SOUTHWEST FISHERIES CENTER

NATIONAL MARINE FISHERIES SERVICE SOUTHWEST FISHERIES CENTER P.O. BOX 271 LA JOLLA, CA 92038

NOVEMBER 1979

WORKSHOP ON TUNA RESEARCH PLANNING

San Clemente, California
September 11-13, 1979

BY
DAVID MACKETT

VOLUME II of 2–SITUATION REPORTS PRESENTED TO THE WORKSHOP

ADMINISTRATIVE REPORT LJ-79-42

A SUMMARY REPORT ON THE SOUTHWEST FISHERIES CENTER WORKSHOP ON TUNA RESEARCH PLANNING

SAN CLEMENTE, CALIFORNIA

September 11-13, 1979

David Mackett

SWFC Program Planning Officer

Workshop Coordinator

VOLUME I of 2 - SUMMARY OF THE WORKSHOP

VOMUME II of 2 - SITUATION REPORTS PRESENTED TO THE WORKSHOP

ADMINISTRATIVE REPORT NO. LJ-79-42

November 2, 1979

Volume II
Southwest Fisheries Center
Workshop on Tuna Research Planning
September 11-13, 1979

Situation Reports on the World's Tuna Fisheries
and Status of Tuna Stocks

The enclosed reports were prepared by staff members of the Southwest Fisheries Center for presentation at a September 1979 Workshop held for the purpose of assessing the status of the world's tuna stocks and for setting out the short and long-range tuna research plans of the SWFC.

It is the intention of the SWFC to update these situation reports annually.

Comments of reviewers are solicited and can be addressed to:

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Volume I of this report is a summary of the Workshop discussions, conclusions, and decisions reached at that meeting.

SITUATION REPORT FOR ATLANTIC ALBACORE

by

Norman Bartoo

The Atlantic albacore population, based on research data, is assumed to be composed of North and South stocks separated at the equator. Separate statistics and analyses are done for each stock.

A. Description of the Fishery

1. North Atlantic Stock

The North Atlantic albacore fishery developed as a surface fishery (troll and baitboat) in the Bay of Biscay in the eastern Atlantic in the 1920's and continued as such until 1956 when an Atlantic-wide longline fishery developed. Both surface and longline fisheries have operated simultaneously from 1956 to the present.

Six relatively separate albacore fisheries (and participants) can be identified in the North Atlantic:

1. Surface (France and Spain) troll fishery-- 2-5 year old fish, mostly juveniles in the Bay of Biscay to the Azores.

2. Summer live-bait (Spain) fishery-- 2-6 year old fish, mostly juveniles in the Bay of Biscay.

3. Autumn live-bait (France and Spain) fishery-- 5-12 year old adults, from Spain to the Azores since 1974.

4. Year round (Spain and France) live-bait fishery-- 5-12 year old adults, from the Iberian Peninsula to the Canary Islands, since 1970.

5. Winter (Taiwan) longline fishery-- 4-7 year old young adults, in the northern Atlantic.

6. Summer (Korea) longline fishery-- 5-12 year old adults in the northern Atlantic.

A total of 10 countries, Taiwan, Cuba, France, Grenada, Japan, Korea, Norway, Portugal, Spain, and Trinidad have reported North Atlantic albacore catches to ICCAT. The vast majority of the reported recent years' catches have been made by France, Spain, Taiwan, and Korea in the various fisheries noted above.

Data on catch for the longline and surface fisheries by country, gear, and year are available from and summarized by ICCAT. The North Atlantic albacore fishery essentially began as a surface fishery about 1920 with reported catches near 10,000 MT (Figure 1). Catches increased slowly at first then more rapidly up to 41,000 MT in 1956. Surface catches fluctuated in the 40,000 to 50,000 MT range from 1956 to 1967. The catches dropped 24,000 MT during the 1967 to 1973 period (Table 1). Catches in 1975 and 1976 rose slightly to 31,000 and 34,000 MT, respectively but maintained the general downward trend started in 1960. The surface fishery apparently concentrates on albacore of ages 1, 2, and 3 years.

Longliners began fishing for North Atlantic albacore in 1956 with catches of a few tons. Catches rose steadily to a peak of 15,000 to 16,000 MT in the 1963 to 1965 period. After the 1965 catch year, longline catches dropped to the 5,000 to 8,000 MT range through 1969. By 1971, the catch rose to 11,000 MT and declined slightly 6,000 MT in 1972. The 1973 to 1976 catches were somewhat higher: at 20,000 MT, 14,000 MT, 9,000 MT, and 21,000 MT, for the respective years. The longline fishery apparently concentrates on adult albacore of age 5 and older.

Thus, the entire North Atlantic albacore fishery produced yields from 10,000 MT in 1920 to 41,000 in 1956 to a peak of 69,000 MT in 1964. The entire 1958 to 1965 period was marked with fluctuating catches from 41,000 to 69,000 MT, averaging about 55,000 MT per year. Since 1965, the catches have continued to fluctuate but have declined generally to the 40,000 to 50,000 MT range. The 1975 and 1976 entire fishery catches were 40,000 and 55,000 MT, respectively.

In 1977 the reported albacore catch from the North Atlantic dropped to 46,000 MT, due in part to a transfer of 11,500 MT of Taiwan's catch from the North Atlantic fishery to the South Atlantic fishery. This redistribution of catch is not yet fully accepted by scientists as conflicting sampling data is available which indicates the catch did come from the North Atlantic. From 1972-1976, the surface fisheries took an average of 70% of the total North Pacific albacore production.

No reliable data are available on the foreign ex-vessel values for the catch. However, in 1977 the United States (U.S.) albacore fishermen received $1284 per MT (ex-vessel). Based on this price, the 1976 and 1977 North Atlantic albacore catch is valued at $70 million and $59 million respectively.

Currently, no international fisheries management measures are in effect for the North Atlantic albacore stock.

2. South Atlantic Albacore Stock

The South Atlantic albacore fishery intensified in 1956 and unlike its northerly counterpart, which uses both surface and longline gear has remained predominately a longline fishery. Catches from the southern stock have increased from a few tons in 1956 to a high of about 42,000 MT in 1972 with 1975-1976 production at about 20,000 plus MT annually. Since 1956, most of the reported southern catch has been produced by Japan, Korea, and Taiwan (Table 1).

The albacore catches rose steadily from 21 MT in 1956 to an early peak of 36,000 MT in 1966. Following a 45% drop in recorded catch in 1967, the catch rose erratically to a record high in 1972 of 42,000 MT. Since 1972, the catch has been in the 18,000-24,000 MT range. The 1977 South Atlantic albacore catch was reported as 27,000 MT, although 11,500 MT of this may have come from the northern stock.

The ex-vessel value of the South Atlantic albacore catch was about $26 million per year from 1973-1976 (assuming $1284 per MT). In 1977 the ex-vessel value increased to a total of $34 million.

Currently, there are no fisheries management measures in force for South Atlantic albacore.

B. Nature and Degree of U.S. Interests

The U.S. does not actively participate in the Atlantic albacore commercial fisheries. The U.S. is, however, interested in the Atlantic albacore stocks for several reasons. The U.S. is a signatory to the ICCAT convention and as such has indicated its willingness to conserve the Atlantic tuna stocks and this requires the best scientific advice available.

The U.S. currently consumes about 45% of the world's total albacore catch. About 45% of the total Atlantic albacore catch, mostly longline caught, is imported into the U.S. for domestic consumption. This imported Atlantic albacore accounts for about 40% (35,000 MT) of the annual U.S. albacore consumption. For comparison, the U.S. domestic fishery provides about 15% to 20% of the albacore consumed in the U.S.

C. Current Research

The vast majority of Atlantic albacore scientific research (particularly stock assessment research) is presented at the SCRS meeting of ICCAT. Most of the current reserach is done by French (F.X. Bard and J.Y. LeGall), Japan (Morita, Shiohama and others), Spain (J. Cort and others), and the U.S. (Bartoo and others). Although actual research effort is difficult to estimate, France appears to devote approximately two man-years to analysis plus their sampling (catch and size composition) programs. Japan appears to devote about one man-year to Atlantic albacore research, and the U.S. spends about 1/2 man-year on Atlantic albacore research. France is the only country devoting effort to more basic biological studies (tagging, genetics, etc.) of Atlantic albacore. Spain's efforts are primarily data collection and some stock assessment analysis.

D. Data Inventory

Atlantic albacore data on catch, catch-effort, and size composition, furnished by member countries, is published and made available by ICCAT. The La Jolla laboratory has a complete set of available data on computer tape which includes, but is not limited to, catch and effort for surface fisheries back to about 1920, length or age composition of surface catches since 1957 and longline catch and effort and length composition of catches since 1956. The data appears to be of good quality and quantity for stock assessment work. The data set is updated annually.

E. Status of Stocks

The condition of both the North and South stocks are reviewed annually by the SCRS at the November ICCAT meeting. The methodology used to assess the state of the stocks, has to date, been relatively conventional relying on production models, age structure models, spawner-recruit models, yield-per-recruit models and some simple simulation models.

The results appear to be reproducible by different scientists working independently. The accuracy of the results is generally limited by biases introduced in the data and analysis techniques.

<u>South Stock</u>

The South Atlantic albacore stock is estimated to have an MSAY in the 28,000 MT-32,000 MT range (Figure 2). The catch in recent years has been below this level although catches in the late 1960's and early 1970's were close to MSAY. The 1977 catch of 27,000 (if accurate) was near MSAY.

The South Atlantic albacore stock appears to be producing a yield-per-recruit of about 7.7 kg (Figure 3) and little is to be gained (5%) by manipulating size-at-first capture or effort levels. No spawner and recruit relationship has been established for this stock. Estimates of Recruitment to age 3 from the 1960-1966 year classes (from cohort analyses) show relatively constant values of about 3.6 million fish per year. In summary the South Atlantic albacore stock is apparently not exploited beyond MSAY, it is producing a yield-per-recruit which is near maximum for the mode of fishing used (longline) and no problems associated with recruitment have been uncovered.

North Stock

The estimated MSAY for the North Atlantic albacore stock is about 50,000 MT (Figure 4). Current catches of North Atlantic albacore are near MSAY (above MSAY in 4 of the last 13 years including 1976). The 1977 North Atlantic albacore catch of 46,000 MT may be as high as 57,000 MT depending on the allocation of 11,500 MT, of longline catch which was possibly misallocated to the South Atlantic statistics. In any event, the production model shows that the North Atlantic albacore stock is heavily exploited.

The North Atlantic albacore stock is currently producing a yield-per-recruit of about 3.8 kg (Figure 5). Relatively small changes in yield-per-recruit are expected with small changes in size-at-recruitment. Substantial yield-per-recruit increases are not possible without severe changes in size-at-recruitment.

Recruitment, as indicated by CPUE of age 2 fish and cohort analysis results (Figure 6) shows a declining trend with increasing variability. These recruitments when paired with appropriate spawning stock indices (CPUE of adult longline caught albacore) can be fitted adequately with a Ricker or Beverton-Holt spawner-recruit relation (Figure 7). The results indicate that the present spawning stock is only about 20-25% of that in 1957 and presumably even smaller in proportion to that which existed before any exploitation had started. The stock produced nearly 30,000-40,000 MT per year from 1949-1957 with production in the 20,000 to 28,000 MT range for the 4 years preceding 1949. Note the catches from 1945-1955 were from surface fisheries only.

In summary, the North Atlantic albacore stock appears to be fished at or slightly beyond MSAY. Yield-per-recruit is not near a maximum value, however, little change appears possible without large changes in the fisheries. The decline in recruitment and apparent increases in variability make a year class failure possible.

F. Problem Areas and Program Needs

For the South Atlantic albacore stock, the only problem area identified by the SCRS was the possible misreporting of longline catches between north and south stocks. It was concluded that "the distribution of longline catch between the northern and southern albacore stocks must be improved by the joint action of the Secretariat and national experts (especially those that concern the Taiwanese fleet)."

This problem is not acute enough to warrant action on our part. The South Atlantic albacore stock only requires monitoring until a significant change in the fishery or catch level occurs.

For North Atlantic albacore development of management actions were proposed by the SCRS:

> "The Committee recommended that the Commission give attention to three classes of management measures:
>
> i) Measures to increase the yield-per-recruit by increasing the effective size-at-first-capture.
>
> ii) Measures to increase the abundance of the spawning stock.
>
> iii) Measures that might have to be introduced very rapidly to preserve the stock if there should be a recruitment failure."

While research to support all three management classes is desirable, the most critical problems seem to be those dealing with the spawner-recruit relationship and expected increases in spawning stock under certain management options. Our first area of concentration should be to quantify the risk of recruitment failure if the current fisheries maintain the status quo and to estimate the likely benefits to the spawning stock that various reductions in catch by the different fisheries will have. Secondly, we should examine alternative management options to increase yield-per-recruit.

Table Atlantic albacore catch (1,000 MT)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978[1/]
TOTAL	88.3	75.0	79.9	72.1	76.2	70.7	83.5	83.9	73.7	72.1	61.7	76.9	79.2	----
NORTH ATLANTIC	57.7	47.8	54.5	43.0	40.0	39.7	50.6	40.4	46.6	51.6	39.8	54.6	45.6	
-SURFACE	43.4	37.8	47.0	38.5	32.2	30.3	40.0	34.9	26.7	37.2	31.0	34.0	32.1	
BAITBOAT	0.	16.4	17.6	13.7	13.8	14.5	15.5	8.4	8.7	15.6	21.1	20.3	14.9	
FRANCE	0.	3.7	4.2	2.4	1.8	2.0	1.6	1.1	1.0	.5	.7	1.1	0.	1.4
SPAIN	0.	12.7	13.4	11.3	12.0	12.5	13.9	7.3	7.7	13.6	19.4	18.8	14.9	
OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.2	1.0	.4	.1	
TROLLING	0.	23.4	31.4	24.9	18.4	15.9	24.5	26.5	18.0	8.5	9.9	13.7	17.1	
FRANCE	0.	10.6	12.4	11.9	8.2	4.6	8.2	8.7	5.1	8.5	5.4	5.6	6.8[2/]	3.2
SPAIN	0.	12.8	19.0	13.0	10.2	11.3	16.3	17.8	12.9	0.	4.5	8.1	10.3	
OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
OTHER GEARS	43.4	0.	0.	0.	0.	0.	0.	0.	0.	13.1	.0	.1	.1	
-LONGLINE	14.3	8.0	5.5	4.5	7.8	9.4	10.6	5.5	19.9	14.4	8.8	20.6	13.6	
CHINA (TAIWAN)	0.	.1	.1	1.1	1.5	2.2	2.7	4.1	10.0	8.2	5.4	14.0	7.7[3/]	15.0
JAPAN	14.3	5.9	4.8	3.3	4.7	5.9	6.5	1.3	1.5	2.1	1.3	1.3	.8	0.6
KOREA	0.	2.0	.6	.1	1.6	1.3	1.5	.1	8.5	4.1	1.9	5.3	5.0	6.0
OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.1	.1	0.	
SOUTH ATLANTIC	30.0	26.7	19.8	27.8	34.6	29.8	31.5	41.2	22.2	19.5	20.9	19.3	26.8	
-SURFACE	0.	0.	0.	0.	0.	0.	0.	.1	.1	.1	.2	.0	.1	
-LONGLINE	30.0	26.7	19.8	27.8	34.6	29.8	31.5	41.1	22.1	19.4	20.8	19.2	26.8	
CHINA (TAIWAN)	.1	.1	1.7	7.6	13.4	14.7	17.7	25.3	21.7	18.0	16.1	15.4	22.1[3/]	8.6
JAPAN	28.3	21.0	7.7	11.9	6.3	5.9	3.2	2.1	.3	.1	.3	.1	.1	0.2
KOREA	.5	4.7	9.7	7.2	14.4	6.7	10.0	13.5	.0	1.1	4.2	3.4	4.3	1.5
OTHERS	1.1	.8	.7	1.2	.4	.5	.5	.2	.1	.2	.2	.3	.2	
MEDITERRANEAN	.5	.5	.5	.5	.7	.6	.5	.7	.5	.5	.5	.6	.6	
UNCL. REGION	0.	0.	0.	.0	0.	0.	0.	1.4	4.2	.4	.5	2.1	1.1	
-SURFACE	0.	0.	0.	.0	0.	0.	0.	.1	.0	0.	.0	0.	.1	
-LONGLINE	0.	0.	0.	0.	0.	0.	0.	1.3	4.2	.4	.5	2.1	1.1	
UNCL. GEARS	.1	.1	.1	.7	.9	.6	.9	.1	.1	.1	.1	.1	0.	

1/ Provisional estimates.

2/ Including baitboats.

3/ Based on data presented by Taiwan. Breakdown by ICCAT Port Sampling showed North 14,013 MT and South 15,802 MT.

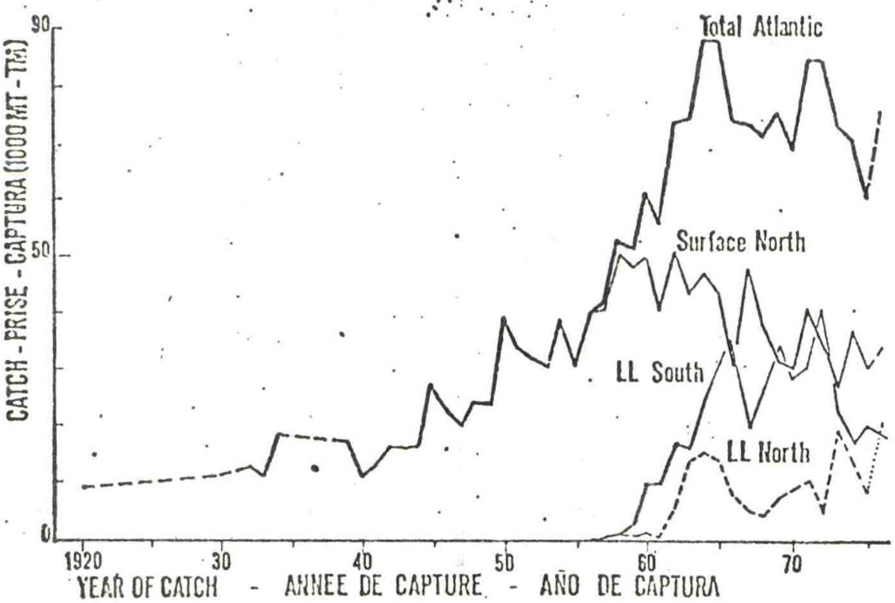


Fig. 1 Catches of Atlantic albacore by stock and principal fishery.

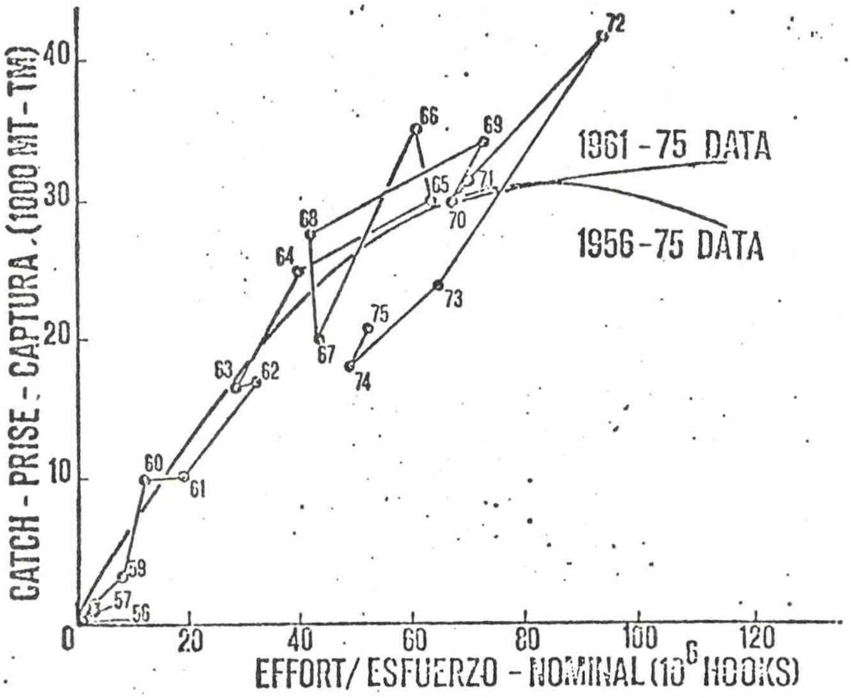


Fig. 2 Production model fitted to South Atlantic albacore catch and effort data for two time series. (SCRS/78/77).

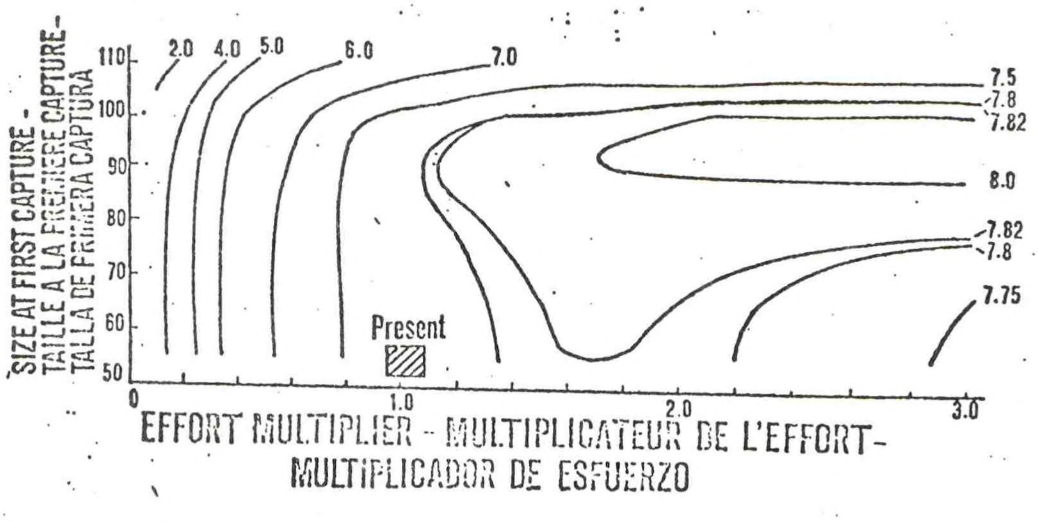


Fig. 3 Isopleths of South Atlantic albacore yield per recruit in kg (SCRS/78/77), M = 0.2, MEAN EFFORT at 1973-75 level.

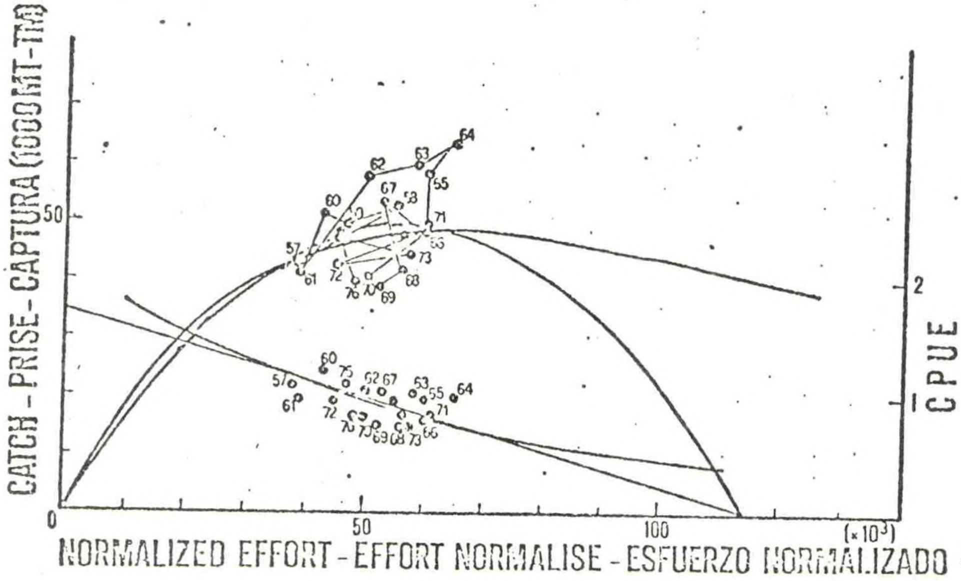


Fig. 4. Production models fitted to North Atlantic albacore catch and effort data (Committee analysis).

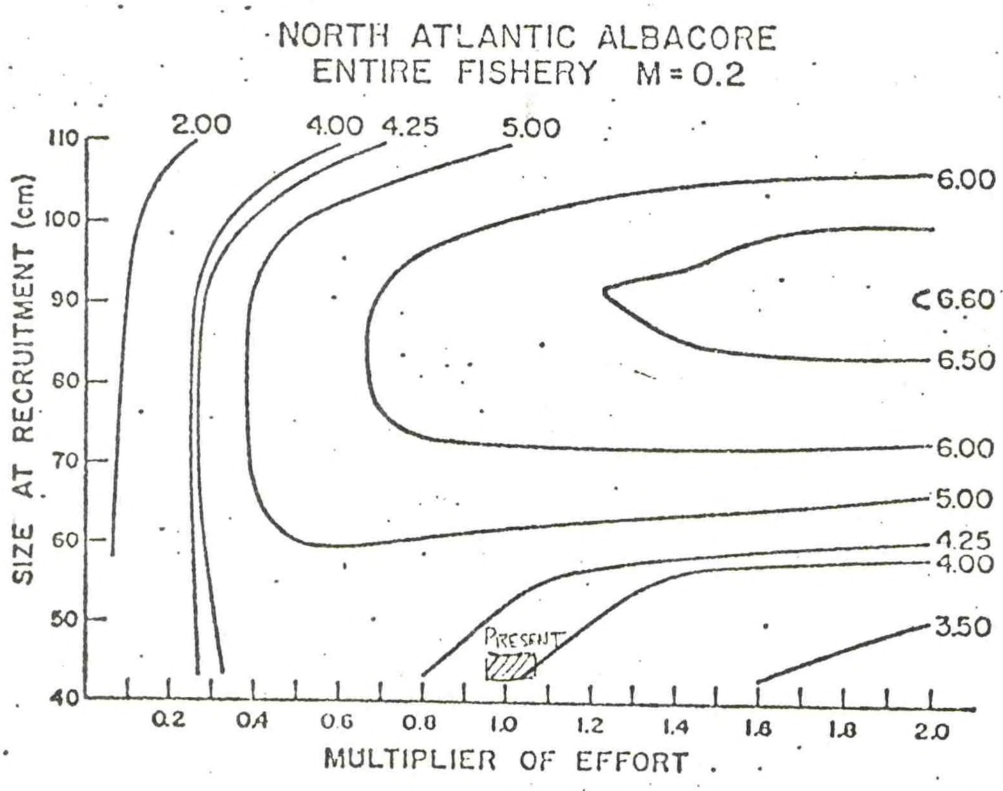


Figure 5 Isopleths of north Atlantic albacore yield per recruit in kg to the entire fishery.

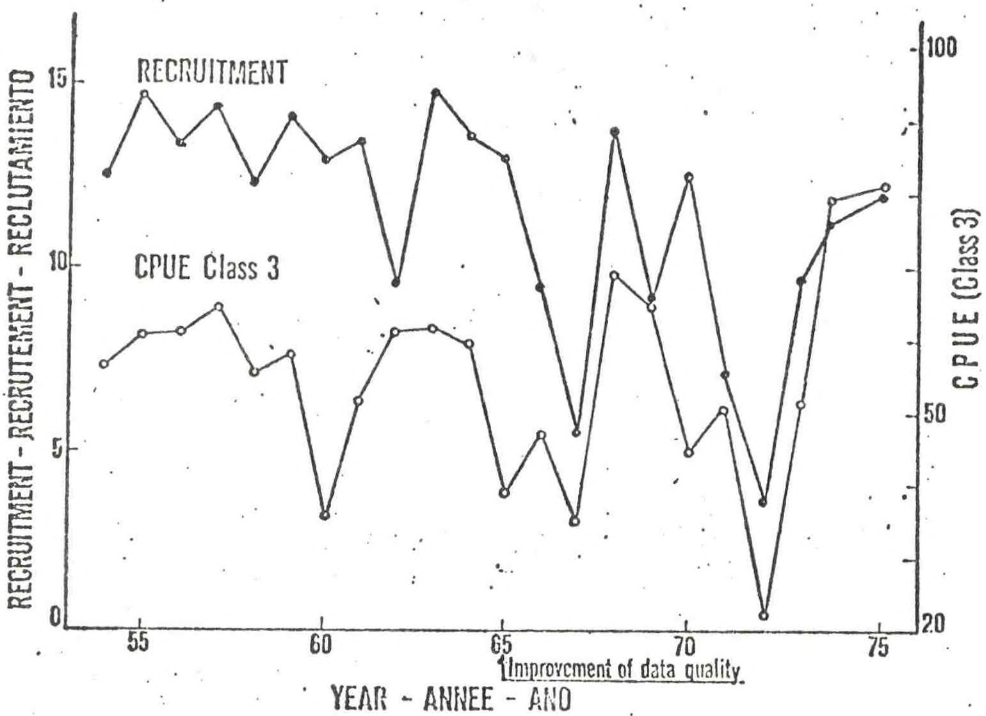


Fig. 6 Recruitment levels in the North Atlantic albacore stock (SCRS/78/63).

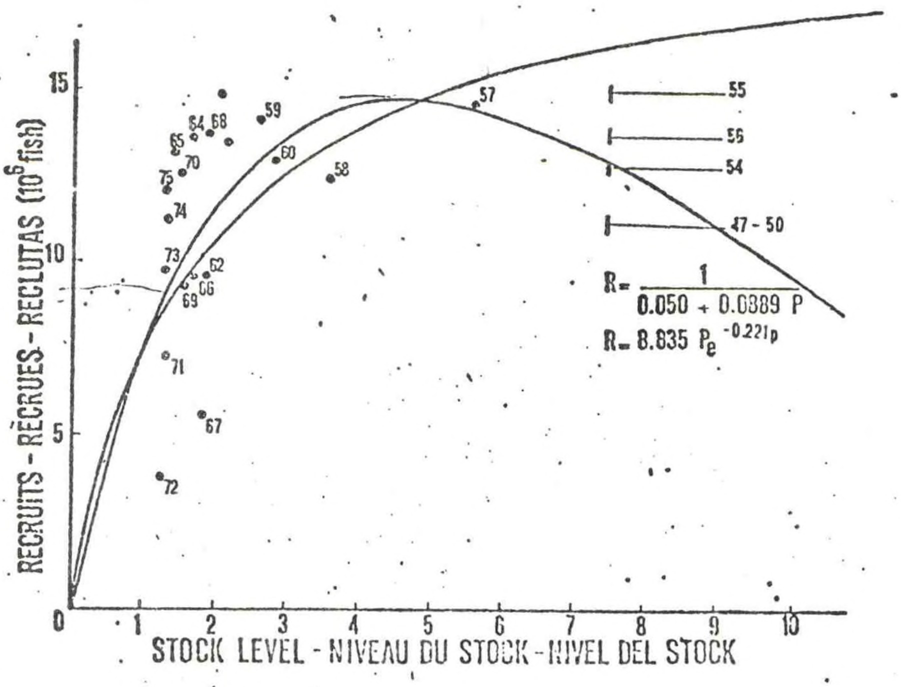


Fig. 7 Indices of North Atlantic albacore spawning stock and recruitment fitted with both the Ricker and Beverton-Holt models (SCRS/78/63).

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ____________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT ON ATLANTIC YELLOWFIN TUNA

by

A. L. Coan, Jr.

Analyses of fisheries for Atlantic yellowfin tuna are usually divided into two geographical regions; an eastern Atlantic fishery and a western Atlantic fishery divided at 30° west longitude (Figure 1). Yellowfin tuna caught by these fisheries are provisionally considered to belong to different stocks, although no definite evidence exists indicating that the two are indeed separate stocks.

I. DESCRIPTION OF THE FISHERIES

I.1. Eastern Atlantic

The fishery for yellowfin tuna in the eastern Atlantic Ocean consists of two major components; the surface fishery (baitboats and purse seiners) and the longline fishery. The yellowfin tuna fishery is part of a multispecies fishery that also catches skipjack and bigeye tunas. Baitboats from France and Spain started the eastern Atlantic surface fishery for yellowfin tuna in 1955 and purse seiners entered the fishery in the early 1960's. The longline fishery for yellowfin tuna in the eastern Atlantic started in 1957 with the Japanese longline fleet. Currently, 14 countries participate in the eastern Atlantic surface fishery and 6 countries participate in the eastern Atlantic longline fishery (Figure 2A).

The major participants in the eastern Atlantic surface and longline fisheries are the French-Ivory Coast-Senegalese (FIS) fleet, the Spanish fleet, the Japanese fleet, and the United States (U.S.) fleet. These fleets caught on the average 45%(FIS), 20%(Spain), 13%(Japan), 9%(U.S.) of the average total eastern Atlantic catches of yellowfin tuna during the period 1966 to 1978 (Figure 2A).

Catches of yellowfin tuna for the eastern Atlantic longline fishery have held relatively constant at an average of 11,200 mt during the period 1966 to 1978. Surface fishery catches have increased from 38,000 mt in 1966 to a record high of 109,000 mt in 1978 (Figure 2B). Increases in surface fishery catches for the period 1975 to 1978 are attributed to an expansion of the fishery farther offshore.

The 1978 ex-vessel price paid by the U.S. for yellowfin tuna was $790/st for yellowfin tuna less than 7 pounds and $840/st for yellowfin tuna greater than 7 pounds. Based on these prices, the value of the 1978 eastern Atlantic longline and surface catch of yellowfin tuna (130,000 mt) is approximately $119,000,000.

I.2. Western Atlantic

The yellowfin tuna fishery in the western Atlantic is primarily a longline fishery, started by the Japanese in the 1950's. Most of the longline catches are concentrated in areas off Brazil and Venezuela although some catches are also made in the Gulf of Mexico and off the U.S. east coast. Surface fisheries for yellowfin tuna in the western Atlantic have existed from time to time off Venezuela in the south Caribbean Sea and off the U.S. east coast, but the catches have been small (highest reported catch is 3,000 mt).

The major participants in the western Atlantic fishery are Korea, Panama, Japan, Taiwan, and Venezuela. These fleets averaged 35% for Korea and Panama combined, 25% for Japan, 8% for Taiwan, and 8% for Venezuela of the total western Atlantic yellowfin tuna catch during the period 1966 to 1978 (Figure 3A). The average western Atlantic longline fishery catch of yellowfin tuna in the period 1966 to 1978 was 15,000 mt and for the surface fishery 800 mt (Figure 3B). Longline catches have declined 57% during the period 1971 to 1978 in the western Atlantic and surface catches fluctuate owing to fluctuating fishing effort in this area.

Based on the ex-vessel price paid by the U.S. for yellowfin tuna in 1978, the value for the western Atlantic catch (17,600 mt) in 1978 is approximately $16,000,000.

I.3. Management

The management regime currently in force for Atlantic yellowfin tuna is an ICCAT size regulation adopted in July 1973 that states,

> ". . . the Contracting States take the necessary measures to prohibit any taking and landing of yellowfin tuna weighting less than 3.2 kg.
>
> Notwithstanding the above regulation, the Contracting States may grant tolerances to boats which have incidentally captured yellowfin weighing less than 3.2 kg, with the condition that this incidental catch should not exceed 15% of the number of fish per landing of the total yellowfin catch of said boats."

The size regulation was adopted to decrease fishing mortality on young yellowfin tuna and increase yield-per-recruit. The effects, if any, of the minimum size regulation are difficult to ascertain at this time. This is due to the lack of information on the catches of undersized fish which are misidentified as bigeye tuna or vice versa and on the quantity of fish that are discarded. The size limit has probably discouraged the growth of fisheries for undersized yellowfin. Increases in yield-per-recruit are estimated to have occurred after the institution of the size limit, but are partly due to changes in the levels of fishing mortality by the three major gear components and to shifts in the sizes of fish they catch.

II. NATURE AND DEGREE OF U.S. INTEREST

The U.S. interest in Atlantic yellowfin tuna is in (1) harvesting by our domestic fleet, (2) processing of domestic and foreign catch, and (3) consumption of the canned product. To maintain a reliable supply and steady market for yellowfin tuna, the U.S. has a stake in conservation of the resource.

The U.S. tuna fleet usually enters the Atlantic yellowfin tuna fishery in June after the yellowfin tuna regulatory area (CYRA) in the eastern tropical Pacific is closed to yellowfin tuna fishing and usually returns to the Pacific by December. The fleet is composed mainly of large purse seiners. The average number of vessels participating in the fishery is 23 (1970-1978) (Figure 4). The average U.S. yellowfin tuna catch (1970-1978) is 7,900 mt (Figure 4). The 1978 U.S. Atlantic yellowfin tuna catch of 9,747 mt was worth approximately $8,900,000.

U.S. imports of Atlantic yellowfin tuna averaged approximately 13,700 mt in the period 1970 to 1978. The value of the 1978 imported catch (12,962 mt) is approximately $11,300,000. Virtually all domestic and imported catches of Atlantic yellowfin tuna are packed and consumed in the U.S. Annual total comsumption of Atlantic yellowfin tuna is approximately 21,600 mt worth about $20,000,000.

The U.S. is a member of the International Commission for the Conservation of Atlantic Tunas (ICCAT) which has a current membership of 18 countries. As a member, the U.S. is committed by Convention rules to supply data from its fisheries in the Atlantic, conduct research aimed at a better understanding of the resource and its management, and to abide by management decisions agreed upon by the Commission. There is also a financial obligation to support the working of the Commission. In 1978 the Commission had a budget of $429,000 of which the U.S. share was $42,745.

III. CURRENT RESEARCH

Research on Atlantic yellowfin tuna will focus on 5 areas; (1) compilation and improvement of catch-per-unit-effort (CPUE) data, (2) estimation of recruitment, (3) reexamination of the growth equation, (4) monitoring of the size of the spawning stock and its possible relation to recruitment, (5) examination of methods (other than a size limit) that might lead to an increase in the size-at-first-capture.

U.S. scientists will spend approximately 1/2 man years on two areas mentioned above. The first analysis will be a production model analysis and will focus on how different estimates of abundance for Atlantic yellowfin tuna affect the results of the production model. The second analysis will take a look at available data on lengths of yellowfin tuna caught by area/time/gear and assess the plausibility of area/time and/or gear closures to fishing as a measure to increase size-at-first-capture, to decrease fishing mortality on young fish and to increase yield-per-recruit.

Foreign countries will also spend research time in some of the above mentioned areas. France will commit approximately 1 man-year to an assessment of yellowfin fecundity, spawning stock and recruitment, and will probably look at growth of yellowfin tuna. Spain will commit approximately 1 man-year to an estimate of yellowfin migration based on a CPUE age analysis, and Japan will spend approximately 1 man-year looking at yellowfin stock conservation methods other than size limits.

IV. INVENTORY OF DATA

Three types of data are available for Atlantic yellowfin tuna (1) total catch, (2) catch and related effort, and (3) biological data (mainly length frequency). Data are compiled and collected by the individual ICCAT participating countries and submitted to ICCAT on an annual basis; this is a requirement of the ICCAT Convention. Nonmember countries are encouraged to submit their statistics, and the Commission collects statistics for countries that are unable to. Since the data bases for storage of these data were supplied to ICCAT by the SWFC, an identical set also exists with the SWFC. The data series is one of the best available and is adequate for population studies. Economic data on U.S. imports and ex-vessel prices are available from the Southwest Regional Office. These data are difficult to segregate by ocean.

Total catch data are available for all countries fishing in the Atlantic by year, gear, and area (if supplied) for as far back as 1960. The data are of very good quality. The data are available approximately 1 year after the fishing season (usually calendar year basis).

Catch and related effort data by area, gear, and time are available for most of the major participants in the Atlantic yellowfin tuna fisheries. Data are usually by gear, 1 degree or 5 degree area and month for a series since 1956 for some fleets. Data are of very good quality although not available for Spain, one of the major participants, for years before 1975. The data are available approximately 1 year after the fishing season (calendar year basis).

Length-frequency data is available for all the major participants except Spain. Data are usually by gear month and summarized ICCAT area although some data are for 1°, 5°, 5x10°, or 10x20° squares. These data extend as far back as 1966 for some countries and are of very good quality. The data are available approximately 1 year after the fishing season (calendar year basis).

