of Natural Mortality ($M = 0.429$) based on these parameters and mean water temperature, Total Mortality Z , Fishing Mortality F , and Exploitation E , rates were estimated: $Z = 1.784$, $F = 1.355$, $E = 0.760$.

Longtail tuna in Omani waters attained a size of 28 - 30 cms fork length at the end of one year. Typical catches consisted of fish between 50 and 82 cms. Full recruitment into the fishery occurred at about 70 cms length (around 3 years). Yield per recruit analysis suggested that current fishing intensity of longtail tuna in Oman should be stabilized. It could be possible that gill net selectivity is a confounding factor in Length Frequency analysis of this species in Oman.

Thunnus tonggol is a slender small species in comparison to other tunas. Essentially an epipelagic neritic species it avoids estuaries, turbid waters and open oceans. Yet this fish is widely distributed. Tunas are opportunistic feeders, its food consisting of crustaceans, cephalopods and smaller fishes like sardines (Yesaki, 87). The largest longtail tuna reported in literature was 136 cms F.L. 30 kg weight in Southern Queensland waters, Australia (Wilson, 1981). The minimum and maximum size measured during this study in Oman were 22 and 116 cms fork length.

This fishery has expanded in recent years in the Gulf of Thailand, Malaysia, India, Pakistan, Iran and especially in the United Arab Emirates and the Sultanate of Oman (I.F.P., 1988). Yet the amount of biological information has not kept pace with the development of fishery (Yesaki, 1987).

Thunnus tonggol ranks second in commercial importance to *Scomberomorus commerson* in Oman. Reported landings in Oman are mainly of longtail and yellowfin tunas, total catches have increased appreciably from 10,410 metric tons in 1985 to 26,533 mt in 1987. I. Tonggol accounts for about 65 % of the total weight of tuna landed in 1987 (McClure and Moussalli, 1987). Longtail tuna in Oman are caught mostly by drift gill nets which are upto 1000 metres long, are about 10 m deep with a mesh size of about 14 cms. At times they are caught by trolling.

Age determination of individual fish is often a prerequisite for a knowledge of growth and mortality rates. Many analytical models of fish population dynamics depend largely on these rates. However fisheries workers are confronted with numerous difficulties in aging fishes especially in tropical waters. Direct methods of aging hard parts like otoliths and scales have gained impetus over the last decade. However they involve expensive equipment, are time consuming and the interpretation of markings is often difficult (Beariz, 1988). Use of size frequency is again becoming a very important part of fisheries investigations all over the world and probably constitutes the most feasible initial method for age and growth studies in many cases.

Prior to this study very little information was available on age, growth and other stock assessment parameters of *T. longirostris* in Omani waters. The present work is a first attempt at estimating these parameters using length data collected over a period of two years by the staff of the Marine Science and Fisheries Centre of the Sultanate of Oman.

MATERIALS AND METHODS

Longtail tuna caught by artisanal fishermen were sold at the local fish market in Muttrah, near Muscat Oman. Fork Lengths were obtained by daily sampling during the first 10 days of each month. Measurements were taken to the nearest centimetre with 153 or 123 cms calipers. Every effort was made to measure a representative sample of all fish present in the market. A target of 300 - 500 fishes was usually reached. The data were entered into computer spreadsheet files and length frequency distributions were plotted in 2 cm groups. This data was later regrouped into 4 cm groups for analysis.

Field trips to other important landing sites such as Sur, Al-Ashkhar, Dugm, the Batinah Coast and Salalah were undertaken as and when opportunities were available. Observations on sex and stage of maturity were made on fish in the range of 22 to 40 cms in the laboratory during the months of October through January, and larger fish were occasionally examined at the fish market.

The Complete Elefan computer package (Gayánilo, Jr. et al., 1988) was used to analyse the length frequency data. The Elefan I Program fits a "best fit" seasonally oscillating version of the Generalised von Bertalanffy Growth Function (Pauly and Gaschütz, 1979) to the data to estimate L_{∞} , infinity, K , C and WP values. C is the factor expressing the amplitude of growth oscillations and WP is the Winter Point or time of the year when growth is slowest. The program incorporates an algorithm which fits the growth curve to peaks defined independently of any assumed underlying distribution.

Part of the Elefan II Program was used to examine a length converted catch curve created from the length frequency data. Total mortality, Z was estimated by selecting fully recruited fish vulnerable to the gear employed (Laurec and Mesnil, 1987).

Natural mortality (M) was estimated from the empirical relationship:

$$\log_{10} (M) = -0.0066 - 0.279 \log_{10} (L_{\infty}) + 0.6543 \log_{10} (K) + 0.4634 \log_{10} (T)$$

where T is temperature in degrees Celsius (Pauly 1980). Surface and subsurface (25 m depth) water temperatures were taken from the Atlas of the Arabian Sea for Fishery Oceanography (Anon., 1976). The annual mean temperature of the coastal waters was estimated from the monthly means and this was used in the above equation (Table 4).

Fishing mortality, F was obtained by subtracting M from 2. Probabilities of capture, recruitment pattern and yield per recruit results were analysed.

RESULTS

GENERAL OBSERVATIONS

Longtail tuna is fished almost throughout the year in Omani waters. The smallest group of fish entering the catch were in the range of 25 to 35 cms F.L. and were found in October of 1987 and 1988 with a mode around 30 cms. These fish were not seen from July to September of 1987 or 1988. A second prominent mode was seen at 72 cms in Oct 87 and at 68 cms in Oct 88. Fish at a mode of 28 cms in October 87 grew to about 42 cms by May 88, a growth of 14 cms in 9 months. A mode seen at 36 cms in February 1987 progressed to 46 cms in May 87 although it is not clearly evident through March and April. An important observation was fish in size range of 46 to 56 cms are very few during the months of July through September each year.

The presence of a mode between 28 - 30 cms consecutively for two years (October 87 & 88) indicates that this mode represents a year class, possibly one year olds (Fig 1). These fish were immature.

GROWTH ANALYSIS

Analysis of length frequency data yielded the following estimates of growth parameters:-

$$\begin{aligned} L_{\infty} &= 133.6 \text{ cms} \\ K &= 0.228 \\ C &= 0.120 \\ WP &= 0.200 \end{aligned}$$

The growth function using these parameters reveals that *I. tonggol* are 29.8 cms at age 1, 50.96 cms at age 2 and 67.81 cms when they are 3 years old (Table 1). Fish above 60 cms are 4 years and more. Accordingly, 2 year old fish are not represented well in Oman's catches. The 3 year old fish are seen as a distinct mode around 70 cms in October of 1987 and 1988. Typical catches which consist of fish between 58 and 62 cms are then 2+ to 4+ years old.

The total mortality coefficient Z , based on a length converted catch curve was estimated at 1.784. The value of Z based on mean length was estimated at 1.888 but was not used.

Natural mortality rate estimated was = 0.429 at an assumed mean environmental temperature of 25.5°C. Fishing mortality, F was estimated at $F = 1.355$ giving an exploitation rate of 0.760.

Yield per recruit analysis suggests a maximum yield per recruit at $E_{max} = 0.7265$.

According to the above figures longtail tuna stocks present in Oman are fully exploited.

Probabilities of capture suggest that 50% of *Thunnus tonggol* at 62.807 cms are vulnerable to the gear employed and full recruitment to the fishery is around 70 cms.

It is emphasized that these are approximate values.

DISCUSSION

Considerable differences are seen in estimated lengths at age of *Thunnus tonggol* from various areas of the world (Table 2). One year old fish are assumed to be about 30 cms F.L. in the Gulf of Thailand, Malaysia and in Oman while in Australia, Papua New Guinea and the Gulf of Mannar one year old *Thunnus tonggol* are approximately 42 cms. Seventy (1956) considered 38, 51, and 62 cms as 2, 3 and 4 years of age.

Another important finding is that fish in the size range of 46 - 56 cms are seldom caught in Oman. The reasons for this could be:-

1. That these fish are present but not caught in the gill nets used by fishermen here
2. It is possible that these fish emigrate out of the area. Yesaki (1987) reported that longtail tuna in the Gulf of Thailand emigrate at a size of about 48 cms. These lines of thought need further investigations.

There is also an obvious difference in the monthly growth rate of longtail tuna during the second year of life.