V. STATUS OF THE STOCKS

Three methods are generally used to determine the status of Atlantic yellowfin tuna stocks, production model analysis, yield-per-recruit analysis, and recruitment analysis. Since CPUE (catch-per-unit-of-effort) are used in all the methods, the accuracy of the results are directly correlated to the accuracy of the CPUE estimates. The effects of differing estimates of CPUE on the results of some of the analyses seems negligible since the results are almost the same.

V.1. Production Model Analysis

Production model analyses were used with three stock structure hypotheses, (1) total Atlantic stock, (2) eastern Atlantic stock, and (3) western Atlantic stock. Surface catches are easily divided into eastern and western components but some differences in allocation of longline catches, that are reported for the total Atlantic, into eastern and western components exist and solutions to this problem are being sought. Old estimates of CPUE have been used in the past to determine the status of yellowfin tuna stocks in the Atlantic Ocean. In 1978 the French introduced new CPUE estimates. Differences between results of production models using these estimates will be looked at.

V.1.1. Total Atlantic Stock

Data were analyzed using three production models m=1, m=2, m=0. The m=1 model was analyzed using the old and new estimates of CPUE. The results using old estimates of CPUE continue to support the conclusion that the curve relating average sustained catch to estimates of effective fishing effort is broad and flat-topped, (m=0) (Figure 5B). However, it must be noted that while the curve labeled with m=0 implies that sustainable catch theoretically never declines at very high levels of effective fishing effort, this cannot be true. At some high level of effective fishing effort, the stock will become so depressed as to result in a significant reduction in recruitment and the sustainable catch will decline. It is not known at what level of fishing effort this will occur.

The estimates of maximum sustainable yield (MSY) of yellowfin from the total Atlantic stock ranged from 108,000 mt to 162,000 mt depending on which curves in Figures 5A or 5B are actually true. These estimates are 8 to 17% higher than originally believed. The increase is due to continual offshore expansion of the eastern Atlantic surface fishery. The curves for m=1 (French consider this the most applicable model) show that while fishing effort has not quite reached the level which produces MSY (10-15% higher than the 1977 level of fishing effort), the MSY is less than the current level of catch. The curve for m=0 showed some increases in catch can be made with further increases in fishing effort at the expense of a further reduction in CPUE. Despite the difference in CPUE used, nearly identical results were obtained with the same model (m=1); the MSY was estimated at 116,000 mt and 109,000 mt, respectively, with a 10-15% increase in effective fishing effort.

V.1.2. Eastern Atlantic Stock

Production model analyses using the hypothesis of separate east and west stocks were applied to the eastern Atlantic surface data only, assuming constant longline fishing (Figures 6A and 6B), and to the eastern Atlantic surface and longline data (Figure 7).

Again despite the differences in measures of CPUE, the general picture is the same. The stock is heavily fished. Under the more conservative models (m=2.0 and m=1.0) the present effort is approaching or at about the level giving the MSY, and no significant increases in yield from the average current levels can be expected (estimates of MSY around 90,000 mt to 100,000 mt by adding the longline catches to the estimates of surface MSY). On the more optimistic (m=0), significant increases in yield can be obtained (MSY=143,000 mt), but, if correct, this would require a very great increase in effort, and a corresponding decrease in catch-per-unit-effort. It must be stressed that these analyses concern the fishery as it is at present operating. In recent years, the expansion of the fishery offshore has been accompanied by some increase in the estimates of MSY. Apart from some effects due to changes in the size of fish caught, this increase is suspected to be largely due to the fishery exploiting a somewhat larger stock. It is not known to what extent this increase might be continued by a further westward expansion of the fishery. Inasmuch as such an expansion is practicable and will harvest groups of fish not currently exploited, or only exploited lightly, there are greater opportunities for increased catch than the production model analysis would suggest.

V.1.3. Western Atlantic Stock

Two production model analyses were conducted with the assumption of a western Atlantic stock. Both analyses used only longline data and ignored the 2,000 mt surface fishery. The big difference between these two analyses was the amount of longline catch allocated to the western Atlantic for years since about 1969. In one analysis, the allocation was about 18,000 mt and in the other, only 14,000 mt. The higher catch allocation was based on allocation of the total longline catch using Japanese longline catch and effort data; and the lower estimate was based on allocation using the ICCAT catch-effort file and published Taiwanese catch-effort data.

The two analyses gave equivalent estimates of the MSY (18,000 mt and 20,000 mt), one corresponds to a present effort at about the MSY level, and the other to a present effort well past that level.

While these analyses showed that little or no additional catch can be taken from the western Atlantic by increasing the longline effort, experience in other areas, including the eastern Atlantic, suggests that a different pattern of fishing, such as increased surface fishing would probably increase the total yield. It is not possible to estimate what this increase in yield might be. It will clearly depend on the degree to which the western Atlantic stock is separate from the eastern Atlantic stock.

V.2. Yield-per-recruit analysis

On the basis of several studies, ICCAT adopted a minimum size limit on Atlantic yellowfin of 3.2 kg or 55 cm in 1973. It was estimated that under the then current fishing pattern this would either give a small increase in yield-per-recruit, or if undersized fish were discarded dead, would not affect the yield-per-recruit. The main objective of the size limit was to discourage the development of fisheries on small yellowfin. Since that time, the fisheries have changed dramatically. Purse seine catches have increased greatly, and have shifted to larger fish. Catches of both baitboats and longliners have decreased, and there has been a shift to smaller fish by the baitboats.

To take these changes into account, updated yield-per-recruit analyses were done for the eastern Atlantic stock. Three analyses were performed using different methods and time periods to estimate fishing mortality. All three analyses produced identical conclusions that there has been an overall increase in yield-per-recruit. Analysis 1 showed an increase of 7% in equilibrium yield-per-recruit based on average F's (fishing mortality rate) for 1966-68 versus 1969-71 cohorts. Analysis 2 showed an increase in realized yield-per-recruit of 18% between the average of the years 1969-71 and 1975-77. Analysis 3 showed a 3% increase in equilibrium yield-per-recruit when comparing the 1975 fishing year with the average for 1966-72.

Analysis 3 also compared changes in yield-per-recruit between gears. The longline fishery experienced a 57% reduction in equilibrium yield-per-recruit, the purse seine fishery a 55% increase, and the baitboat fishery a 45% decrease. The longline fishery's reduction in yield-per-recruit was due to the competition from purse seine and baitboat gears for catches. The purse seine fishery's increase in yield-per-recruit was due to increased effort and a shift to larger fish. The baitboat's decrease in yield-per-recruit was due to reduced effort on older fish and increased effort on very small fish.

Increases in yield-per-recruit to the fishery as a whole can be obtained with an increase in size-at-first-capture or a moderate increase in fishing effort. But the outcome is different for the different gears. The longline fishery would gain by an increase in size-at-first-capture up to about 120 cm, the purse seine fishery would gain by an increase up to 110 cm, and the baitboat fishery would lose by any increase in size-at-first-capture.

The situation with respect to changes in minimum landing size is more complex. If the fishermen avoid catching small fish, then the benefits to the fishery as a whole will occur as predicted by the yield-per-recruit model. On the other hand, if small fish continue to be caught, and are discarded dead, there may be little or no increase in effective size-at-first-capture, and no benefit. Indeed, there will be a wastage of discarded fish. Japanese Tema-based baitboats apparently discarded 1,130 mt of undersized yellowfin in 1977 while landing only 2,488 mt. Similar, but higher, rates of discarding were noted for two trips of Tema-based baitboats accompanied by Ghanaian technicians in 1978.

V.3. Recruitment Analysis

Studies were conducted that analyzed recruitment of yellowfin tuna to the eastern Atlantic fisheries in recent years. Cohort analyses were used to obtain estimates of the abundance at ages 1 and 0 and CPUE analysis for abundance at age 0. Cohort analysis did not give a solution for the 1974 year-class but CPUE estimates suggest that the year class was below average (Figure 8).

For the CPUE analysis study which estimated recruitment at age 0, recruitment fluctuated considerably but has remained rather constant over the total time period of 1968-75 - 53.6 million fish for 1968-71 and 55.5 million for 1972-75 (discarding the 1974 point as having no solution). The other two studies which included estimates for earlier years were for age 1 recruitment, showed increased recruitment over their time periods. However, the 1966 cohort was at the same level as the 1969-72 cohorts, which were estimated to be remarkably stable, while it is likely that the 1965, 1967, and 1968 cohorts were below average.

There is no suggestion as yet that the increased catches over the past decade have had adverse effect on recruitment. However, the CPUE of the longline fishery has decreased, suggesting that the spawning stock has declined. In view of this trend and of the increased catches of large fish by purse seiners, the size of the spawning stock, and of subsequent recruitment need to be carefully monitored.

V.4. Current Appraisal

Regardless of the stock structure assumed, the appraisal of the condition of the yellowfin stock is that the stock (or stocks) are heavily fished, particularly in the eastern Atlantic. Given the present geographical distribution of the fishery and pattern of fishing by different gears, it is unlikely that appreciable increases in yield can be achieved by increasing the amount of fishing effort. The increases in total catch that have occurred in recent years seem to have been largely the effect of geographical expansion of the area of fishing. It is not known to what extent a further expansion can be achieved, or what further increase in catch might result from such an expansion.

The level of the catches also depends on the sizes of fish caught. An increase in the effective size-at-first-capture should increase the yield. Conversely, increased fishing on small yellowfin would tend to decrease the total long-term yield.

VI. PROBLEM AREAS AND NEEDS

VI.1. Research

Research needs to be continued along established lines, covering such matters as compilation and improvement of CPUE data, use of production models, estimation of recruitment, etc. In addition, the following should be studied:

a. Examination of the effects of differences in the growth rates on the population dynamics of yellowfin tuna (cohort analyses).

b. Monitoring of the size of the spawning stock, and its possible relation to recruitment,

c. Examination of management methods (other than a minimum size limit) that would reduce the catch of small fish. Also determine the economic effects of these methods.

d. Examination of environmental parameters and their relation to fishing success,

e. Examination of the economics of the Atlantic, yellowfin tuna fishery,

f. Establish biological and population dynamics parameters for the western Atlantic to determine if it is indeed a separate stock. (e.g. growth, migration, fecundity, etc.).

VI.2. Data

i. The actual catches of small yellowfin and small bigeye must be estimated through:

   a. Increased species composition sampling in Puerto Rico of the American catch;

   b. Species composition sampling with the use of diagnostic characters to identify species at landing sites even where the small tunas are landed,

c. Correction of reported landings through species composition sampling of the major purse seine fleets, e.g. FIS and Spanish fleets,

d. Collection of information on catches not passing through normal market channels.

ii. The amount of small yellowfin discarded at sea must be estimated through:

a. Sending technicians to sea to estimate and record amounts of discards,

b. Or, failing this, encouraging fishermen to record estimates in logbooks.

iii. Logbooks should be modified to require catch by set for purse seiners rather than catch by day and should provide for entries involving running time (i.e. not searching for fish), time down for repairs (i.e. not searching for fish nor conducting any part of a set), duration of each set and total time at sea. These data are required for studies aimed at improving CPUE as a measure of relative population density and for actual use if the studies are successful in improving CPUE as a population density index.

iv. Catch and effort data are needed from certain longline fleets (Korean, Taiwanese) in order to divide their catches between the eastern and western Atlantic.

v. In addition to the technical improvements in logbooks mentioned under recommendation iii), better coverage is needed for some important tropical tuna fleets especially the Spanish fleet.

vi. Collection and analysis of economic data for the Atlantic tuna fisheries that will aide in understanding the effects of management decisions on the economics of the fishery.

VI.3. Management

It is clear that the yield from the fishery as a whole would benefit from measures that would limit or reduce the catches of small yellowfin, and that ICCAT should give serious attention to the possibilities of such measures, other than a minimum size limit. These might include closed areas or closed seasons, or controls on the use of certain types of gear.

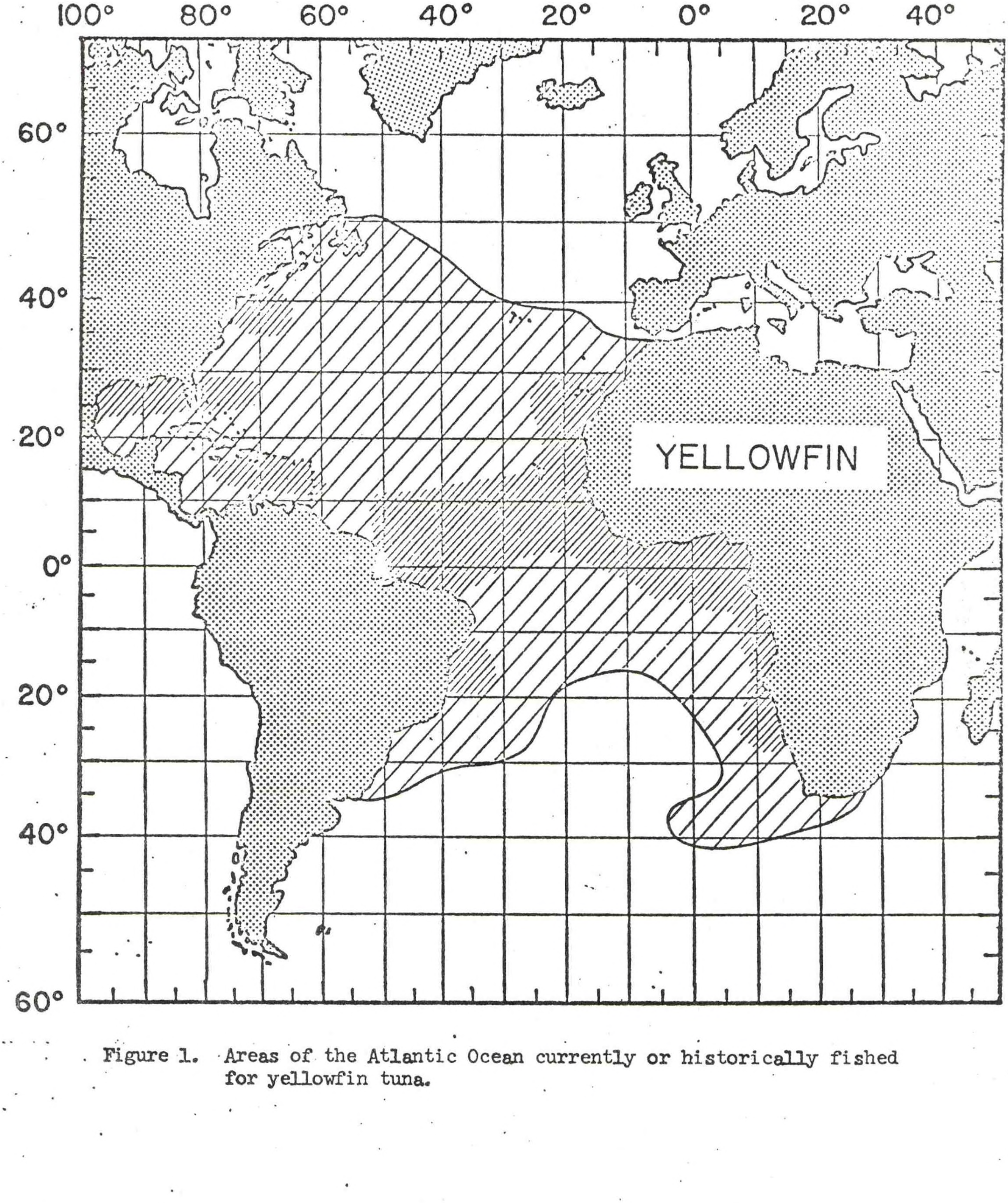


Figure 1. Areas of the Atlantic Ocean currently or historically fished for yellowfin tuna.

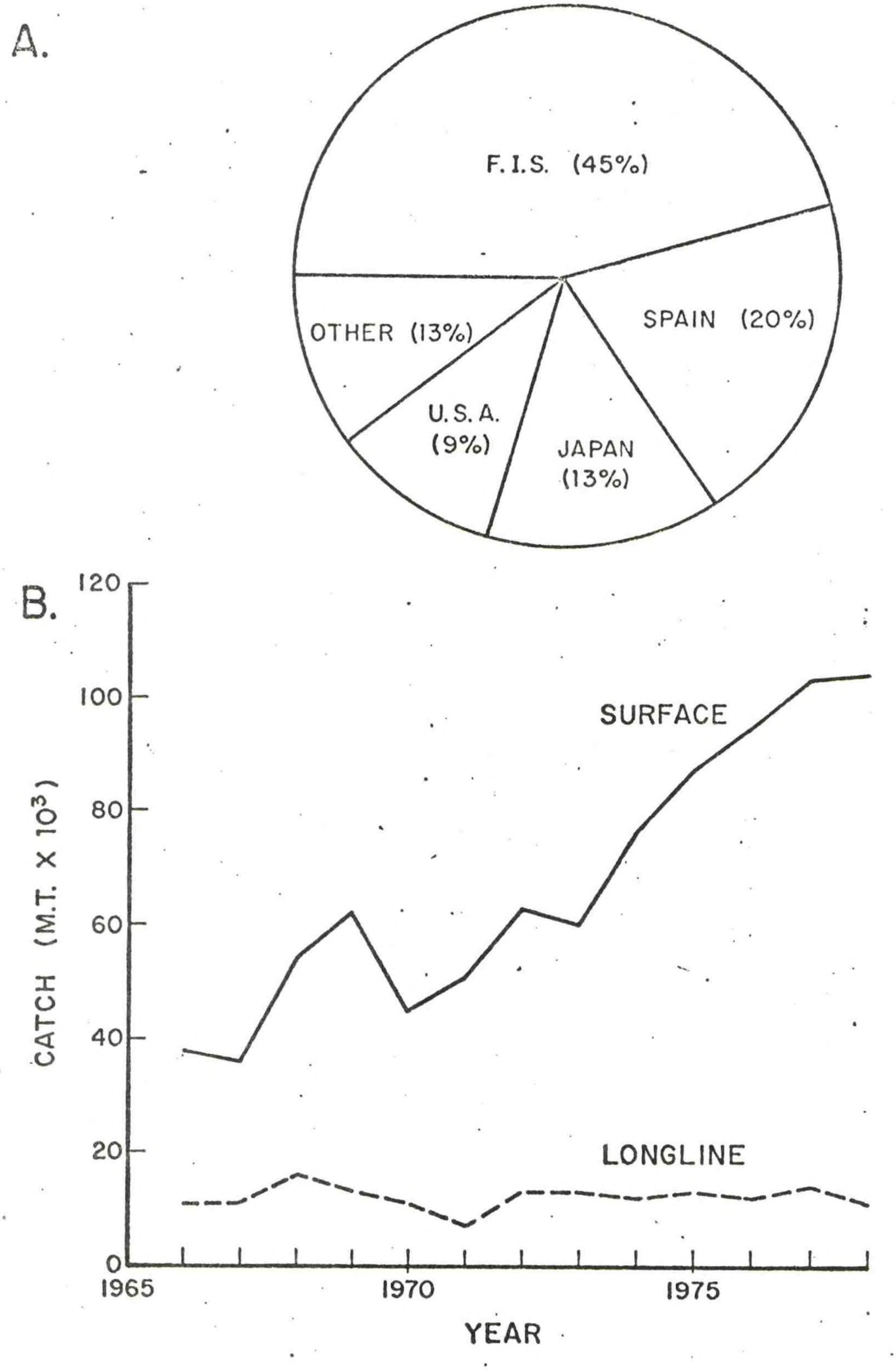
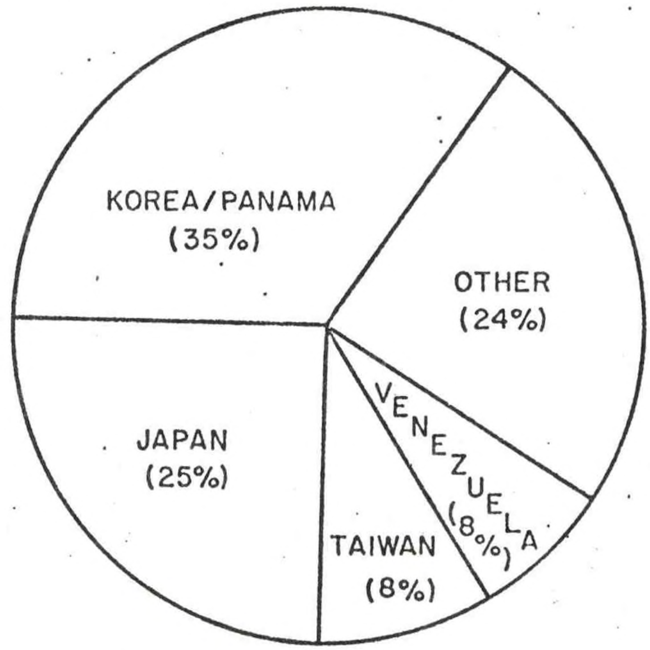


Figure 2. A) Major participants in the eastern Atlantic surface and longline fishery for yellowfin tuna.
B) Total catch of yellowfin tuna from longline and surface gears fishing in the eastern Atlantic, 1966-1978.

A.



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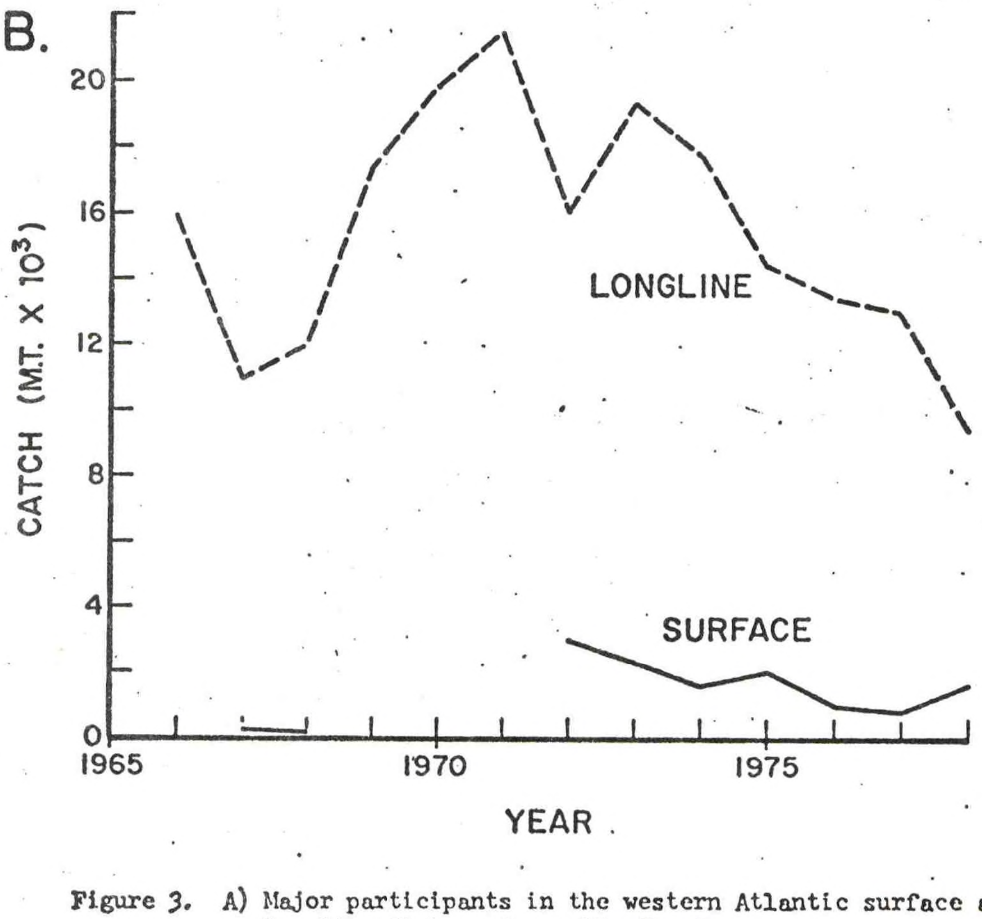


Figure 3. A) Major participants in the western Atlantic surface and longline fishery for yellowfin tuna.
B) Total catch of yellowfin tuna from longline and surface gears fishing in the western Atlantic, 1966-1978.

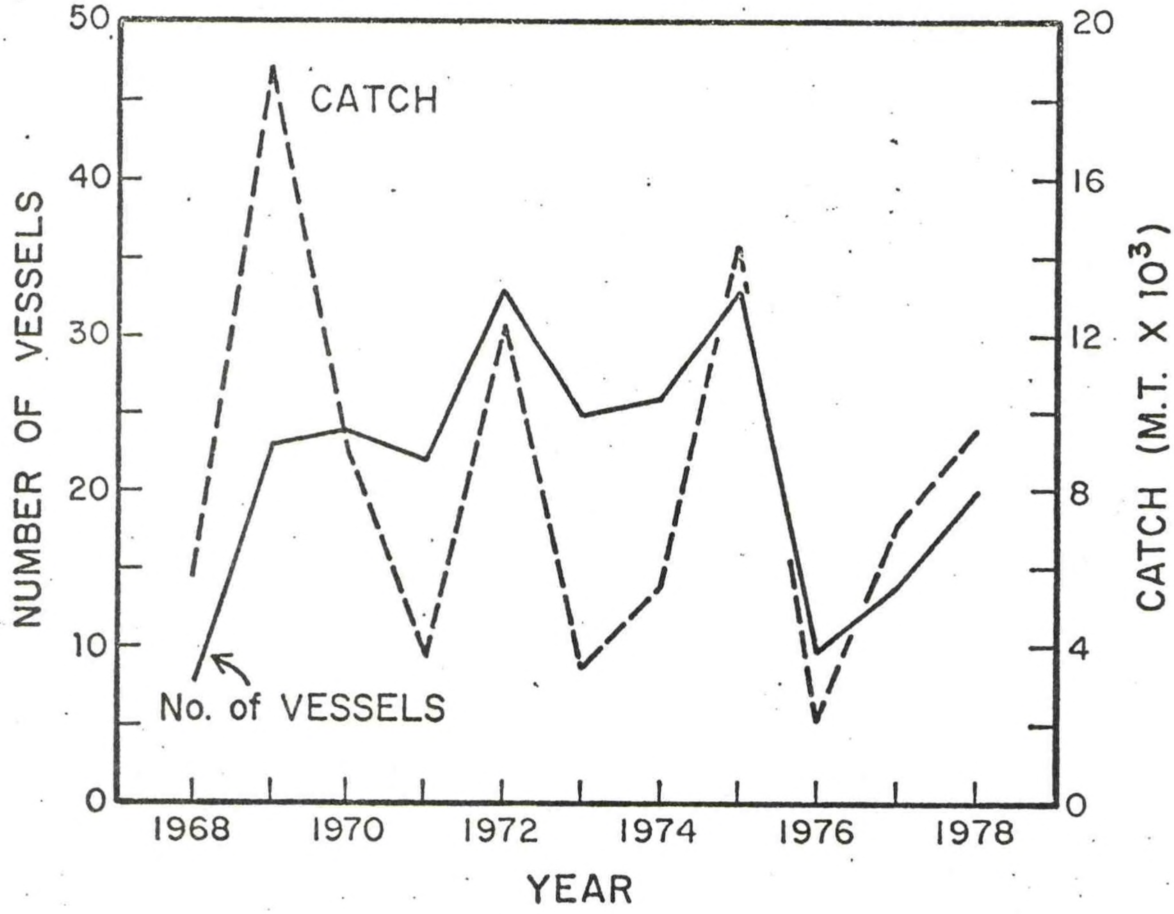


Figure 4. Total catch of yellowfin tuna and effort in # of vessels for the United States purse seine fleet fishing in the Atlantic Ocean, 1968-1978.

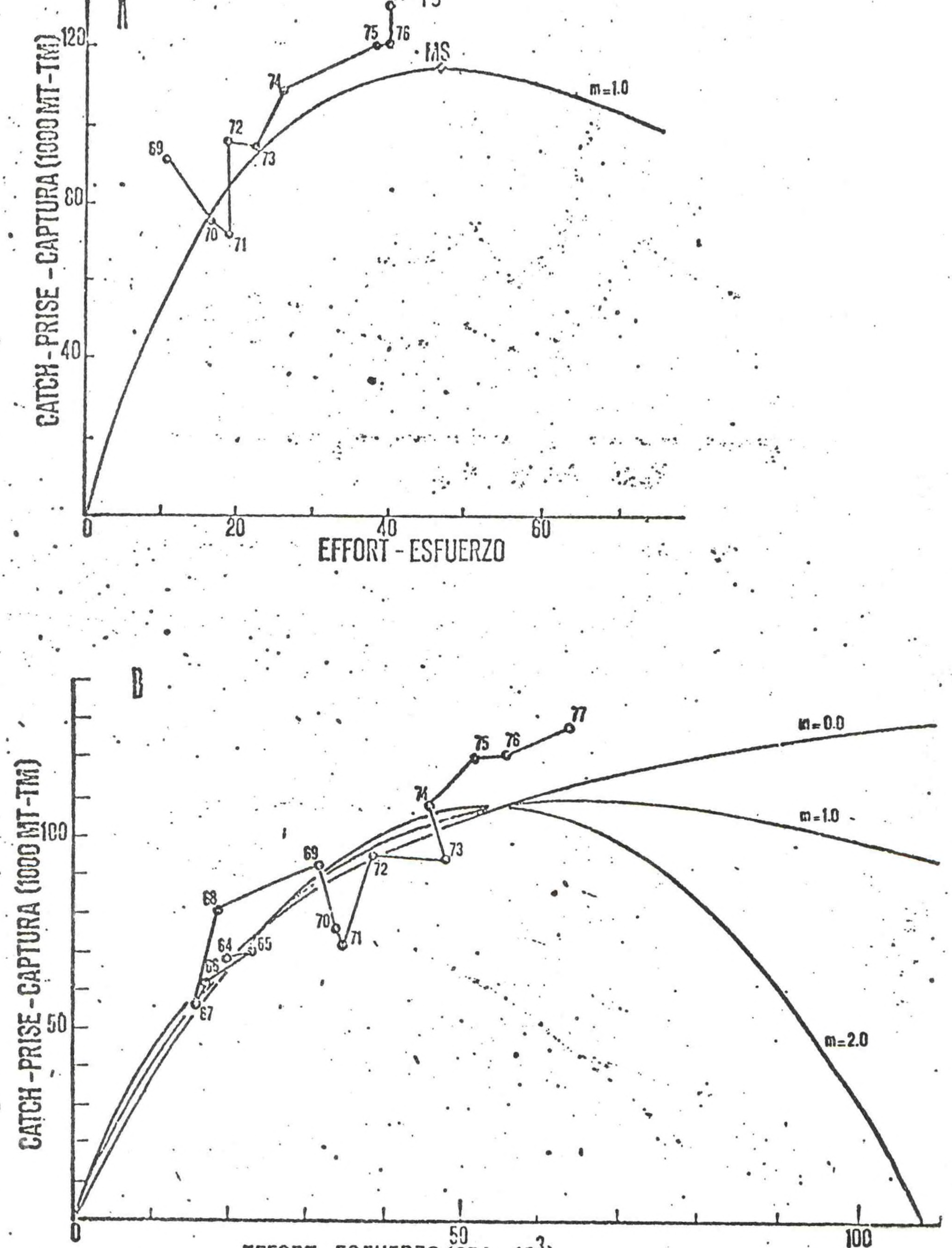
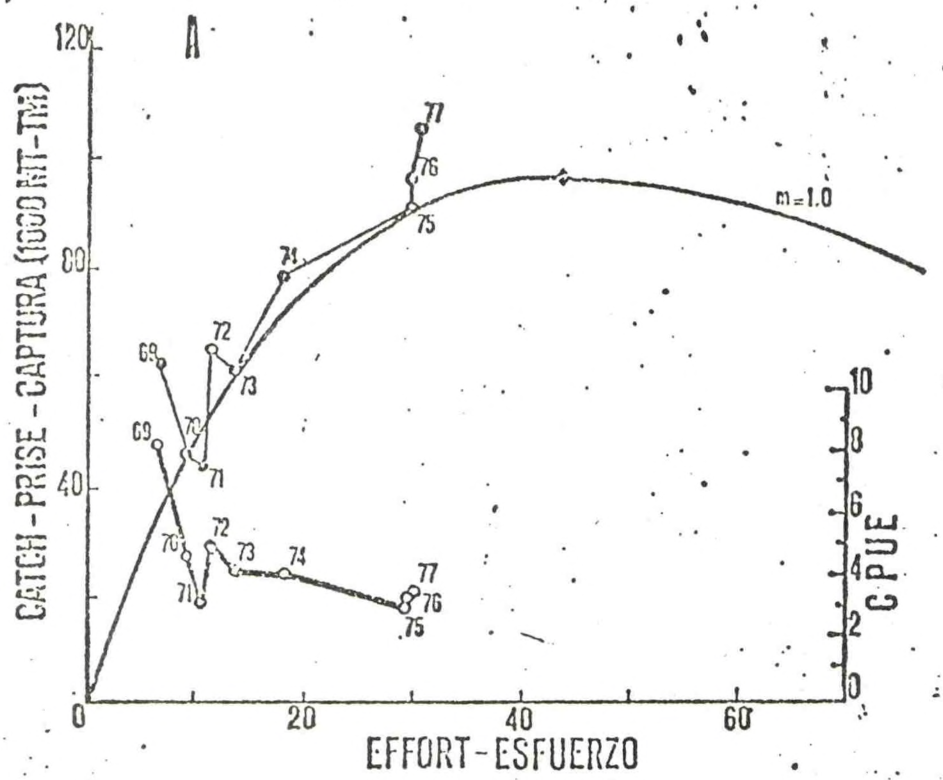


Figure 5. Equiblibrium yield curves for various production models fitted to catch and effort data of the total Atlantic fishery for yellowfin tuna; A) using new catch-per-unit-effort(CPUE) estimates, B) using old CPUE estimates.



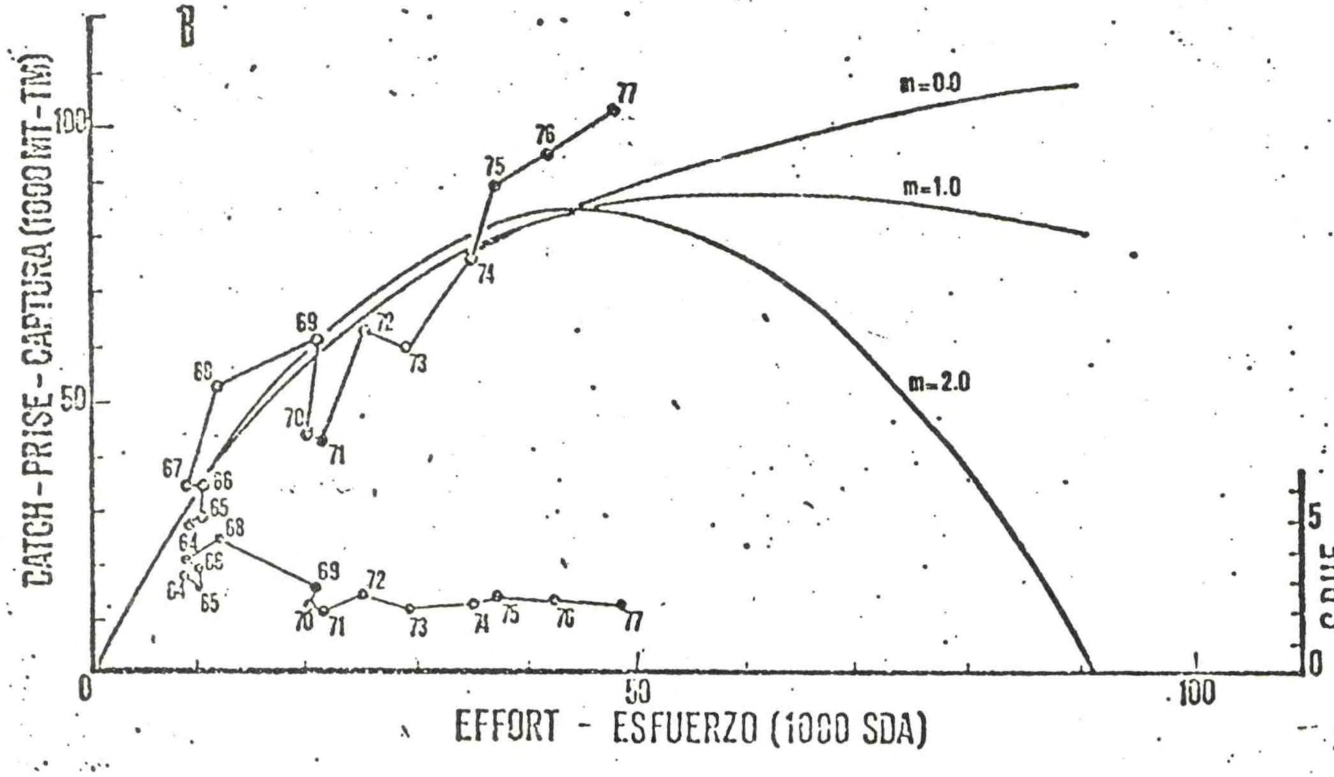


Figure 6. Relationships between catch and effort and catch-per-unit effort for the eastern Atlantic yellowfin tuna surface fishery. A) New estimates of catch-per-unit-effort, B) old estimates of catch-per-unit-effort.

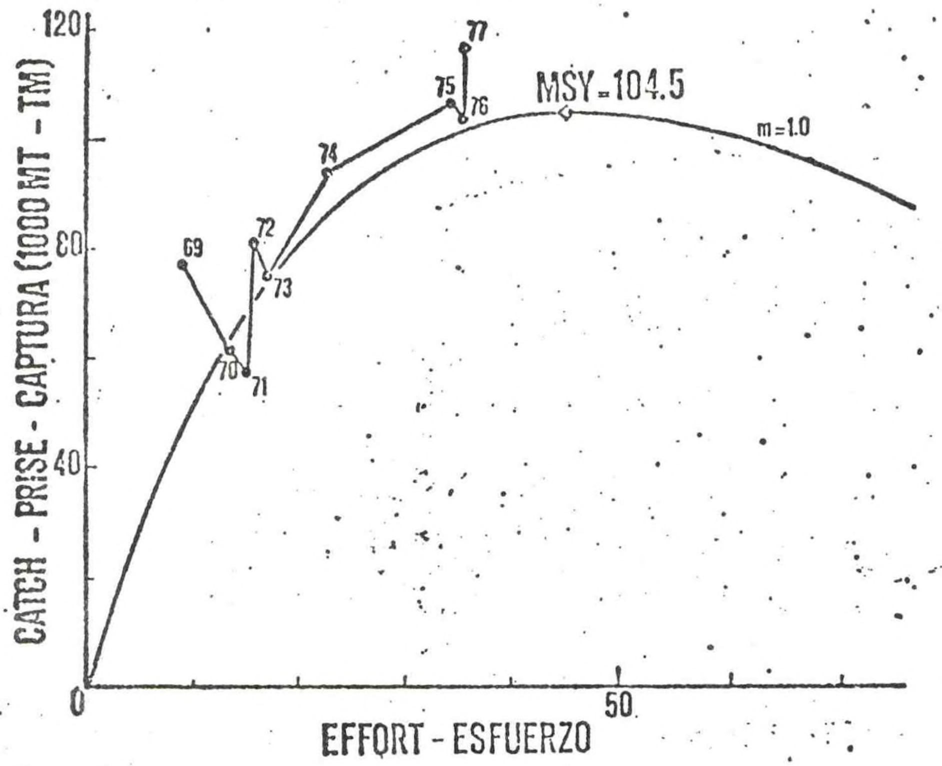


Figure 7. Equilibrium yield curve for the eastern Atlantic surface and longline fishery for yellowfin tuna.