Monthly growth rate of longtail tuna in Oman is faster than Thailand and Malaysia and slower than Gulf of Mannar and Gulf of Papua New Guinea. (Table 3). Growth estimated from length frequency data could be biased by the emigration of mid-size fish (46-56 cms). If this occurs, our analysis will reveal lower incorrect growth rates.

Small longtail tuna are caught along with the smaller sizes of other species like *Euthynnus*, *Sarda* and *Auxis*, with gillnets having a mesh size less than 8 cms. Most gillnets used for tuna in Oman have a mesh size of 14 cms. It is possible that gill net selectivity is one of the factors affecting our length frequency data although there is no experimental evidence to support this view at present.

Our analysis of the length data of *Thunnus tonggol* in Omani waters suggests that this population is being well exploited. The current fishing intensity should be stabilized, at least until improved estimates of mortality rates are available.

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Table 1:-

THUNNUS TOROCCOL (Longtail tuna)

Growth Parameters and Lengths(in cm) at the 15th of each month

(Derived from Elefan I Program of the Complete Elefan Computer Package)

MONTH	AGE IN YEARS									
	1	2	3	4	5	6	7	8	9	10
SEP	0.47	27.61	49.22	66.42	80.12	91.02	99	106.62	112.12	116.5
OCT	3.21	29.8	50.96	67.31	81.22	91.9	100	107.17	112.56	116.85
NOV	5.91	31.95	52.67	69.17	82.31	92.77	101	107.72	113	
DEC	8.34	33.88	54.21	70.4	83.29	93.54	101	108.21	113.39	
JAN	10.66	35.73	55.68	71.57	84.22	94.29	102	108.68	113.76	
FEB	12.81	37.44	57.05	72.65	85.08	94.97	102	109.12	114.11	
MAR	14.67	38.92	58.22	73.59	85.83	95.57	103	109.5	114.41	
APR	16.69	40.53	59.5	74.61	86.64	96.21	103	109.91	114.74	
MAY	18.69	42.11	60.77	75.62	87.44	96.85	104	110.31	115.06	
JUN	20.83	43.82	62.13	76.7	88.3	97.54	104	110.74	115.41	
JUL	22.99	45.54	63.5	77.79	89.17	98.23	105	111.18	115.75	
AUG	25.29	47.38	64.96	78.95	90.09	98.97	106	111.65	116.13	

$$L - \text{infinity} = 133.6 \text{ cm}$$

$$\kappa = 0.228$$

$$W.P. = 0.2$$

$$C = 0.12$$

$$\begin{aligned} \text{Subsample } &\# 9 \\ SL &= 29 \text{ cm} \end{aligned}$$

Table 2 :-- SUMMARY OF GROWTH PARAMETERS AND LENGTH AT AGE FOR LONGTAIL TUNA

I - AUSTRALIA AND PAPUA NEW GUINEA

AUTHOR	YEAR	LOCATION	METHOD	L-AGE1	L-AGE2	L-AGE3	L-AGE4	C	MP	MEAN L. MODE
Seremey	1956	Northern Australia	LF	41-89	43-80	46-71	50-81	0.002	60	100.43
Wilson	1961	East/West Australia & Otolith	LF	41-89	43-80	46-71	50-81	0.002	60	100.43
Wilson	1961a	Port Moresby, (Papua New Guinea)	LF	62-110	70-100	74-110	80-110	0.002	60	100.43
Wilson	1961a	Koror Bay (Papua New Guinea)	LF	62-110	70-100	74-110	80-110	0.002	60	100.43
Wilson	1961a	Start Bay, (Western Australia)	LF	42-120	44-100	46-90	50-80	0.002	60	100.43
Wilson	1961b	Papua New Guinea Otolith	LF	46-103	49-99	51-91	54-99	0.002	60	100.43
Wilson	1961b	Papua New Guinea	LF	50-65 (av. wt=3.2kg)	50-65 (av. wt=3.2kg)	50-65 (av. wt=3.2kg)	50-65 (av. wt=3.2kg)	0.002	60	100.43
Yesaki (reported)	1967	North coast Australia (Taiwanese gillnetters)	LF	42-120	44-100	46-90	50-80	0.002	60	100.43
II - JAPAN										
Kishimura	1964	Wakasa Bay	LF	50-80	52-80	54-80	56-80	0.002	60	100.43
Fukuda and Fujita	1972	Tashiro Island	LF	50-80	52-80	54-80	56-80	0.002	60	100.43
III - SOUTH EAST ASIA										
Chiamprecha	1978	Gulf of Thailand East coast Malaysia	LF	27-30	30-35	35-40	40-45	0.002	60	100.43
Klinchung	1978	Gulf of Thailand East coast Malaysia	LF	20-56 20-54	30-50	31-49	35-49	0.002	60	100.43
Yesaki	1982	West coast Thailand	LF	40-50	40-50	40-50	40-50	0.002	60	100.43
1977 DATA	1966	Last coast Malaysia	LF	26-49	26-49	26-49	26-49	0.002	60	100.43
Silas	1967	Gulf of Kutch	LF	36-78	40-58	42-53	46-61	0.002	60	100.43
IV - WESTERN INDIAN OCEAN										
Muthiah	1966	Mangalore	LF	26-76	26-76	26-76	26-76	0.002	60	100.43
Anonymous	Undated	Iran	LF	40-95	60-85	60-85	60-85	0.002	60	100.43
Sivasubramaniam	1981	Omani waters	LF	31-58	31-58	31-58	31-58	0.002	60	100.43
Present study	1989	Sultante of Oman	LF	22-116	58-82	29.8	50.96	67.81	81.22	133.6

Table 2
 Depth distribution (meters) of the growth rate of longtail tuna
 (Detailed table given in Table 3 of each entry)

Table 3 :-- SUMMARY OF MONTHLY GROWTH RATE OF LONGTAIL TUNA DURING SECOND, THIRD AND FOURTH YEAR OF ITS LIFE

AUTHOR	PLACE	YEAR	METHOD	GROWTH RATE (%)				G.R. (1-2)	G.R. (2-3)	G.R. (3-4)	PERCENT
				L-AGE1	L-AGE2	L-AGE3	L-AGE4				
Wilson	Papua New Guinea	1961	LF	42	45	49	51	104	99	99	1
Chiamprecha	Gulf of Thailand	1978	LF	40	45	49	54	104	99	99	1
Klinchung	Gulf of Thailand East coast of Malaysia	1978	LF	31	34	38	41	104	99	99	1
Yesaki	West coast of Thailand	1982	LF	30	34	38	42	104	99	99	1
Silas et al	India	1966	LF	42.3	46.9	51.9	57.4	104	99	99	1
Present study	Sultante of Oman	1989	LF	29.8	50.96	67.81	81.22	133.6	0.12	0.2	0

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THUNNUS TONGGOI

Feb 1987 - Jan 1988

Feb 1988 - Jan 1989

95

TABLE 4

SEA SURFACE AND SUBSURFACE (25 METRE DEPTH) TEMPERATURES OF CHAM MATEES

REGION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
SURFACE	23	21	24.25	26.25	29	30.5	30	28.5	29	21	25	
GULF	25 MTS	21.5	22.5	21.5	24.5	25.5	25.5	24	22	21	25	25.5
SUBSURFACE	21.75	21.75	21.75	26.75	28	27	25.5	24	25.5	26.5	27	25.25
N SHARKIA	25 MTS	25	25.100	26	26.5	26	21.5	21.5	23.5	24.5	26	27
SUBSURFACE	24.25	24.5	25.5	27	28	27	25	23	25	26	27	25.5
S. SHARKIA	25 MTS	25	25.5	26.25	27	21.25	26	23	20.5	22	25	27
SUBSURFACE	24.75	25	26	27.5	29	27.5	25.5	24	25.5	27	27	25.5
CHOGRA	25 MTS	25	25	26.5	27	26.5	24.5	22	20.5	22	25	26

MEAN SURFACE TEMP = 26.12 DEGREES CENTIGRADE
 MEAN SUB SURFACE TEMP = 24.73 DEG. CENT
 (AT 25 M DEPTH) 200

AVERAGE TEMP = 25.5 DEG. CENT

8000

6000

4000

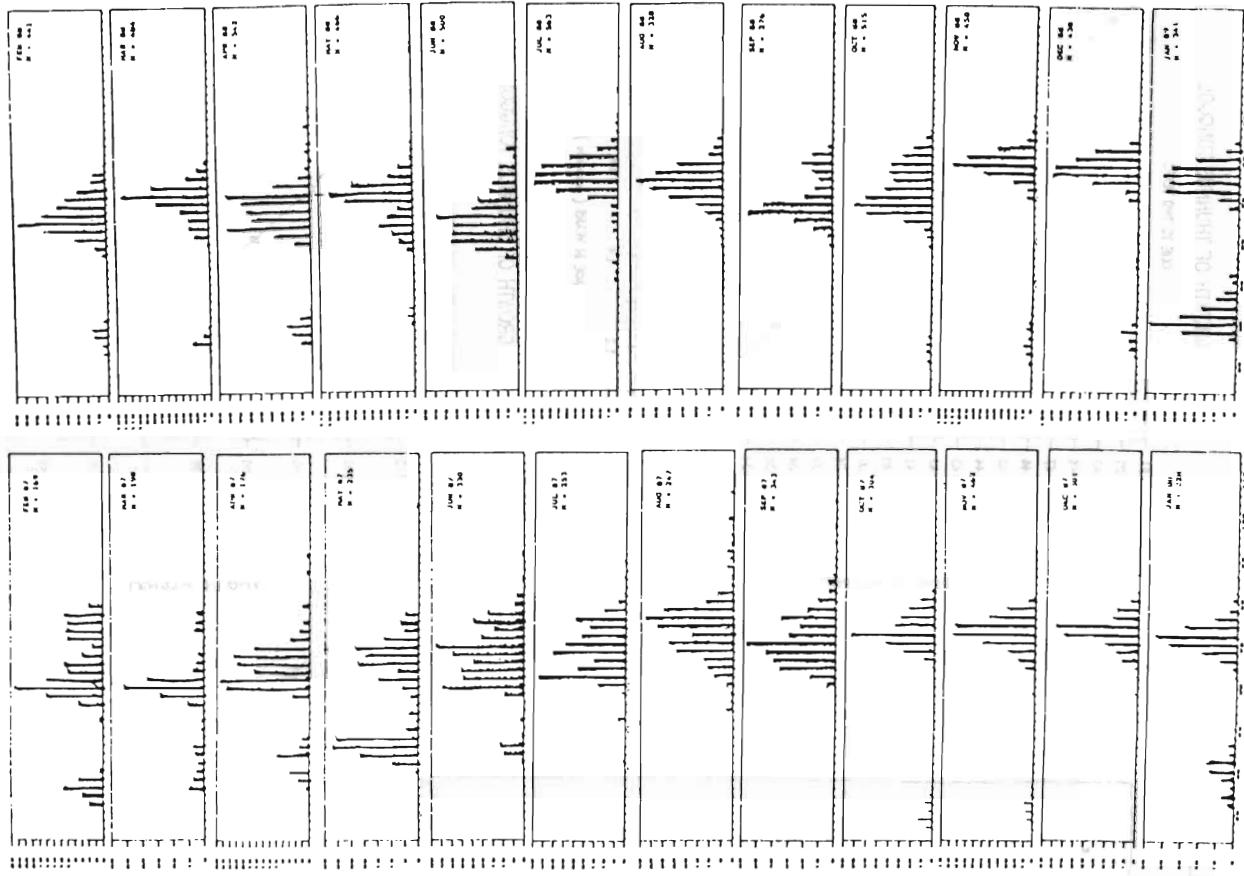
2000

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THE OFFICIAL RECORDS (OCT 87 - JAN 88)
 FISHING FREQUENCY OF THUNNUS TONGGOI

LENGTH (2 cm groups)



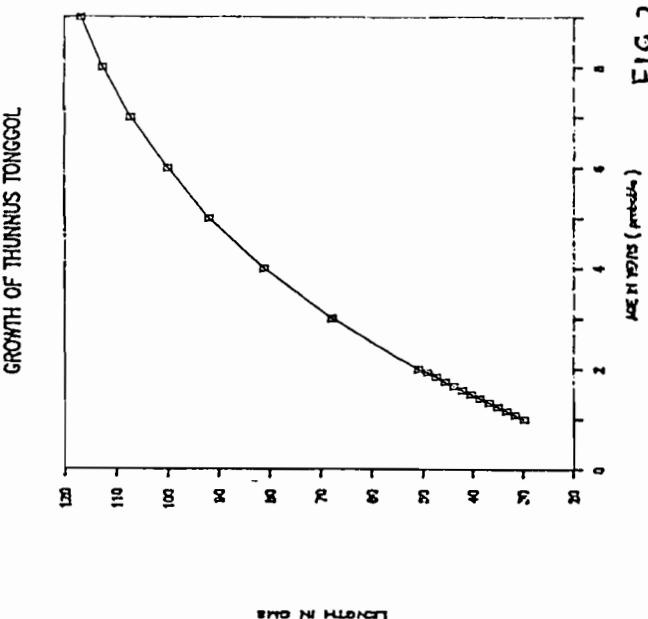
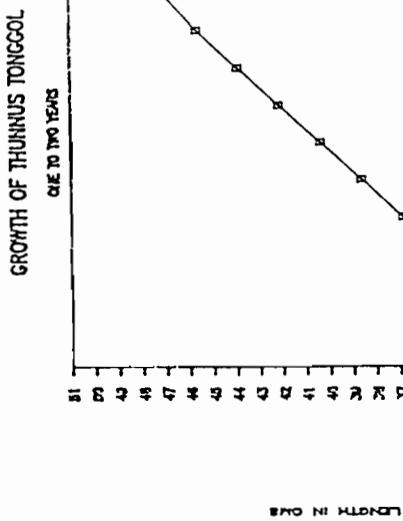
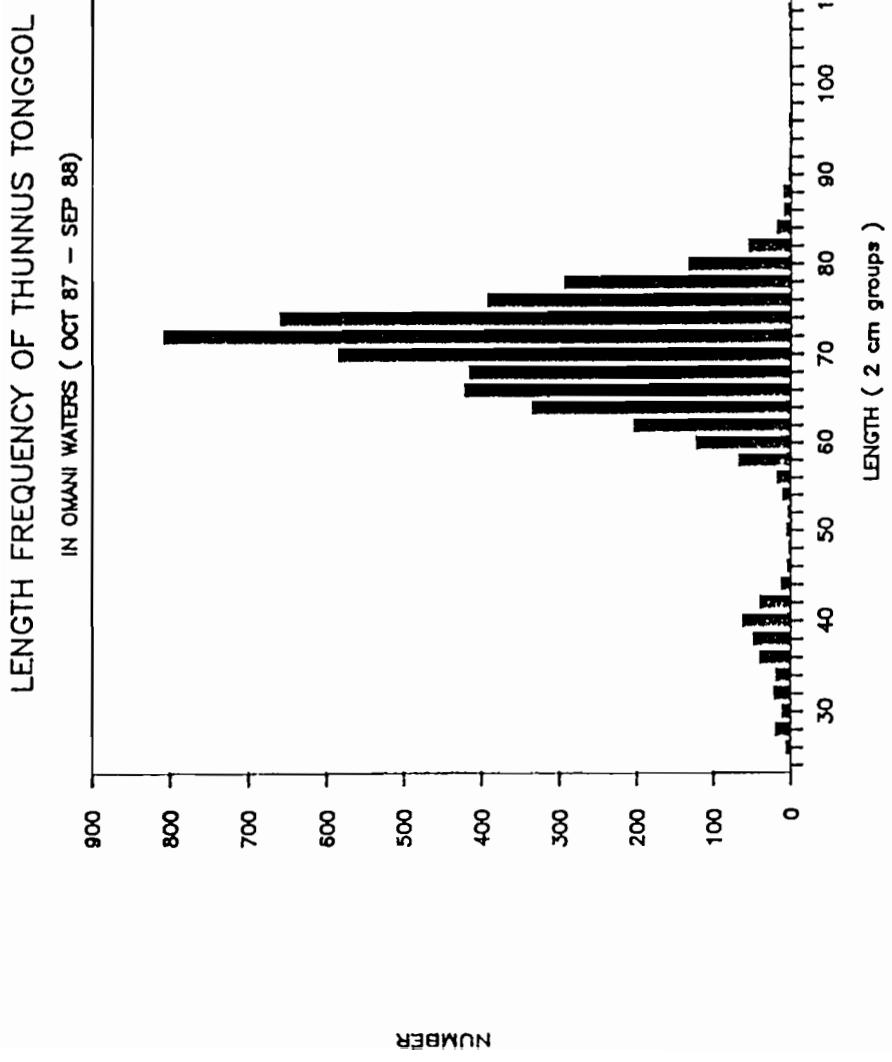


FIG 2

Appendix 17.