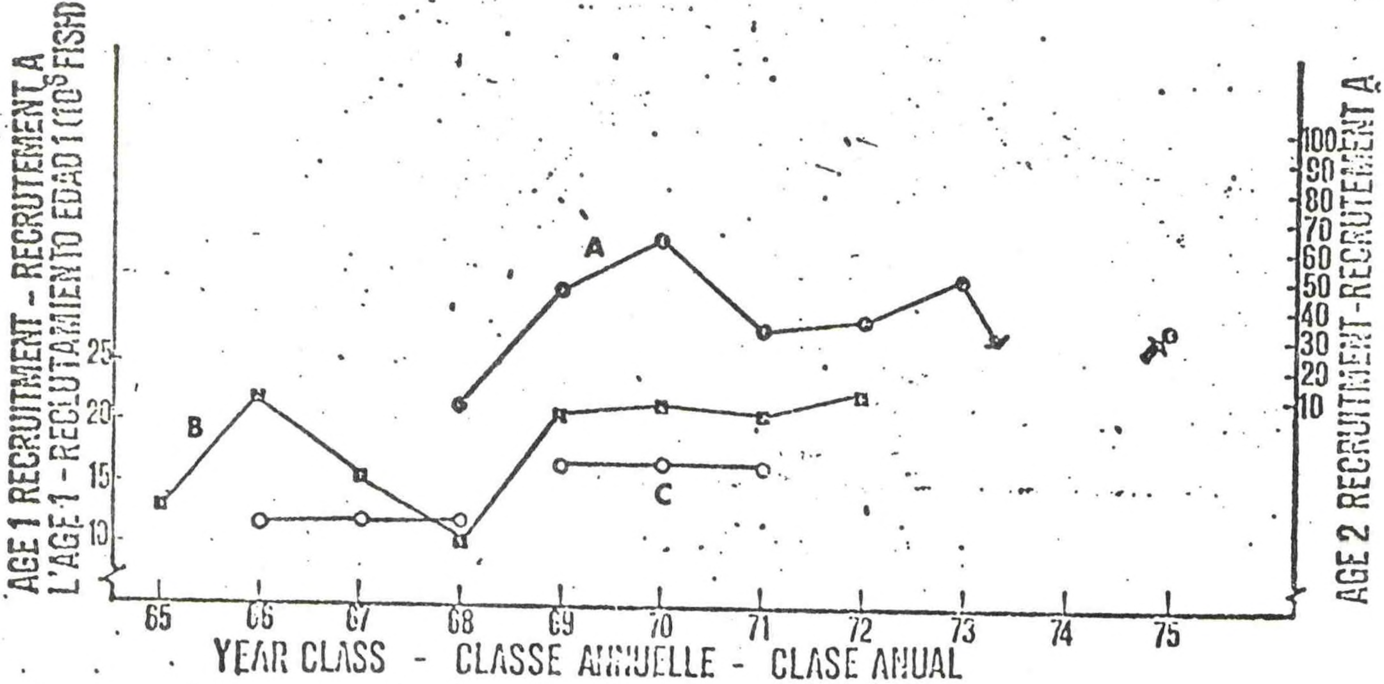


Figure 8. Estimated recruitment of yellowfin tuna from the eastern Atlantic Ocean by year of birth; A) to age 0 using CPUE analysis, B-C) to age 1 using cohort analysis.

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT FOR ATLANTIC BIGEYE TUNA
by

Earl Weber

INTRODUCTION

Atlantic bigeye tuna are distributed between 45°N and 35°S latitudes. Low hook rates by longliners fishing near the equator has led to a hypothesis of separate north and south stocks, as assumed in this report.

A. Description of the fishery

The major Atlantic bigeye tuna fishery began in 1956 when the Japanese fleet expanded operations to the Atlantic Ocean. The longline gear continues to be the principal method of capturing bigeye tuna. However, in recent years surface gears have become increasingly more important. The catch by surface gears represented only 6% (1,500 mt) of the total in 1970, but increased to 33% (13,400 mt) by 1976.

Of the ten nations with longline fleets participating in the Atlantic bigeye tuna fishery, the catches of Japan, Korea and the USSR accounted for 71% (20,800 mt) of the total 29,000 mt 1977 longline catch. Other longlining nations include Taiwan, Cuba, Venezuela, Brazil, Argentina, Spain and Panama. The catch by nation for the longline gear is shown in Figure 1.

Unlike longlines that catch bigeye tuna throughout most of their range, surface gears generally operate in the tropical east Atlantic off the coast of Africa. Surface fleets operate under the flags of France (whose catches are reported with those of Ivory Coast and Senegal), Spain, Japan, Korea, Panama, Portugal, United States, Ghana and Morocco. The surface catches of the fleets of these nations is shown in Figure 2.

The total catches of Atlantic bigeye tuna showed a generally increasing trend until 1975 when approximately 52,000 mt were landed. Catches in 1976 and 1977 dropped to approximately 42,000 mt (Table 1). Longline catches increased until 1971, were reasonably stable until 1975 at about 35,000 mt, and decreased in 1976 and 1977 to the 25,000 to 28,000 mt range. Surface catches showed a generally increasing trend to 14,000 mt through 1975 and also declined slightly in 1976 and 1977. Baitboats account for at least 80% of the Atlantic bigeye tuna surface catches. The longline, surface and total Atlantic bigeye tuna catches for years 1967-1977 are shown in Figure 3.

The ex-vessel price of bigeye tuna is considered to be the same as that of yellowfin tuna because no effort is made to distinguish between these similar species when they are marketed. Currently, yellowfin tuna is valued between approximately $800 and $1,000/mt, ex-vessel, depending on fish size.

No management regulations are currently in effect for Atlantic bigeye tuna.

B. The Nature and Degree of U.S. Interest

The U.S. lands and imports bigeye tuna for canning in its light meat tuna industry. In 1978 the U.S. reported catching 248 mt of Atlantic bigeye and imported an additional 1,907 mt through facilities in Puerto Rico.

Yearly U.S. Atlantic bigeye tuna landings have been variable with a record 865 mt in 1974 (Figure 4). Decreases in recent years may be the result of a regulation aimed at increasing the yield-per-recruit of yellowfin tuna which are found in association with bigeye tuna. A proposed regulation to prohibit the catching of small bigeye could further reduce bigeye catch levels by the U.S. surface fleet. The estimated percentages of Atlantic bigeye tuna 55 cm caught by baitboats, the principal surface gear, ranged from 30% to 89% between 1972 and 1975.

C. Current Research Effort

The status of Atlantic tuna stocks are assessed each year by ICCAT. At that time research needs are determined and research assignments are recommended. To date most Atlantic bigeye research has been conducted by the U.S., France and Japan. In recent years each of these nations has devoted an estimated 0.5 man years to Atlantic bigeye research.

Earlier studies focused on analysis of longline hook rates and basic population biology. More recent works have employed production model, virtual population and yield-per-recruit analyses. ICCAT research assignments for 1979 are as follows:

TASKS	
1. Production model	U.S.A., Japan, France
2. Cohort analysis	France
3. Size/age composition	Japan, Spain, France
4. Yield-per-recruit	Japan, France
5. Analysis of impact of regulations	Ghana, Japan
6. Study of proportion of undersized fish	U.S.A., Japan, France, Korea
7. Investigation of variability in multi-species fishery	Japan

The U.S. continues to sample landings and importations of (mainly) surface caught tunas from the eastern tropical Atlantic for species composition and length frequency data. The U.S. is also conducting an age and growth study using all available length-frequency information.

D. Inventory of Data

Annual catch, catch-effort and size composition data for Atlantic bigeye tuna are routinely collected and submited to ICCAT by member nations and in some instances by ICCAT scientists. These data are compiled and made available by ICCAT. The Southwest Fisheries Center maintains a data base with this information that is updated annually.

A reasonably complete data series has been collected by the Japanese longline fleet, historically the major bigeye tuna harvester. In recent years most harvesters have contributed to improving the quality and quanity of data which at present appear to be suitable for general stock assessment. However, recommended research, such as an analysis of the undersized yellowfin and bigeye problem and improved population parameters, will require that additional data be collected, particularly from surface fleets.

E. Status of Stocks

The status of Atlantic bigeye tuna stocks is reviewed annually by the SCRS during the ICCAT meetings. To date, analyses have focused on production model, virtual population, and yield-per-recruit (Y/R) analyses.

Production model analyses for the entire Atlantic indicate that bigeye are currently being fished at or near effort levels necessary to achieve maximum sustainable average yield (MSAY) depending on the value of "m" used. Likely MSAY estimates ranged from 49,000 mt to 55,000 mt. Catches in recent years have been between 35,000 mt and 53,000 mt.

The production model did not fit the data for the north Atlantic stock very well. Reasonable MSAY estimates appear to be in the range of from 33,900 mt to 38,600 mt. Northern bigeye tuna catches were at the 38,000 mt level in 1974 and 1975 but dropped to approximately 20,000 mt in 1976.

The production model did fit the data for the southern stock reasonably well (r^2=0.8). Estimates of MSAY were between 16,400 mt and 17,900 mt. Because current effort levels are near those required for harvest at the MSAY level, the southern bigeye tuna fishery should be closely monitored.

A virtual population analysis was performed on data for the entire Atlantic. Results indicate that recruitment was weak in the mid-1960's but increased in the late 1960's and early 1970's. Because this analysis is dependent on population parameters whose accuracy have not been confirmed, this analyses should be regarded as being preliminary.

A yield-per-recruit (Y/R) analysis was conducted with data for the entire Atlantic and predicted inceases in Y/R of between 30 and 50% if the fishing mortality due to surface fishing were eliminated. Y/R analyses are also preliminary and should be improved by increased research on the population biology and stock structure of Atlantic bigeye tuna.

F. Problem Areas and Research Needs

A yellowfin tuna minimum size regulation aimed at increasing the yield-per-recruit in that fishery has also affected the Atlantic bigeye tuna fishery. Because young bigeye tuna are found in association with, and are difficult to distinguish from young yellowfin tuna, undersized yellowfin tuna (< 3.2 kg) are frequently misreported as bigeye tuna. Consequently, ICCAT has recently proposed that the effects of a minimum size regulation on bigeye tuna be studied. This regulation would avoid the misidentification problem and is intended to increase the yield-per-recruit within the bigeye tuna fishery. A possible disadvantage of this measure would be reduced effort toward skipjack tuna which is considered to be underutilized. In addition, ICCAT recommends that more effort be directed toward improving the basic biological information on bigeye tuna.

Thse types of problems require that specialized programs be instituted to improve our estimates of species composition and size composition for areas where surface gears are used. High spatial resolution samples, including single set data, will be necessary for optimizing not only the harvest of yellowfin and bigeye tunas, but skipjack tuna as well. ICCAT recommends that the biological information regarding bigeye tuna be improved by research in the areas of age and growth, maturity and fecundity, fishing and natural mortality rates, recruitment indices, stock structure and abundance indices.

Research effort at the Southwest Fisheries Center should concentrate on continued sampling of landed and imported tunas to provide estimates of species composition, particularly among surface gears, and to provide length-frequency data for Atlantic bigeye tuna. Future sampling should include the collection of somatic hard parts from Atlantic bigeye tunas for confirmation of age and growth studies that have, to date, been based on the modal progressions of length frequencies. Also, the status of Atlantic bigeye stocks should continue to be monitored. Finally, the Center should support increased research effort directed toward the study of stock structure, migration, maturity and fecundity, and other topics necessary for the improved management of Atlantic bigeye tuna.

Table 1 Atlantic bigeye catch (1,000 MT)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978 1/
TOTAL	29.2	19.0	12.0	18.2	23.0	27.0	44.6	34.0	42.2	51.9	52.1	40.8	43.1	
LONGLINE	28.9	18.7	[illegible]	[illegible]	20.8	25.5	36.3	30.9	35.0	35.7	37.1	27.5	28.9	-----
ARGENTINA	.4	.2	.1	.3	.2	.1	0.	0.	.0	.0	.1	.2	.1	
BRAZIL	0.	0.	0.	0.	0.	0.	0.	0.	.1	.2	.1	.2	.1	
CHINA (TAIWAN)	0.	.6	2.2	5.3	7.5	7.3	5.5	5.0	3.0	3.1	4.0	2.3	2.0	2.0
CUBA	0.	0.	0.	0.	0.	0.	3.2	2.0	2.0	2.4	1.9	1.3	1.8	
JAPAN	28.5	17.6	8.5	10.3	10.3	9.0	20.3	18.1	22.6	22.7	19.4	9.2	10.0	5.0
KOREA	0.	.3	.3	.3	1.9	4.7	7.4	5.7	5.8	7.4	10.2	6.7	7.8	13.7
OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	.0	0.	0.	4.9	6.3	
SURFACE	.1	.0	.5	1.1	2.2	1.5	8.3	3.9	7.2	16.1	15.0	13.9	14.2	
EAST ATLANTIC	.1	.0	.5	1.1	.6	.3	7.8	3.9	7.2	16.1	15.0	13.9	14.2	
FIS	0.	0.	0.	0.	0.	0.	0.	.3	2.5	1.3	1.4	1.1	4.0	
GHANA	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0	.3	.7	.3	3.0
JAPAN	.1	.0	.5	1.1	.5	.1	.2	.3	.2	.7	.3	3.5	1.1	0.5
KOREA	0.	0.	0.	0.	0.	0.	0.	.0	0.	1.0	2.2	1.7	.0	
PORTUGAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.1	4.9	2.1	4.0	
SOUTH AFRICA	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
SPAIN	0.	0.	0.	0.	0.	0.	7.0	3.1	4.4	3.2	5.7	4.2	3.6	4.4
USA	0.	0.	0.	.0	.1	.2	.5	.2	.1	.9	.1	.0	.3	
OTHERS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	.0	0.	.0	
WEST ATLANTIC	0.	0.	0.	0.	0.	0.	0.	0.	.3	0.	0.	.0	0.	
UNCL. REGION	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
UNCL. GEARS	.1	.3	.3	.9	2.6	5.3	.5	0.	0.	0.	1.5	1.7	0.	

1/ Provisional estimates.

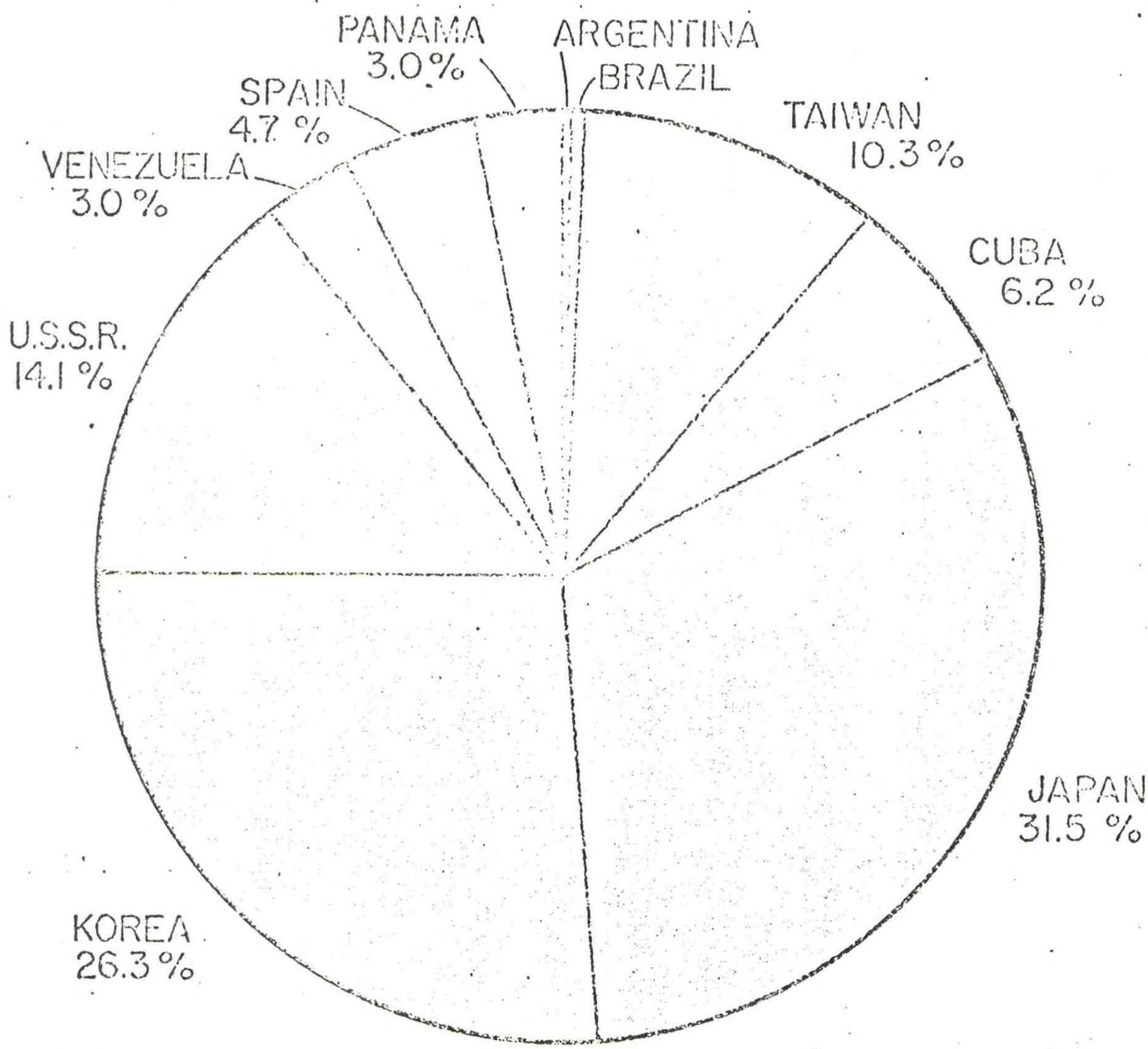


Figure 1. The percent of the Atlantic bigeye tuna longline catch landed by each country in 1977.

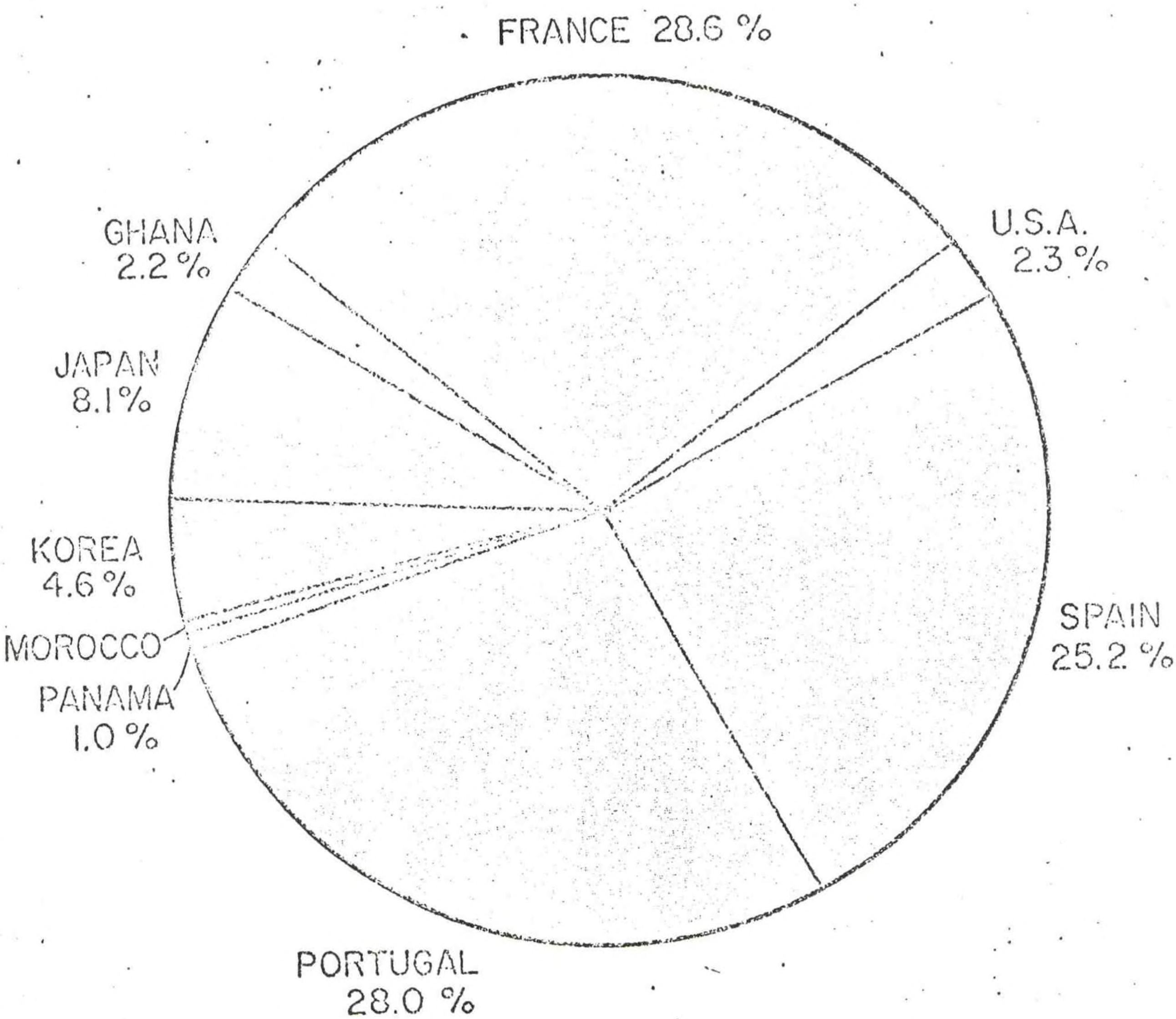


Figure 2. The percent of the Atlantic bigeye tuna surface catch landed by each country in 1977.

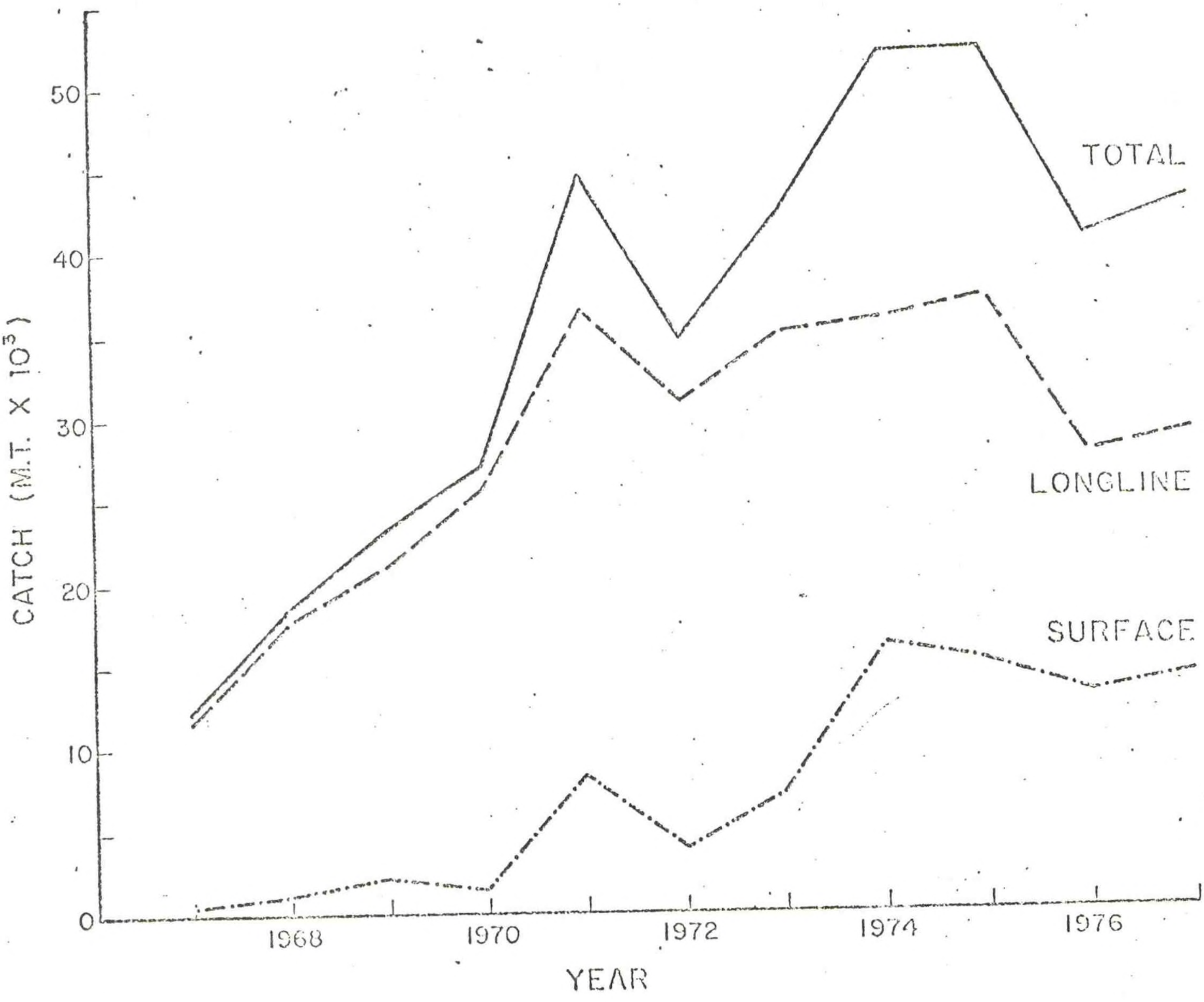


Figure 3. The surface, longline and total catch of Atlantic bigeye tuna, 1967 - 77.

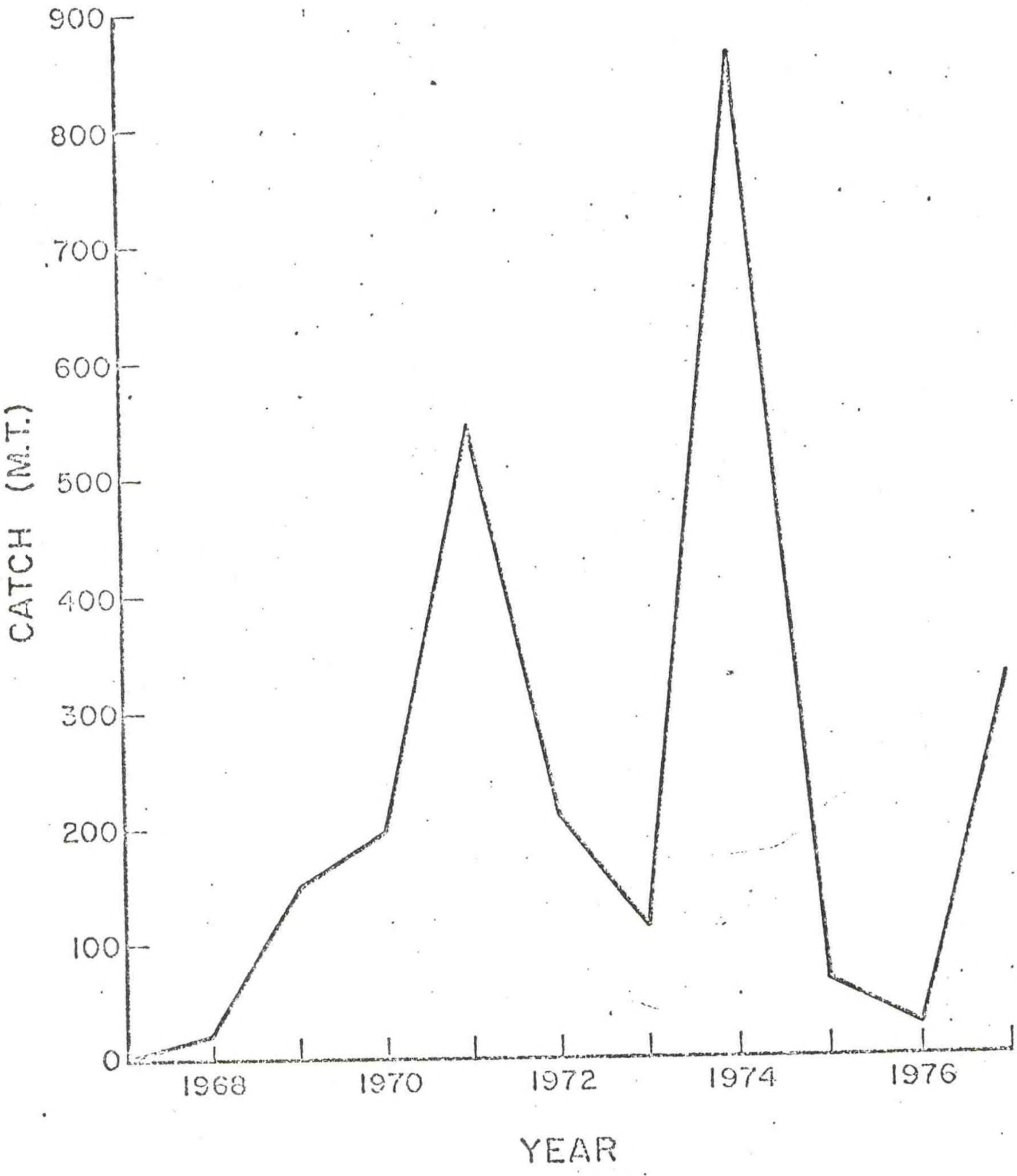


Figure 4. Yearly United States landings of Atlantic bigeye tuna, 1967 -77.

SWFC TUNA RESE/ ORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

ATL-4
REVISED SEP. 5,

Atlantic Skipjack Situation Report

by

Ronald G. Rinaldo

A. Description of fishery

1. Short history

Skipjack tuna, Katsuwonus pelamis, are caught in the Atlantic Ocean as one of two principal species by the tropical tuna fleet. The other major species harvested by the fleet is yellowfin tuna, Thunnus albacares. The tropical tuna fishery is currently the largest tuna fishery in the Atlantic Ocean and supports an international fleet of over 1200 purse seiner, baitboat, and longliner vessels (Figure 1). these vessels employed in the fishery range from a few hundred metric tons to in excess of 2,000 metric tons in carrying capacity. Longliners fish throughout the Atlantic, but catch few skipjack, while purse seiners and baitboats, generally fish within 200 miles of land and catch surface schools of skipjack tuna. The bulk of the fishery is in the eastern Atlantic, with a small, presumably underdeveloped fishery in the western Atlantic.

The eastern Atlantic fishery began to develop about 1955 when French baitboats from Europe moved into the Dakar area to fish for yellowfin. The fishery expanded quickly and by 1960 a year-round fishery had developed between Spanish Sahara and Zaire. Purse seiners began to enter the fishery in the early 60's and currently 10 times more purse seine carrying capacity than baitboat carrying capacity is fishing in the eastern tropical Atlantic for skipjack. Skipjack was a secondary catch to yellowfin in the 60's, with an average 56% of the total yellowfin-skipjack tuna surface catch from the eastern Atlantic being yellowfin tuna. As more units of fishing effort were applied to the fishery, yellowfin catch rates dropped and fishermen began relying more on skipjack tuna to fill their boats. Concurrently, the price for skipjack tuna increased. These events resulted in a gradual change in fishing strategy of the fleets which currently includes skipjack as a target species, along with yellowfin tuna.

The skipjack fishery in the western tropical Atlantic is small with the catch ranging from 1,300 MT to 3,500 MT/per year. In recent years most of the catch has been from the Caribbean sea where the Cuban baitboat fleet has operated annually since 1932.

2. Participants

The western Atlantic fishery is primarily a small surface fishery in the Caribbean with Cuban, Japanese, and Venezuelan baitboats and French, Spanish and American seiners. A small local catch is taken by troll gear off Brazil.

Principals in the eastern tropical Atlantic fishery include French, Ivory Coast, and Senegalese vessels (FIS), Spanish, Japanese, American, Ghanaian, Korean, and vessels of the people of Taiwan.

3. Amount Caught

Total Atlantic catch of skipjack for the years 1965-1978 is shown in Table 1. Most (95% or more) of the catches come from the eastern Atlantic. An averge of 3,000 MT is caught annually in the western Atlantic. Longliners report their incidental catches, but these are very small, approximately 100 to 200 MT a year. The catch for 1977 was 122,000 MT, which was a record year for skipjack. Provisional estimates of the catch for 1978 place it at 106,000 MT, of which 103,000 MT was caught in the eastern Atlantic.

4. Catch trends

The catch of skipjack tuna from the Atlantic Ocean increased markedly between 1965 and 1977 (Figure 2). Catches increased until 1973 when they reached 75,000 MT. Since then catches have fluctuated between 62,000 MT and 122,000 MT. The catch first peaked in 1974 at 116,000 MT. In 1975 the catch suddenly declined to 62,000 MT. The sudden drop between 1974 and 1975 is believed to be due to poor availability, particularly off Angola in 1975. Effort has subsequently remained low off Angola. The catch increased in 1977, probably due in part to catches that had not previously been reported, in particular, the USSR catch of 6,674 MT, and in part to greater availability in the Gulf of Guinea.

The eastern Atlantic surface catch has accounted for over 95% of the total Atlantic skipjack catch since 1970. Purse seiners currently harvest most of the tropical eastern Atlantic tuna catch. In the mid-1960's baitboats harvested most of the skipjack tuna.

The proportion of skipjack tuna caught by baitboats declined from 64% (13,000 MT) of the total eastern Atlantic surface skipjack catch in 1967 to 33% (20,000 MT) in 1972 and has remained near that percentage through 1978. Baitboat catches of skipjack are still important in the eastern Atlantic (Figure 3), while baitboat catches of yellowfin for the same area are presently less than 10%.

5. Ex-vessel value

In 1979 skipjack tuna less than three pounds have brought from \$420 to \$505 a short ton. Skipjack less than four pounds have brought from \$610 to \$690 a short ton, and skipjack larger than four pounds from

$760 to $805 a short ton. The average weight of the U.S. catch for 1978 was about 4.5 pounds, and the average weight of the foreign-caught fish sampled at Puerto Rico was about 4 pounds.

The estimated ex-vessel value of the 1978 catch, using an average 1978 value ($632 per short ton) for the average four pound fish, was 74 million dollars.

6. Current management

No regulations are in effect for Atlantic skipjack tuna.

B. Nature and degree of U.S. interest

Significant American participation in the Atlantic fishery began in 1967 with 3 American tuna purse seiners fishing of Africa. Their success attracted other American seiners into the fishery (Table 2). The maximum number of American vessels fishing for Atlantic tuna was 35 in 1972, when 24,630 MT of tuna was caught. Since then, American participation has fluctuated from 10 to 26 vessels. In 1978, 21 American vessels fished in the Atlantic and caught 8,490 MT of skipjack and 9,750 MT of yellowfin tuna.

The U.S. catch and canned product of Atlantic tunas amounts to 12.74% of the total catch of Atlantic tunas. This places the U.S. third behind Spain (25.82%) and France (21.76%). The U.S. contributes to the ICCAT budget (11% of the total ICCAT budget in 1978 and 1979), according to utilization under the terms of the International Convention for ICCAT. The principle U.S. fishery in the Atlantic is the tropical Atlantic fishery for yellowfin and skipjack tunas.

In 1978 the United States tuna processors imported at least 40,639 MT of skipjack in whole weight from the Atlantic foreign-caught fish. Imports from Japan, Korea, Panama, and Venezuela are not included in this total. The imports from these four countries account for an estimated 40,000 MT from all oceans of which some portion is caught in the Atlantic. Estimated total U.S. utilization of Atlantic skipjack stocks for 1978 is in excess of 50,000 MT, which, at $632 per short ton is worth at least 29 million dollars.

C. Current research effort

1. Who is doing what? Where?

At a special meeting of the International Commission for the Conservation of Atlantic Tunas (ICCAT) in November 1978, an International Skipjack Year Program (ISYP) was adopted. The proposed program for the International Skipjack Year is planned as an international research program. Fundamental to the program is investigation and research on the distribution of skipjack tuna stocks, the relation of skipjack tuna to the environment, estimates of abundance of skipjack tuna, the relation among abundance, catch-per-unit of effort, fishing effort and fishing mortality, stock stucture of the population, and estimates of basic population dynamics parameters. A set of 13 research activities are specified in the International Skipjack Year Program to provide the required basic information and knowledge. These research activities are: (1) tagging with dart tags, (2) tagging with sonic tags, (3) port sampling, (4) intensive (on board) sampling, (5) physical oceanography, (6) fishing environment, (7) maturity and fecundity, (8) genetics, (9) ageing, (10) stomach analysis, (11) larval survey, (12) exploratory fishing, and (13) aerial survey.

Investigations will address four basic questions on skipjack tuna:

a. Can catches of skipjack tuna be increased by fishing new areas (and presumably new stocks), especially in the western Atlantic?

b. Can catches of skipjack tuna be increased by fishing other elements of the currently exploited stocks, especially fish over 5 kg?

c. What could be the effects of the above two actions, if successful, on the existing fisheries?

d. How can better assessment be obtained of the existing fisheries? In particular, will increasing effort in these fisheries significantly increase the total catch?

Research activities whose data will help to provide knowledge on the presence or absence of skipjack tuna, and availabililty to fishing outside the known skipjack fishing grounds are: tagging with dart tags, exploratory fishing, stomach analysis, and aerial survey. Analysis of these data will help solve questions a and b.

Skipjack tuna is a highly migratory species and little is known of the structure of different stocks . Data from tagging with dart tags, larval surveys, and genetic studies should provide answers to the degree of mixing and/or separation between adjacent schools on the same fishing grounds, and between fish in the eastern and western Atlantic. Analysis of these data will be used to help answer question c, and additionally may provide some insight to the answers for question d.

Studies of the physical environment in the Atlantic and studies on the interaction of skipjack with their environment; through studies on physiology and behavior, will help answer question a. These studies will be conducted through the tagging with sonic tags, physical oceanography, fishing environment, intensive sampling, and aerial survey activities. On a smaller scale, local aggregations of skipjack, formation of schools and local behavior can be ascertained from analysis of data from these same activities. Knowledge gained will assist with question d by providing information for the development of improved fishing techniques, and aid in the interpretation of catch and effort statistics.

No good method is presently available to adequately monitor the abundance of skipjack tuna and its changes from year to year. The nominal catch per unit of effort is inconsistant because part of the effort is directed towards yellowfin tuna. Port sampling, intensive sampling and exploratory fishing activities will concentrate on obtaining a better understanding of the relation of catch-per-unit of effort to abundance and also the relation of fishing mortality to nominal effort. This research would represent a major advance in the data base for the analysis required to answer question d. If results of these activities are applied to improving efficiency of the fleet question b could be addressed and possibly answered.

Analysis of the population dynamics of skipjack tuna and therefore better understanding of the reaction of the stocks to different patterns of exploitation, require a knowledge of the parameters of growth, natural and fishing mortality, and reproduction which are, at present poorly known. The activities of intensive sampling, ageing, and maturity and fecundity are essential to this analysis and a prerequisite to addressing question d.

As the program is designed, it is to extend for 4 years: starting with a preparatory- planning phase in the first year (1979), continuing into a limited execution phase in the second year (1980), rising to a peak "International Skipjack Year" phase in the third year (1981), and winding down with an analytical-evaluation phase in the fourth year (1982). The program is designed as one in which ICCAT coordinates the collective inputs of ICCAT member countries and other interested parties.

2. Amount or indication of relative effort

Each program activity of the skipjack research plan consists of two parts: one involves collection of field data and execution of experiments; the other, analysis of data and drawing conclusions or inferences from the data. Resources, such as vessels, scientists, technicians, research equipment, etc., will be required to execute the activities during specific periods in 1980 and 1981. The resources required for each activity are shown in Tables 3 and 4. Table 4 shows research, by field activities and analysis, that each country will contribute to the International Skipjack Year Program. Plans call for field activities to be centered in the Annobon and Cape Verde areas of the eastern Atlantic and from Brazil to Cuba in the western Atlantic (Table 3). The U.S. is committed to a 4-month tagging program in 1980 between Brazil and Puerto Rico, and a research cruise (1-3 months) in 1981 off the northeast coast of South America. Our efforts will amount to about 5 man years. Total international committment to the program is difficult to estimate, but could exceed 100 man years and 10 million dollars. Coordination efforts by the ICCAT are estimated at approximately 7 man years.

D. Inventory of data

1. Location

Data for Atlantic skipjack tuna are collected by member countries of the International Commission for the Conservation of Atlantic Tuna (ICCAT). The data is sent to ICCAT for compilation. The SWFC has computer tape copies of all data contained in the ICCAT data base. There are three formats for hard copy of the data; (a) a Statistical Series which contains data on specific fisheries sampled by the ICCAT staff, (b) a Statistical Bulletin which contains cummulative catch, fishing power, and statistics by country raised to complete coverage, and (c) a Data Record which contains catch, effort, and biological data as reported by the individual countries (unraised).

There is also a Scientific Papers series where analyses prepared for the Standing Committee on Research and Statistics (SCRS) are presented.

2. Content

Skipjack tuna records occur in the data record from 1962 for catch- effort information and from 1964 for size- frequency data. Since the fishing is centered in the Gulf of Guinea, data coverage is mostly for the eastern Atlantic and data is very sparce for the western Atlantic. Catch data is available by country, gear, and area by calender year. Catch and related effort are available by gear, 1^{0} or 5^{0} area, and time in months or quarters. Length-frequency data are available usually by gear, month and ICCAT area (Figure 1a) although some data are for 1^{0}, 5^{0}, $5^{0} \times 10^{0}$, or $10^{0} \times 20^{0}$ squares. Most data are available one year after the fishing season.