BIOLOGICAL STATUS OF YELLOWFIN (*Thunnus albacares*) IN THE GULF OF ADEN

by Bakhraysa

1988. The catch of yellowfin tuna in Shugra peaked during August - October 1988.

This period was observed to be a feeding period (season). All investigations and biological characteristics shows that the yellowfin move to the western part of Aden Gulf, during the feeding season. It was also observed that the adult tuna in Aden Gulf were of different sizes.

Biological statistics for such commercial resource was collected in the period 23 - 25, October 1988 from the main landing centre (Fish Canning Factory) in Shugra village (80 km from Aden).

For the purpose of biological analysis, 95 fresh fish were taken. For length and weight parameters, 86 fresh fish were taken. All these species were sampled from one gear (trolling) and from equal size of mechanized boat with Hp 15.

Yellowfin were observed during our biological analysis to have the following characteristics:

$$\begin{array}{ll} 62 - 72 \text{ cm}, & 4.0 - 7.0 \text{ kg} \\ 87 - 95 \text{ cm}, & 13.0 - 15.0 \text{ kg} \end{array}$$

Lengths less than 55 cm were not observed and only one Yellowfin was observed to be more than 100 cm as shown in Fig 1. The weight and length relationship (Fig. 2) for yellowfin was calculated to be:

$$W = 0.00.05 L2.1106$$

During our biological analysis on yellowfin, it was observed that, this species was in the active feeding stage.

The gonad - index of males was observed to be between 0.44 - 1.87% and for females, it was observed to be between 1.00-5.45%.

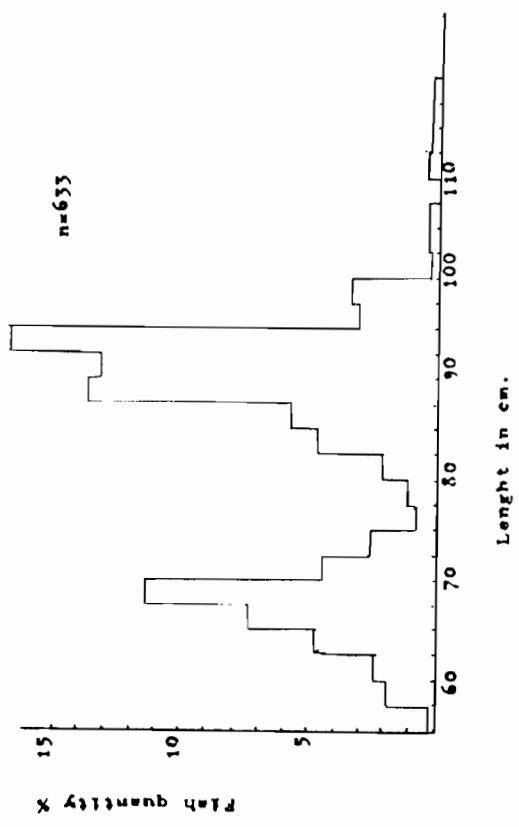
The average gonad - index was observed to be 5.92 for males and 2.96 for females (Fig. 3).

It was also observed, that the liver - index was between (0.52 - 1.12%). From Figure 4, we observe that the liver weight index of small yellowfin was 0.92% and for larger yellowfin it was 0.76%.

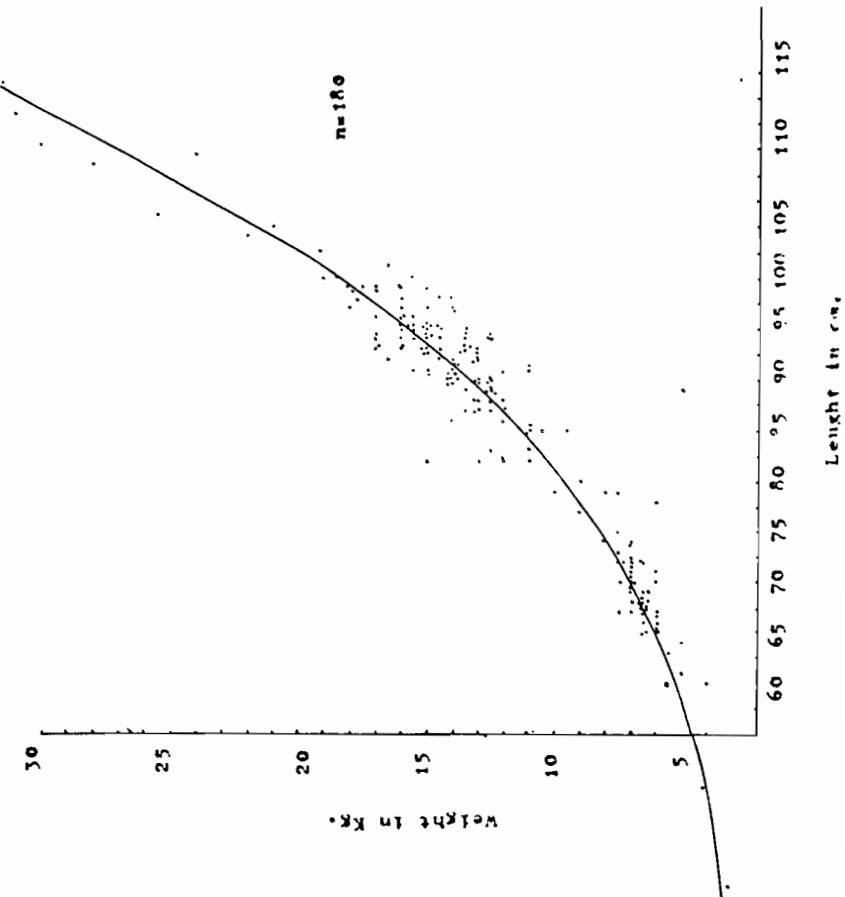
The feeding stage of this species was observed to be 71% in stage O. The stomach index was observed to be between 1-5%, only two yellowfin had stomach index greater than 13%. The swimming crab (Portunidae) was the main food of yellowfin Percentage composition of food items was 54% swimming crab and 36% small fish (juvenile Decapterus kilahli).

During our biological investigation, it was observed that the adult yellowfin tuna were sexually immature, all of which were in stage 2.

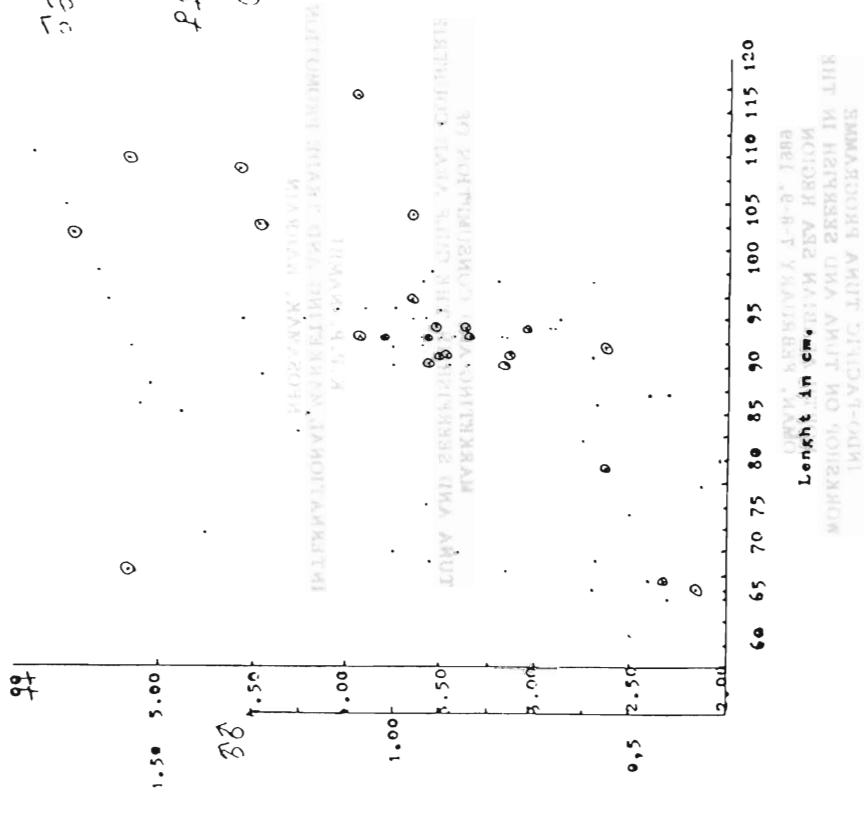
Fig(1) Length frequency distribution of *T. albaeae* by Trawl trawl
fishery of shuqra fishery cooperative (23-25 October 1980)



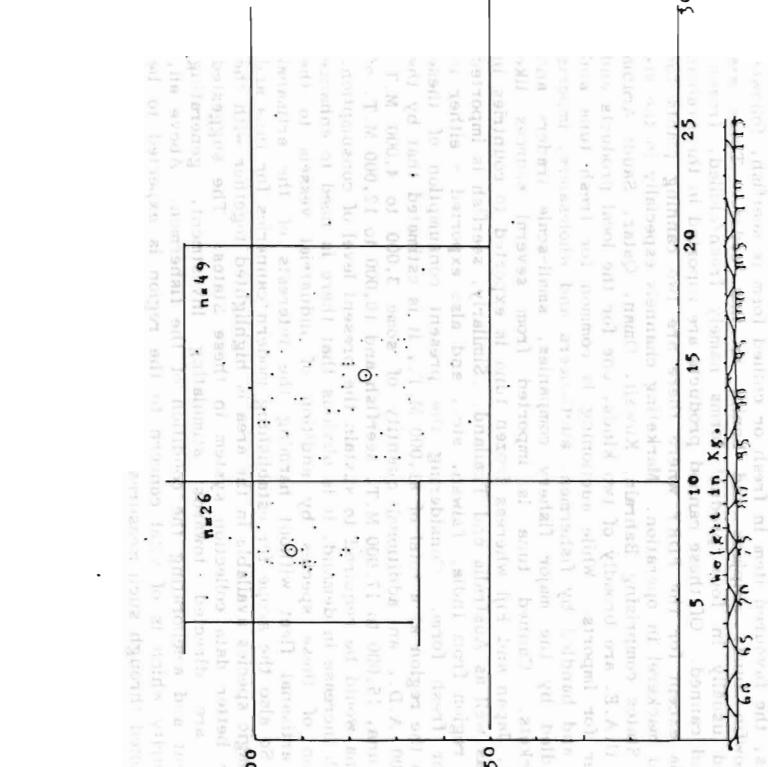
Fig(2) Length - Weight Relationship of *T. albaeae*
(shuqra 23 - 25 October 1988)



The relation between Gonad-Index and length of fish
MATERIALS AND METHODS (CONT'D.)



The relation between liver - index and total weight of fish
MATERIALS AND METHODS (CONT'D.)



**INDO-PACIFIC TUNA PROGRAMME
WORKSHOP ON TUNA AND SEERFISH IN THE
NORTH ARABIAN SEA REGION
OMAN, FEBRUARY 7-8-9, 1989**

EXECUTIVE SUMMARY

Though tuna and seerfish are landed in almost all the Gulf Arab countries, the favoured item in fresh or chilled form is seerfish, followed by yellowfin tuna, skipjack and bonito in that order. These are consumed usually in four product forms namely fresh-chilled, frozen, dried and canned. Of these canned products are imported in the Arabian Peninsula except for the PDRY where there are two canning plants for tuna and mackerel in operation. Marketing channels especially in the six G.C.C. States comprising Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the U.A.E, are broadly of two kinds, one for the local products and the other for imports. While auctioning is common for fresh tuna and seerfish and handled by fishermen, auctioneers and wholesalers, imports are handled by the major fishery companies, small-scale traders and supermarkets. Canned tuna is imported from several sources like Thailand, Japan and Fiji whereas frozen tuna is exported to countries in Europe as well as Australia and Thailand. Similarly, seerfish is imported into the region from India, Taiwan, etc., and also exported - either in frozen or fresh form. Considering the present consumption of these fishes in the region at a total of 81,000 M.T., it is estimated that by the year 2000 A.D., an additional quantity of some 3,000 to 4,000 M.T. canned tuna, 16,000 to 17,000 M.T. seerfish and 10,000 to 12,000 M.T. of fresh tuna would be required to sustain the present level of consumption. With such increase in demand, it is obvious that there is need to enhance production of these species by addition of industrial vessels to the present artisanal fleet without harming the interests of the artisanal sector. So also the scope for establishing modern canneries for tuna and other pelagic species available in the area is highlighted together with the need for better data collection system in these States. The suggested measures are directed towards stimulating investment, generating employment and ameliorating the condition of the fishermen. Above all, food security which is of vital concern to the region is expected to be strengthened through such measures.

**MARKETING AND CONSUMPTION OF
TUNA AND SEERFISH IN THE GULF ARAB COUNTRIES**

BY

**K.P.P. NAMBIAR
INTERNATIONAL MARKETING AND TRADE PROMOTION
INFOSAMAK, BAHRAIN**

1. INTRODUCTION

Historically, tuna like fishes rather than tuna have always been more popular among the consumers in the Arabian Peninsula. Seerfish, Spanish mackerel or king mackerel known as 'Kannad' in Arabic is a common item of tablefish in the Gulf markets. Tunas like yellowfin, longtail and skipjack are usually marketed in Oman, United Arab Emirates and the two Yemens in fresh or dried form but rarely as frozen. On the other hand, canned tuna imported from Japan, Thailand, Fiji, and such other supply sources are a familiar item in all these States especially in the interior areas. Canned products, due to their convenience in transportation, storage and longer shelf life compared to the other product forms, have readily spread out in the arid climate prevailing in the Arab Gulf states as a preferred dish. In a way, the position occupied by the salted and dried fish a century ago, is claimed by the canned fishery products at present. However, the high cost of canned products is a limiting factor that makes dried and salted products more attractive for the rural consumer.

In the GCC (Gulf Cooperation Council) member states namely Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, the annual consumption of seerfish and tuna including canned tuna is estimated at 80,000 to 85,000 M.T. While the total population of the GCC is around 15 million, when North and South Yemens are included the total comes to 25 million. Considering the fact that the rate of growth in population at about 3.5% is one of the highest in the world, there is every possibility for substantial increase in demand for fishery products in this region in future. There is also a growing trend in exports of tuna and seerfish, especially from Oman in recent years. Such favourable factors are sure to stimulate fuller exploitation of the available resources and improved methods of handling, processing and marketing in the region.

2. PRODUCT FORMS

Tuna and tuna like fishes marketed at present in this region can broadly be divided into four categories as follows:

2.1. Fresh/Chilled: Tunas and tuna like fishes are marketed mostly as fresh or chilled in whole form. Due to the innate preference for fresh fish among the local consumers, this product form is more common than the other methods of processing or semiprocessing. Fresh fish is also marketed as fillets or steaks, produced from the freshly caught fish. Though the local consumers do not like their fish to be mixed with ice for chilling, lately export of fresh or chilled fish to Far East and European markets is picking-up and in such cases, chilling is ensured with ice and dry-ice.

2.2. Frozen: Normally freezing is resorted to when large quantities of fish are landed, as a measure of long term storage. Quick freezing is carried out by major fishery firms in the region that are engaged in exporting frozen tuna and seerfish. Seerfish is also frozen for retailing in the local markets as well as for exports. But the deep freezing method used for 'sashimi' type tuna in Japanese market is not in vogue and most of the frozen tunas exported are destined as raw material for canning.

Lately, small quantities of seerfish steak frozen and vacuum packed are produced for exports from, U.A.E. to U.K. and other European markets.

Frozen seerfish sold in the retail fish markets are either imported or slow frozen in a deep freezer or cold storages attached to the fish retail markets. Unsold fresh tuna and seerfish that is not sent for salting/drying is stored in these 'coldstores' so that by the next day the fish can be sold as frozen rather than fresh or chilled fish.

2.3. Dried: Sun drying and salting is a traditional method used for preserving tunas and seerfish. In olden days regular export of salted dried tuna and seerfish from the Arabian Peninsula to the neighboring South Asian and South East Asian countries used to be common, using the classic Arab Dhow. Presently, salted dried tuna and seerfish are produced by fishermen from their excess catch that cannot be sold in fresh, and marketed mostly in the region and also exported.