3. Quality

Although the quality of the limited available data is, in general, good, the data is too sparse to perform the necessary analyses. Data from U.S. vessels are from logbook information. Length-frequency sampling of U.S. vessels and foreign transshipments takes place in Puerto Rico. Various member countries of ICCAT have logbook records and dockside sampling programs. The ICCAT staff samples landings from countries where data have been weak in the past, including non-member countries. Non-member countries are encouraged to contribute data.

E. Status of stocks

1. Methodology

Two attempts have been made to analyze the Atlantic skipjack tuna fishery using production model analysis. One cohort analysis and one yield-per-recruit analysis have been conducted.

Production model analysis

Data were analyzed using total Atlantic and only eastern Atlantic data for three production models m=0, m=1.001, and m=2. Results from the two studies indicate the solutions obtained with m=0 correspond to the best statistical fit, however, none of the models fit the data very well (Table 5).

The results from the 1967-75 analysis are probably less representative owing to little effort data available in 1967 and 1968. If the values obtained from m=0 and m=1.001 which have a high error index (>100%) are eliminated the estimates for maximum sustainable average yield (MSY) vary from 89,000 to 122,000 metric tons. Within the scope of the assumptions taken into account the highest catch level during the study period (116,600 MT in 1974) was close to the MSY.

Much of the variation in the MSY and poor fit of the model is expected due to the facts that the fishery exploits two species simultaneously making it difficult to accurately standardize the fishing effort, that the fishery exploits a low number of year classes(one or two) and that the skipjack characteristically show large fluctuations in availability by different areas.

Cohort Analysis

Skipjack tuna are available to the fishery only as 0's and I's. Separation of age groups is difficult since skipjack are recruited to the fishery year-round. These facts made ageing and separation of cohorts difficult. A cohort analysis using Murphy's method was run and due to the short age sequence and problems in choosing the assumed initial fishing mortality (F) values the results showed a large spread in the resultant quarterly fishing mortality vectors for the cohorts. No problems concerning recruitment were detected.

Yield- per-recruit analysis

A Ricker yield-per-recruit model was applied to the Atlantic skipjack fishery data using the F vectors calculated from the cohort analysis. The assumed F vector was considered representative of the 1972-73 fishing mortality levels. The major conclusion of the study was that, given the state of the data, no practical gain in yield-per-recruit was likely by increasing size at first capture.

2. Accuracy

Assessment is difficult because the growth and mortality rates are not well known, so that the more sophisticated analytical models of fish population dynamics cannot be used. Even the simpler models are difficult to use because of uncertainties in the measurement of abundance, and catch per unit of effort, due in particular to the fact that the fleets fish for both skipjack and yellowfin tuna. The principal fishery harvests 0 and I group fish, and no comprehensive index of abundance for larger fish is available, even for some sub-areas of the Atlantic. This prohibits a critical examination of the population as a whole and creates doubts as to the accuracy of analyses conducted on the limited data available.

Reviews of the population biology of Atlantic skipjack tuna have shown that despite the importance of the fishery for skipjack tuna and the volume of research that has already been done, many important questions about skipjack cannot be answered. Even the belief that current catches could be considerably increased is based on qualitative impressions, rather than on any quantitative assessment of how much skipjack tuna could be caught in the Atlantic. Primarily Atlantic stocks are not well defined. The present fishery is concentrated along the eastern border of the Atlantic, and catches fish up to about 60 cm (5 kg). There are some minor catches by the surface fisheries in the Caribbean, and catches of a few fish which are bigger (60-80 cm, 5 to 15 kg) by longliners in the central Atlantic. There is a reasonable hypothesis, therefore, that catches could be increased by extending fishing into other areas, and onto other sizes of fish, though the extent of such increases will depend critically on the relation between the fish in different areas; whether any increase in catch would be partially or wholly at the expense of the present eastern Atlantic catches.

3. Evaluation of stocks (over/under harvested)

Eastern Atlantic - It may be possible to increase the harvest of skipjack in the eastern Atlantic, particularly if fish larger than 60 cm could be exploited, but it is difficult to determine the current state of the stocks in the eastern Atlantic. Catches dropped abruptly from the peak of 116,000 metric tons (MT) in 1974 to about 62,000 tons in 1975 and increased to 122,000 MT in 1977. In 1978 the catch was 106,000 MT. Previously there have been year-to-year fluctuations in the catch and the drop in 1975 and 1976 may be no more than a pause in a general upward trend that could be continued for some time yet; on the other hand, it may indicate that the eastern Atlantic stock (or stocks) are already fully exploited within the present pattern of exploitation.

Western Atlantic - The fleet fishing in the western Atlantic is not of the magnitude of the eastern Atlantic fleet. American seiners of the tropical tuna fleet normally fish in the western Atlantic only while crossing the region enroute to unload their catch, or on the way to the fishing grounds in the eastern Atlantic or eastern Pacific. On these occassions, good catch rates have been reported at times. It is generally felt that the harvest in this area can be increased.

F. Problem areas and program needs to solve problem

1. Research

Fundamental research on the distribution of skipjack tuna stocks, the relation of skipjack tuna to the environment, estimates of abundance of skipjack tuna, the relation among abundance, catch-per-unit of effort, fishing effort and fishing mortality, stock structure of the population, and estimates of basic population dynamics parameters is needed from a broader data base than is currently available.

The ISYP (see Section C) has addressed many of the problem areas and is a developed, comprehensive program.

2. Data

A much broader data base will be available from the ISYP, but a few data needs are apparent besides those for the ISYP.

There is a need for data from the western Atlantic. Length-frequencies and catch-effort by time are very scarce because of the lack of fleet effort in this area. The size of incidental skipjack caught by the Japanese longline fleet is also needed, but is difficult to obtain as skipjack tuna is not a longline target species and at times is discarded.

In the eastern Atlantic catch-effort is needed from the Spanish fleet, and from countries fishing in the Angola area.

Atlantic wide, data is needed on the sizes and amounts of skipjack tuna caught by small coastal fisheries, and on the environmental parameters associated with successful fishing operations.

3. Management

There is currently no apparent need for management in the form of controls on the fishery. However, information obtained during the ISYP should provide some insight into management options that could benefit the Atlantic skipjack fishery.

Table 1 Atlantic skipjack catch (1,000 MT)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978 1/
TOTAL	28.0	36.4	22.4	48.4	29.1	49.4	74.3	73.4	75.5	116.6	62.2	78.1	122.4	105.9
SURFACE - EAST ATLANTIC	26.4	34.6	19.7	45.9	27.3	47.0	71.9	71.9	72.6	113.0	58.5	74.4	119.5	103.2
-PURSE SEINE	3.6	5.3	7.1	22.7	14.4	30.8	49.6	51.6	50.7	76.9	38.8	37.1	66.7	66.2
FIS	.7	1.9	1.6	5.1	3.8	9.2	13.8	16.7	8.7	24.8	13.9	16.2	29.5	29.0
JAPAN	1.8	1.4	2.2	6.3	.7	3.5	6.2	3.4	1.5	.9	.1	0.	0.1	-
SPAIN	1.0	1.9	2.3	7.1	5.0	5.7	12.1	19.3	17.8	31.1	16.9	17.6	29.1	25.0
USA	.1	.0	.5	3.3	4.8	11.8	16.2	12.2	21.2	20.0	7.4	1.0	5.9	12.2
OTHERS	.0	0.	.6	.9	.1	.6	1.2	.1	1.3	.1	.5	1.4	2.3	-
-BAITBOAT	22.8	29.3	12.6	23.2	12.8	16.2	22.2	20.2	21.9	36.0	15.2	27.3	40.5	32.7
ANGOLA	1.3	2.8	2.0	4.2	1.8	.9	1.9	1.5	1.3	3.4	.6	1.5	3.8	2.0
FIS	3.5	4.5	3.9	7.9	4.6	4.8	5.7	3.8	3.7	4.7	1.8	2.0	2.9	3.1
GHANA.	0.	0.	0.	0.	0.	0.	0.	0.	.1	.7	1.3	2.1	3.5	
JAPAN	6.3	4.4	3.7	7.3	4.9	7.5	11.7	10.1	13.0	18.7	3.7	15.0	14.8	24.9
KOREA + PANAMA . . .	0.	0.	0.	0.	0.	0.	0.	.7	1.1	3.1	6.3	4.4	7.6	
SPAIN	8.5	16.2	2.0	3.0	1.4	1.8	2.7	4.1	2.6	5.4	.8	.6	0.7	.5
OTHERS	3.2	1.5	.9	.8	.1	1.1	.1	.0	.1	.1	.7	1.6	5.2	2.2
-OTHER GEARS	.1	0.	0.	.0	.1	0.	.1	.1	.0	.1	4.5	9.9	12.2	4.3
SURFACE - WEST ATLANTIC	0.	0.	0.	0.	0.	0.	1.6	1.1	2.5	3.1	3.2	3.5	2.5	2.5
SURFACE - UNCL. REGION .	0.	0.	0.	0.	0.	0.	.2	0.	0.	0.	0.	0.	0.	-
UNCL. GEARS 2/	1.5	1.8	2.7	2.5	1.7	2.4	.7	.3	.4	.5	.6	.2	.4	.2

1/ Provisional estimates.

2/ Includes longline.

Table 2

Number of American tuna purse seiners
and catches from the eastern tropical Atlantic
1967-1978

Year	No. of Vessels	Skipjack tuna catch MT	Yellowfin tuna Catch MT
1967	3	490	1,140
1968	8	3,310	5,940
1969	27	4,850	18,790
1970	25	11,750	9,030
1971	24	16,220	3,760
1972	35	12,290	12,340
1973	19	21,250	3,590
1974	26	19,970	5,620
1975	33	7,570	14,340
1976	10	2,290	2,260
1977	24	6,180	7,210
1978	21	8,490	9,750

TABLE 3 PERIODS OF THE FIELD ACTIVITIES AND BOATS AND PERSONNEL REQUIRED FOR EACH MAJOR AREA OF RESEARCH:

ACTIVITIES	1978	1979	1980	1981	1982
ANNOBON AREA					
TAGGING WITH DART TAGS			1-3 BB	3-5 BB	
TAGGING WITH SONIC TAGS			Using tagging boats	Using tagging boats	
INTENSIVE SAMPLING					
FLEETS (No. of researchers aboard / Estimated no. of commercial boats): FRANCE			1-2/25	10/25	
GHANA			1/5	2/5	
IVORY COAST			1/7	2/7	
JAPAN			1/20	5/20	
KOREA			1/20	5/20	
USA			1/10	5/10	
OTHERS *				*	
PHYSICAL OCEANOGRAPHY				2-3 Research vessels	
AERIAL SURVEY				1 aircraft	
CAPE VERDE AREA					
TAGGING WITH DART TAGS			1-3 BB	3-5 BB	
TAGGING WITH SONIC TAGS			Using tagging boats	Using tagging boats and Ocean. R.V.	
INTENSIVE SAMPLING					
FLEETS (No. of researcher aboard / Estimated no. of commercial boats.): FRANCE				10/25**	
IVORY COAST				2/7 **	
MOROCCO				1/3	
SENEGAL				1/2	
SPAIN			1/42	5/42	
OTHERS *				*	
PHYSICAL OCEANOGRAPHY				2-3 research vessels	
AERIAL SURVEY			1 aircraft		
WEST ATLANTIC					
TAGGING WITH DART TAGS			3-5 BB	1-2 BB	
EXPLORATORY FISHING				3-5 PS, 2-10 BB, 2-10 TROLL.	
AERIAL SURVEY				2 aircrafts	

* ALL OTHER COUNTRIES WHICH MIGHT HAVE DEVELOPED SKIPJACK FLEET BY 1981 (e.g. USSR, CUBA, ETC) SHOULD ALSO HAVE AT LEAST TWO OBSERVERS PER FLEET ABOARD:

** THOSE LISTED HERE MIGHT BE THE SAME AS THOSE LISTED FOR ANNOBON AREA:

BB- Baitboats, PS- Purseseines, TROLL- Trolling boats

REVISED TABLE of CONTRIBUTIONS BY COUNTRIES
(SCRS/78/14)

1980

A = Field activities.
B = Analyses

	(Semi-monthly) Ocean. 80	Ocean. 81	Fish. 80	Fish. 81	Tagging with dart tags	Tagging with conic tags	Port Sampling	Intensive Sampling	Physical Oceanography	Fishery Environment	Maturity and Fecundity	Genetics	Ageing	Stomach Analysis	Larval Survey	Exp. Fishing	Aerial Survey	AREA
ANGOLA																		
BENIN																		
BRAZIL[A]	4	4	4	4	A, B		A, B		A, B	A, B	A, B	A	A	A, B	A, B	A, B	A, B	W.Atl
CANADA			Maybe			B	A, B			A, B								W.Atl
CUBA							A				A, B			A	A, D	A, 3		E.Atl W.Atl.
FRANCE	—	4-6	2	4-6	A, B	A	A, E	A, B	A, B	A, D	A, B	A	A, B		?	?	A, B	E.Atl W.Atl ?
GABON																		
GHANA	—		—				A				A, 3			A				
IVORY COAST	-	-	-	-	A		A, B	A, B	A, B	A, B	A	A	A	A				E.Atl
JAPAN	-	-	3	3	A, B		A, B	B		A, B	A, B	A, B	A	A, B				E.Atl
KOREA	-—		—·		A, B		A, B							A, B				E.Atl
MOROCCO																		
PORTUGAL					A		A		?		?	?	?			?		E.Atl
SENEGAL			?	?	A, B	?	A, 3	A, B	A, B	A, B	A	A,	A, B					E.Atl
SOUTH AFRICA																		
SPAIN			2	2	A, B		A, B	A, B	A, B		A	A	A		A			E.Atl & Canary Is. (E)
U.S.A.	3		4		A, B	?	A, B	A, 3	A, B	A, B	A	A	A, B		A	A, B		W.Atl
U.S.S.R.	6	6			A, B				A, B	A, B	A, 3	A, B	A, B	A, B	A, B	A		E.Atl

[A] Tentative

Table 5. Estimates of some parameters of the production model for the skipjack tuna fishery of the Atlantic Ocean.

Period : 1 : 1969-75, 2 : 1967-75		10 (Atlantic mean c.p.u.e.			
		k = 1		k = 2	
		MSY	I.E.	MSY	I.E.
m = 0	1	279	144 %	122	53 %
	2	792	431 %	198	100 %
m → 1	1	102	56 %	92	33 %
	2	129	107 %	89	39 %
m = 2	1	93	35 %	89	23 %
	2	95	49 %	89	35 %

MSY = Maximum sustainable yield (thousands of metric tons).
I.E.= error index, in %.
K = [illegible]

m	Y_3max ($x10^3$ tons)	f_{op} ($x10^3$ day's fishing)	U_{op} (tons/day's fishing)	Degree of fit index
1 significant year class 1969-1975				
0	115.0	∞	-	0.473
1.001	89.3	61.2	1.46	0.455
2.0	90.3	53.7	1.68	0.440
2 significant year class 1967-1975				
0	118.4	∞	-	0.538
1.001	93.4	61.5	1.52	0.505
2.0	95.1	54.9	1.73	0.471

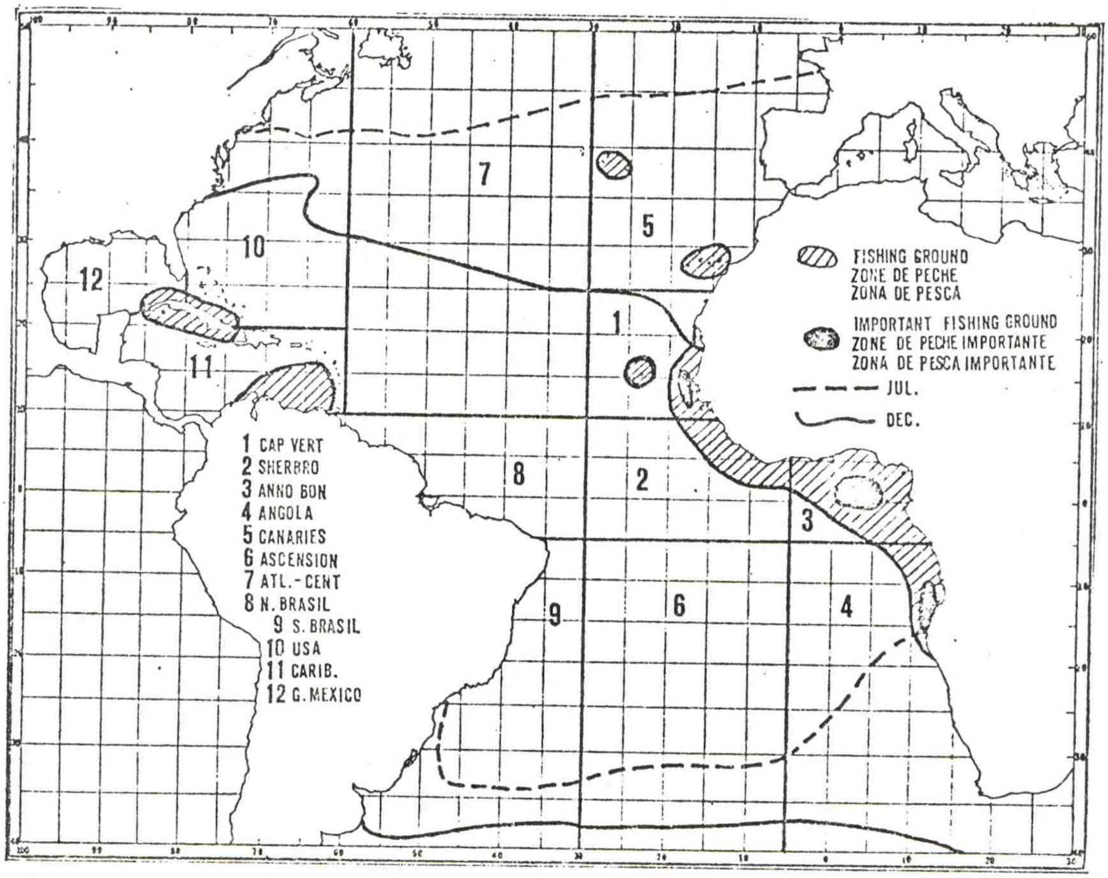
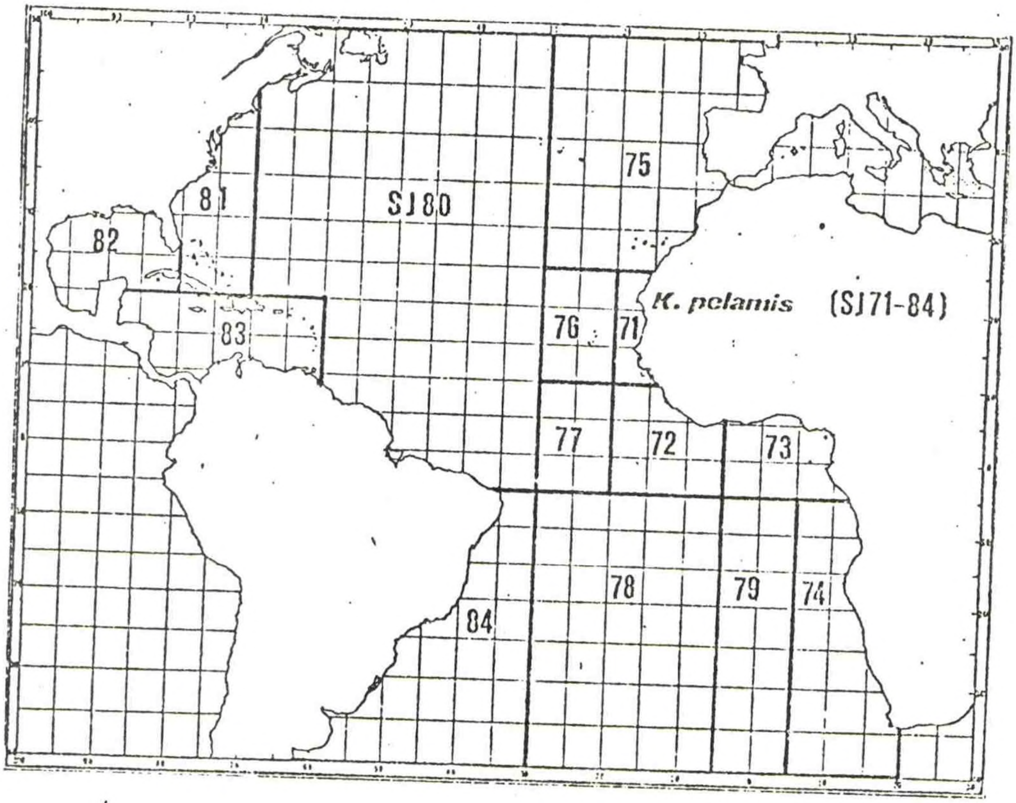


Fig. 1. Distributional range and location of fisheries for Atlantic skipjack tuna. Range is determined from data on larvae distribution, catches and skipjack preferred temperature of 18°C.



New ICCAT regions (areas)	Map area	Alph. num.	Num.	Remarks
Skipjack	71	SJ71	69 ••	Old SJ areas 1 — Cape Verde
"	72	SJ72	70	2 — Sherbro
"	73	SJ73	71	3 — Annobon
"	74	SJ74	72	4 — Angola
"	75	SJ75	73	5 — Canary Islands
"	76	SJ76	74	
"	77	SJ77	75	
"	78	SJ78	76	8 — Ascensión
"	79	SJ79	77	
"	80	SJ80	78	10 — At. Central
"	81	SJ81	79	11 — U.S. Coast
"	82	SJ82	80	12 — Gulf of Mexico
"	83	SJ83	81	13 — Caribbean
	84	SJ84	82	14 — S. Brazil

Figure 1a. The areas given in Figure 1 are no longer ICCAT skipjack sample areas. They have been revised as indicated above.

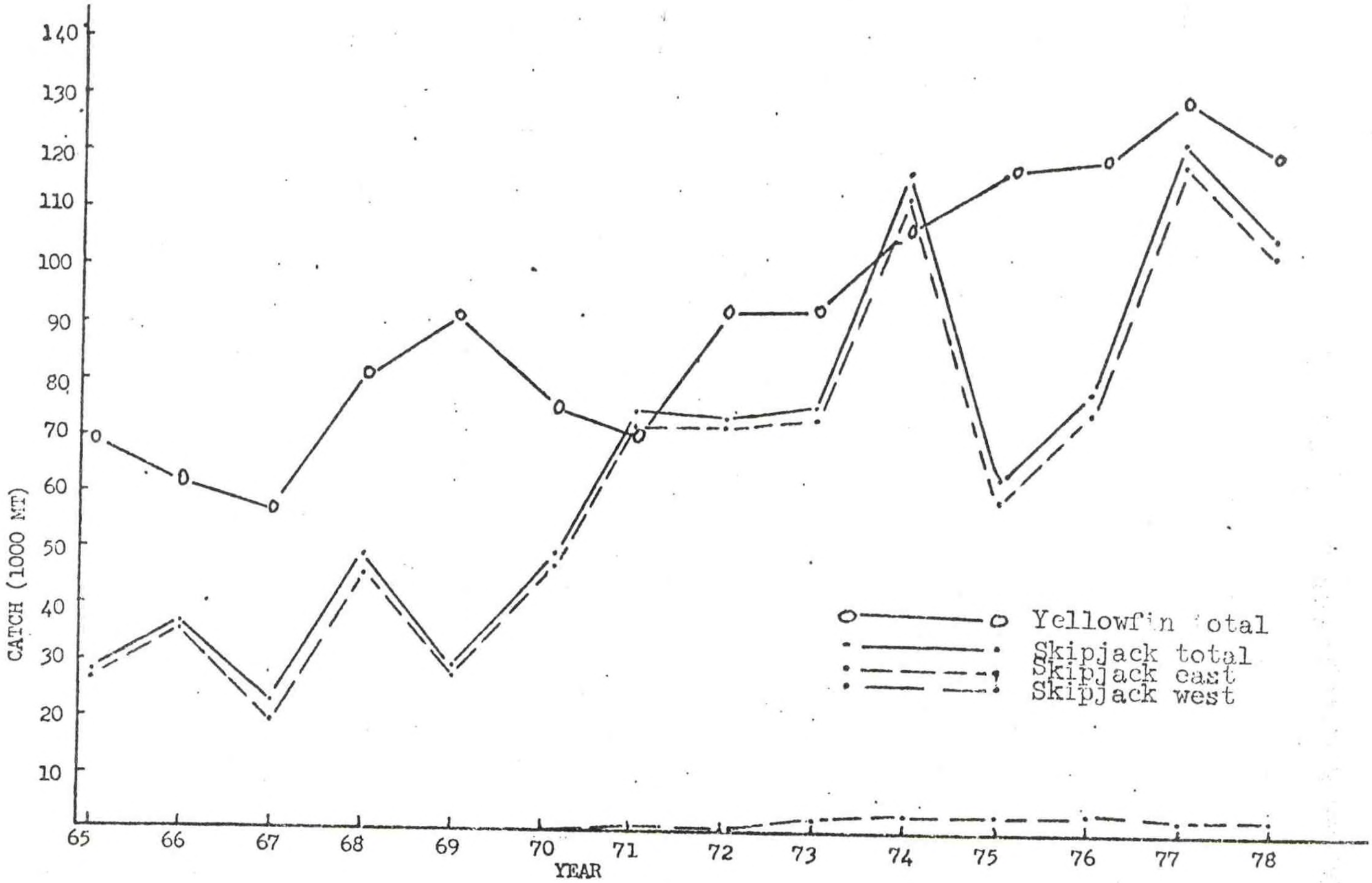


Figure 2. Eastern, western, total Atlantic skipjack tuna catch and total Atlantic yellowfin tuna catch 1965 - 1978.

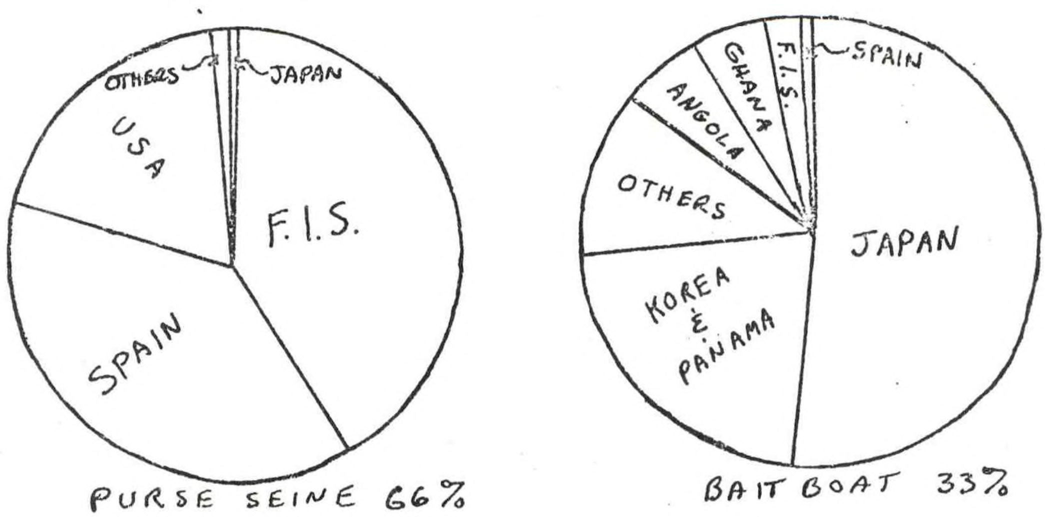


Figure 3. Percent composition of the 1978 eastern Atlantic skipjack tuna catch by gear and country.

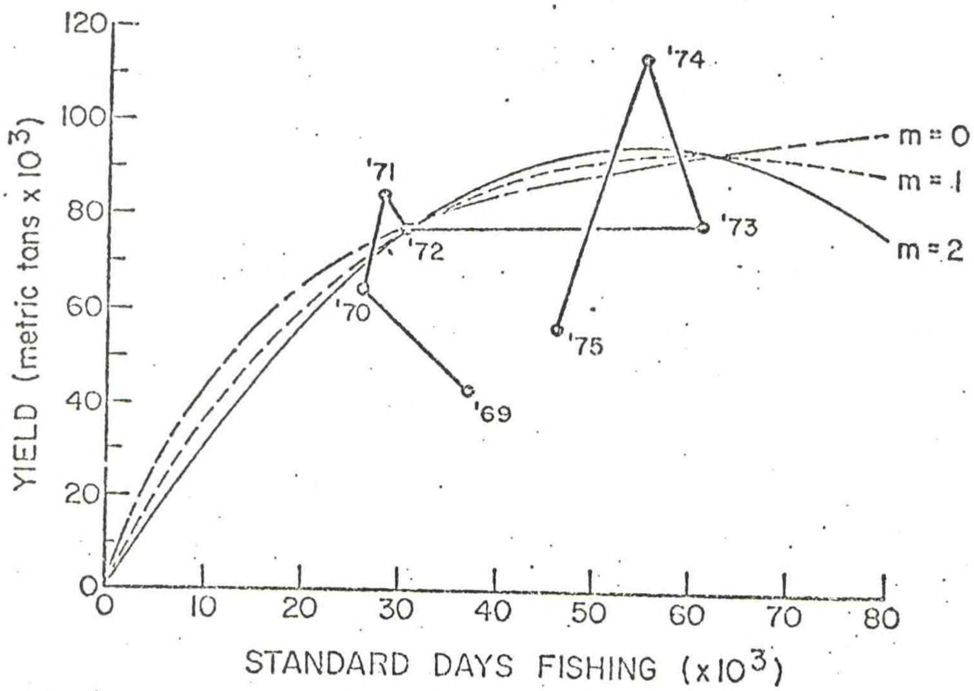


Figure 4. Relation between catch and standardized fishing effort for skipjack tuna of the eastern Atlantic Ocean. Average sustainable yield curves for three special cases of the production model with the assumption of two significant year classes are shown.

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ____________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT ON ALBACORE, BIGEYE TUNA, SKIPJACK TUNA, AND YELLOWFIN TUNA IN THE INDIAN OCEAN

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August 1979

A. Description of fishery

1. Short history

Commercial longline fishing for albacore, Thunnus alalunga, bigeye tuna, T. obesus, and yellowfin tuna, T. albacares, in the Indian Ocean started after World War II although exploratory fishing by Japanese vessels in the early 1930's indicated the presence of tunas in the eastern Indian Ocean. Intensive commercial longline fishing in the Indian Ocean began in 1952 in the eastern sector and rapidly expanded westward to reach the African coast by 1956 (Figure 1) (Nakamura et al. 1956; Kikawa et al. 1969).

The surface skipjack tuna fishery in the Indian Ocean is relatively undeveloped. Most of the catches of skipjack tuna are made in localized fisheries along the coastline of the various countries bordering the ocean and around the many island groups. The origins of these fisheries are obscure and their historical accounts are few and fragmentary. In Sri Lanka (Ceylon), skipjack tuna are taken by trolling gear, drift nets, and pole and line. Yellowfin tuna are also caught by these surface gears. The use of the pole-and-line method dates back to 1919 in Sri Lanka and in Minicoy, Laccadive, and Maldive Islands to 1909 (Sivasubramaniam 1965).

2. Participants

Longliners from Japan, Korea, Taiwan, U.S.S.R., and Sri Lanka fish in the Indian Ocean. Vessels from Australia, India, Madagascar, Maldives, Pakistan, Sri Lanka, Democratic Republic of Yemen, Seychelles, and Oman catch surface yellowfin tuna.

Comoros, Japan, Korea, Maldives, Seychelles, and Sri Lanka have fisheries for skipjack tuna in the Indian Ocean (FAO 1978).

3. Amount caught

The estimated total annual catch of tunas in the Indian Ocean ranged from 67 to 28,250 MT (metric tons) (1952-76) for albacore, 1,500 to 38,709 MT (1952-76) for bigeye tuna, 8,858 to 88,121 MT (1952-76) for yellowfin tuna, and 13,200 to 41,304 MT (1965-77) for skipjack tuna (Table 1).

4. Catch trends

The estimated total annual catch of albacore in the Indian Ocean climbed rapidly from 67 MT in 1952 to 17,668 MT in 1962 and fluctuated widely from 1963 to 1976, reaching a high of 28,250 MT in 1974 (Figure 2).

The catch of bigeye tuna rose from 3,600 MT in 1953 to a peak of 38,709 MT in 1968, declined to 14,955 MT in 1973, and reached another peak of 38,359 MT in 1975 (Figure 3).

The yellowfin tuna catch was on a generally upward trend from 1953 onward and reached a peak of 62,717 MT in 1969; the catch then declined rapidly to 40,013 MT in 1972 and fluctuated from 36,545 to 40,486 MT from 1973 to 1977 (Figure 4).

The skipjack tuna catch fluctuated on a generally rising trend from 13,200 MT in 1965 to a peak of 38,378 MT in 1974 and declined to 32,482 MT in 1977 (Figure 5).

5. Ex-vessel value

No information. Presumably most of the tunas caught in the longline fishery are landed in Japanese, Korean, and Taiwan ports.

6. Current management

None of the tunas in the Indian Ocean is under management.

B. Nature and degree of U.S. interest

No information. As far as is known, American interests are not currently active in the Indian Ocean.

C. Current research effort

1. Who is doing what? where?

The Far Seas Fisheries Research Laboratory (FSFRL), Shimizu, Japan has been doing research on albacore, bigeye tuna, and yellowfin tuna caught by longline in the Indian Ocean, including stock assessment studies (Suda 1973, 1974).

Recently, production model analyses on Indian Ocean albacore, bigeye tuna, and yellowfin tuna were completed at the Southwest Fisheries Center Honolulu Laboratory (Wetherall et al.[1]).

Research on the systematics, biology, and fishery biology of Indian Ocean tunas has been conducted at the Central Marine Fisheries Research Institute, Mandapam Camp, India and at the Fishery Research Station, Sri Lanka.

The status of albacore, bigeye tuna, and yellowfin tuna in the Indian Ocean was reviewed at the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans (Shimizu Workshop) at Shimizu, Japan, 13-22 June 1979.

2. Amount or indication of relative effort

The FSFRL has published roughly 12 papers on Indian Ocean tunas (albacore, bigeye tuna, and yellowfin tuna) since about 1955.

D. Inventory of data

The Shimizu Workshop evaluated the availability of data for Indian Ocean albacore, bigeye tuna, and yellowfin tuna (Table 2).

1. Location

The FSFRL, Japan and Taiwan National University, Taiwan maintain Indian Ocean longline fishing data. Copies of these data are in the data bank of Southwest Fisheries Center Honolulu Laboratory. Landings data are also published in the FAO yearbook of fishery statistics.

2. Content

The data from Japan (1952-76) and Taiwan (1967-77) consist of annual total catch, nominal effort in number of hooks, and associated catch in number of fish by month and 5° square.

3. Quality

Data on Indian Ocean fisheries are available primarily from the Japanese longline fishery. However, in recent years the Japanese longline fleet has been targeting primarily on southern bluefin tuna; therefore analyses relating to the other species of tunas caught in the Japanese longline fishery may not be entirely dependable.

Nominal catch figures for skipjack and yellowfin tunas caught in the surface fisheries are thought to be incomplete.

E. Status of stocks

1. Methodology

Production model analyses have been applied to Indian Ocean albacore, bigeye tuna, and yellowfin tuna data (Kume and Morita[2]; Suzuki[3]; Wetherall et al. see footnote 1). No assessment studies have been done on skipjack tuna.

2. Accuracy

The results should be considered tentative because of the inaccuracies in the total catch estimates.

3. Evaluation of stocks

Tentatively, MSY (maximum sustainable yield) of yellowfin tuna in the Indian Ocean is believed to be somewhere between 40,000 and 60,000 MT. The production models indicated that it was unlikely that the catch would decrease even if effort was reduced to less than half that of the present level. However, they also indicated that any increase in effort over the present level would not result in a substantial increase in yield. Although the available data have not allowed a yield-per-recruit analysis, a recruitment analysis in the yellowfin tuna stocks has been made.

The production model analysis for bigeye tuna did not provide a reliable prediction of MSY. The bigeye tuna stock in the Indian Ocean appears to be only lightly exploited.

An MSY between 15,000 and 20,000 MT was suggested by the production model analysis for Indian Ocean albacore. The MSY appeared to be asymptotic and there was little change in the catch although effort doubled from 1966 to 1974. The increased effort was associated with a smaller average size fish. The consensus is that there appears to be no reason for concern over the future of the Indian Ocean albacore stock at this time.

F. Problem areas and program needs to solve problem

1. Research

Several research needs were identified at the Shimizu Workshop. For yellowfin tuna, because the data base will be inadequate for some time, sensitivity studies under various hypotheses of stocks, catch, etc., were recommended. Also recommended were studies to (1) estimate coefficients of mortality particularly in relation with fishing effort; (2) determine changes in effectiveness of fishing gear particularly in relation to total fishing effort; (3) apply production model analyses to the catch in number of fish and fishing effort because the size frequencies are functions of fishing intensity and also because of the uncertainty in applying a fixed age-size key to estimate the age composition; and (4) determine hypothetical yields for various new fishing strategies.

It was recommended that a study of the population relationship of bigeye tuna in the Banda Sea and in the Indian Ocean be carried out. Research on bigeye tuna population parameters was not considered of high priority.

As for albacore, the workshop recommended that an effort should be made to determine precisely what data are missing and needed for minimally sophisticated stock assessments such as production models and cohort analyses.

Aside from localized studies on Indian Ocean skipjack tuna, research on this species has been almost nil.

2. Data

The Shimizu workshop identified the following yellowfin tuna data needs: 1) more accurate estimates of nominal catch particularly for the surface fisheries, 2) catch, effort, and size-frequency data by temporal-spatial strata for yield-per-recruit and stock structure studies, 3) improved data from that segment of the longline fishery which targets on yellowfin tuna (and bigeye tuna and albacore) (the available analyses were based on data from the Japanese longline fishery, which are now inadequate because the Japanese longliners target on southern bluefin tuna), and 4) fishing effort and other biological data for the surface fisheries (also for bigeye tuna).

Unpublished albacore catch and effort data thought to exist in government and industry files should be obtained and published. Improved catch and effort data for skipjack tuna in the various localized surface fisheries are needed.

3. Management

No management plans are recommended for any of the Indian Ocean tunas discussed here at this time.

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1978. Catches and landings, 1977. FAO Yearb. Fish. Stat. 44, 343 p.

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NAKAMURA, H., Y. YABUTA, and K. MIMURA.

1956. Longline fishing grounds in the Indian Ocean. Indo-Pac. Fish. Counc., Proc., 6th Sess., p. 220-238.

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TEXT FOOTNOTES

[1]Wetherall, J. A., F. V. Riggs, and M. Y. Y. Yong. 1979. Assessment of the South Pacific albacore stock. Southwest Fisheries Center Admin. Rep. H-79-6. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, 17 p.

[2]Kume, S., and Y. Morita. 1979. Brief review of the fishery biology of bigeye tuna in the Indian Ocean and its stock assessment. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, 9 p.

[3]Suzuki, Z. 1979. Stock assessment of yellowfin tuna in the Indian Ocean exploited by tuna longline fishery. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, 9 p.

Table 1.--Estimated total catch of albacore, bigeye tuna, yellowfin tuna, and skipjack tuna in the Indian Ocean. (Data for albacore, bigeye tuna, and yellowfin tuna from Wetherall et al. see text footnote 1. Data for skipjack tuna from FAO 1974, 1978.)

Year	Albacore catch (MT)	Bigeye tuna catch (MT)	Yellowfin tuna catch (MT)	Skipjack tuna catch (MT)
1952	67	1,500	8,858	--
1953	1,099	3,600	13,258	--
1954	2,759	7,900	25,093	--
1955	3,302	6,060	47,148	--
1956	4,821	8,040	65,491	--
1957	4,664	12,400	37,288	--
1958	6,285	11,300	27,552	--
1959	10,412	8,900	26,808	--
1960	11,066	15,700	42,533	--
1961	15,438	13,500	37,248	--
1962	17,668	19,926	55,133	--
1963	12,620	14,153	29,390	--
1964	18,084	18,871	30,111	--
1965	12,397	20,162	34,459	13,200
1966	17,276	26,375	56,774	16,000
1967	23,703	27,024	44,777	18,100
1968	17,369	38,709	88,121	16,500
1969	21,873	34,280	62,717	18,700
1970	15,220	34,104	42,624	20,100
1971	10,186	22,701	43,907	29,000
1972	11,735	18,143	41,313	16,300
1973	22,305	14,955	40,586	20,100
1974	28,250	26,448	42,656	41,304
1975	11,205	38,359	50,444	36,174
1976	14,937	28,246	46,336	38,378
1977	--	--	52,669	32,482

Table 2.--Evaluation of availability of Indian Ocean albacore, bigeye tuna, and yellowfin tuna data. (Adapted from data in proceedings of the Shimizu Workshop.)