2.4. Canned: Tuna is consumed mainly in canned form unlike seerfish which is consumed mostly in fresh or frozen form. Canned tuna is imported into the region from several sources under different brand names and specifications. Mainly three categories are imported viz (a) solid pack, (b) chunk and flake, and (c) flakes or grated, depending on the nature of the meat. Based on the color of the meat there are two categories including white meat exclusively from albacore and light meat that comprises all the other tuna and tuna like species.

The net weight of the contents vary widely. Common cans are either 185 gm, 200 gm, 170 gm, 95 gm, 7 oz, or 3.5 oz. All are round cans and normally packed 48 or 24 cans/pack. The media used for canning are principally of three types namely olive oil, other vegetable oil and brine (water). But other media like sauces, sweetcorn, etc. are also available.

In the Arabian Peninsula, two canneries are in operation for producing canned tuna and mackerel at Shuqra and Mukalla respectively in Yemen Democratic Republic. Canned yellowfin tuna produced in these plants are 200 gm round using tomato sauce and oil as the canning media.

3. MARKETING CHANNELS

Depending on whether domestic production or imported, the distribution channels in the region except for PDRY, can be broadly divided into four as follows:

Import of seerfish into the Arab Gulf countries is a regular feature especially from India to U.A.E., Kuwait and Bahrain, and from Taiwan to Saudi Arabia. Intra-regional trade involving canned tuna from South Yemen to North Yemen and fresh tuna and seerfish among the GCC States is also common.

5. PRICE INDICATION

5.1 Domestic Price: The domestic price for fresh/chilled tuna and seerfish can be taken as a measure of consumer appeal in the respective regions. Based on the wholesale price collected from the various markets, it can be said that seerfish fetches the best price followed by yellowfin tuna, Bonito and skipjack in that order. Mark-up a wholesaler to retailer varies from 20% to 40% on an average, sometimes reaching even 100% to 200%.

Price varies from market to market and also depends on season. Prices have been more or less steady in the Gulf states' markets for the past several years except for a general fall in 1985-1987 due to the effect of the economic recession. However, compared to 1987 prices, there has been slight increase in 1988. In markets like Bahrain, U.A.E. and Kuwait. Except for the PDRY, Government intervention in marketing activities is minimal, that too confine to the quality aspects rather than pricing.

Table 1 below gives the indicative fresh fish prices recorded from some of the wholesale markets in this region for fresh/chilled seerfish and tuna.

TABLE 1

INDICATIVE DOMESTIC PRICES FOR FRESH CHILLED
SEERFISH AND TUNA
(1987-88)

Date	Fish Name	In local Currency	Price/Kg in USD	Market Reference	Origin
Feb.'87	Seerfish	KD. 1.000	2.82	Kuwait Central Fish Market	Indonesia
- do -	-	KD. 1.500	5.01	I.T.I. Al Aali Fish Market	Kuwait
April '87	-	KD. 0.800	2.29	Kuwait Central Fish Market	Indonesia
Nov. '87	-	YR 35.00	4.75	Hodeidah Central Market	Y.A.R.
June '88	-	-	-	- do -	- do -
July '88	-	-	2.44	-	Bahrain
Sept. '88	-	-	5.32	Kuwait Central Fish Market	Oman
Feb.'89	-	Q.R. 2.000	5.32	Hodeidah Central Fish Market	Oman
April '89	-	Q.R. 12.00	3.30	Hodeidah Central Fish Market	Oman
- do -	-	Q.R. 1.500	3.99	Kuwait Central Fish Market	Indonesia
- do -	-	Q.R. 10.00	2.73	Hodeidah Central Fish Market	Y.A.R.
Nov. '89	-	Y.R. 70.00	2.72	Hodeidah Central Fish Market	Y.A.R.
- do -	-	Q.R. 12.00	3.30	Hodeidah Central Fish Market	Y.A.R.
- do -	-	Q.R. 1.200	3.46	Kuwait Central Fish Market	Indonesia
- do -	-	Q.R. 10.00	2.72	Hodeidah Central Fish Market	Y.A.R.
- do -	-	Q.R. 3.00	0.82	Hodeidah Central Fish Market	Y.A.R.
June '88	Skippack	Y.R. 8.400	1.09	Hodeidah Central Fish Market	Y.A.R.
April '88	-	Q.O. 0.250	0.63	Muthrik Central Fish Market	Oman
- do -	-	Q.R. 9.00	1.65	Hodeidah Central Fish Market	Oman
Nov. '88	-	D.H. 2.00	0.54	Fujairah	- do -
- do -	-	-	-	-	-
-	Milk-eye tuna	Y.R. 27.00	3.67	Hodeidah Central Fish Market	Y.A.R.

4. EXTERNAL TRADE

Though the domestic markets depend on canned tuna imports, both tuna and seerfish are exported from the region to several world markets, as raw material for canning and for direct consumption.

Oman, in particular, has emerged as a major exporter of both tuna and seerfish in fresh and frozen form, lately. Export markets include Korea, Japan, France, Thailand, Spain, U.K. and U.S.A. While Korea is the biggest importer of Omani frozen fish, exports of Spanish mackerel to Japan has increased from about 1 ton in 1987 to 4 ton in 1988. A sample consignment of fresh chilled yellowfin tuna (108 kg) was also airfreighted from Oman to Japan during 1988.

Spanish mackerel as gutted, frozen was exported from Oman to the U.K. in May 1988. Similarly in June 1988, whole gutted Bonito was exported to Thailand, whereas in August, similar product as well as whole frozen longtail tuna (*Thunnus longirostris*) was also shipped to European markets. Such exports have continued in November 1988, with frozen Yellowfin tuna - filled and gutted to the other Gulf Arab countries and Europe as also whole frozen Bonito and longtail tuna to Europe, Middle East and Australia.

Available data on prices point to a lack of uniformity and organised marketing efforts in these States. Prices are controlled mostly by the localised demand and supply. Distribution network is yet to be strengthened to avoid severe price fluctuations and to ensure even distribution.

5.2 Export Price: Exports are normally in fresh/chilled, or frozen form - either as whole, gutted or steaks.

Table 2 below gives indicative export prices collected from some of the Gulf States.

TABLE 2

INDICATIVE EXPORT PRICE FOR
SEERFISH AND TUNA FROM OMAN/UAE
(1987 - 1988)

Date	Fish Name	Product Form	Price/kg. in USD	Market Reference	Origin
June '87	Seerfish	Whole, frozen	3.25	CNF London (17.4t)	Oman
July '87	- do -	Whole, frozen	3.50	CNF UK (by air)	- do -
- do -	- do -	Onboard	- do -	CNF Saudi Arabia (by sea)	- do -
- do -	- do -	- do -	2.00	FOB Dubai	U.A.E.
Jan. '88	- do -	- do -	0.80	- do -	U.A.E.
May '88	- do -	3-10 kg/pc	1.80	Gutted, frozen	U.A.E.
- do -	- do -	Gutted, frozen	1.80	FOB Oman to U.K.	U.A.E.
July '88	- do -	Chunks, dressed	2.30	FOB Oman for Europe	U.A.E.
August '88	- do -	Gutted, frozen	2.00	FOB Muscat for Europe and Mid. East	U.A.E.
July '87	Bonito	Whole, frozen	1.10	FOB Muscat for U.K.	U.A.E.
- do -	- do -	- do -	1.96	CFN Australia to New York	U.A.E.
March '88	- do -	5-12 kg/pc	1.35	FOB Thailand from UAE	U.A.E.
April '88	- do -	Gutted, frozen	1.15	- do -	U.A.E.
June '88	- do -	5-12 kg/pc	1.00	CNF Thailand from Oman	U.A.E.
August '88	- do -	5-12 kg/pc	1.00	FOB Muscat for Europe	U.A.E.
Nov. '88	- do -	Whole, frozen	1.05	FOR Oman Dest. Europe and Mid. East	U.A.E.
March '88	Yellowfin	- do -	1.95	FOB Oman to Europe	U.A.E.
- do -	- do -	Gutted 20-40 kg/pc	1.55	CFN Spain	U.A.E.
April '88	- do -	Gutted, frozen	1.15	CNF Spain from UAE	U.A.E.
May '88	- do -	20-40 kg/pc	1.50	CNF France from UAE	U.A.E.
Nov. '88	- do -	Whole, frozen	1.50	Gilled & Gutted 1.40	U.A.E.
August '88	Longtail tuna	Whole, frozen	0.90	FOB Muscat for Europe Middle East	U.A.E.
Nov. '88	- do -	- do -	1.00	CNF Thailand	U.A.E.
				- do -	Australia

Source: INFOSANAK Database

Export prices depend on the species, mode of processing as well as the mode of transport. For example, during June/July period in 1987, Omani export of seerfish in whole, frozen form was at US\$3.25 CNF London by air, whereas same product was shipped to Saudi Arabia by surface at US\$2.00/kg CNF. So also Bonito frozen onboard was shipped to Australia at US\$1.06/kg CNF in July '87 whereas similar product was sold at US\$1.10 FOB Muscat for U.K. during this period.

Yellowfin tuna Oman origin was shipped from U.A.E. to France in whole frozen form during May 1988 at US\$1.50/kg CNF France. This is against US\$1.95/kg FOB for Europe received two months before in March 1988 for similar product. Likewise, gilled and gutted Bonito of 5 to 12 kg/pc from Oman was sold at US\$1.35/kg FOB Dubai to U.S.A. (New York) against US\$1150/M.T. CNF to Thailand in April same year. While 1000 kg frozen seerfish from Oman could fetch only US\$1.99/kg or US\$1.989 from Japan in 1987, 4 M.T. exported in 1988 was at an average rate of US\$2.68/kg. But in 1988 for the first time, a sample consignment of fresh/chilled yellowfin tuna was exported from Oman to Japan by air at the rate of US\$17.67/kg CNF.

5.3 Import Price: Retail price prevailing in Bahrain for imported canned tuna of different brands and source of supply during the year 1988 are given in table 3. Also import prices collected from different Stats are presented in table 4. Against these prices, it is interesting to note that canned tuna produced in PDRY with 200 gm net weight is sold at the fixed retail price of US\$0.74 and export price of US\$0.74 FOB per can.

TABLE 3

Product Form	Net weight	Brand Name	Origin	Retail Price/ ^{cwt} in B.D	Retail Price/ ^{cwt} in US
Tuna in Brine	185 Gr.	SAFCOL	Thailand	BD 0.373	US 1.00
Tuna in Tomato Sauce	- do -	- do -	- do -	- do -	"
Lightmeal in Veg. oil	- do -	- do -	- do -	BD 0.390	1.04
Lightmeal, steaks in Veg. oil	200 Gr.	John West	- do -	BD 0.475	"
Whitemeat solid pack Veg. oil	- do -	Diamond	- do -	- do -	"
Deluxe lightmeal-steak in Veg. oil	- do -	John West	Fiji	BD 0.550	1.46
Skipjack tuna with sweet corn	185 Gr.	- do -	Thailand	BD 0.475	1.26
Skipjack tuna, chunks in Veg. Oil	- do -	- do -	- do -	BD 0.450	1.20

(Exchange rate BD 1= USD 2.66)

Source: INFOSANAK Database

TABLE 4

INDICATIVE PRICES FOR
CANNED TUNA IMPORTED INTO
SOME ARAB GULF STATES
(1987-1988)

Date	Product Form	Price in U\$ / ctn	Market Reference	Origin
May '87	48 x 7 oz	22.00	CNF Damman Saudi Arabia	Thailand
June '87	Tuna white meat 48 x 7 oz	35.00	CNF Kuwait	Japan
- do -	48 x 3.5 oz	20.00	- do -	- do -
- do -	48 x 7 oz	27.00	- do -	- do -
July '87	Tuna lightmeat 48 x 3.5 oz	15.00	- do -	- do -
	Tuna lightmeat In Vegetable Oil	22.00	CNF Damman, Saudi Arabia	Thailand
Nov. '87	48 x 7 oz	19.20	- do -	Japan
July '88	Tuna 48 x 95 g Tuna white meat	29.30	CNF Kuwait	Thailand
	48 x 7 oz	17.30	- do -	- do -
	48 x 3.5 oz	27.00	- do -	- do -
	Tuna light meat 48 x 7 oz	15.90	- do -	- do -
Sept. '88	Lightmeat tuna 48 x 7 oz.	32.50	CNF Damman Saudi Arabia	Japan
Dec. '88	Tuna Chunk in Brine 48 x 185 gr.	24.00	- do -	Thailand

Source: INFOSANAK Database

A significant trend seen in the import market is the gradual shift from Japanese suppliers to Thailand during the past few years. Nevertheless, Japanese canned tuna are still available in several markets in the region.

5.4 Trade Regulations and Tariff: Export and import of fish and fishery products including fresh, chilled, frozen tuna and seerfish as well as canned tuna are normally subject to licencing by the concerned Ministries. But the product quality is checked by the Municipality health authorities. Trade is usually against irrevocable letter of credit.

Canned tuna and fresh/chilled/frozen fish attract 5% advalorem imports duty in Bahrain, while in the other Gulf countries, fresh, chilled, frozen products are duty free. While in Saudi Arabia and Kuwait canned products are dutiable at 4%, all food products are exempt from import duty in the U.A.E. There is no duty on exports.

6. PRESENT CONSUMPTION

Based on the data available for the GCC States, the total consumption has been estimated at 80,981 M.T. as worked out in table 5.

TABLE 5

TUNA AND SEERFISH
ESTIMATED AVERAGE ANNUAL CONSUMPTION IN THE GCC STATES
(1986-1988)

	SEER FISH (B)			Total Consumption A+B
	Production	Export	Import	
Bahrain	4.0	-	100	104
Kuwait	-	600	600	94
Oman	25,500	8,000	100	25,340
Qatar	-	100	100	114
Saudi Arabia	9,120	-	5,000	14,120
U.A.E.	6,300	1,200	1,000	6,640
Total for GCC	41,924	9,200	6,900	39,624

* Product weight-not adjusted to live weight
Quantities in Metric Ton.

This includes 41,357 M.T. seerfish, 32,724 M.T. tuna and 6,300 M.T. canned tuna. Accordingly, per capita consumption in the GCC as a whole for tuna and seerfish put together (without converting canned products into live weight) is 5.2 kg/head. Canned tuna consumption is estimated at nearly half a kg/head. This is also likely to reflect the general consumption pattern in the other Arab Gulf states as well with the exception of PDRY where the rate is estimated to be comparatively higher.

Of the six GCC States, the highest per capita consumption estimated for fresh tuna and seerfish is in Oman. However, canned tuna consumption is the highest in U.A.E. followed by Saudi Arabia, Qatar, Kuwait, Bahrain and Oman in that order. Oman's consumption is the lowest. It is likely that the large share of expatriate population in U.A.E. that comes to 75% (1985) accounts for the high rate of canned tuna consumption there.

7. FUTURE DEMAND

The total population of the six GCC countries put together is expected to increase from 15.4 million estimated in 1985 to 22.8 million by the year 2000 A.D. Therefore, even if the current level of consumption is to continue, an additional quantity of 35,000 to 40,000 M.T. of tuna and seerfish products would be required to meet the growing domestic demand. Item-wise, it is estimated that some 3,000 to 4,000 M.T. of canned tuna; 16,000 to 17,000 tons of seerfish and 10,000 to 12,000 M.T. of fresh tuna will be additionally needed in the GCC to maintain the present level of consumption. Together with this is the anticipated improvement in the purchasing power of the consumer with the current encouraging signs in general economy resulting from the end of the Gulf war. Moreover, various studies point to a substantial fall in meat supply in the Arab world in the years to come that will lead to an increase in fish consumption. Another aspect to be considered in projecting future demand in the GCC is the significant share of expatriates in the population. The major consumers of canned tuna in this region are the expatriates, who form nearly 45% of the total GCC population now. At the same time, consumption of tuna in the interiors where fresh fish used to be difficult to be marketed is likely to fall with the advances being made in the distribution system for fresh chilled and frozen fish in the region.

The Gulf consumers have also become more price conscious lately, in such a way that they would even like a cheaper but good quality product of little known brand name to an expensive product of well known brand. As such, it is time opportune for the local entrepreneurs to explore the possibility of establishing a modern cannery in the region to utilize the tuna currently being used for drying and exports. Such a venture can also use the other small pelagic species like mackerels and sardines available in plenty in the region for canning operation.