Species	Gear	Country	1976 catch 1,000 MT	Catch and effort data		Biological data	
				Coverage	Rating	No. fish	Rating
Yellowfin tuna	Longline	Japan	3.5	80%	Adequate		Adequate
Yellowfin tuna	Longline	Korea	12.8		No data		No data
Yellowfin tuna	Longline	Taiwan	2.5	25%	Partial		No data
Yellowfin tuna	Longline	Sri Lanka	?		No data		No data
Yellowfin tuna	Longline	U.S.S.R.	?		No data		No data
Yellowfin tuna	Surface	Australia	?		No data		No data
Yellowfin tuna	Surface	Bangladesh	?		No data		No data
Yellowfin tuna	Surface	India	?		No data		No data
Yellowfin tuna	Surface	Madagascar	1.7*		No data		No data
Yellowfin tuna	Surface	Maldive	4.8*		No data		No data
Yellowfin tuna	Surface	Pakistan	0.2*		No data		No data
Yellowfin tuna	Surface	Sri Lanka	5.0*		No data		No data
Yellowfin tuna	Surface	Seychelles	0.1*		No data		No data
Yellowfin tuna	Surface	Yemen	7.4*		No data		No data
Yellowfin tuna	Surface	Oman	8.3*		No data		No data
Bigeye tuna	Longline	Japan	2.9	80%	Adequate		Adequate
Bigeye tuna	Longline	Korea	21.0		No data		No data
Bigeye tuna	Longline	Taiwan	3.2	25%	Partial		No data
Bigeye tuna	Longline	U.S.S.R.	1.0*		No data		No data
Bigeye tuna	Surface	Yemen	0.2		No data		No data
Albacore	Longline	Japan	1.2	90%	Adequate		Adequate
Albacore	Longline	Korea	3.8		No data		No data
Albacore	Longline	Taiwan	8.9	25%	Partial		No data
Albacore	Longline	U.S.S.R.	1.0*		No data		No data

*Preliminary

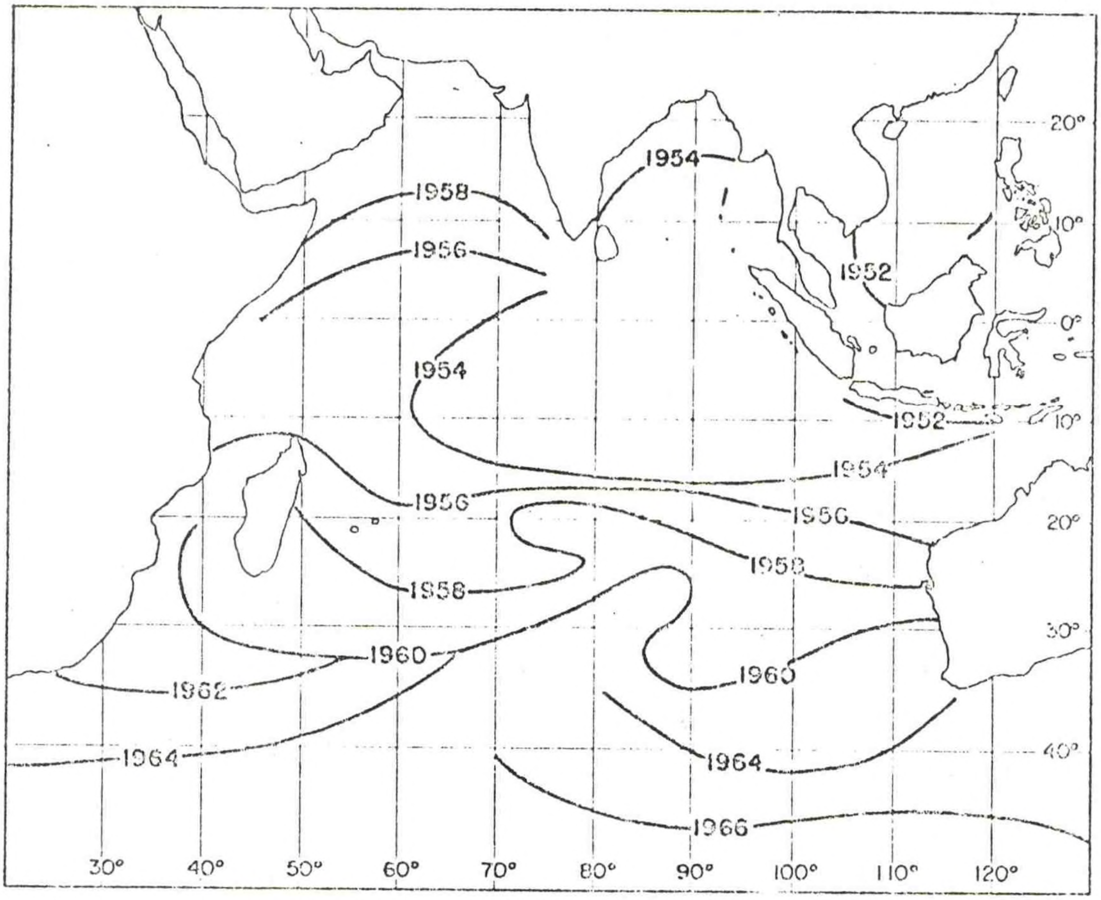

Figure 1.--Geographical expansion of the Japanese longline fishery in the Indian Ocean. (From Kikawa et al. 1969.)

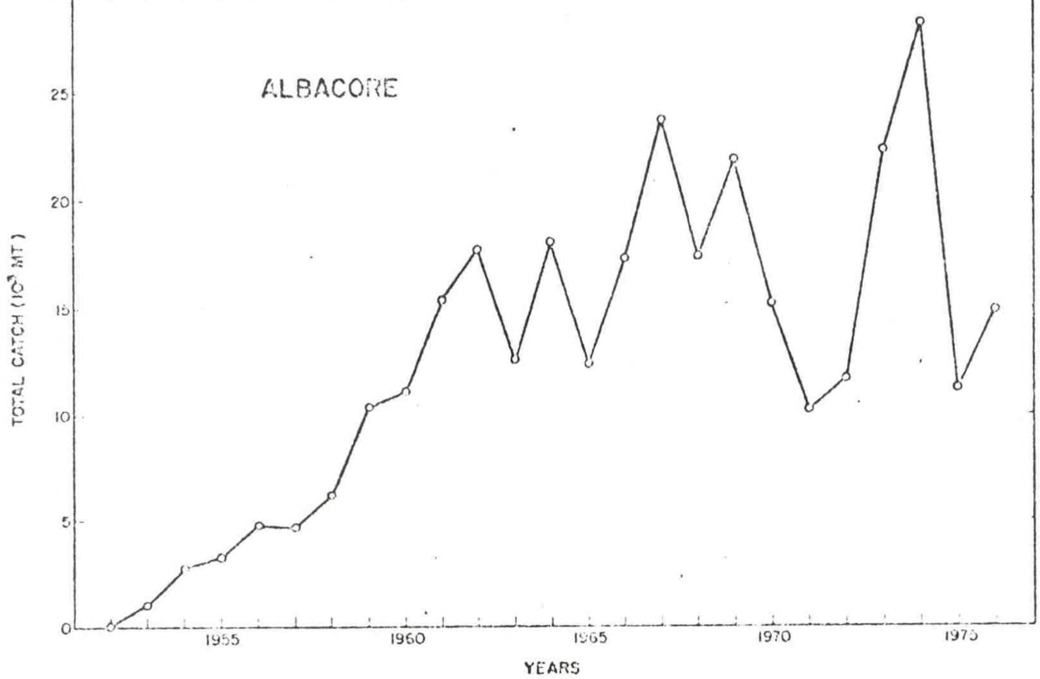

Figure 2.--Estimated total catch of albacore in the Indian Ocean. (From Wetherall et al. see text footnote 1.)

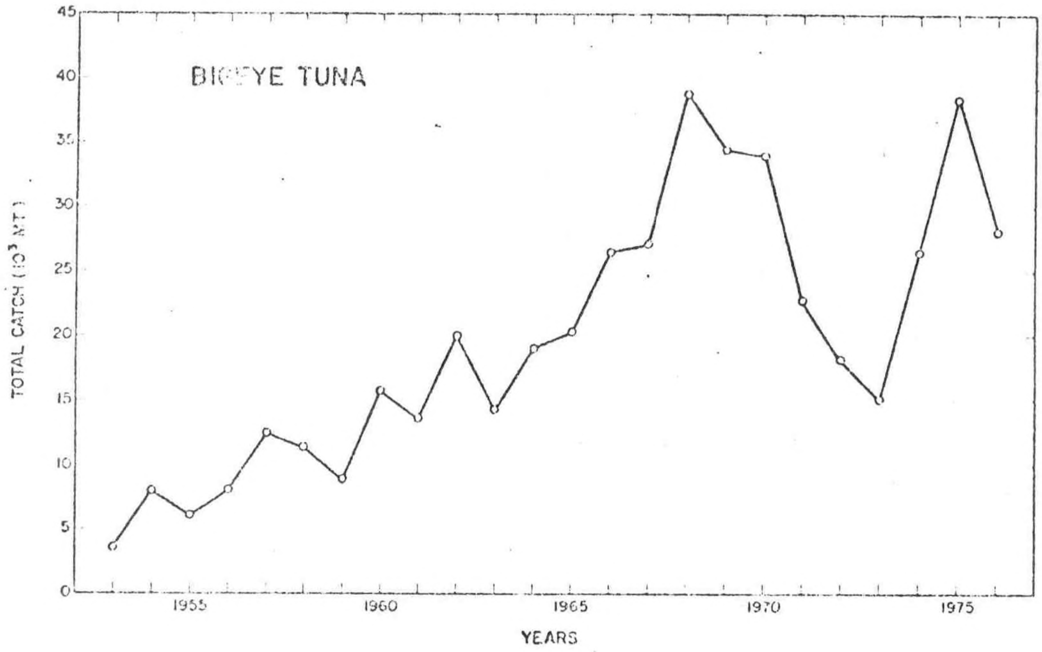

Figure 3.--Estimated total catch of bigeye tuna in the Indian Ocean.

(From Wetherall et al. see text footnote 1.)

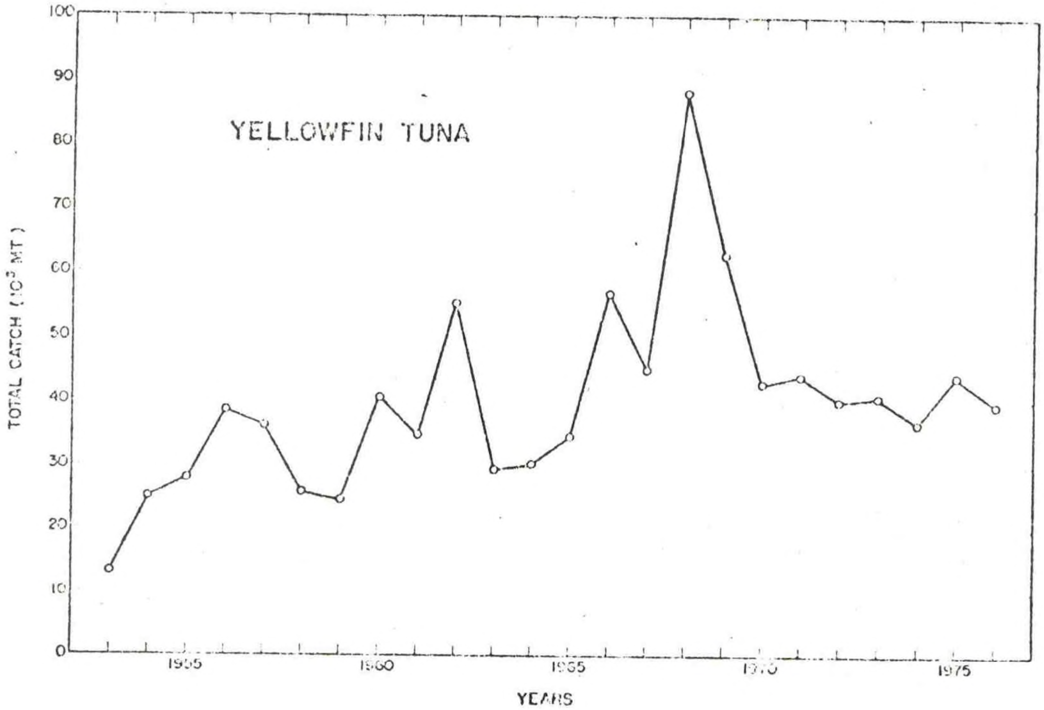

Figure 4.--Estimated total catch of yellowfin tuna in the Indian Ocean.

(From Wetherall et al. see text footnote 1.)

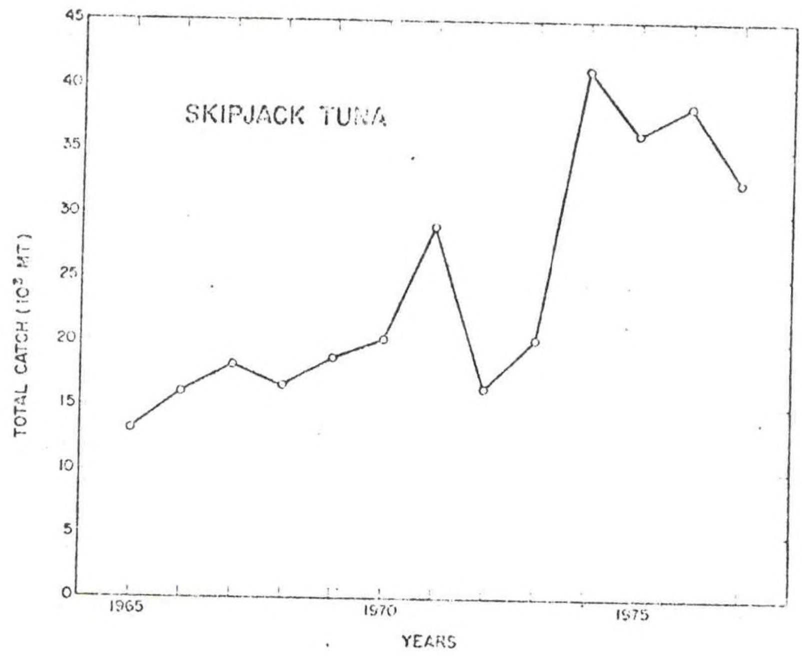

Figure 5.--Skipjack tuna catch in the Indian Ocean.

(Data from FAO 1974, 1978.)

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT ON BILLFISHES OF THE INDIAN OCEAN

Heeny S. H. Yuen

Southwest Fisheries Center
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96812

August 1979

A. Description of fishery

1. Short history

According to Ueyanagi (1974) the longline fishery for yellowfin tuna around the Lesser Sunda Islands began expanding into the Indian Ocean in 1952 (Figure 1). By 1956 the coast of Africa had been reached. By 1958 the northern limit of the Indian Ocean had virtually been reached. Subsequent expansion was southward, the only direction left. By 1964 longline operations had reached lat. 40°S, the southern limit of billfish distribution. Further southward expansion was solely for the southern bluefin tuna. Longline boats of Taiwan and Korea began fishing in the Indian Ocean in 1954 and 1967, respectively (Honma and Suzuki 1972).

2. Participants

The major participants are the longliners of Japan, Taiwan, and Korea. Tanzania and U.S.S.R. are other countries reporting billfish catches from the Indian Ocean to FAO (FAO 1977). Indonesian vessels and sport fishermen in South Africa, Kenya, Seychelles, and Western Australia probably catch a small amount of billfishes.

3. Amount caught

The estimated total billfish catch from the Indian Ocean amounted to 7,804 MT (metric tons) in 1975 and 7,062 MT in 1976 (Wetherall et al.[1]). The catch is listed by species, country, and year in Table 1.

4. Catch trends

Data for catch, relative abundance, and effective effort are available from 1952 to 1976 (Table 2).

Blue marlin, Makaira nigricans, catches rose to a high of 4,980 MT in 1956, fluctuated between 4,980 and 2,634 MT from 1956 to 1970, and dropped to 1,515 MT in 1976 (Figure 2.). Relative abundance declined sharply from 49.35 kg/100 hooks in 1952 to 3.84 kg/100 hooks in 1963. Thereafter it has fluctuated between 1.72 and 4.32 kg/100 hooks (Figure 2).

Striped marlin, Tetrapturus audax, catches reached a high of 4,729 MT in 1969 and has varied between 1,117 and 3,401 MT since (Figure 3). The abundance index (Figure 3) shows a decrease from 5.60 kg/100 hooks in 1952, to a low of 0.79 kg/100 hooks in 1972, and then a rise to 1.92 kg/100 hooks in 1976.

Black marlin, Makaira indica, catches increased to a peak of 2,460 MT in 1968 and has generally decreased since then (Figure 4). The abundance index for black marlin declined steadily from a peak of 11.10 kg/100 hooks in 1955 to 1.75 kg/100 hooks in 1976 (Figure 4).

Swordfish, Xiphias gladius, catches were almost 2,300 MT in 1969 and 1970. There was a steady rising trend before those years and an irregularly declining trend after (Figure 5). Relative abundance fluctuated between roughly 1 and 2 kg/100 hooks with no obvious trend (Figure 5).

The trend of sailfish, Istiophorus platypterus, catches was up before 1967 when 1,972 MT were caught and down since (Figure 6). The index of abundance for a north area (20°N-5°S, 45°-100°E) and a south area (0°-30°S, 35°-50°S) exhibited wide variations but no trends (Figure 6). Relative abundance varied between 0.97 and 3.17 kg/100 hooks in the north and between 0.92 and 5.28 kg/100 hooks in the south.

5. Ex-vessel value

As most of the Indian Ocean billfish catch is presumed to have been sold in Japan, the average monthly ex-vessel price at the Yaizu fish market for blue, striped, and black marlins, and swordfish from January 1978 to May 1979 ([U.S.] National Marine Fisheries Service, 1978-1979) are presented (Table 3). During that period striped marlin, the most valuable of the billfish species, sold for $2,316 a short ton to $4,345 a short ton. Swordfish prices were usually better than blue marlin prices which were in turn usually better than black marlin prices. Swordfish prices ranged from $2,129 a short ton to $2,833 a short ton; blue marlin, $1,933-$3,165 a short ton; black marlin, $1,638-$2,744 a short ton.

6. Current management

None is under management.

B. Nature and degree of U.S. interest

The U.S. is interested in the billfishes of the Indian Ocean as a resource. The U.S. is not actively involved, however, in the catching of billfishes or doing research on them in the Indian Ocean.

C. Current research effort

1. Who is doing what? where?

P. P. Pillai of the Central Marine Fisheries Research Institute, India, is doing general biological studies, M. Honma, Z. Suzuki, and S. Ueyanagi of the FSFRL (Far Seas Fisheries Research Laboratory) are involved with biological and population dynamics studies.

2. Amount or indication of relative effort

The primary concern of FSFRL is tunas. Working on billfishes is secondary.

D. Inventory of data

1. Location

Catch and effort statistics of longline operations are collected by the governments of Japan, Taiwan, and Korea. Longline data have been published annually by Japan since 1962 and by Taiwan since 1967. The Korean data are not regularly published. Unpublished data have been made available by FSFRL of Japan, R. T. Yang of the National Taiwan University, and B. Y. Kim of the Fishery Resources and Development Agency of the Republic of Korea.

2. Content

The longline data of Japan and Taiwan consist of the date, number of fish caught, position, and number of hooks fished. The data received from Korea were catch summaries by species for 1971-78 and catch and effort data by 5° squares for 1975 and 1976.

3. Quality

The catch statistics of Japan and Taiwan for blue marlin, striped marlin, black marlin, and swordfish are relatively reliable. Catches of sailfish and shortbill spearfish, however, are combined. It is suspected that some blue marlin have been recorded as black marlin and vice versa. In the Korean records, billfishes were not separated by species prior to 1975. Although the reports from Korea have shown significant improvement in recent years, misreporting apparently still occurs since FAO statistics show no catch of black marlin by Korea in the Indian Ocean.

E. Status of stocks

1. Methodology

Stock assessments were based on CPUE (catch per unit effort) and effort trends and production model analysis (Fox 1975).

2. Accuracy

There is question on the reliability of the estimates of total catch. The accuracy of the results of the production model analysis will be to the degree of accuracy of the estimates of total catch.

3. Evaluation of stocks (Wetherall et al.[1])

Production models for blue marlin suggest a MSY (maximum sustainable yield) of 3,400-3,600 MT achievable at an effort substantially less than any recent level (Table 4) but the curves fit poorly (Figure 7). There may be significant errors in the total catch estimates.

For striped marlin, assuming a single stock, the MSY from the production model analysis is 3,500 MT at a level of effort considerably more than the highest effort to date (Table 4). Annual catches at effort levels of 150 million-300 million hooks are widely variable about the equilibrium yield curve (Figure 8).

The estimated MSY for black marlin is 1,400-1,500 MT (Table 4). Optimum effort is less than recent levels but the yield-effort curve (Figure 9) is quite flat. Effort levels of 40 million-60 million hooks have resulted in catches with considerable variation about the equilibrium yield curve (Figure 9). The catch data points for 1972-76 are below the curve, whereas the points for 1968-71 are all above the curve, suggesting the possibility of some systematic bias in the above estimates.

The data for swordfish suggest that longlining has had no significant impact on the swordfish population, so no production model analysis was attempted.

The sailfish data, like the swordfish data, indicate the stock has not been affected by fishing. The potential yield for sailfish is much higher than the maximum annual catch taken thus far.

F. Problem areas and program needs to solve problem

1. Research

Knowledge of stock structure of all of the billfish species is lacking. Research is needed to define the stocks of each species.

2. Data

The practice of combining the sailfish and shortbill spearfish in the same category creates an obvious problem. The apparent problem of misreporting black and blue marlins by the Korean longliners needs to be addressed.

3. Management

There is no apparent need for management of the fishery at the present.

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TEXT FOOTNOTE

[1]Wetherall, J. A., F. V. Riggs, and M. Y. Y. Yong. 1979. Some production model analyses of tuna and billfish stocks in the Indian Ocean. Southwest Fisheries Center Admin. Rep. H-79-7. Prepared for the Workshop on the Assessment of Selected Tunas and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, 12 p.

Table 1.--Estimated annual catches (metric tons) of billfishes of the Indian Ocean by species and country, 1975 and 1976.

Country	Blue marlin	Striped marlin	Black marlin	Swordfish	Sailfish
1975					
Japan	700	900	500	700	200
Taiwan	447	344	192	291	511
Korea	1,130	870	495	244	280
1976					
Japan	300	500	200	300	200
Taiwan	343	819	78	371	261
Korea	872	2,082	198	398	140

Table 2.--Estimated total catch (metric tons) relative abundance (kg/100 hooks) and effective effort (10^6 hooks) for Indian Ocean billfishes. (From Wetherall et al. see text footnote 1.)

Year	Blue marlin			Striped marlin			Black marlin			Swordfish			Sailfish		
	Catch	Abundance index	Effective effort	Catch	Abundance index	Effective effort	Catch	Abundance index	Effective effort	Catch	Abundance index (kg/100 hooks)		Catch	Abundance index (kg/100 hooks)	
	(MT)	(kg/100 hooks)	(10^6 hooks)	(MT)	(kg/100 hooks)	(10^6 hooks)	(MT)	(kg/100 hooks)	(10^6 hooks)	(MT)	North	South	(MT)	North	South
1952	800	49.35	1.62	100	5.60	1.78	300	8.99	3.34						
1953	2,000	23.86	8.40	300	4.24	7.10	800	9.17	8.72						
1954	3,300	16.78	19.70	800	5.23	15.32	1,100	10.11	10.87	200	1.38		200	1.90	
1955	3,600	14.21	25.38	780	4.42	17.66	1,080	11.10	9.72	240	2.06		180	1.41	3.90
1956	4,980	10.58	47.17	1,740	3.99	43.72	1,500	7.87	19.06	480	2.00		300	0.97	2.29
1957	3,800	9.09	41.87	1,800	3.36	53.64	1,400	6.29	22.24	300	1.30		300	1.61	1.84
1958	4,100	11.07	37.09	1,700	3.56	47.89	1,200	9.57	12.31	500	1.72	1.47	400	1.90	0.92
1959	4,300	8.94	48.17	2,100	4.26	49.38	1,200	6.83	17.56	500	1.15	2.10	500	3.07	1.84
1960	3,700	6.17	60.06	2,000	2.70	74.19	1,700	5.93	28.64	600	1.36	1.40	500	2.29	2.98
1961	3,200	5.07	63.28	2,400	2.39	100.82	1,400	4.50	31.14	700	1.26	1.33	500	2.63	1.84
1962	3,100	5.08	61.10	1,800	2.24	80.53	1,800	5.17	34.81	900	1.17	1.12	800	2.34	3.90
1963	2,634	3.84	68.63	1,783	2.01	88.93	1,451	4.50	32.27	1,051	1.22	1.40	675	1.70	2.52
1964	3,740	4.32	86.66	1,886	1.85	102.09	1,654	4.23	39.13	1,254	1.10	1.40	777	1.51	1.84
1965	3,878	2.95	131.53	3,335	2.45	136.61	1,344	3.42	39.33	1,344	1.22	1.05	1,222	2.73	3.21
1966	3,754	2.84	132.51	4,163	1.92	215.80	1,391	4.09	34.00	1,391	1.24	1.12	1,296	2.24	3.21
1967	4,074	2.59	157.54	4,463	1.34	334.90	1,548	3.64	42.50	1,831	1.46	1.05	1,972	3.12	3.90
1968	4,036	2.26	178.85	3,436	1.55	226.58	2,460	4.18	58.83	1,971	1.32	0.91	1,630	2.34	2.98
1969	3,875	1.86	203.19	4,729	1.31	361.45	2,339	4.27	54.76	2,284	1.35	1.33	1,187	1.80	3.67
1970	3,038	1.72	177.35	3,110	1.00	313.06	1,845	2.65	69.55	2,255	1.25	1.40	1,016	3.17	3.90
1971	2,532	2.03	124.97	2,092	0.94	222.82	1,435	3.24	44.33	1,583	1.10	1.61	1,349	2.63	3.44
1972	2,509	2.82	89.08	1,511	0.79	191.88	893	1.89	47.29	1,554	1.62	1.96	1,145	2.87	4.36
1973	1,891	3.28	57.69	1,117	1.03	108.48	709	1.93	36.67	1,148	1.05	1.12	429	2.09	5.05
1974	2,370	3.30	71.94	2,800	1.31	214.01	1,342	1.98	67.83	1,771	1.32	0.84	652	2.09	4.59
1975	2,277	1.86	22.33	2,114	1.37	154.43	1,187	1.93	61.39	1,235	1.21	1.19	991	1.51	3.21
1976	1,515	1.88	80.68	3,401	1.92	177.13	476	1.75	27.14	1,069	1.26	1.12	601	2.39	5.28

Table 3.--Monthly average ex-vessel prices of billfishes (U.S. dollars per short ton) at Yaizu fish market, January 1978-May 1979.

Month	Striped marlin	Blue marlin	Black marlin	Swordfish
1978				
January	3,482	2,009	2,605	2,423
February	2,823	2,326	2,070	2,503
March	3,452	2,299	2,025	2,647
April	2,722	2,515	2,082	2,833
May	2,614	2,112	1,929	2,343
June	2,462	1,991	2,090	2,263
July	4,345	2,122	2,272	2,658
August	2,507	2,275	1,638	2,826
September	2,903	2,039	1,943	2,769
October	2,856	2,412	2,055	2,793
November	3,981	3,165	2,202	2,590
December	2,698	2,323	1,934	2,703
1979				
January	4,141	1,933	2,744	2,455
February	4,046	2,027	2,059	2,440
March	4,095	2,510	1,871	2,580
April	2,316	2,658	1,730	2,232
May	2,489	2,626	1,818	2,129

Table 4.--Results of production model analyses for Indian Ocean blue marlin, striped marlin, and black marlin. (From Wetherall et al. see text footnote 1.)

Smoothing period	Striped marlin				Blue marlin				Black marlin			
	$\widehat{MSY}$	$\hat{E}_{opt}$	$\hat{M}$	Fit index	$\widehat{MSY}$	$\hat{E}_{opt}$	$\hat{M}$	Fit index	$\widehat{MSY}$	$\hat{E}_{opt}$	$\hat{M}$	Fit index
(yr)	(MT)	(10^6 hooks)			(MT)	(10^6 hooks)			(MT)	(10^6 hooks)		
1	3,215	449	0.10	1.0000	3,572	229	0.05	0.9774	1,526	173	0.75	1.0001
2	2,930	219	0.24	1.0128	3,652	71	0.62	1.0282	1,484	158	0.63	1.0001
3	3,557	∞	0.00	1.0022	3,527	77	0.63	1.0023	1,430	170	0.35	1.0000
4	3,153	607	0.07	1.0008	3,377	78	0.52	1.0008	1,397	217	0.17	1.0000

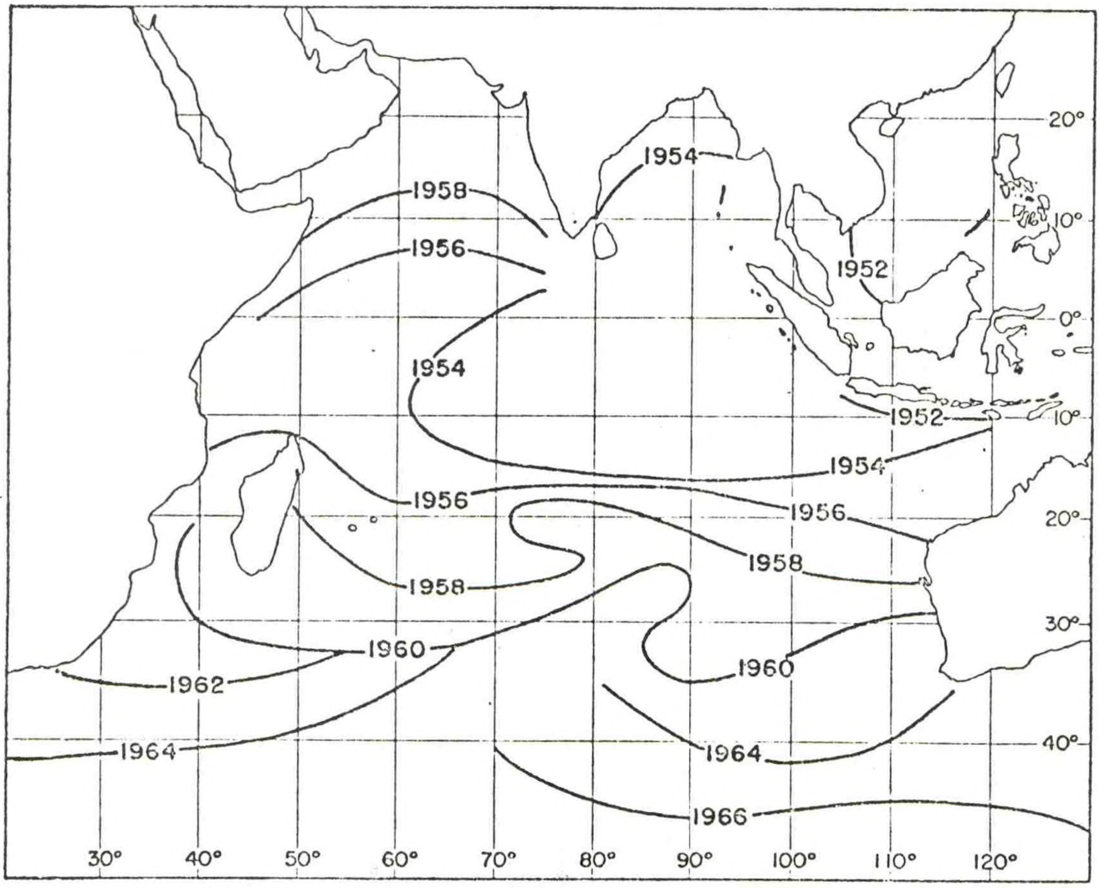

Figure 1.--The expansion of Japanese longline fishing grounds in the Indian Ocean. (Adapted from Kikawa et al. 1969).

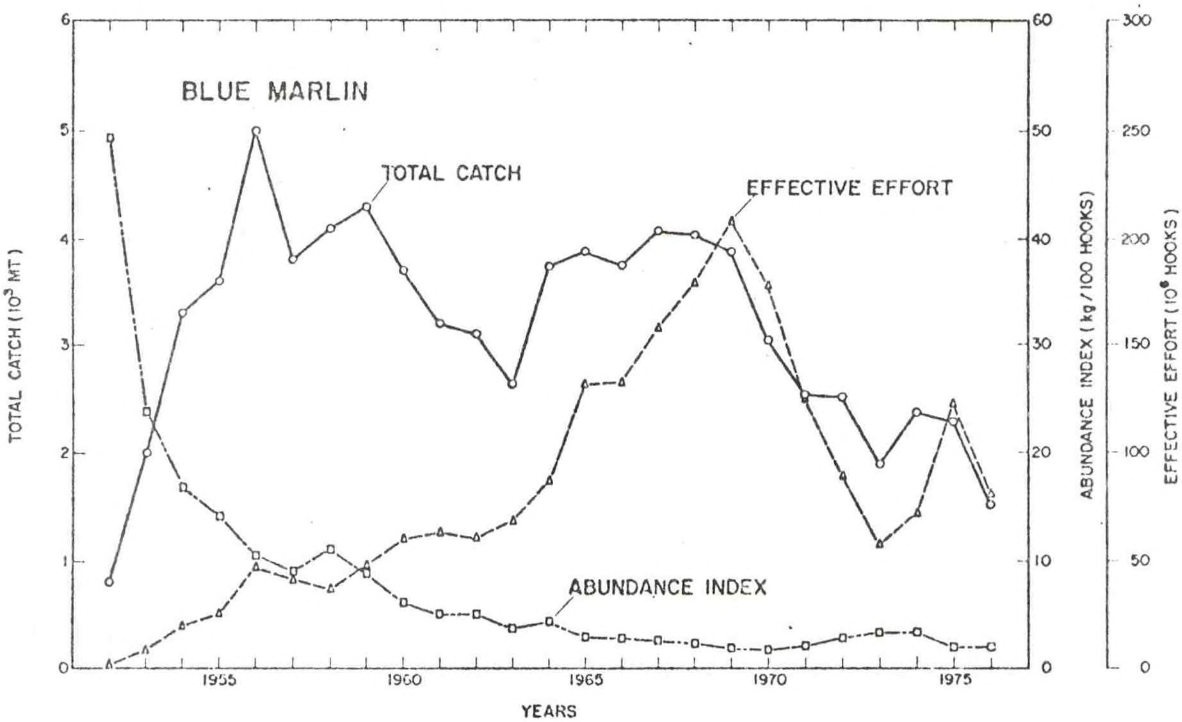

Figure 2.--Estimated total catch (10^3 MT), relative abundance (kg/100 hooks), and effective effort (10^6 hooks) for Indian Ocean blue marlin. (From Wetherall et al. see text footnote 1.)

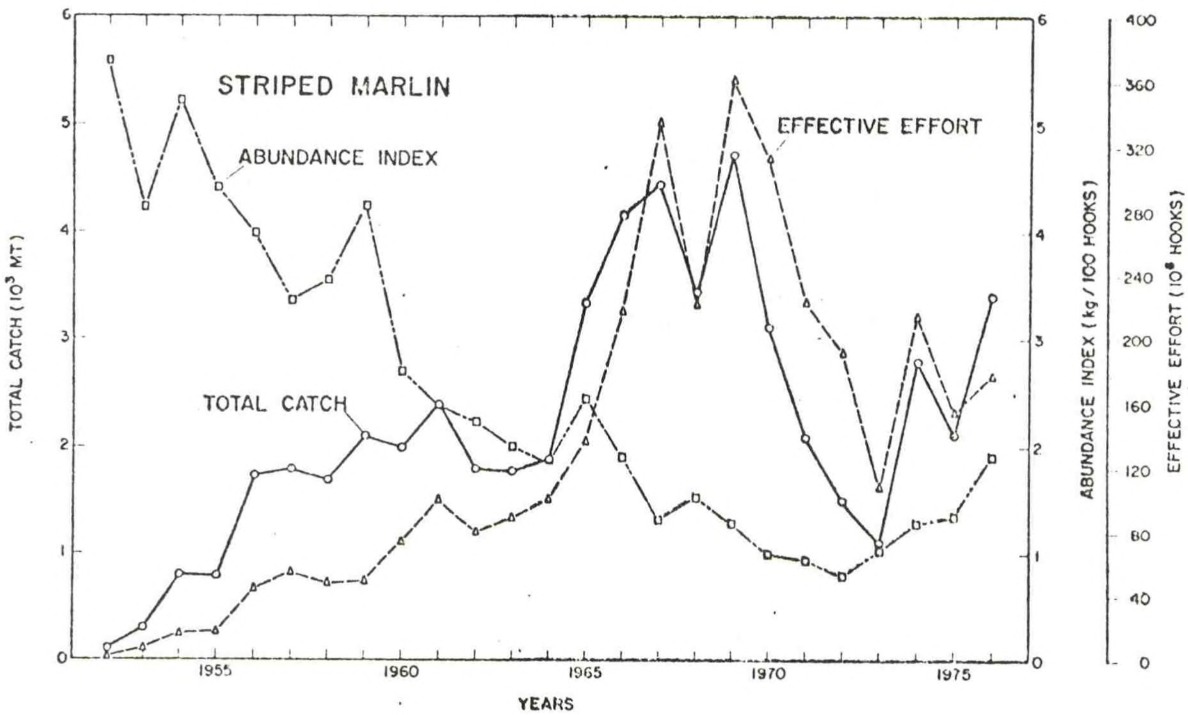

Figure 3.--Estimated total catch (10^3 MT), relative abundance (kg/100 hooks), and effective effort (10^6 hooks) for Indian Ocean striped marlin. (From Wetherall et al. see text footnote 1.)

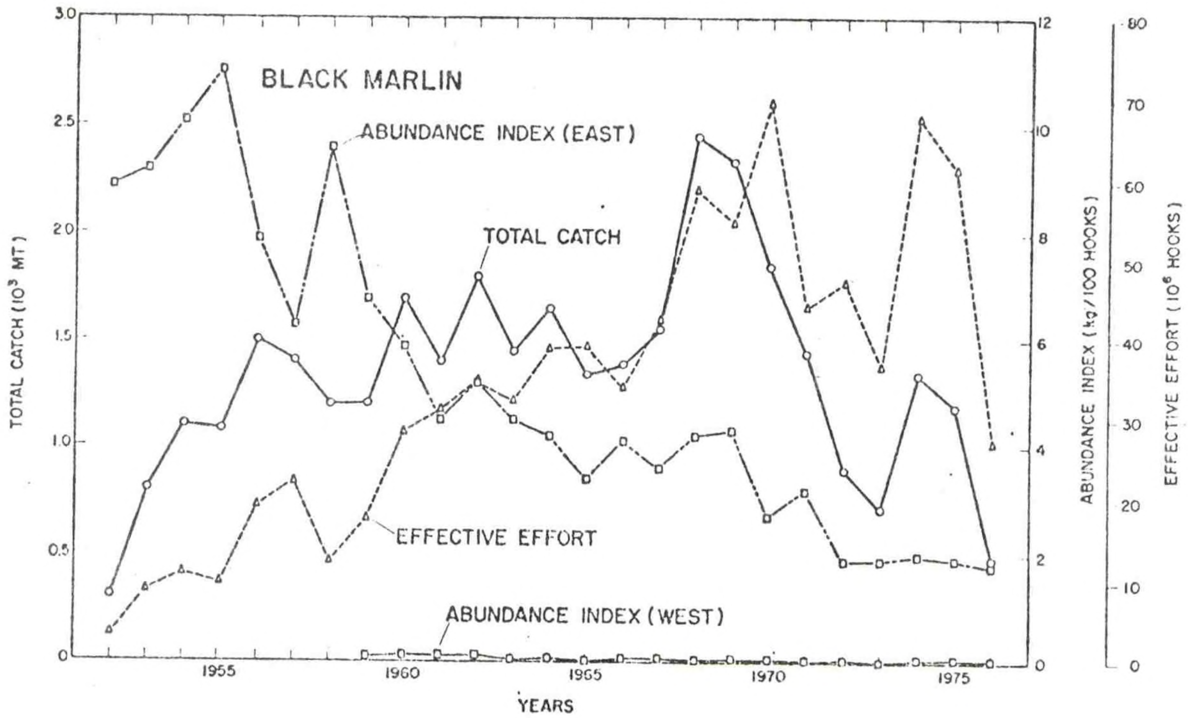

Figure 4.--Estimated total catch (10^3 MT), relative abundance (kg/100 hooks), and effective effort (10^6 hooks) for Indian Ocean black marlin. (From Wetherall et al. see text footnote 1.)

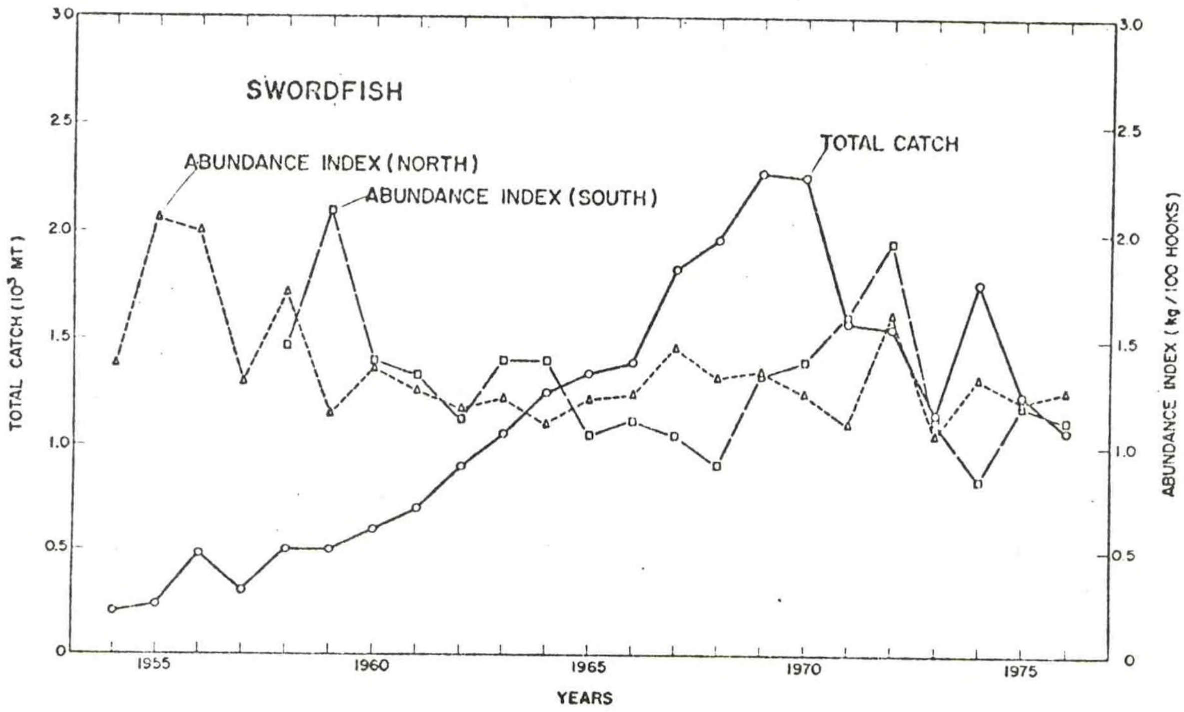

Figure 5.--Estimated total catch (10^3 MT) and relative abundance (kg/100 hooks) for Indian Ocean swordfish. Abundance indices are given for two index areas. (From Wetherall et al. see text footnote 1.)

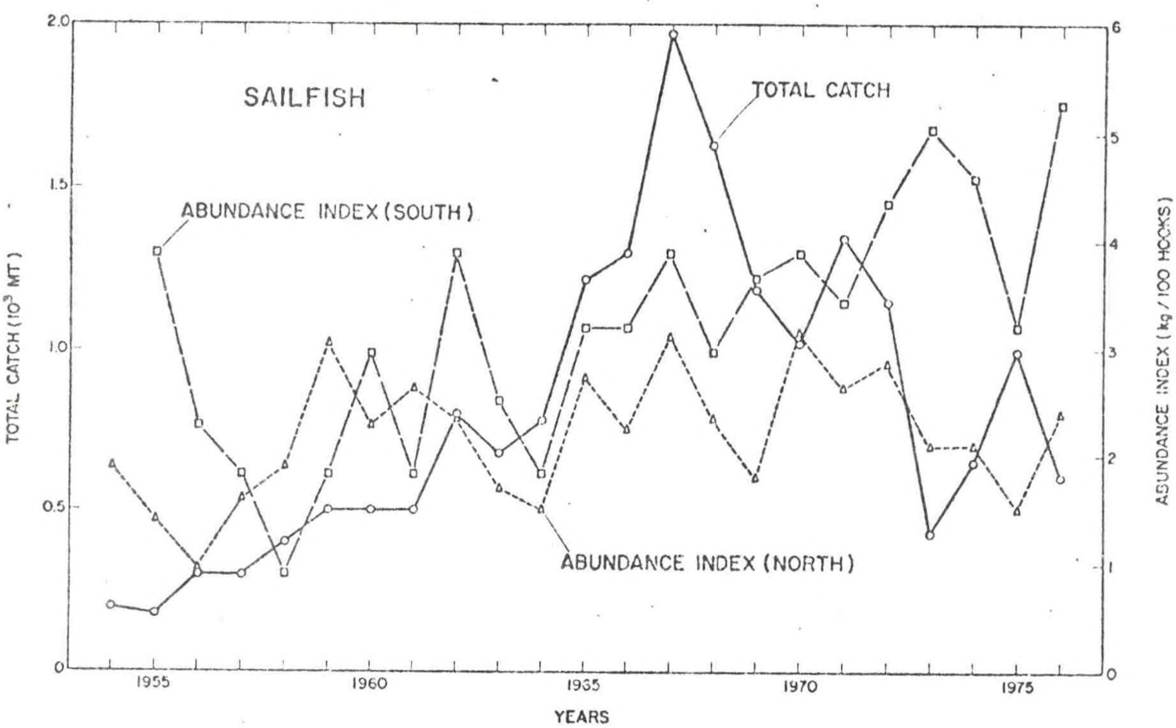

Figure 6.--Estimated total catch (10^3 MT) and relative abundance (kg/100 hooks) for Indian Ocean sailfish. Abundance indices are given for two index areas. (From Wetherall et al. see text footnote 1.)

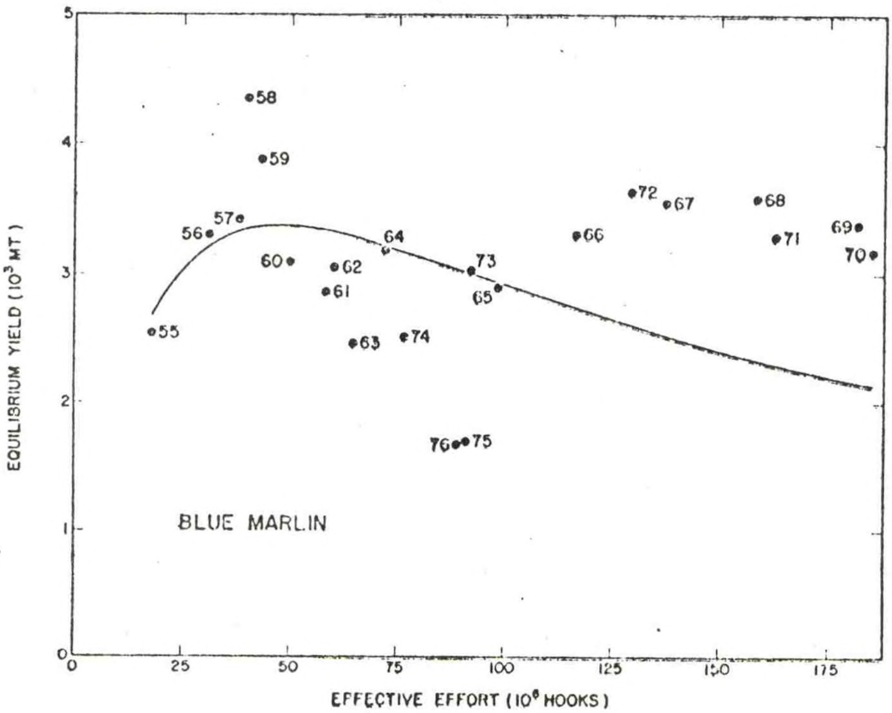

Figure 7.--Predicted relationship between equilibrium yield (10^3 MT) and effective effort (10^6 hooks) for Indian Ocean blue marlin, based on production model analysis. (From Wetherall et al. see text footnote 1.)

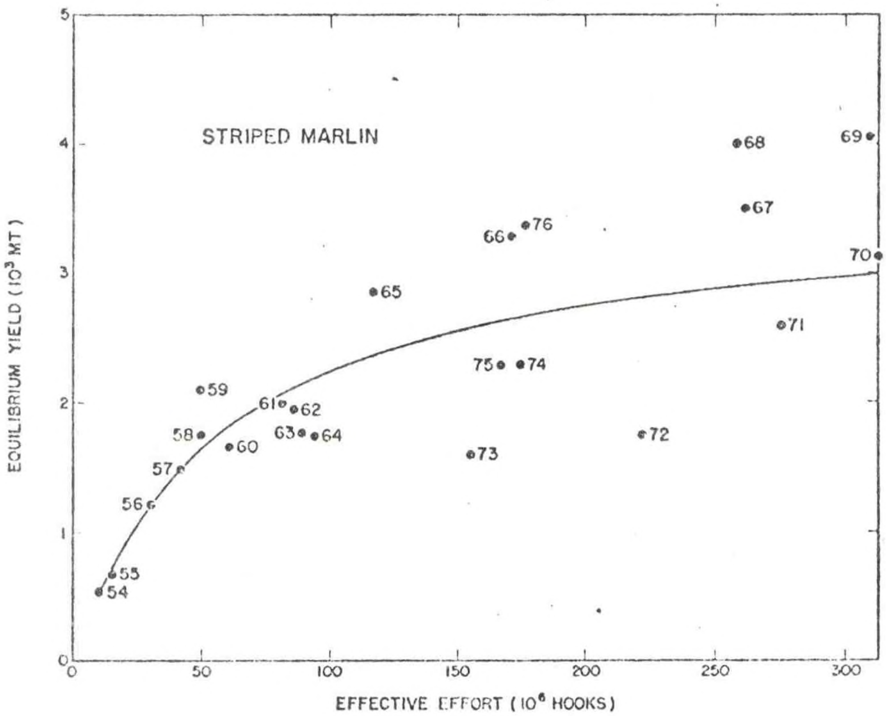

Figure 8.--Predicted relationship between equilibrium yield (10^3 MT) and effective effort (10^6 hooks) for Indian Ocean striped marlin, based on production model analysis. (From Wetherall et al. see text footnote 1.)

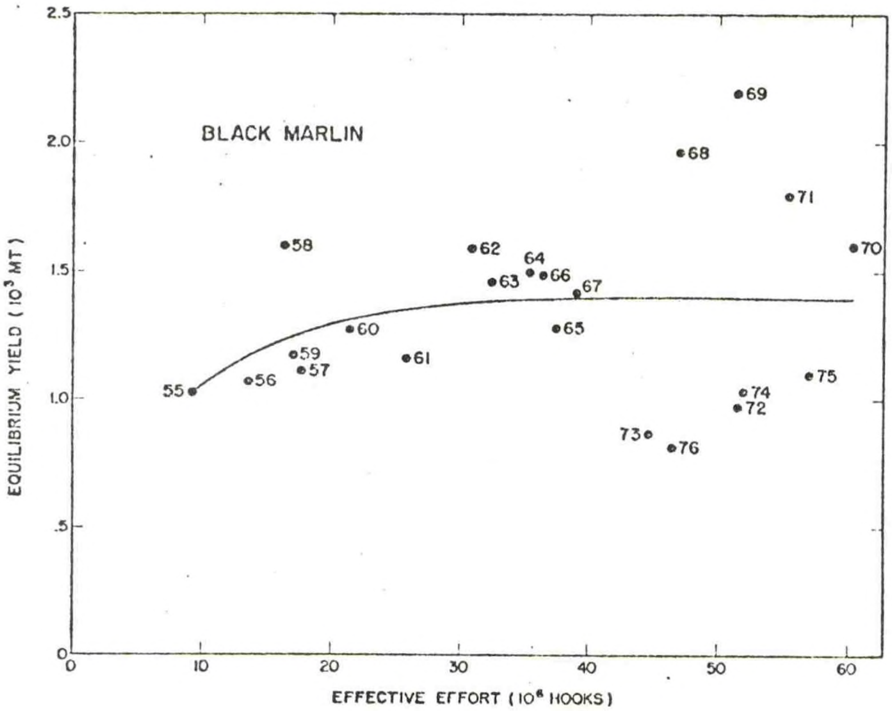

Figure 9.--Predicted relationship between equilibrium yield (10^3 MT) and effective effort (10^6 hooks) for Indian Ocean black marlin, based on production model analysis. (From Wetherall et al. see text footnote 1.)

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT FOR NORTH PACIFIC ALBACORE

by

Norman Bartoo

A. Description of the Fishery

Albacore in the Pacific Ocean is found in both hemispheres. The Pacific albacore population is generally held to be composed of two major stocks, one north of the equator and another south of the equator.

The North Pacific albacore stock is subjected to three major fisheries. An intense spring surface fishery operates off the coast of Japan by vessels from the Japanese skipjack tuna pole-and-line fleet. In previous years, 1926 to 1970, the pole-and-line fishery generally operated south of 35°N and along the coast of Japan. Since 1970 the pole-and-line fishery has expanded north and eastward along the Kuroshiro Front, to the Emperor Sea Mount area, with generally increased fishing success. Off the coast of North America, another surface fishery operates, generally in mid to late summer and early fall. The fleet is composed primarily of jig (troller) boats with a few baitboats. This fishery has been operating since just after the turn of the century. This surface fishery is coastal in nature and located predominately off the United States. However, some catches are taken off British Columbia (with some participating Canadian boats) and off Mexico. The third major fishery is a longline fishery (principally Japanese) which operates in the mid to west North Pacific during the winter months. This fishery has been in existence since the early 1950's. The Taiwan Fisheries Agency reported that in 1977 Taiwan had taken several hundred tons of North Pacific albacore. Currently, a promising jig fishery operated by United States vessels is developing in the mid-Pacific near Midway Island.

The estimated annual catches of North Pacific albacore are shown in Table 1. The 1940 to 1960 data series are incomplete for some fisheries, however, the 1961 to 1977 data series can be regarded as complete. The catches by Japanese vessels are compiled by the Fisheries Agency of Japan. Canadian catch statistics are gathered by Fisheries and Environment Canada. The statistics for the United States jig catch are estimated from landings data furnished by California, Oregon, and Washington. Estimates for the U.S. bait boat fleet reflect only the catch of vessels submitting log books to the Inter-American Tropical Tuna Commission, this includes most of the fleet. The remainder of the bait boat catch is included in the U.S. jig catch. An estimate of the U.S. sport catch from party boat anglers is also included as well as the 1977 Taiwan catch. Excluded from Table 1 are the catches taken in the last few years by bait boats and longliners of the Republic of Korea. The catch is considered to be only a small fraction of the total North Pacific albacore harvest.

The general trend in catch from 1961 to 1977 was upward. Catches rose slower from 1960 to 1970 (44,000 mt to 67,000 mt) than from 1970 to 1976 (67,000 mt to 124,000 mt) the year with the highest catch on record. The 1977 catch dropped to 57,000 mt, 1/2 of the 1976 level. The peaking of catches since 1971 corresponds to the period of spatial expansion by the Japanese pole-and-line fleet. During the 1971 to 1976 period, the pole-and-line catches rose from 19,000 mt to 85,000 mt. In 1977, their catches dropped to 32,000 mt. The catches by longline in the North Pacific have remained essentially constant since 1961 near 15,000 mt. The North American fishery catches from 1961 to 1977 averaged slightly more than 20,000 mt and were fairly stable until 1977 when a low catch of 12,000 mt was recorded.

Preliminary catch estimates for 1978 indicate that fishing was slightly better than in 1977. The preliminary 1978 Japanese pole-and-line catches are up to about 62,000 mt. The fishery, which took an unusually large number of age two fish (4,000,000 plus) began late but improved in the Emperor's Sea Mount area late in the season. In 1979, the pole-and-line fishery again began late and catches to the mid-season point were relatively low. If this level of catch continues, the 1979 catch is expected to be lower than in 1978. The 1978 catch by the North American fishery rose to 17,000 mt, above the 1977 catch but below the ten-year mean of 20,000 mt. The 1978 U.S. bait boat catches were low at under 1000 mt. Three-year old fish were most prevalent in the 1978 U.S. catch. In 1978 about 300 mt of albacore was caught in the Midway Island area by U.S. jig boats. In 1979 15 to 20 jig boats fished near Midway Island. Estimates of the 1978 longline catches are not yet available due to the nature of their fishing operations.

The ex-vessel value of the albacore catch, based on $1284 per mt (1977 U.S. price) average $126 million per year from 1973-1977. The U.S. fishery received $25 million (includes sport catch) per year over the same period. Currently, there are no fisheries management regulations in force for North Pacific albacore.

B. Nature and Degree of U.S. Interest

The U.S. has a domestic fishery operating on the North Pacific albacore stock. In addition, imports of albacore far exceed the domestic caught supply, and some of these imports come from the North Pacific albacore stock.

The U.S. albacore provides 10-20% (about 20,000 mt) of the albacore consumed in the U.S. The fishery contributes to the support of the 800 to 900 regularly participating jig vessels, and in years of high catch, another 800 or so jig vessels. About 50 large pole-and-line regularly fish for albacore with another 50 or so on an intermittent basis. At an ex-vessel value of $1284 per mt, the U.S. catch is worth about $25 million annually.

The U.S. annually imports about 80% (80,000-90,000 mt) of the albacore consumed in the U.S. Imports from the Pacific supply about 40-45% of the total U.S. albacore imported. The actual proportions of Pacific albacore imported from the North stock alone are not yet available but could vary from 40% to 75% of the Pacific total depending on the year.

C. Current Research Effort

Currently, most of the research on the North Pacific albacore stock is being conducted by NMFS, La Jolla, and the Tohoku and Far Seas Fisheries Research Laboratories (Japan). The level of research in the U.S. is about 7.5 man years in the area of Fisheries Investigations and 0.5 man years in the area of Stock Assessment. The level of research by Japanese agencies appears to be about 2-3 man years, exclusive of sampling time.

In the United States, the Fisheries Investigations research efforts are structured on the distribution, availability, and migration patterns of North Pacific albacore and associated environmental influences in the eastern North Pacific. Areas of emphasis have been oceanographic and environmental process measurements, tagging for substock structure, and physiology investigations.

The Stock Assessment research efforts are targeted at providing a reliable, detailed, assessment of the condition of the stock as well as an understanding of the population dynamics of the stock. Research has concentrated on the application of conventional population dynamics models to available data.

D. Inventory of Data

1. Copies of all available data are located at the La Jolla laboratory, Far Seas Laboratory, and Honolulu Laboratory. Some small unknown data may exist elsewhere.

2. Data includes catch by year and time strata, catch-effort by gear and time strata, and catch length composition by gear and time strata.

3. The data quality is generally good. Longline catch and effort data is very good especially in later years. For the surface fleets, catch and effort data has improved in more recent years and is now generally good. Better measures of effort are needed for the Japanese and American surface fleets. Length frequency data is currently excellent. The data from longliners in the mid-1950's was only adequate.

E. State of Stock

The state of the North Pacific albacore stock has been evaluated using conventional techniques. Production model analyses indicate that a conservative estimate of MSY is 125,000 mt. The accuracy of this estimate is questioned, however, because of several basic assumptions (particularly that CPUE is an accurate indicator of stock abundance) in the analysis which have not yet proven to hold. Thus, the precision and reliability of the resulting MSY estimates are very low.

Age specific models indicate that recent increase in surface catches (since 1971) have reduced the realized yield-per-recruit although no accurate estimates are available.

No clear cut spawner-recruit relationships have been developed. Indices of spawning stock have declined since 1974.

F. Problem and Program Needs

The recent Fourth North Pacific albacore workshop produced the following unprioritized recommendations (draft) of data and research needs.

"

V. Recommendations

As a result of the workshop, the participants selected several areas of research to be addressed over the next year, as being desirable to the successful assessment of the stock in the future.

A. The participants noted that while statistical coverage is improving several improvements in statistics are needed and some specific actions should be taken:

1. Statistics on the operation of longliners and baitboats from Taiwan and the Republic of Korea should be investigated and additional historical data secured.

2. In the Canadian fishery, the collection of log books and biological data should be strengthened.

3. Data for fleets based in American Samoa and fishing north of the equator should be summarized and made available.

4. For the Japanese pole-and-line fishery, improvements in the measurement of fishing effort are needed. Alternatives to the present effort measures should be evaluated.

(This is true for the U.S. fleet also).

B. The participants noted that the question of stock structure and substock structure could have significant impact on assessments and some specific actions should be taken:

1. To obtain information useful for identification of stock structure and migration patterns, a review of existing literature should be undertaken and information summarized on albacore catches, from the central and eastern Pacific, taken incidental to fishing operations on other species or by research cruises.

2. Using existing data, simulation analyses should be done to examine the effects of various possible stock structure hypotheses on analysis results.

3. Examination of data on size composition by time and space and distribution of larvae, should be done to help determine stock structure.

4. Additional tagging effort should be exerted to better define both surface-longline fisheries interactions and east-west surface fisheries interactions.

C. The participants noted that the question of age and growth in albacore has not been resolved and can significantly affect assessments. In light of the encouraging preliminary aging results presented, the following actions should be taken:

1. Aging studies using both the otolith "daily increment" method and "finray" method should be continued and close cooperation between scientists pursuing these methods should be maintained.

2. The "fin ray" aging method should be evaluated with samples of known origin. In this light, the FSFRL has agreed to provide sample albacore for aging.

D. The participants emphasized that to confidently assess the status of the stock, detailed analyses using age structure models are needed and the following actions should be taken:

1. The effects of using a fixed age-length key derived from different growth equations on the results of the Cohort analysis should be done. (A simulation model or sensitivity analyses approach was suggested as a useful tool).

2. The robustness of age structure analyses to assumed parameters in the analyses (such a natural mortality rate) should be evaluated.

3. Estimates of indices of both spawning stock size or fecundity and recruitment indices for the North Pacific albacore stock should be developed.

E. The participants noted the need to identify and evaluate environmental parameters which can be used to adjust abundance indices for variation in availability and vulnerability. The following specific actions should be taken:

1. Key oceanographic processes and parameters that influence vulnerability, availability, migratory patterns etc. be identified and that quantitative indices be developed for these factors.

2. The effects on CPUE that variations in key quantitative indices cause should be identified and quantified for incorporation into analyses of the condition of the stock."

If the primary goal of the SWFC is to offer fisheries management advice, then those recommendations leading to a confident estimate of the state of the stock should be pursued. Because of problems in standardizing effort for apparently great changes in availability and vulnerability, stock assessment research should emphasize age-structure based models, and environmental research should emphasize investigations into quantifying key oceanographic processes and parameters affecting vulnerability and availability and their effects on CPUE measures.

7

Table ~~7~~ 1. Catches of North Pacific albacore in metric tons, 19~~5?~~46-77.

Year	Japan[1] Pole-and-line	Japan[1] Longline	Japan[1] Other gears	Japan[1] Total	Taiwan LL	United States[2] [6] Pole-and-line[5]	United States Jig	United States Sport[6]	United States Total	Canada Jig	Total[3]
1940						6,212			6,212	2	
1941						5,266			5,266	34	
1942						10,535			10,535	-	
1943						17,071			17,071	13	
1944						23,948			23,948	210	
1945						17,800			17,800	648	
1946						10,950			10,950	196	
1947						12,234		84	12,318	362	
1948						22,403		113	22,516	987	
1949						24,895		166	25,061	1,012	
1950						32,847		866	33,713	961	
1951						15,629		557	16,186	66	
1952		20,718				23,843		1,373	25,216	71	
1953		26,055				15,740		171	15,911	5	
1954		16,506				12,246		147	12,393	-	
1955	24,186	17,883		42,069		13,264		577	13,841	-	55,910
1956	42,723	12,794		55,517		18,751		482	19,233	17	74,767
1957	49,400	17,473		66,873		21,165		304	21,469	8	88,350
1958	22,130	16,818		38,948		14,855		48	14,903	74	53,851
1959	14,223	15,894		30,117		20,990		-	20,990	212	51,319
1960	25,201	15,832		41,033		20,100		557	20,657	5	61,695
1961	13,535	~~15,999~~ 17437		34,635		2,837	12,054	1,355	16,246	4	50,885
1962	8,729	~~12,617~~ 15764		21,346		1,085	19,753	1,631	22,519	1	43,876
1963	26,420	~~11,445~~ 13464		37,865		2,432	25,142	1,161	28,735	5	66,605
1964	23,858	~~11,558~~ 15456		35,416		3,411	18,389	824	22,624	3	58,043
1965	41,491	~~11,214~~ 13701	121	52,826		417	15,461	731	17,609	15	70,450
1966	22,830	~~20,874~~ 25050	585	44,289		1,600	15,169	538	17,357	44	61,690
1967	30,481	~~24,374~~ 28569	520	55,375		4,113	17,814	707	22,634	161	78,170
1968	16,597	~~19,040~~ 23961	1,109	36,746		4,906	20,441	951	26,298	1,028	64,072
1969	31,912	18,006	1,480	51,398		2,996	18,826	358	22,180	1,355	74,943
1970	24,263	15,372	956	40,591		4,416	21,039	822	26,277	354	67,222
1971	52,957	10,915	1,262	65,134		2,071	22,196	1,175	25,442	1,537	92,163
1972	60,591	12,622	922	74,135		3,750	23,600	637	27,987	3,558	105,680
1973	69,640	16,000	1,922	87,562		2,236	15,652	72	17,960	1,720	107,242
1974	73,576	12,932	1,289	87,817		4,777	20,177	739	25,693	1,207	114,717
1975	52,157	9,931	568	62,656		3,243	18,926	1,243	23,412	101	86,169
1976	85,335	15,738	2,464	103,538		2,700	16,314	766	19,780	252	123,570
1977	31,934	10,000	2,500	44,434	524	1,497	10,012	619	12,128	53	56,615
78[4]	62000	---	---	--		950	15700	-8-	16650	23.	---

[1] Japanese longline catch for 1961-68 excludes minor amount taken by vessels under 20 gross tons. Longline catch in weight is estimated by multiplying annual number of fish caught by an average weight statistic.

[2] United States pole-and-line catch excludes minor amount taken by vessels not submitting logbooks to IATTC; this amount is included in the jig catch.

[3] Omitted are unknown but minor catches by longline and pole-and-line vessels of the Republic of Korea and Taiwan.

[4] 197~~7~~8 figures are preliminary.

[5] All gears 1940-1960 added together.

6/ ESTIMATED MINIMUM BASED ON PARTIAL COVERAGE

DRAFT

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ____________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT ON SOUTH PACIFIC ALBACORE

Howard O. Yoshida

Southwest Fisheries Center
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96812

August 1979

A. Description of fishery

1. Short history

Albacore, *Thunnus alalunga*, is one of the important species taken in the South Pacific longline fishery for tunas and billfishes.

As part of the general eastward expansion of the Japanese longline fishery after World War II, Japanese longliners began fishing in the western South Pacific in 1952, principally for yellowfin tuna. In 1954 a small fleet of Japanese longliners based at American Samoa began fishing for tunas to supply an American tuna cannery in Pago Pago. The Japanese also established a base in 1958 at Espiritu Santo, New Hebrides and in 1963 at Fiji. A base for foreign longliners has also been established at Tahiti. The geographical boundaries of the fishery in the South Pacific, based on Japanese longline fishing operations from 1952 to 1976, extends from the equator to approximately lat. 45°S between long. 135°E and 80°W (Figure 1).

Only small amounts of albacore are taken by surface gear in the South Pacific.

2. Participants

Longliners from Japan, Korea, and Taiwan based either at foreign bases or at home ports fish in the South Pacific fishery. Small troll fisheries for albacore exist in Chile and New Zealand.

3. Amount caught

The estimated total annual catch of albacore in the South Pacific longline fishery from 1952 to 1977 ranged from 210 to 48,691 MT (metric tons) (Table 1). Because catch figures are often available only in number of fish caught and incomplete in other ways, the total catch in weight for Japan, Korea, and Taiwan was estimated in various ways (Wetherall et al.[1]).

4. Catch trends

The total catch of albacore in the South Pacific longline fishery (Figure 2) rose rapidly from 210 MT in 1952 to 39,479 MT in 1962. The catch fluctuated between a low of 24,975 MT and a high of 48,691 MT from 1963 to 1977.

5. Ex-vessel value

Except for a decline in 1975, the mean annual ex-vessel value of albacore landings in the American Samoa longline fishery rose from a low of $426 per short ton in 1969 to $1,358 per short ton in 1978 (Figure 3).

6. Current management

The South Pacific albacore is currently not being managed.

B. Nature and degree of U.S. interest

In 1953 a California seafood company obtained a lease from the Department of the Interior to a small modern tuna cannery located along the shore of Pago Pago Bay, American Samoa. This event marked the beginning of the tuna longline fishery in the South Pacific (Otsu 1966). In 1963 a second U.S. firm began operating a tuna canning plant in American Samoa. American interests are also represented in a joint venture with French interests in operating a tuna transshipping base at Tahiti.

The 23,880 MT of albacore landed at American Samoa represented an estimated 78% of the catch of this species in the South Pacific in 1970 (Figure 4).

C. Current research effort

1. Who is doing what? where?

The Far Seas Fisheries Research Laboratory (FSFRL), Shimizu, Japan and the Southwest Fisheries Center Honolulu Laboratory are currently engaged in South Pacific albacore research. The Shimizu Laboratory, however, has published few papers on the South Pacific albacore in the last 10 years. Earlier papers published by the Shimizu Laboratory related to studies on spawning, distribution and abundance,and size composition of South Pacific albacore.

Honolulu Laboratory papers on South Pacific albacore have included a recent paper on the assessment of the stock (Wetherall et al.[1]) and an earlier paper on stock assessment by Skillman (1975). Several papers on descriptions of the American Samoa longline fishery and on the biology of South Pacific albacore were also published (Otsu and Hansen 1961; Otsu 1966; Otsu and Sumida 1968; Yoshida 1971, 1975).

The status of the South Pacific albacore was reviewed at the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans (Shimizu Workshop) held in Shimizu, Japan, 13-22 June 1979. The Shimizu Workshop was jointly arranged by the FSFRL, Shimizu, Japan and the Southwest Fisheries Center Honolulu Laboratory.

D. Inventory of data

The Shimizu Workshop evaluated the availability of South Pacific albacore data (Table 2).

1. Location

The FSFRL has albacore catch statistics of Japanese longliners fishing in the South Pacific since 1952. The governments of Taiwan and Korea, likewise, compile data on their respective flag vessels fishing in the South Pacific. Some of these data and data from the fishery based at American Samoa are available on tapes in the files of the Honolulu Laboratory.

2. Content

Logbook systems maintained by Japan, Korea, and Taiwan provide data on catch in number of fish, effort in number of hooks fished, and locality fished for each day of fishing. The government of American Samoa also collects logbook data providing the same kinds of data from vessels based at Pago Pago. Data on the size composition of the catches are collected by the governments of Japan, Taiwan, and American Samoa. In addition, the Honolulu Laboratory maintains files of landings statistics provided by the two canneries in American Samoa.

3. Quality

It is estimated that logbook data are obtained from 80% to 90% of the vessels. The quality of such data is believed to be adequate. The quality of the size composition data is also believed to be adequate. However, owing to changes in unloading procedures at the tuna canneries, sex and weight determinations have been discountinued, but length-frequency data are still being collected in American Samoa.

E. Status of stocks

It is believed that there is only one stock of albacore in the South Pacific which is separate from that in the North Pacific.

1. Methodology

A production model has been fit to South Pacific albacore data on total catch statistics and measures of effective effort which were smoothed over 1-, 2-, 3-, or 4-yr periods to approximate equilibrium conditions (Wetherall et al. see footnote 1). The parameter, m, was fixed at 2.0 (Schaefer model) and also allowed to vary. The production model smoothed over a 3-yr period provided the best fit (Figure 5).

2. Accuracy

The results showed that the Schaefer model (m = 2.0) was inappropriate. In the results using variable m, a MSY (maximum sustainable yield) between 33,000 and 36,000 MT and optimum effective effort levels of 60×10^6 to 389×10^6 hooks were predicted depending on the smoothing interval used.

3. Evaluation of stocks

The production models indicated a MSY between 33,000 and 36,000 MT and that virtually no increase in yield can be expected by an increase in effort above the 1977 level (191×10^6 hooks) and that an average yield almost equal to MSY could be obtained at half the 1977 effort.

F. Problem areas and program needs to solve problem

1. Research

In the area of the biological side, there are several tasks needing attention. First, there is an abundance of size composition data, so the possibility of doing a cohort analysis should be explored. A cohort analysis is likely to be difficult because relatively few age groups are found in the catch and there is no clear separation of length-frequency modes for most of the catch. If a cohort analysis is attempted, it should be done by sex, and sex composition will have to be estimated for catches since 1970.

The recent simulation model studies could be expanded, exploring more complicated hypotheses with respect to age-specific rates of natural mortality and catchability. An investigation of the robustness of the production model could be part of this.

A detailed study of relative population density by time and area could be undertaken. Indices of abundance by size-class should be constructed, and forecasting models using such indices should be attempted.

The possibility of tagging 2- and 3-yr old albacore in New Zealand waters should be evaluated, so that hypotheses on the interdependence of the surface and longline fishery can be tested and so that growth rates and migration patterns can be estimated.

2. Data

Data on the Fiji-based longline fleet are needed, also data from the developing surface fisheries in the South Pacific.

3. Management

The Shimizu Workshop participants concluded that the current South Pacific longline fishing did not appear to be seriously affecting the stock and if the current fishing patterns do not change, increases in fishing effort would result in only slight increases in yield, if any. However, changes in fishing patterns such as the development of major surface fisheries may alter the total yield and impact on the longline fisheries. Consequently, the development of the surface fisheries should be closely monitored.

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TEXT FOOTNOTE

[1]Wetherall, J. A., F. V. Riggs, and M. Y. Y. Yong. 1979. Assessment of the South Pacific albacore stock. Southwest Fisheries Center Admin. Rep. H-79-6. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, 12 p.

Table 1.--Estimated total catches of albacore in the South Pacific longline fishery, 1952-77. (Data adapted from Wetherall *et al.* see text footnote 1.)

Column	1	2	3	4	5	6
Year	Japan	Taiwan	Japan and Taiwan	R	Korea	Total
1952	210	--	210	--	--	210
1953	1,091	--	1,091	--	--	1,091
1954	10,200	--	10,200	--	--	10,200
1955	8,420	--	8,420	--	--	8,420
1956	6,220	--	6,220	--	--	6,220
1957	9,764	--	9,764	--	--	9,764
1958	21,558	--	21,558	--	146	21,704
1959	19,344	--	19,344	--	456	19,800
1960	23,756	--	23,756	--	610	24,366
1961	25,628	--	25,628	--	330	25,958
1962	38,880	0	38,880	0.0154	599	39,479
1963	33,500	608	34,108	0.0400	1,367	35,475
1964	21,435	629	22,064	0.1319	2,911	24,975
1965	19,305	1,640	20,945	0.3058	6,405	27,350
1966	23,401	6,669	30,070	0.3597	10,817	40,887
1967	16,640	14,910	31,550	0.4347	13,717	45,267
1968	7,707	14,496	22,203	0.4566	10,138	32,341
1969	5,559	9,883	15,442	0.6451	9,963	25,405
1970	6,560	12,463	19,023	0.6097	11,599	30,622
1971	4,339	21,584	25,923	0.5586	14,482	40,405
1972	2,796	23,050	25,846	0.5586	14,439	40,285
1973	2,381	28,858	31,239	0.5586	17,452	48,691
1974	1,847	19,980	21,827	0.5586	12,194	34,021

Table 1.--Continued.

Column	1	2	3	4	5	6
Year	Japan	Taiwan	Japan and Taiwan	R	Korea	Total
1975	1,045	15,092	16,137	0.5586	9,015	25,152
1976	1,906	19,954	21,860	0.5586	12,212	34,072
1977	2,240	21,345	23,585	0.5586	13,176	36,761

Comments:

Column 1 - Japanese longline catch in metric tons, courtesy of S. Ueyanagi, Far Seas Fisheries Research Laboratory.

Column 2 - Catch by Taiwan's high-seas longliners (>50 GT) based at foreign ports, estimated from published Taiwan catch statistics and average weights of albacore landed at Pago Pago.

Column 3 - Column 1 plus column 2.

Column 4 - R is ratio of Korean catch of South Pacific albacore to total catch of this species by Japan and Taiwan, estimated from data in Skillman (1975).

Column 5 - Column 3 x column 4, except for 1958-61, which are from American Samoa cannery records.

Table 2.--Evaluation of availability of South Pacific albacore data/

(Adapted from data in proceedings of the Shimizu Workshop.)

Gear	Country	1976 Catch 1,000 MT	Catch and effort data		Biological data	
			Coverage	Rating	No. of fish	Rating
Longline	Japan	1.9		Adequate		Adequate
Longline	Korea	12.2		Adequate		Adequate
Longline	Taiwan	20.0		Adequate		Adequate
Longline	Others	2.5		No data		No data

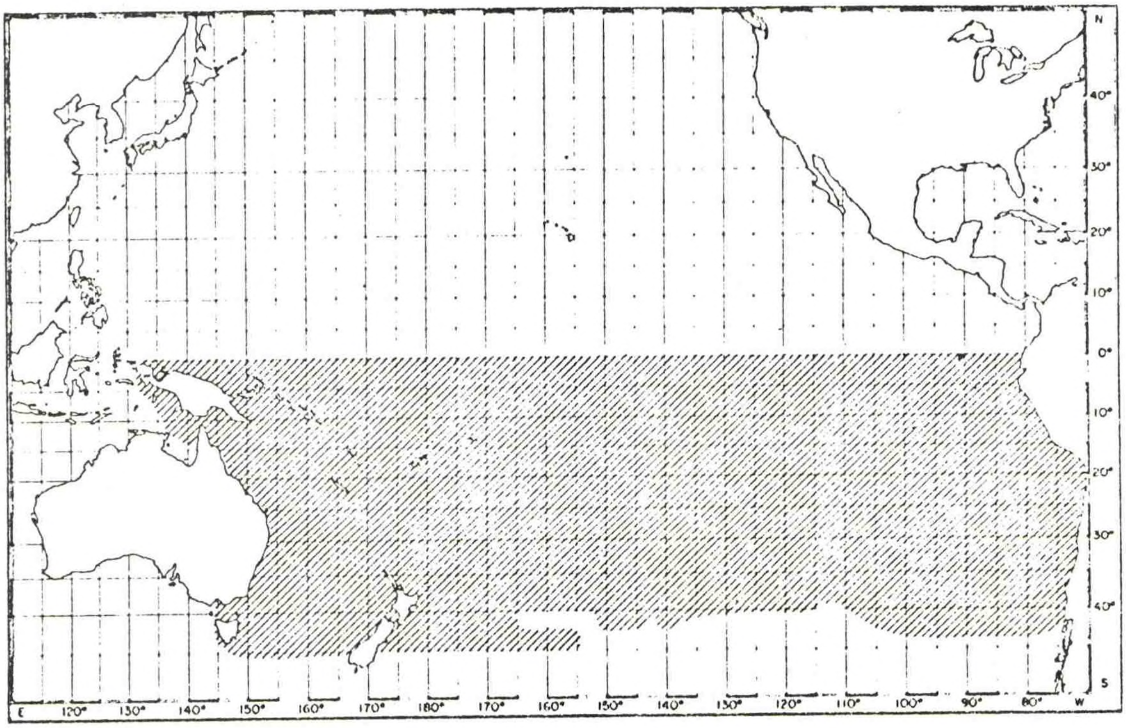

Figure 1.--The geographical boundaries of the South Pacific longline fishery for albacore. (Adapted from Wetherall et al. see text footnote 1.)