8. SUMMARY AND CONCLUSIONS

Among the tunas and tuna like fishes landed in the Arab Gulf countries, the most important item for the local consumers is seerfish followed by yellowfin tuna, skipjack and bonito. Canned tuna is mostly consumed by the expatriates. Local preference is for fresh fish. However, in the interior areas where fresh or frozen fish is not readily available, canned products find a ready market due to the convenience in storage and transportation.

Considering the overall supply and demand in this area, it is estimated that present consumption in the six GCC states is to the tune of 81,000 M.T. that includes 41,000 M.T. seerfish, 33,000 M.T. tuna and nearly 7,000 M.T. canned tuna. The total demand is expected to go up by 40 to 50% in about a decade - offering an excellent opportunity to concentrate on fuller exploitation of the available resources and its better utilization. To match future demand and supply, this is the time for initiating advance planning and the following steps are called for in this context:

8.1 The countries with proven resources of these species like Oman should encourage introduction of industrial vessels including purse-seiners and long-liners for more efficient exploitation and handling of tuna and seerfish. Such vessels may be initially brought in on charter basis and allowed to operate only in areas beyond the reach of the artisanal fleet for a fixed period of four to five years initially to enable effective investment decisions on ultimately acquiring such vessels.

8.2 In view of the estimated local demand for canned tuna at present and in future, there is scope for establishing one or two modern canneries for tunas and mackerels in the region. The location of such canneries should be decided on the basis of the availability of raw material, transport and storage facilities and the other related infrastructure. While Oman offers an ideal location for the purpose, the other G.C.C. States like Saudi Arabia and the U.A.E. are also suitable for the purpose. Though canning facilities are now available in the PDRY, what is proposed here will be units of much higher output for obtaining substantial economies of scale including technical economies, marketing economies and so forth.

8.3 Finally, there is a pressing need for continuous and reliable data collection and dissemination on species-wise, landings as well as item-wise processing, export, import and domestic prices. Apart from helping in the profitable exploitation of the resources, such data are essential for marketing and investment decisions as well. The steps suggested above are directed towards stimulating investment, generating employment and ameliorating the condition of the fishermen. Above all, food security which is of vital concern to the region is sure to be strengthened through such measures.

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OMAN'S MARINE SCIENCE AND FISHERY CENTER¹**Background**

At present about 100,000 tons of fish and shellfish are harvested from Omani waters. With careful development and proper management this total could probably be raised to 200,000 tons. Second only to oil, fish are Oman's most valuable natural resource.

Because of the tremendous importance of fisheries and marine resources in Oman, the government realized the need for a focal point for its research efforts. In 1976 Oman made the decision to establish a Marine Science and Fisheries Center and requested advice from international agencies such as UNESCO and FAO.

During the next eight years planning continued, a site was selected, and plans were drawn up. Construction started in 1984 and was completed in late 1986.

During the planning period the Oman American Joint Commission for Economic and Technical Cooperation agreed to fund several senior staff positions at the Center and to provide moderate amounts of equipment and logistic support via a contract with Oregon State University.

Oman's Marine Science and Fisheries Center was officially opened on 29 December 1986.

Objectives of the Center

The primary objective of the Marine Science and Fishery Center is to provide scientific advice on which to base the careful management of Oman's fishery and other marine resources. The Marine Science and Fishery Center is Oman's primary source of scientific information concerning the management of these important resources.

Secondary objectives include the provision of 1) an increased understanding of the marine environment, especially fisheries, and 2) a means of educating Oman's citizens about the marine environment.

More specifically the objectives of the Center are:

- 1) to provide assessment of the stocks of fish in Omani waters in order to determine the levels of fishing which can take place,
- 2) to provide basic biological information for the management of specific fisheries.

- 3) to improve the utilization of seafood products.
- 4) to better understand ocean environment as it affects fishery resources and management.
- 5) to enhance the public's knowledge of marine life.
- 6) In the future we also expect the center to improve our understanding of the best methods for mariculture in Oman.

The Center's Programs During the Past 2 Years

During its first two years of operation the Center has worked to implement research programs which address the above goals. Because the Directorate General of Fisheries already had a small fishery research department, the initial programs were already in place in 1986, but the department had only eight Omani staff. During the past two years staffing was expanded so that the current scientific staff is about 30 including a Director (Thabit Zaran Al-Mohammed Amor Al-Barwani), Deputy Director (Thabit Zaran Al-Abdusalam), 8 section heads, and 20 junior scientific staff (plus support staff). Several of these staff are away on training. Programs have been established in eight sections at the Center

A **Large Pelagics** section concentrates on studies related to the biology and management of tunas and related fishes. For example, this section has completed a preliminary study of the very important Indopacific Spanish mackerel which accounts for 35 percent of the value of Oman's fish catch.

A **Small Pelagics** section deals with sardine, anchovy and other small open water species. This section is concentrating its work on the sardine fisheries which hold great promise for expansion.

A **Shell Fish** section is studying bottom fish, lobster, and abalone, and has already collected considerable information about Oman's valuable, but overfished, lobster fishery, and has already made recommendations for improved management.

A **Demersal Finfish** section (previously combined with Shellfish) has just been established with the primary current goal of training data collectors to work on-board commercial trawlers.

A **Seafood Technology** section is working to improve the processing and utilization of Oman's fishery products.

A small marine library has modern computerized equipment which allows scientific staff to have access to the latest literature to support their research.

A public Aquarium forms an important link between the Marine Science Center and the general public, helping the public to better understand Oman's marine life by allowing them to see live fishes and to learn about them from trained staff. This section also maintains a wet-lab for research by other sections.

An Oceanography section which is conducting research to improve our understanding of the effects of oceanic factors on Oman's fishery resources.

A Marine Ecology section which is working to provide a better understanding of spawning areas of important fish species, in addition to its work with marine turtles.

Future Targets for the Center

In the future we expect the Marine Science and Fishery Center expand its programs and to become one of the regions well known centers of marine and fisheries research. We expect that its primary goals will remain the same: To provide scientific fisheries advice to the Government of Oman for use in developing and protecting fishery and other marine biological resources.

Gradually the center's programs will expand to provide information on the hundreds of important fish species found in Omani waters, and to merge this information with data about the fish catches, and marine environment to provide up to date, accurate information for fishery planners.

We expect the current scientific staff of about 30 to double by the year 2,000. The increased staffing will probably include a Marine Aquaculture section and a section specializing in Demersal Finfish.

Currently the Center's programs also provide on the job training for Omani staff who arrive from university, or secondary and technical school programs. At present, some staff are on leave for degree training, and several others are receiving technical training. Oman presently has a great need for fisheries and marine science training at the BSc, MSc, and PhD level.

Fortunately the Center's training needs can be partially fulfilled through its close cooperation with Sultan Qaboos University. The University will start to graduate students with appropriate training in about two years time. We hope that the Center will play a role in the education of these students since the Center can provide laboratory space and on the job training for student projects in fisheries and marine sciences.

Oman's Marine Science Center will continue to grow, and to work toward the better understanding and management of marine resources. This will allow Oman to use its marine resources wisely to provide food and income to Oman's population for generations to come.

AN OVERVIEW OF
THE TUNA FISHERIES DEVELOPMENT AND MANAGEMENT PLAN
OF THE SULTANATE OF OMAN
IN THE NORTH ARABIAN SEA REGION
FEBRUARY 7-8-9, 1989

DISCUSSION FORMAT:

1. OVERVIEW

- Some macroeconomics; what is it worth?
- Recent Indian Ocean developments.

2. PLANS FOR DEVELOPMENT

- Prospects for small-scale tuna fisheries - gear, target species, processing and markets.
- Prospects for large-scale tuna fisheries - gear, target species, processing and markets.
- What prospects for further development of the seerfish fisheries?

- General problems of tuna fisheries development; will regional countries eventually displace the distant water fishing nations?

3. PLANS FOR MANAGEMENT

- Tuna and seerfish management in the context of the Indian Ocean and the North Arabian Sea Region
- Management of tuna fisheries within the Oman EEZ
- Management of the seerfish fisheries.
- General problems of large pelagic fisheries management.

4. INFORMATION NEEDS FOR DEVELOPMENT AND MANAGEMENT
- Types of information required; how can these be analysed; what results can be expected?
 - Are interaction studies important; how can these be achieved?
 - Types and forms of cooperative and collaborative research mechanisms.

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