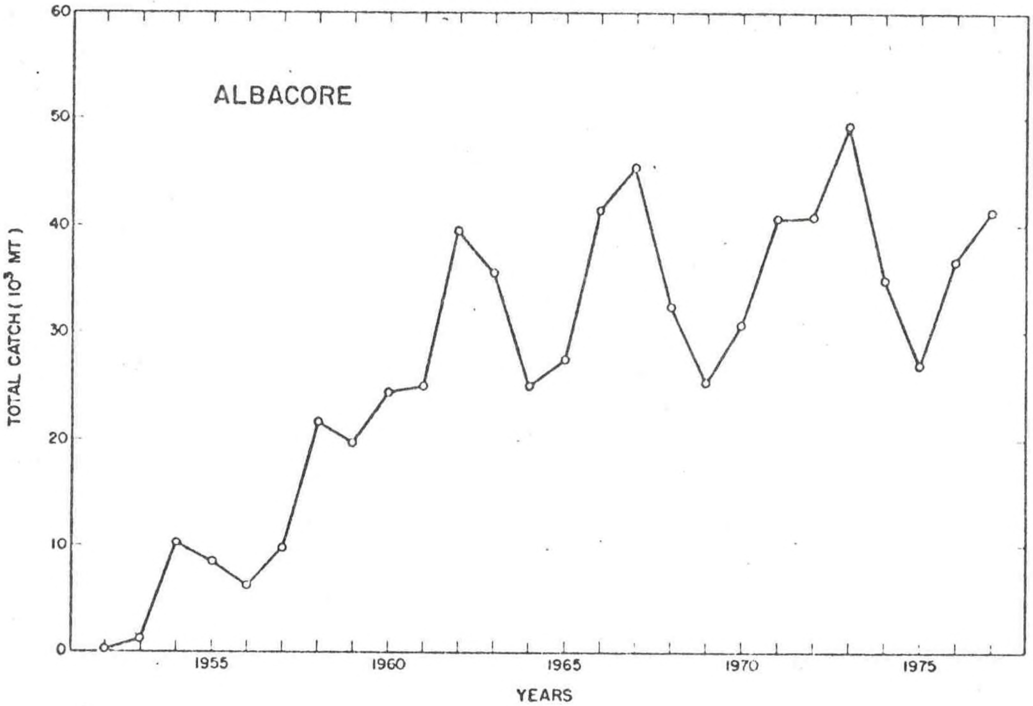

Figure 2.--Total catch of albacore in the South Pacific longline fishery, 1952-77. (Data from Wetherall et al. see text footnote 1.)

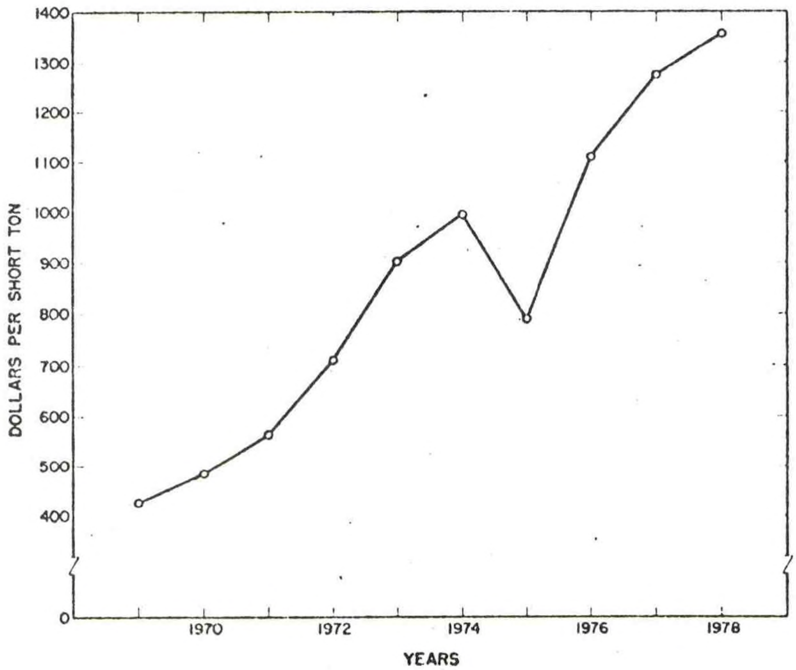

Figure 3.--Ex-vessel value of albacore in the American Samoa longline fishery. (Data from [U.S.] National Marine Fisheries Service 1969-1978.)

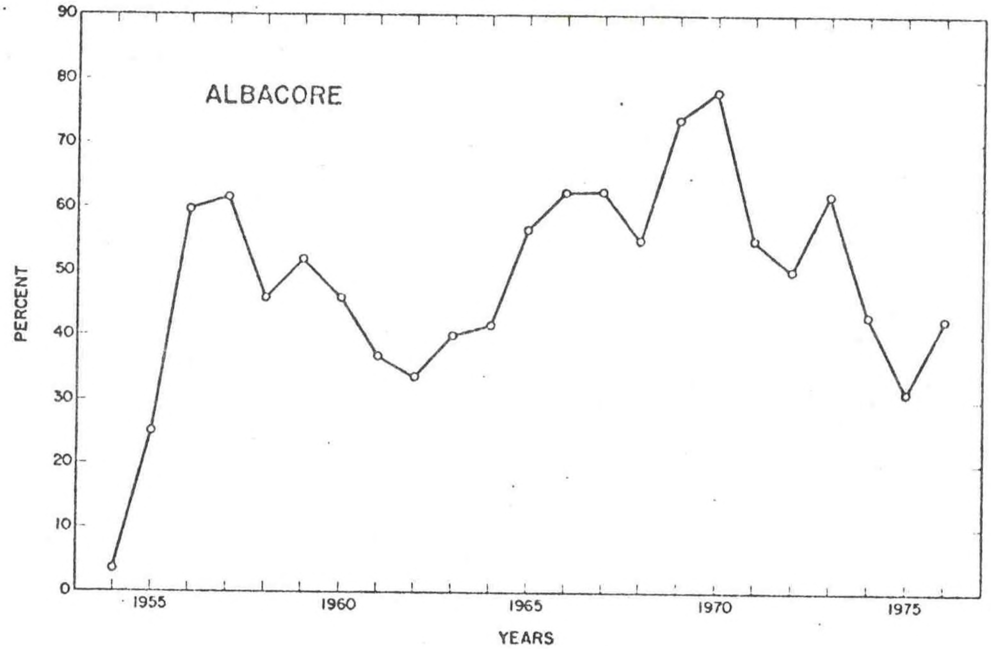

Figure 4.--Fraction of the estimated total South Pacific longline catch of albacore landed at American Samoa, 1954-76. (Data from Wetherall et al. see text footnote 1.)

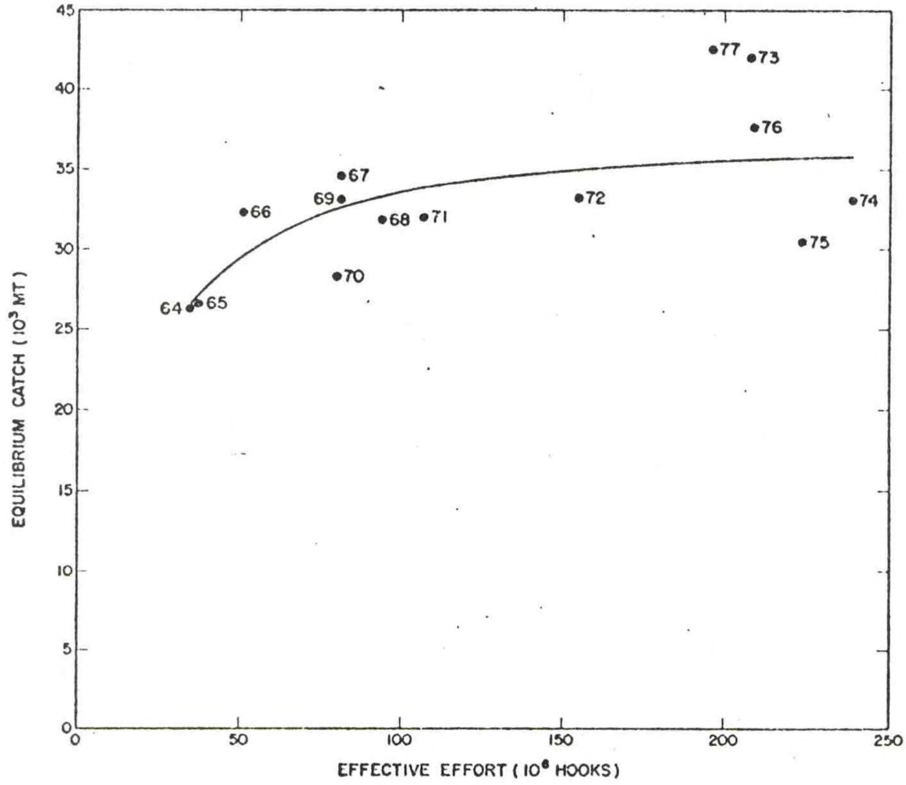

Figure 5.--Projected relationship between equilibrium yield and effective effort for South Pacific albacore, based on production model with 3-yr effort averaging. (From Wetherall et al. see text footnote 1.)

VI. PROBLEM AREAS AND PROGRAM NEEDS

VI.1 Research

Research on eastern Pacific yellowfin tuna (suggested in the IATTC annual reports) should concentrate on the following areas:

1. Length/age-frequency analyses should be continued to keep track of the number of age-1 fish being harvested by the fishery.

2. Production model analyses should be continued to assess the status of yellowfin tuna stocks in the eastern Pacific. Some assessment should be made on the possibility that the production model curve relating equilibrium catch to equilibrium effort is not logistic (m=2), but instead, Gompertz or asymtotic (m=1, m=0). The analysis should address the risks involved in assigning quotas based on a more optimistic view of MSY.

3. Analyses of management methods such as area/time/gear closures should be conducted to assess the merit of these methods in reducing the fishing mortality on small fish.

Other research topics that should receive consideration are:

1. Effort standardization techniques should be assessed as to biases encountered in a multi-species, multi-gear fishery and the effect of these biases on results of the production model assessed.

2. Yield-per-recruit analyses on a gear by gear basis should be continued to assess the effects of increases in size of capture on the gear. Also, after the critical size is determined, the effects of dumping on yield-per-recruit should be assessed.

3. An economic data base that will aid in determining the effects of area/time closures should be compiled.

The most important area of research is in the assessment of the number of age-1 yellowfin tuna being caught by the fishery in recent years. This increase in age-1 catches and decreases in yield-per-recruit could lead to recruitment failure in the future.

VI.2 Data

The data for eastern Pacific yellowfin tuna collected by the IATTC is very comprehensive and complete. The only area that may need attention is in the area of age-1 catches. Single set length-frequencies should be taken to assess the occurrences of age-1 fish in relation to type of set, areas, times, or any other parameters that may be related to age-1 fish catches.

this age being unusually high in 1973, 1974, and 1978. This is a cause for some concern. If this pattern continues, the catches could become more variable, due to dependence on fish of only one cohort at a time, and would probably be reduced due to the harvesting of the majority of the fish at sizes considerably less than the critical size. Further, if there are nothing but weak cohorts for several consecutive years, the catches would be so drastically reduced that severe economic hardship would be suffered by the majority of vessel owners and fishermen.

One way to reduce the dependence of the fishery upon age-1 fish would be to protect the fish less than a certain size from the fishery until they have had a chance to grow larger. This might be accomplished by (1) setting a minimum size limit, (2) prohibiting fishing in certain area-time strata in which small fish predominate, or (3) altering the opening date of the season in such a way that most of the vessels are subject to regulation at the time when small fish are most available. There are obstacles to such courses of action, however, for small and medium yellowfin are frequently mixed within schools, and skipjack are commonly associated in schools with small yellowfin. In the first case (minimum size limit), the fishermen would have the unfortunate choice of catching these schools and discarding large amounts of small yellowfin or passing the schools up and losing large amounts of skipjack and medium yellowfin. In the second and third cases, the choice would be with the rulemakers; if the regulations were strict large amounts of skipjack and medium yellowfin might be lost, while if the regulations were lenient, large amounts of small yellowfin might be caught. There is the possibility, however, that there are ways to achieve large savings of small yellowfin with relatively small losses of skipjack and medium yellowfin.

Another way to reduce the dependence of the fishery upon age-1 fish would be to reduce the fishing effort in 1979, thereby allowing more of the age-1 fish to survive throughout that year and be available as age-2 fish in 1980, and so on. This would tend to make the age structure of the population revert to its condition of the 1960's and early 1970's, when age-2, -3, and -4 fish contributed most to the weight of the catch. The immediate result would be a reduction in the catch, but this would eventually increase again.

The management scheme which is provided in the future should be flexible. The age structure of the fish in the catch should be monitored from the start of the season. If age-2 and age-3 fish are relatively abundant, the quota might be set at 210 thousand tons. If age-1 fish are again predominant, the quota might be set at considerably less than that in an attempt to reverse the trend toward dependence of the fishery on age-1 fish.

estimate of 0.8 is believed to be the most likely one, but that of 0.6 is included to determine how much higher the age of entry should be if the natural mortality rate is lower. In all figures, the yield-per-recruit increases with increasing multipliers of fishing effort up to about 1.0 regardless of the size at entry. With multipliers greater than about 1.0, the yields per recruit remain about the same with lower sizes at entry, but continue to increase with greater sizes at entry. Except at levels of effort less than about half the corresponding current effort, the yield-per-recruit increases with increases in the size of entry.

V.4 Current Appraisal

The total catch of yellowfin has stayed roughly the same for the 1973-1978 period, while the effort has nearly doubled (Figs. 4A and 4B). The catch-per-standard days fishing (CPSDF) has been reduced by about half during the same period. Accordingly, it seems unlikely that the MSY can be much greater than about 175 to 210 thousand tons. However, the increased effort during the 1973-1978 period has not reduced the catch, so perhaps the curve expressing the relationship between catch and effort does not turn downward on its overfishing side as precipitously as the curve in Figures 4A and 4B. If there were no information other than that used as input for the general production model, the best decision, from a biological point of view, would be to set a catch quota of about 160 to 165 thousand tons. This would, if the estimates of the parameters of the model are correct, increase the population in one year to the level at which it is capable of producing the MSY. On the other hand, since the catch has been maintained at about 190 to 200 thousand tons since 1973, the risks of doing damage to the stock by continuing with catch quotas of about 175 to 210 thousand tons appear to be low.

However, the size composition data are a source of concern with regard to continuing to fish with sufficient effort to ensure a catch equal to that of 1978. Tropical fish tend to have short life spans and moderate recruitment in each year. Temperate fish tend to have longer life spans and much more variable recruitment. For the latter, there may be very low recruitment for a number of years, followed by one or two years of very high recruitment and then a number of additional years with very low recruitment. Thus, one or two cohorts may support the fishery almost entirely alone for several years. Such being the case, the catches tend to vary considerably from year to year. Such highly variable recruitment would not be possible for a tropical species with a short life span because it would become extinct if there were virtually no recruitment for several years.

The recruitment of yellowfin seems to have become more variable in recent years, the 1974 and possibly the 1978 cohorts being strong ones, and the 1976 and 1977 apparently being weak ones. Also, the fishery seems to be more dependent on age-1 fish, the catches of fish of

V.2 Recruitment Analysis

Large catches of age-1 fish were made in 1973, 1974, and 1978 (Fig. 6). The question naturally arises as to whether these increased catches were due to increased recruitment, increased vulnerability of small fish resulting from average recruitment, or a combination of increased recruitment and increased vulnerability. In the first case, large catches could be expected in subsequent years when the fish from the large recruitment were available as medium and large fish, but in the second case, the reverse would be true due to scarcity of medium and large fish after the small ones were heavily exploited. The catches of the 1973 cohort as age-2, -3, and -4 fish were below average, indicating that the recruitment of this cohort was about average, and the high catch in 1973 was due to increased vulnerability of these fish at age 1. For the 1974 cohort, however, the catch during 1974 at age 1 was even higher than had been the case for the 73 cohort during the preceding year, and the catches of the 1974 cohort fish were about average, or a little above average, during the following three years. Accordingly, the recruitment of the 74 cohort was well above average. It cannot be determined until 1979 whether the large catch of age-1 fish in 1978 was due to above-average recruitment or above-average vulnerability. The age composition of the catch will be of particular interest in 1979.

It appears that there has been an increased dependence of the fishery upon age-1 fish in recent years. Catches of age-1 fish for cohorts 1976 and 1977 have been below average. It is likely, judging from the age distribution of the catches of fish of previous cohorts, that the catches of fish of the 1976 and 1977 cohorts will be relatively low during 1979. There has been greater apparent variability in recruitment during the 1973-1978 period than during the years previous to 1973. This may be due to reduced stock size resulting from the increased fishing effort in recent years, or it may be due to environmental factors. If it is due to reduced stock size, the variability is likely to persist as long as the fishing effort remains high.

V.3 Yield-Per-Recruit Analysis

The object of management carried out according to analysis of the yield-per-recruit model is to obtain the maximum yield-per-recruit. The estimated relationships among size at entry, multiplier of instantaneous fishing mortality, and yield-per-recruit are shown in Figures 7A-C. Various combinations of fishing effort and size at entry give various yields per recruit, which are indicated by the curved lines. Figure 7A is based upon age-specific fishing mortality rates estimated from length-frequency data obtained during the 1968-1972 period and an instantaneous natural mortality rate of 0.8; Figure 7B is based upon age-specific fishing mortality rates estimated from length-frequency data obtained during 1973-1978 and the same instantaneous natural mortality rate; Figure 7C is the same as the Figure 7A except that an instantaneous natural mortality rate of 0.6 is substituted. The natural mortality effort required to catch this amount at equilibrium conditions is about 52 thousand Class-3 days (Fig. 4A). All of the points, except those for 1967 and 1971, occur above the line. (In 1967 and 1971, large catches of skipjack were made, which diverted effort away from yellowfin, almost certainly reducing the catch of the latter species.) The occurrence of most of the points above the line is not unexpected, as the line represents levels of catch which would be taken at equilibrium conditions, and during the period in question the effort was increasing, thereby reducing the accumulated stock by catching amounts of fish in excess of the net gain due to recruitment plus growth minus natural mortality. The catch cannot be expected to remain at its present level indefinitely if the effort continues to increase each year for, unless the trend is reversed, the stock will eventually be reduced to the extent that the catch will decrease no matter how much effort is exerted.

For the second analysis, the catch-per-days-fishing (CPDF) for Class-6 purse-seine vessels (greater than 400 tons capacity) was employed as a measure of catch-per-unit-of-effort (CPUE). This was done because it had been observed that the CPDF's for the larger vessels had decreased more in recent years (1974 and 1975) than had those for smaller vessels. Since the larger vessels fish in more areas of the eastern Pacific Ocean and take a larger share (more than 85%) of the catch than do the smaller ones, the possibility exists that use of Class-6 data only will produce different estimates of the parameters. In this case, the MSY is again estimated to be 175,000 st, and the effort required to catch this amount at equilibrium conditions is about 22 thousand Class-6 days (Fig. 4B).

In each of the two cases, the MSY is estimated to be about 175,000 st. The 1976, 1977, and 1978 points in each case are located to the right of the highest point of the curve, which means that the effort has apparently exceeded the level necessary to achieve the MSY. If the effort is maintained at the 1976-1978 levels for the next several years there are two possibilities. First, the catch could decrease, which would indicate that the stock of yellowfin in the CYRA probably changes in response to fishing in accordance with the general production model on the overfishing side of the curve. Second, the catch could remain approximately constant or even increase. If the latter occurs, it could indicate that the model may not be appropriate. This can be determined only by continuation of the Commission's experimental overfishing program commenced in 1969.

Catch-and-effort data from outside the CYRA indicate that catch has been increasing proportionately to effort (Fig. 5). No production models have been fit to these data but if the logistic model were fit, then it seems that the data would indicate that the fishery is operating on the left-hand or underfishing side of the curve. Accordingly, at this time, there appears to be no biological reason for placing limits on the catch or the intensity of fishing outside the CYRA.

and are on computer data bases. Access to these data is extremely difficult due to the confidentiality of the data. Longline catch and effort data by 5° square and month are available for the Japanese and China (Taiwan) fleets through the SWFC data bases. Coverage on the Taiwanese fleet is very poor sometimes less than 20% and data are for 1967 to 1977. Coverage on the Japanese fleet is very good and data are for 1962 to 1977.

Many types of biological data are collected, length-frequency data, species composition data, tagging data, morphometric data, serological data, and larval distribution data. The biological data are sufficient to conduct analyses. Detailed descriptions of coverage and methods are available in several IATTC Bulletins. Data are available on cards or computer tapes.

Oceanographic and meteorological data are usually gathered by other organizations, i.e. the EASTROPIC expedition that utilized vessels from the University of California, the California Fish and Game, the U.S. Fish and Wildlife Service, and the Peruvian Navy. The IATTC has collected data in the Gulf of Nicoya, Gulf of Panama, and Gulf of Guayaquil using vessels from the Commission, Ecuador, Costa Rica, and the U.S.

V. STATUS OF THE STOCKS

It is the responsibility of the IATTC to monitor and assess the status of yellowfin tuna stocks in the eastern Pacific Ocean and to make the necessary recommendations for management of the species. In 1978 the status of yellowfin tuna stocks in the eastern Pacific was assessed using production model analyses, recruitment analyses, and yield-per-recruit analyses.

V.1 Production Model Analyses

Tagging experiments have shown that yellowfin tuna mix slowly between the area inside the CYRA and outside the CYRA. Therefore, production model analyses have been done considering yellowfin tuna in these two areas as two separate stocks.

Two production model analyses were used to determine the status of the yellowfin tuna stock inside the CYRA. Both methods used the logistic model but incorporated different time periods and used different purse seine classes to standardize effort.

For the first analysis, the effort was standardized to Class-3 purse-seine days (vessels of 101 to 200 tons capacity). Only the data for 1967 through 1978 were used, as prior to 1967 the fishing effort was not as well dispersed over the CYRA as later; also major changes in the efficiency of the purse-seine vessels were apparently taking place in the earlier years. The MSY is estimated to be 175,000 st, and the

Import tonnages of yellowfin tuna from the eastern Pacific catch of yellowfin are impossible to obtain with the present data set. Imports of yellowfin tuna from the Pacific and the Indian Oceans are available and have averaged approximately 42,500 MT during the period 1973 to 1978; the 1978 import of 51,000 MT was worth approximately $42,000,000. Virtually all of the domestic catch and imports of yellowfin tuna from the eastern Pacific Ocean, over 95% of the catch, is consumed in the U.S.

The U.S. commitment to the conservation of yellowfin tuna stocks in the eastern Pacific is indicated by its membership in the IATTC. The monitary commitment to the IATTC was $1,603,000 for 1978 or approximately 73% of the 1978 IATTC budget ($2.2 million).

III. CURRENT RESEARCH

The IATTC spends approximately $2.2 million (1978) for research and support of research on tunas in the eastern Pacific. Nearly all research on eastern Pacific yellowfin tuna is done by the IATTC. During 1978 research was done in the following areas: (1) Abundance estimates and their relation to fishing success, (2) Population structure and migration, (3) Size composition, (4) Feeding habits, (5) Otolith studies, (6) Tuna/porpoise studies, and (7) Tuna ecology and oceanography. Summaries of the results of these studies are available in the IATTC annual reports.

IV. INVENTORY OF DATA

The IATTC in accordance with its convention rules collects data from baitboats and purse seiners fishing in the eastern tropical Pacific. Total catch, catch and effort, biological data, oceanographic and meteorological data are collected. Data for the longline fisheries of Japan, Korea, and Taiwan are obtained from data publications of these countries.

A complete data set on catches of yellowfin tuna in the eastern Pacific (inside and outside the CYRA) are compiled from information furnished by canneries and longline data furnished by the participating countries. These catch data exist from 1919 to the present. The data are of high quality although in some cases, the data omits longline yellowfin tuna catches outside the CYRA in the eastern Pacific.

Catch and effort data for yellowfin tuna in the eastern Pacific are obtained from abstracts of logbook records from purse seiners and baitboats. The coverage rate for these data is more than 90%. Information collected include, for each day, the location of the vessel, whether or not it was fishing for tuna or for bait, the number and times of the sets, the catch of each species, the type of set and some environmental parameters such as sea surface temperature. These data are of high quality the quota may be increased by one or more increments; otherwise, the fishery inside the CYRA is closed to unrestricted yellowfin tuna fishing when it appears that the quota will be reached. However, if the catch per standard day's fishing ever falls below 3 short tons (2.7 metric tons) at any time during the year, unrestricted fishing for yellowfin in the CYRA is curtailed immediately so as to safeguard the resource.

Because the fishery in the CYRA operates also on tunas other than yellowfin, a specified allowance is made for the incidental catch of yellowfin tuna by vessels who choose to fish in the CYRA after the closure.

Although the catch quota can be taken on a first-come-first-served basis, special allocations for small vessels, new vessels of nations in the process of developing their tuna fisheries, and vessels carrying out designated research, have been granted over the years.

The closure date of the fishery in the CYRA is established at the time when the quantity of yellowfin already caught, plus the expected catch of yellowfin by vessels which are at sea on unrestricted fishing trips and by vessels expected to depart on unrestricted trips within the grace period reaches the yearly established quota, less the portion reserved for the incidental catch of yellowfin and any special allocations granted during the year.

II. NATURE AND DEGREE OF U.S. INTEREST

The U.S. concern with eastern Pacific yellowfin tuna is in the catch of the domestic fleet and the processing and consumption of the domestic and import catches. To maintain the market for yellowfin tuna, the U.S. is also concerned with conservation of the resource.

The U.S. fleet is composed of purse seiners (65%), baitboats (19%), and jigboats (16%). The fleet usually fishes the CYRA for yellowfin tuna from January to the closure of the CYRA. When the CYRA closes to yellowfin fishing, the larger purse seiners either move to areas outside the CYRA or to the Atlantic Ocean. Smaller purse seiners, baitboats, and jigboats continue to fish the CYRA but for species of tuna other than yellowfin (skipjack, bluefin, or albacore). During 1978 the U.S. fleet's catch of yellowfin tuna from the CYRA was approximately 94,700 MT; worth approximately $85,000,000 or 57% of the total 1978 CYRA catch and value in 1978. The U.S. catch of yellowfin tuna in 1978 from outside the CYRA was approximately 14,000 MT; worth approximately $13,000,000. The U.S. catch outside the CYRA is almost 95% of the total catch in this area. Therefore, the total value of the 1978 U.S. yellowfin tuna catch in the eastern Pacific was approximately $98,000,000.

I.2 Outside CYRA

The yellowfin tuna fishery outside the CYRA in the eastern Pacific was started by longliners in the 1950's and was solely a longline fishery. In 1968, two years after a quota system was established in the CYRA, large purse seiners also started fishing for yellowfin tuna outside the CYRA in the eastern Pacific, usually during the last two quarters of the year. The U.S., Japan, Korea, Taiwan, and Costa Rica currently participate in the fishery. The U.S. catches more than 95% of the total catch from outside the CYRA. Surface fishery catches of yellowfin tuna from outside the CYRA in the eastern Pacific have ranged from a low of 1,100 MT in 1968 to a record high of 46,000 MT in 1976. Since 1976, catches have dropped to 14,000 MT in 1978 (Fig. 2).

I.3 Ex-vessel Value

Ex-vessel values for countries other than the U.S. are unavailable except for Japan (Small=$894/st and large=$2663). Ex-vessel prices paid by the U.S. for yellowfin tuna in 1978 was approximately $790/short ton for yellowfin tuna less than 7 pounds and $840/short ton for yellowfin tuna, greater than 7 pounds. Based on the 1978 U.S. ex-vessel price and the 1978 catch of yellowfin tuna in the CYRA of 165,000 MT, the value of the 1978 yellowfin tuna catch in the CYRA is approximately $148,800,000. Based on the 1978 catch of yellowfin tuna from outside the CYRA and the 1978 U.S. ex-vessel price, the value of the yellowfin tuna catch from outside the CYRA (14,000 MT) is approximately $13,000,000. Therefore, the 1978 eastern Pacific catch of yellowfin tuna was worth approximately $162,000,000.

I.4 Management

The yellowfin tuna stocks of the eastern Pacific are managed by the Inter-American Tropical Tuna Commission (IATTC), which was established by convention between Costa Rica and the U.S. in 1949. Any government whose nationals fish for the tuna species covered by the convention in the waters of the eastern Pacific may join the IATTC. In this manner, Panama became a member in 1953, Ecuador in 1961, Mexico in 1964, Canada in 1968, Japan in 1970, and France and Nicaragua in 1973. Ecuador withdrew from the IATTC in 1968, Mexico in 1978, and Costa Rica in 1979.

Regulations limiting the total annual catch of yellowfin tuna inside the CYRA were first implemented in 1966 and have been in force ever since. Commencing in 1973, various experimental areas inside the CYRA have been opened to unregulated fishing on a yearly basis.

The annual catch quota is set on the basis of current research by the Commission on the dynamics of the yellowfin fishery inside the CYRA. After establishing the quota for a given year, the catch is closely monitored, and if it appears that the stock will not be damaged,

SITUATION REPORT FOR EASTERN PACIFIC YELLOWFIN TUNA

by

A. L. Coan, Jr. and Ron Rinaldo

I. DESCRIPTION OF FISHERY

The fishery for yellowfin tuna in the eastern tropical Pacific is divided into two geographical regions as a consequence of managing the fishery; (1) Inside the Commission Yellowfin Regulatory Area (CYRA) and (2) Outside the CYRA (Fig. 1). The fishery is composed of longline and surface gears (baitboats, purse seiners, and jigboats) that catch skipjack, bigeye, albacore, and bluefin tunas as well as yellowfin tuna.

I.1 Inside CYRA

Catches of yellowfin tuna have been recorded since 1919 for United States (U.S.) baitboats fishing inshore areas off southern California. Purse seiners (converted baitboats) started fishing as early as 1914, but the method was not perfected until 1920. A large-scale conversion of the fleet to purse seining took place in 1961 when the purse seine composition of the fleet jumped from 54% to 72%. Jigboats or trollers also fish the northern extremities of the CYRA, but their catches of yellowfin tuna are usually incidental to albacore tuna, their target species, and are negligible when compared to baitboat or purse seine catches. Longliners from Japan started fishing in the eastern tropical Pacific in the late 1950's and longliners from China (Taiwan) and South Korea joined the fishery in 1962 and 1965 respectively.

As better refrigeration methods and larger capacity vessels were introduced into the fleet, the fishing area grew rapidly southward and many Latin American countries started developing their own fishing fleets. During 1978 vessels of 18 nations participated in the eastern Pacific tuna fishery. Based on 1978 catches, the major participants in the fishery are the U.S. (57%), Mexico (11%), and Panama (6%) (Fig. 2).

As mentioned previously, catches of yellowfin tuna have been recorded as far back as 1919 when approximately 300 MT were landed in California. As the fishery expanded, catches of yellowfin tuna increased steadily (except for a decrease in catches during World War II) to 102,000 MT in 1950. Catches during the 1950's decreased to a low of 63,000 MT in 1954 then rose again to 109,000 MT in 1961 (Fig. 2). A quota system was established in 1966 and since then, the catch trends have reflected the quota (83,000 MT in 1966 to a record 191,113 MT in 1976, Fig. 2). The preliminary estimate of the 1978 yellowfin tuna catch from the CYRA is 165,000 MT.

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

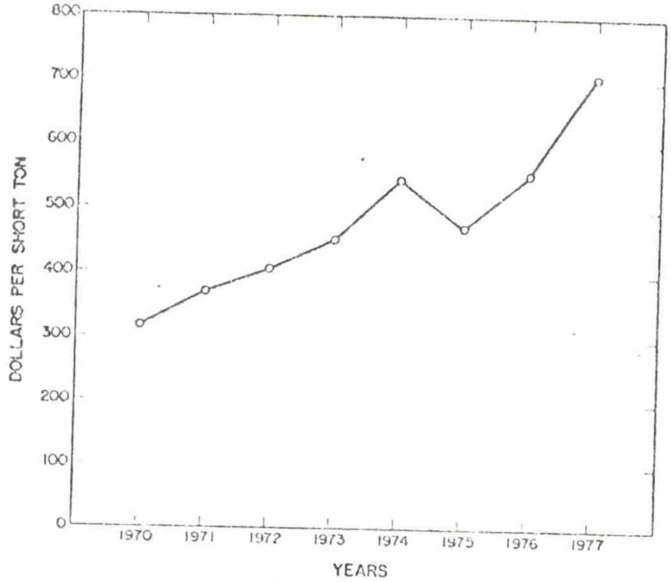

Figure 6.--Annual mean midpoints of ex-vessel price range for skipjack tuna in California. (Data from [U.S.] National Marine Fisheries Service 1978.)

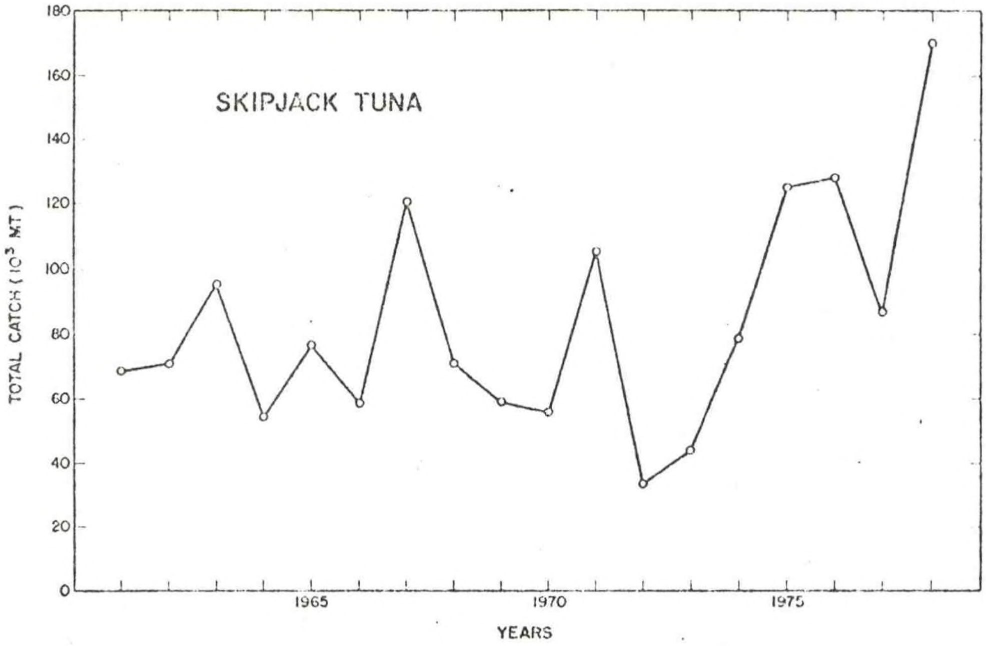

Figure 5.--Annual catch of skipjack tuna in the eastern Pacific Ocean.

(Data from IATTC 1979.)

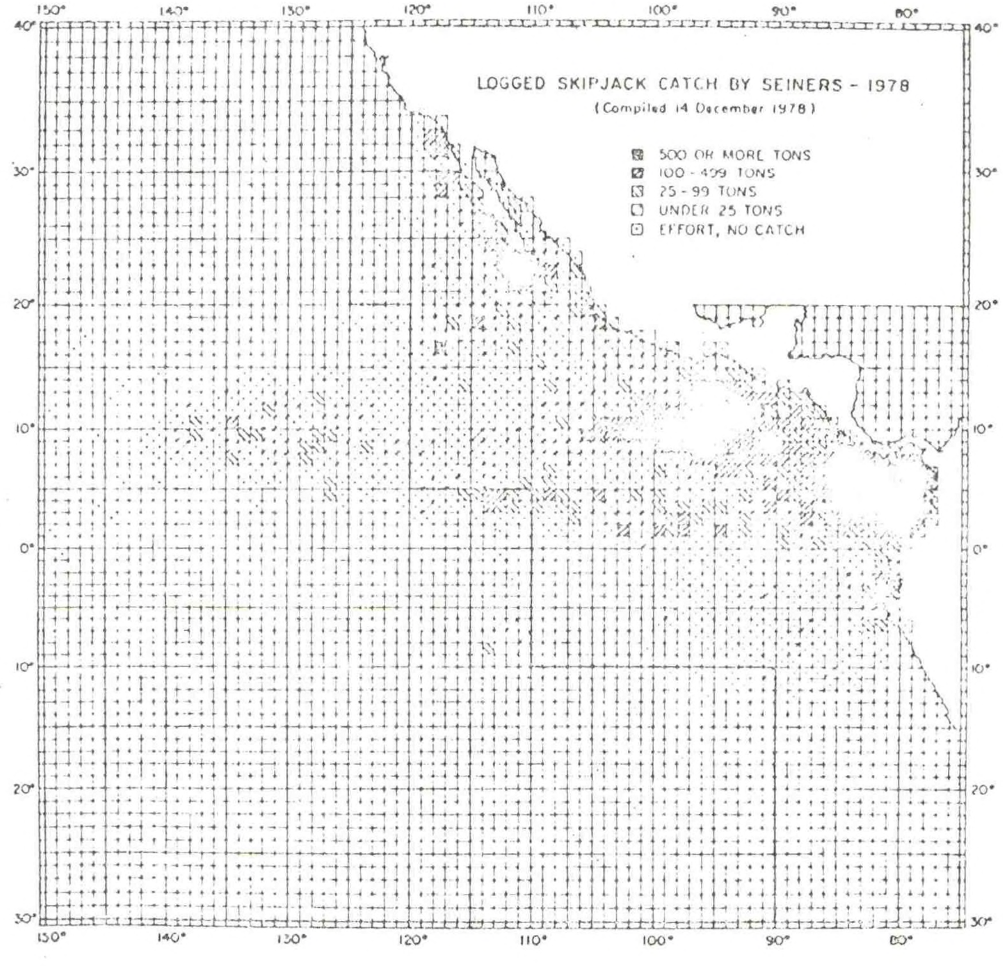

Figure 4.--Catches of skipjack tuna in 1978 in the eastern Pacific Ocean.

(From IATTC 1979.)

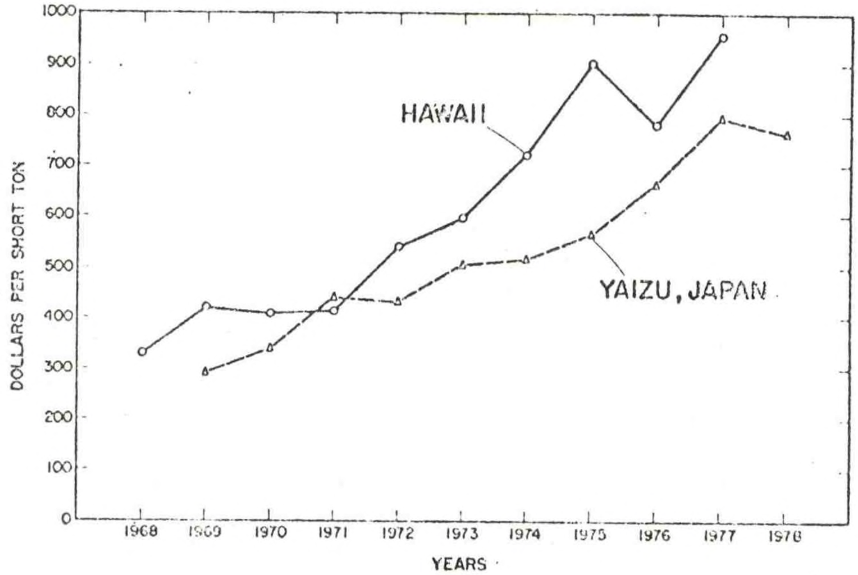

Figure 3.--Ex-vessel value of skipjack tuna landed in Yaizu, Japan, 1969-78, and in Hawaii, 1968-77. (Data from [U.S.] National Marine Fisheries Service 1969-1978 and Hawaii Division of Fish and Game see text footnote 2.)

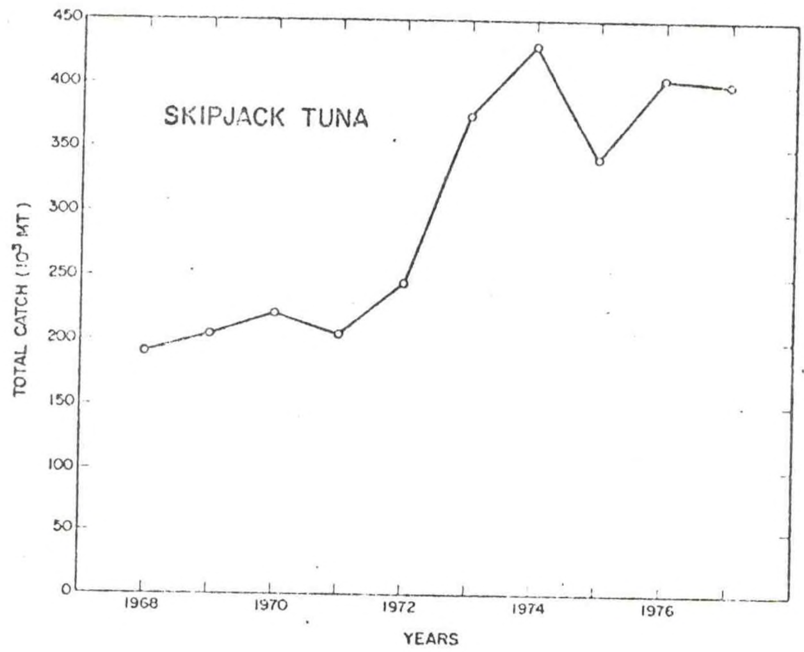

Figure 2.--Catch of skipjack tuna in the western Pacific Ocean.
(Data from FAO 1974, 1978.)

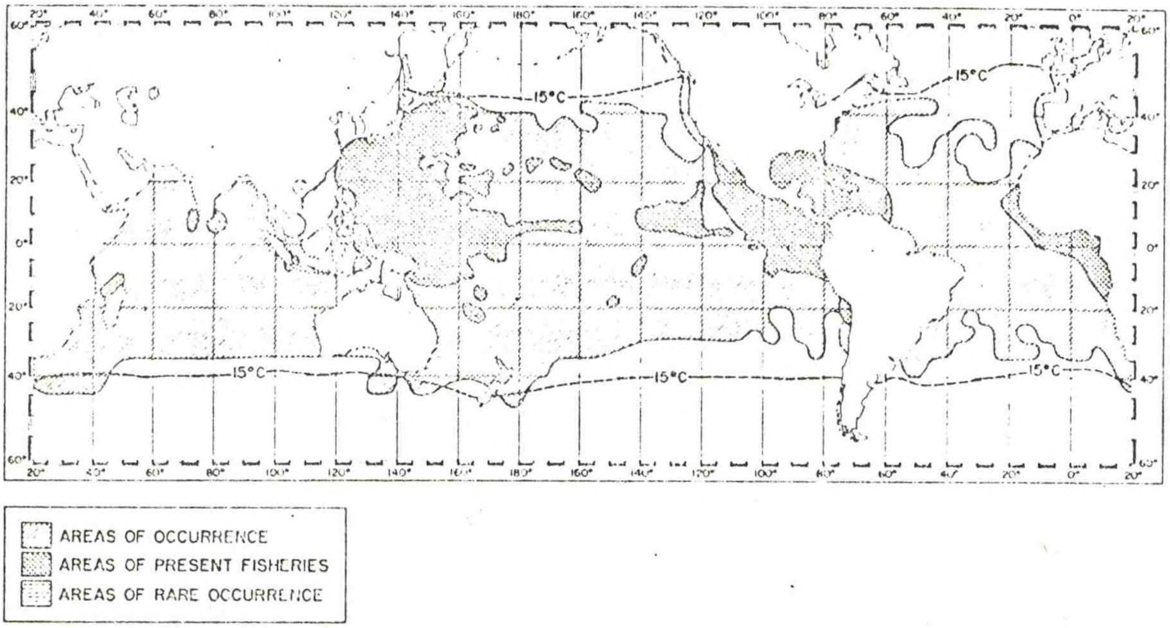

Figure 1.--Skipjack tuna distribution and fisheries in the Pacific Ocean.

(From Matsumoto and Skillman see text footnote 1.)

Table 1.--Catch of skipjack tuna by flag of vessel in the CYRA in 1978. (From IATTC 1979.)

Country	Catch (metric tons)	Percent
Bermuda	5,192	3.1
Canada	4,323	2.6
Colombia, Congo, Korea, New Zealand, Nicaragua, Senegal, Spain, Venezuela	20,790*	12.4
Costa Rica	5,942	3.5
Ecuador	11,820	7.1
Mexico	4,675	2.8
Netherlands	5,782	3.5
Panama	8,205	4.9
Peru	3,053	1.8
United States of America	97,688	58.3

*Preliminary

TEXT FOOTNOTES

[1]Matsumoto, W. M., and R. A. Skillman. Manuscr. in prep. Synopsis of biological data on skipjack tuna, *Katsuwonus pelamis* (Linnaeus). Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, HI 96812.

[2]Hawaii Division of Fish and Game. Commercial fish catch by species, State of Hawaii (issued monthly; also annual summaries).

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of the fishery and there apparently are no major problems in the system. In addition IATTC compiles statistics on world catches of tunas to better understand the factors which may affect the precision of IATTC tuna statistics for the eastern Pacific and also influence tuna fishing strategy in the area.

3. Management

The importance of understanding the annual variability in catch and availability of skipjack tuna to properly manage the fishery has been pointed out. Part of the research being conducted by IATTC towards this end has been attempts at predicting skipjack tuna catch and abundance.

could not be detected and as of 1977 there apparently was still no relationship between skipjack tuna abundance and fishing effort (IATTC 1978).

2. Evaluation of stocks

The fishery for skipjack tuna in the eastern Pacific has not affected stock abundance and it appears that the stocks could support increased harvests (Joseph and Calkins 1969; IATTC 1978).

Estimates of the potential yield of the combined eastern Pacific stocks were made by Rothschild (1966) and Silliman (1966). Assuming that the stocks were harvested beyond the range of the existing fishery, Rothschild estimated that the eastern Pacific skipjack tuna yield could be increased between 2 and 17 times. Silliman estimated a potential yield 2.75 times the 1954-61 yield of about 60,000 MT.

F. Problem areas and program needs to solve problem

1. Research

The stock structure of skipjack tuna in the Pacific Ocean, including the eastern Pacific, is poorly understood. It has been suggested that this is due to the fact that most studies on skipjack tuna have been based on populations occurring in relatively small areas whereas studies on an oceanwide basis are needed (IATTC 1978).

2. Data

In 1973 IATTC began updating its system of data handling and collection for catch and effort statistics of vessels that fish in the eastern Pacific to create a computer data bank. This has made it possible to more efficiently compute basic catch and effort statistics

2. Content

Data on the amounts of skipjack tuna and other species of tunas caught in the eastern tropical Pacific are gathered by IATTC from a variety of sources including records of government agencies of countries utilizing tunas, records of tuna canners, and import declarations in the U.S.

The IATTC also has a logbook and a statistical area system to obtain detailed information on current fishing operations, including bait catching operation, of vessels fishing in the CYRA. Using these sources of data, IATTC is able to obtain summaries of total catch of skipjack and other tunas by flag of vessel and country of landing, catch per effort data, and other data summaries of interest.

3. Quality

The quality of the data is generally adequate.

E. Status of stocks

The population structure of skipjack tuna in the Pacific Ocean is unclear. One hypothesis states that there are at least two skipjack tuna subpopulations in the Pacific, one in the western Pacific and the other in the eastern and central Pacific (Fujino 1970).

1. Methodology

It has not been possible to assess the potential production of skipjack tuna stocks in the eastern tropical Pacific using Schaefer's (1957) model or a method extending the results of yield-per-recruitment studies to total yield (Joseph and Calkins 1969). Schaefer's model was not usable because a relation between stock abundance and total effort

1978 totaled 104,823 MT (61.8% of total carrying capacity of all flag vessels) made up of 261 seiners, 65 bait boats, 8 bolicheras, and 33 jig boats (IATTC 1979).

C. Current research effort

1. Who is doing what? where?

Under the provisions of a convention originally entered into by the United States of America and the Republic of Costa Rica which became effective in 1950, the Inter-American Tropical Tuna Commission (IATTC) studies the "biology, ecology, and population dynamics of the tunas and related species of the eastern Pacific Ocean with a view to determining the effects that fishing and natural factors have on their abundance" and recommends "appropriate conservation measures so that the stocks of fish can be maintained at levels which will afford maximum sustainable catches if and when the commission research shows such measures to be necessary" (IATTC 1978).

2. Amount or indication of relative effort

The research program of IATTC is now in its 30th year. At the end of 1978, IATTC scientists had published 114 bulletins in the IATTC bulletin series, 176 articles in other journals, and 27 annual reports presenting results of research (IATTC 1978, 1979).

D. Inventory of data

1. Location

Skipjack tuna catch and related data for the fishery in the CYRA and adjacent areas in the eastern tropical Pacific are in the files of IATTC.

3. Amount caught

The catch of skipjack tuna in the eastern Pacific from 1961 through 1978 ranged from a low of 33,325 MT in 1972 to a high of 170,296 MT in 1978.

4. Catch trends

The annual catch of skipjack tuna has fluctuated widely and there are no obvious trends (Figure 5). The annual variation in the catch appears most likely to be the result of natural factors; however, whether this natural variability represents changes in the entire stock of skipjack tuna or merely reflects changes in the portions of a relatively constant stock available to the eastern Pacific fishery is not known (IATTC 1978).

5. Ex-vessel value

The ex-vessel value of skipjack tuna landed in California ports from 1970 to 1977 ranged from $317 per short ton to $707 per short ton (Figure 6). The value per short ton is an annual mean of midpoints of price ranges computed from the monthly midpoints of price ranges.

6. Current management

The eastern Pacific skipjack tuna is not under management.

B. Nature and degree of U.S. interest

The fishery for skipjack and yellowfin tunas in the eastern tropical Pacific was started by American fishermen. In 1978 American flag vessels caught 97,688 MT of skipjack tuna which constituted 58.3% of the total catch of this species in the eastern Pacific. The carrying capacity of American flag vessels fishing in the eastern Pacific in

II. Eastern Pacific Skipjack Tuna Fishery

A. Description of fishery

1. Short history

The skipjack tuna fishery in the eastern Pacific is an outgrowth of the California albacore fishery and is part of a multispecies tuna fishery where a number of tuna species are taken including yellowfin tuna, which together with skipjack tuna comprises the major species harvested in the fishery. The tuna industry originated in California near the turn of the century when albacore was successfully canned for the first time in 1903. The impetus for the growth of the fishery for yellowfin and skipjack tunas was provided when the California albacore fishery could not satisfy the demands of the industry and tuna canners turned to these two species for canning. The expansion of this high-seas tuna fishery was rapid as the fishermen found that yellowfin and skipjack tunas were abundant in the warmer waters of the eastern Pacific and by 1930 the fishery had expanded south to the Central American coast and outlying islands (Shimada and Schaefer 1956). In 1978 the fishery extended from about lat. 34°N to 26°S and from the North and South American coast to long. 150°W (Figure 4).

2. Participants

In 1978 vessels from Bermuda, Canada, Colombia, Congo, Costa Rica, Ecuador, Japan, Korea, Mexico, Netherlands, New Zealand, Nicaragua, Panama, Peru, Senegal, Spain, United States, and Venezuela engaged in the eastern Pacific tuna fishery (IATTC 1979). Ten of the 17 countries made significant catches of skipjack tuna in the CYRA (Commission Yellowfin Regulatory Area) (Table 1).

2. South Pacific Commission and other island areas

Landings data for the various island area skipjack tuna fisheries appear in the FAO yearbook of statistics. Other than these data, the location, content, and quality of the data are unknown.

E. Status of stocks

The stock structure of skipjack tuna in the Pacific is not very clear. It has been hypothesized that two subpopulations exist in the Pacific, one in the western Pacific and the other in the eastern and central Pacific (Fujino 1970).

No estimates of the status of skipjack tuna stocks in the western Pacific are available.

F. Problem areas and program needs to solve problem

1. Research

As noted in the discussion on the eastern Pacific skipjack tuna fishery, the stock structure of skipjack tuna in the Pacific is poorly understood. The stock structure of Pacific skipjack tuna must be clarified before any valid stock assessment studies can be initiated.

The importance of elucidating the stock structure dictates that the SPC tagging program currently underway should be maintained and new tagging programs elsewhere in the Pacific should be initiated.

2. Data

It is essential that complete catch and effort data from all harvesting nations and political entities be made available.

3. Management

Any management recommendations on limiting catch or effort seem premature.

In search of new sources of tuna, U.S. purse seiners have been making exploratory fishing cruises to the western Pacific.

C. Current research effort

1. Who is doing what? where?

The South Pacific Commission (SPC) headquartered at Noumea, New Caledonia recently initiated a skipjack tuna assessment program in the SPC area of interest. The SPC research effort includes tagging, exploratory fishing for tuna and bait, and analyzing basic biological data (length, weight, sex, maturity, and stomach contents).

In Japan, the lead agency for skipjack tuna research is presumably the Tohoku Regional Fisheries Research Laboratory. The Tohoku Laboratory prepares an atlas of Japanese skipjack tuna fishing operations in the southern fishing grounds, which includes data on monthly catch rates and length-frequency distributions.

Research on skipjack tuna has also been conducted in Taiwan including studies on age and growth, larvae, sexual maturity and fecundity, and morphometrics.

D. Inventory of data

1. Japan

a. Location.--Japanese Fisheries Agency. Tohoku Regional Fisheries Research Laboratory.

b. Content.--Total landings; sample catch and effort; length composition.

c. Quality.--Unknown.

FAO yearbooks of fishery statistics show no landings of skipjack tuna in Taiwan, there apparently is a troll fishery of unknown magnitude there. The U.S.A. (Hawaii) has a small surface fishery in the western Pacific; and American tuna seiners have been making western Pacific exploratory fishing cruises.

3. Amount caught

The landings of skipjack tuna in the western Pacific (area west of long. 175°W, lat. 65°N-25°S) ranged from 190,100 to 430,199 MT (metric tons) from 1968 to 1977 (FAO 1974, 1978).

4. Catch trends

The catch of skipjack tuna in the western Pacific during the period from 1968 to 1977 peaked at 430,199 MT in 1974 and has appeared to level off thereafter (Figure 2).

5. Ex-vessel value

The mean annual ex-vessel prices of skipjack tuna from 1969 to 1978 at Yaizu, one of the important tuna landing ports in Japan, ranged from $291 to $797 per short ton; the ex-vessel value of skipjack tuna in Hawaii during the period from 1968 to 1977 ranged from $330 to $957 per short ton[2] (Figure 3). Except for slight setbacks in 1972 and 1978, the ex-vessel prices at Yaizu have been on a continuous upward trend.

6. Current management

The western Pacific skipjack tuna stock currently is not under management.

B. Nature and degree of U.S. interest

A U.S. tuna company operates a freezing plant at Palau.

I. Western Pacific Skipjack Tuna Fishery (west of ca. long. 150°W)

A. Description of fishery

1. Short history

The major fisheries for skipjack tuna, Katsuwonus pelamis, in the Pacific Ocean are located adjacent to continents and islands where oceanographic features such as upwelling concentrate large numbers of fish near the surface. Of the major fisheries the western Pacific fishery (Japanese pole-and-line, live-bait fishery) is by far of greatest antiquity. The origin of the Japanese fishery is obscure; however, skipjack tuna fishing is mentioned in the oldest (semi-legendary) account of Japanese history. Keen (1965) stated that the Japanese pole-and-line fishery for skipjack tuna dates from at least the early part of the Tokugawa Period (1603-1868).

The Japanese skipjack tuna fishery which was earlier limited to coastal waters of Japan has expanded eastward and southward into subtropical and tropical waters[1] (Figure 1).

Skipjack tuna fisheries are also well developed or developing in Hawaii and many island areas in the western Pacific.

2. Participants

In addition to Japan, which is the major producer of skipjack tuna in the western Pacific, Fiji, Gilbert Islands, Indonesia, Korea, Trust Territory of the Pacific Islands, Papua New Guinea, Philippines, Singapore, and Solomon Islands show landings of skipjack tuna (FAO 1978). However, Japan is also involved in the fisheries of some of these countries or political entities through joint venture arrangements. Although the

CWP-3

SITUATION REPORT ON SKIPJACK TUNA IN THE PACIFIC

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August 1979

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

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REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

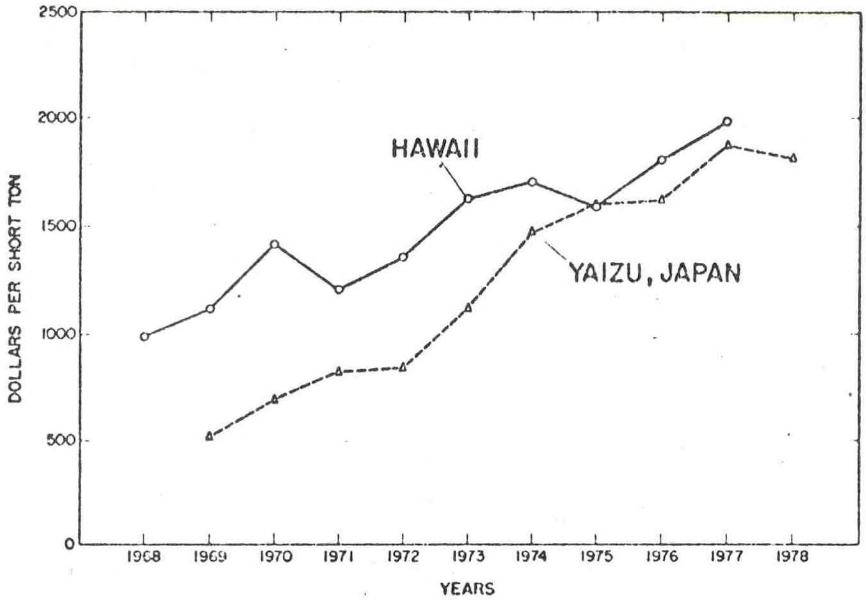

Figure 3.--Mean annual ex-vessel value of yellowfin tuna landed in Yaizu, Japan, 1968-78 and in Hawaii 1968-77. (Data from [U.S.] National Marine Fisheries Service 1968-78; Federation of Japan Tuna Fisheries Cooperative Association and Japan Tuna Fisheries Federation [1976?]; Hawaii Division of Fish and Game see text footnote 2.)

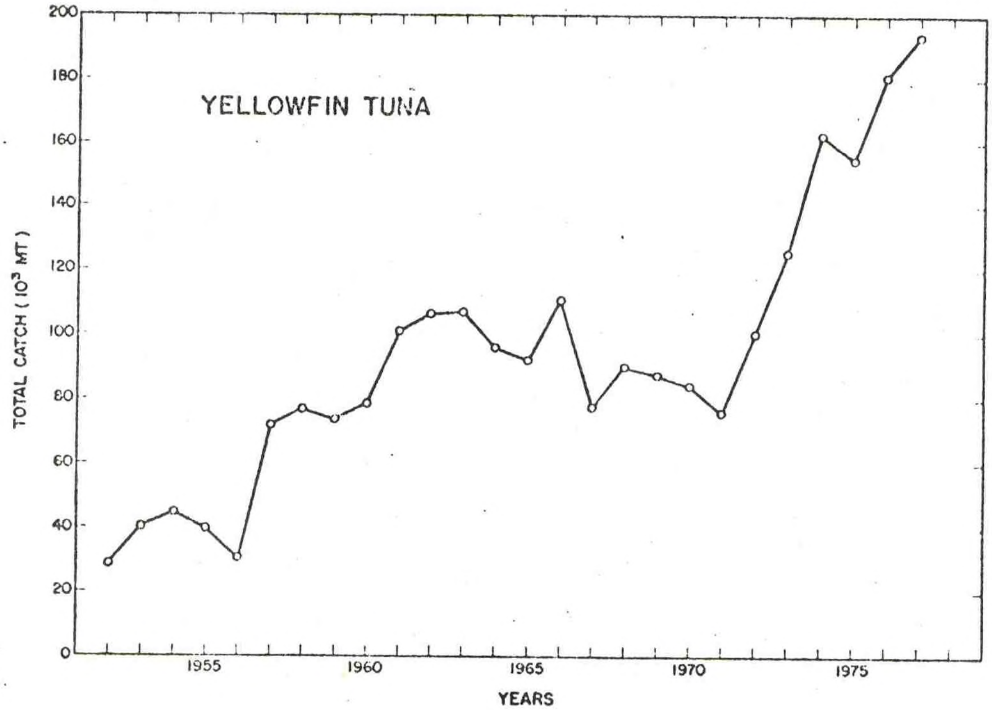

Figure 2.--Yellowfin tuna annual catch trends in the western Pacific Ocean. (Data from Honma and Suzuki see text footnote 1.)

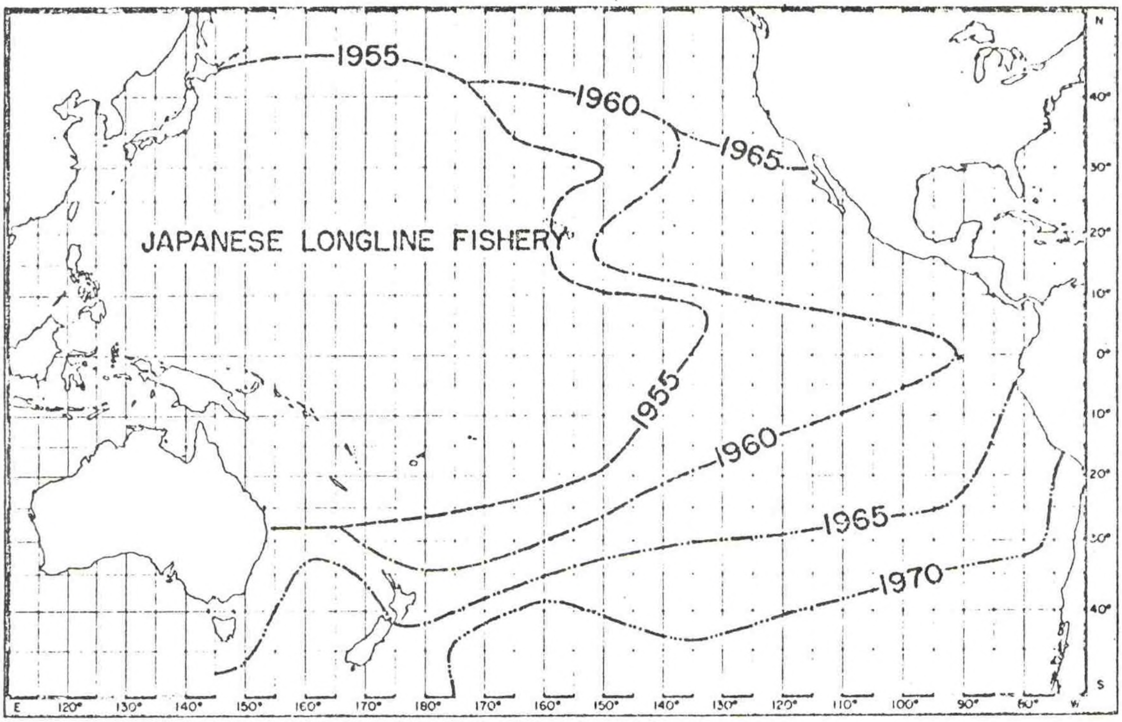

Figure 1.--Expansion of the Japanese longline fishery in the Pacific Ocean. (From Kume 1972.)

Table 1.--Catch of yellowfin tuna in the western Pacific (all gear) in metric tons. (Data from Honma and Suzuki see text footnote 1.)

Year	Japan	Korea	Taiwan	Philippines	Others	Grand Total
1952	28,586					28,586
1953	40,164					40,164
1954	43,450		1,192			44,642
1955	36,903		2,724			39,627
1956	28,118		2,377			30,495
1957	69,865		2,109			71,974
1958	74,929		1,753			76,682
1959	72,189		1,568			73,757
1960	77,485		1,301			78,786
1961	98,363		2,606			100,969
1962	100,426		5,513			105,939
1963	101,480		5,149			106,629
1964	89,440	500	5,795		300	96,035
1965	82,265	2,000	7,890		100	92,255
1966	96,137	3,000	11,221		100	110,458
1967	68,867	1,900	6,629		100	77,496
1968	73,116	5,300	11,452		100	89,968
1969	73,520	3,500	10,598		100	87,718
1970	71,645	2,000	10,502		100	84,247
1971	56,317	5,300	14,404		100	76,121
1972	75,053	11,800	13,368		100	100,321
1973	77,468	12,000	19,226	14,900	1,620	125,214
1974	81,359	15,104	12,706	51,732	1,511	162,412
1975	72,674	10,366	16,867	52,793	1,823	154,523
1976	94,818	15,613	17,235	44,478	8,852	180,996
1977	93,638	16,580	20,042	59,263	3,995	193,518

TEXT FOOTNOTES

[1]Honma, M., and Z. Suzuki. 1979. Stock assessment of Pacific yellowfin tuna exploited by the tuna longline fishery together with surface and other fisheries in the western and central Pacific. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979, [10 p.].

[2]Hawaii Division of Fish and Game. Commercial fish catch by species, State of Hawaii. (Issued monthly; also annual summaries.)

[3]Wetherall, J. A., F. V. Riggs, and M. Y. Y. Yong. 1979. Assessment of the South Pacific albacore stock. Southwest Fisheries Center Admin. Rep. H-79-6. Prepared for the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979.

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[1976?]. Katsuo to maguro (skipjack and tunas). Statistics of Japanese tuna fishery, 1975, 25 p.

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1972. Tuna fisheries and their resources in the Pacific Ocean. Indo-Pac. Fish. Counc. Proc., 15th Sess., p. 390-423.

SUZUKI, Z., P. K. TOMLINSON, and M. HONMA.

1978. Population structure of Pacific yellowfin tuna. [In Engl. and Span.] Inter-Am. Trop. Tuna Comm. Bull. 17:277-441.

[U.S.] NATIONAL MARINE FISHERIES SERVICE.

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The Shimizu workshop noted that improvements in data collection were made in the Philippines wherein an improved system to collect statistics was instituted in 1976 for the municipal fisheries (conducted by vessels ≤ 3 gross tons). The improved system was largely responsible for the reported increase in the apparent catch of yellowfin tuna in recent years in the Philippines.

3. Management

Although the condition of the western Pacific yellowfin stocks(s) is not certain, tentatively, it appears that the stock can withstand the current level of fishing or perhaps more. The lack of much critical data did not allow a more positive assessment.

2. Accuracy

Because of the uncertainties introduced by the surface fisheries, the analysis should be considered tentative.

3. Evaluation of stocks

Although the condition of the western Pacific yellowfin tuna stock(s) is not certain, it appears that the stock is capable of sustaining the current level of fishing or perhaps more. It was estimated that the MSY (maximum sustainable yield) for the Pacific longline fishery for yellowfin tuna was around 80,000 to 90,000 MT, and that increased longline fishery effort was unlikely to result in a significant increase in sustained catch.

F. Problem areas and program needs to solve problem

1. Research

Growth parameters of western Pacific yellowfin tuna need to be determined. The relation and the extent of mixing of fish available to surface gear and longline gear should be determined. Production model analysis incorporating surface catch and effort data should be undertaken. Also yield per recruit estimates are needed.

2. Data

Data on catch, catch per effort, and length frequencies are lacking or inadequate for assessment studies and should be secured. Particularly the large surface catch of yellowfin tuna in the Philippines in recent years should be documented and longer historical catch data obtained. Also, problems on double reporting of catches and misidentified or unidentified yellowfin tuna catches should be corrected.

fishing. The logbook data are used to estimate total catch and effort.

Length frequencies of yellowfin tuna caught by Japanese longliners have been published (Suzuki et al. 1978).

3. Quality

Total catch estimates of western Pacific yellowfin tuna are considered poor, but improving. In many countries the catches are not reported or yellowfin tuna are aggregated with other species in the catches. The yellowfin tuna catch in the Philippines is believed to be large, but landings figures have been available only for recent years. Also length-frequency data for western Pacific yellowfin tuna are available only from Japanese longline catches.

E. Status of stocks

The stock structure of yellowfin tuna in the Pacific Ocean is not perfectly clear but a hypothesis has been advanced that there are two separable stocks, one in the eastern Pacific and the other in the western Pacific, separated by a less clearly defined stock in the central Pacific (Suzuki et al. 1978).

1. Methodology

Although a production model analysis was not possible for the combined surface and longline fisheries for yellowfin tuna in the western Pacific, an analysis (Honma and Suzuki[1]) was possible for the entire Pacific longline fishery, which probably reflects the situation in the western Pacific longline fishery.

Some research on yellowfin tuna in the western Pacific is also being done in Taiwan. Investigators in Taiwan have published papers on age and growth, morphometrics, and population structure of western Pacific yellowfin tuna.

The status of the western Pacific yellowfin tuna was reviewed at the Workshop on the Assessment of Selected Tuna and Billfish Stocks in the Indian and Pacific Oceans, Shimizu, Japan, 13-22 June 1979.

2. Amount or indication of relative effort.

The yellowfin tuna is one of the more important species taken in the Japanese longline fishery and consequently, a large amount of research effort is directed towards this species by the FSFRL.

D. Inventory of data

The Shimizu workshop evaluated the general availability of data by various fisheries and species, including yellowfin tuna.[3]

1. Location

The governments of Japan, Taiwan, and Korea collect catch statistics and related data from the various yellowfin tuna fisheries. The Japanese and Taiwan (since 1967) catch statistics are published annually. The Korean catch statistics are either not regularly published or available. Japanese data have been made available in the past by the FSFRL, Shimizu, Japan and the Taiwan data by Dr. R. T. Yang of the National Taiwan University.

2. Content

Longline vessel logbooks provide data on catch in number by species, position, and number of hooks fished for each day of

4. Catch trends

The total western Pacific catch of yellowfin tuna peaked in the mid-1960's, declined slowly to 76,121 MT in 1971, then increased rapidly to levels higher than that in the 1960's to reach 193,518 MT in 1977 (Figure 2).

5. Ex-vessel value

The mean annual ex-vessel value of yellowfin tuna at Yaizu, Japan ranged from $511 to $1,873 per short ton from 1969 to 1978; the ex-vessel value ranged from $985 to $1,984 per short ton during the period from 1968 to 1977 in Hawaii[2] (Figure 3).

6. Current management

The western Pacific yellowfin tuna is not under management.

B. Nature and degree of U.S. interest

The yellowfin tuna is one of the important species caught in the Hawaiian longline fishery. It is also an important species in the recreational fishery in Hawaii.

Yellowfin tuna are landed at American Samoa, Tahiti, and other island areas where U.S. interests operate canneries or transshipment facilities. American purse seiners have also been making exploratory fishing voyages in the western Pacific.

C. Current research effort

1. Who is doing what? where?

The Far Seas Fisheries Research Laboratory (FSFRL) has been doing research on the Pacific yellowfin tuna for many years. Recently in cooperation with the Inter-American Tropical Tuna Commission (IATTC), a paper discussing the population structure of yellowfin tuna in the Pacific was published (Suzuki et al. 1978).

A. Description of fishery

1. Short history

The yellowfin tuna, Thunnus albacares, in the western Pacific Ocean (west of ca. long. 150°W) is caught primarily by longline gear; smaller amounts are taken by pole-and-line, purse seine, and other surface-fishing gear. The longline fishery that now extends completely across the Pacific Ocean between approximately lat. 45°N and 45°S is an outgrowth of the Japanese longline fishery, which was generally confined to the western Pacific before World War II. The Japanese longline fishery quickly expanded eastward after the war and reached the American Continents in 1964 (Figure 1). Longline vessels from Taiwan joined the fishery in 1962 and those from South Korea, in 1965 (Suzuki et al. 1978).

2. Participants

As indicated above, longliners from Japan, Korea, and Taiwan are engaged in the longline fishery in the Pacific.

Japan, Taiwan, and the Philippines have surface fisheries for yellowfin tuna in the western Pacific. Australia, Fiji, Gilbert Islands, Papua New Guinea, New Zealand, and French Polynesia also show landings of yellowfin tuna (FAO 1977, 1978).

The U.S.A. (Hawaii) has a small longline fishery and also a surface fishery for yellowfin tuna.

3. Amount caught

The total catch of yellowfin tuna, all years combined, ranged from 28,586 to 193,518 MT (metric tons) from 1952 to 1977 in the western Pacific (Table 1).

CWP-2

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SITUATION REPORT ON YELLOWFIN TUNA IN THE WESTERN PACIFIC OCEAN

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August 1979

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

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REVIEWER'S NAME (OPTIONAL):

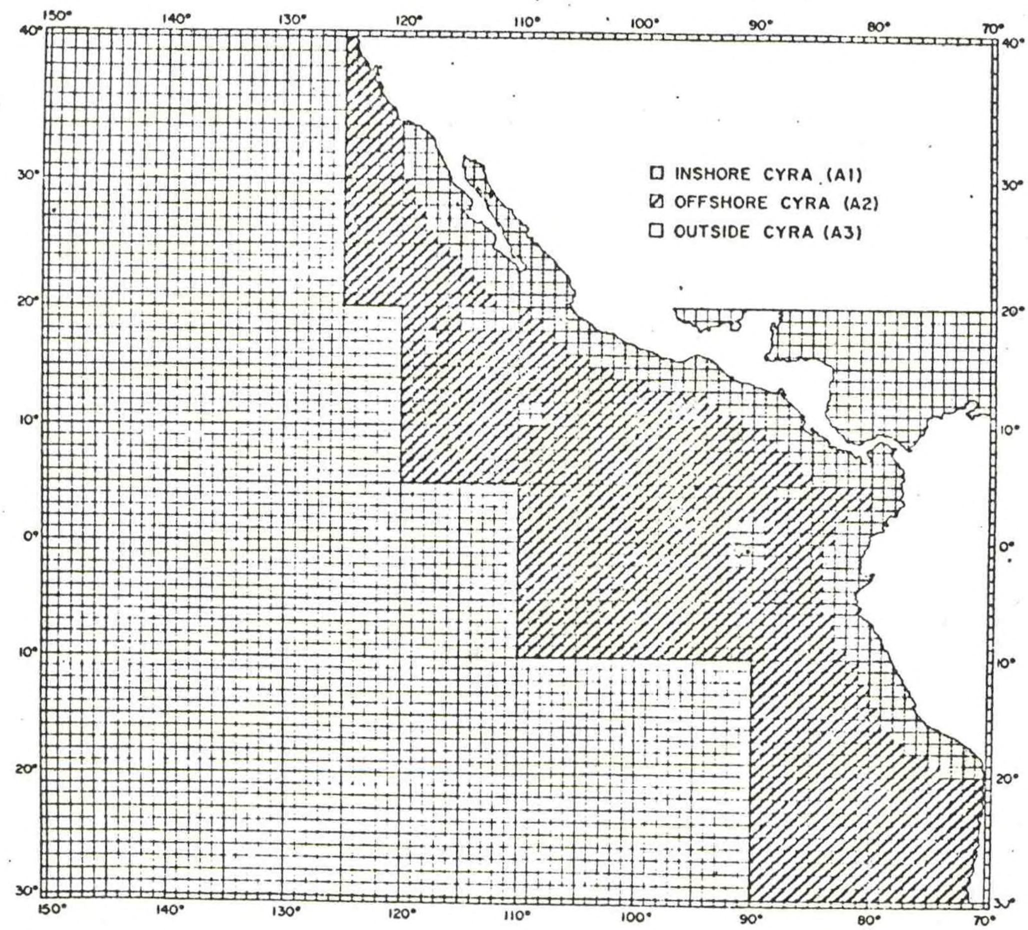

Figure 1. The eastern tropical Pacific Ocean showing the historical area of the fishery for yellowfin tuna, the more recently fished area within the Commission's Yellowfin Regulatory Area(CYRA) and the area outside the CYRA.

Data from the IATTC is hard to obtain due to the confidentiality of some of the data. A complete catalog of the available data should be distributed and quidelines established for their use.

VI.3 Management

The major management problem is in relation to the controversy over the quota system that has risen in recent years. Member countries have become concerned about the way allocations of the quota are handled and about their positions on their countries 200 mile limits. This problem is currently under negotiation between member countries but no solution is in sight; the existence of the IATTC may be in jeopardy.

Another problem in the area of management that may present itself in the near future is management of fishing on age-1 fish. Methods to achieve this need to be examined as to their effects on the fisheries and stocks.

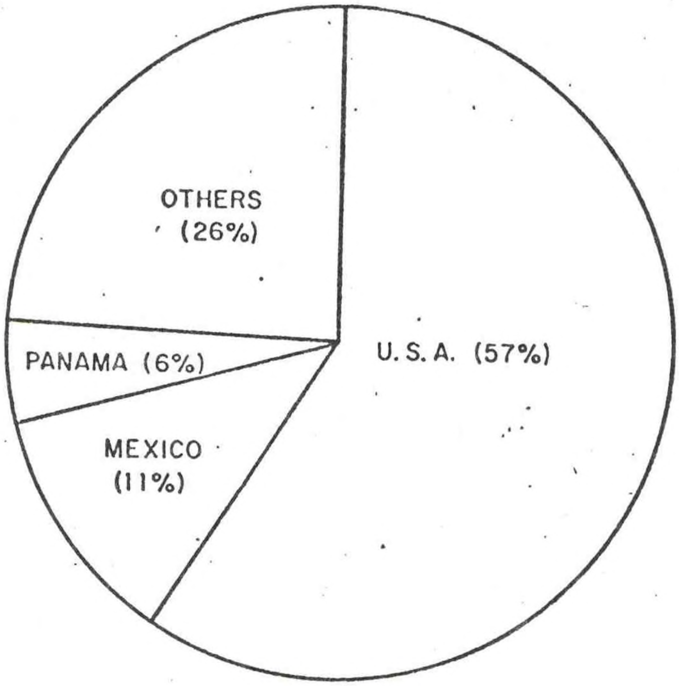

Figure 2. Major participants in the eastern tropical Pacific Ocean yellowfin tuna fishery in 1978.

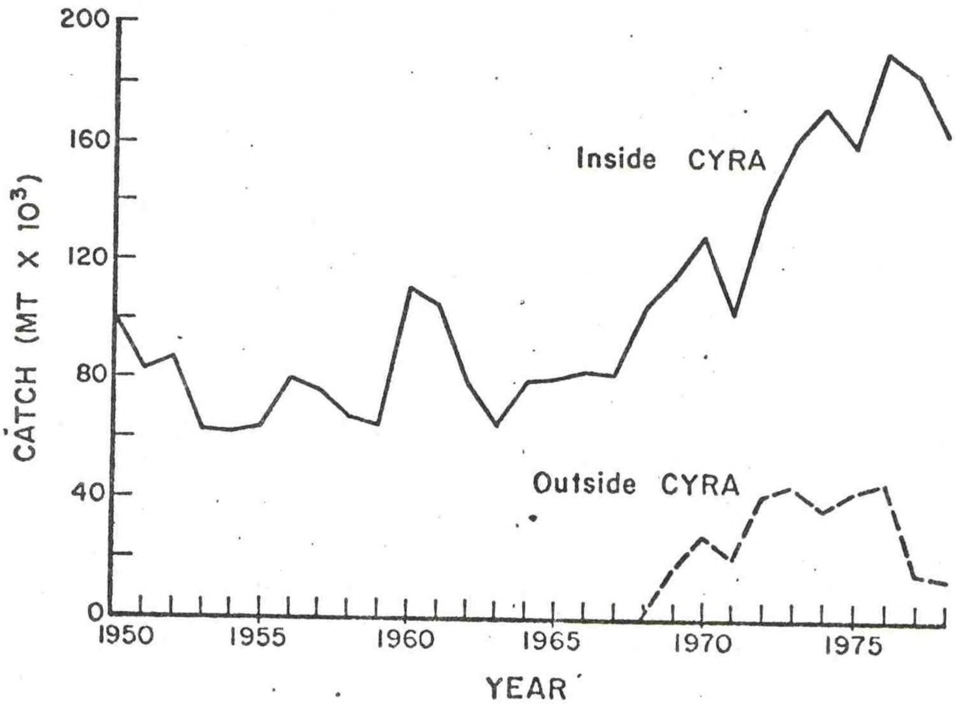

Figure 3. Catches of yellowfin tuna from inside the CYRA and outside the CYRA in the eastern tropical Pacific Ocean.

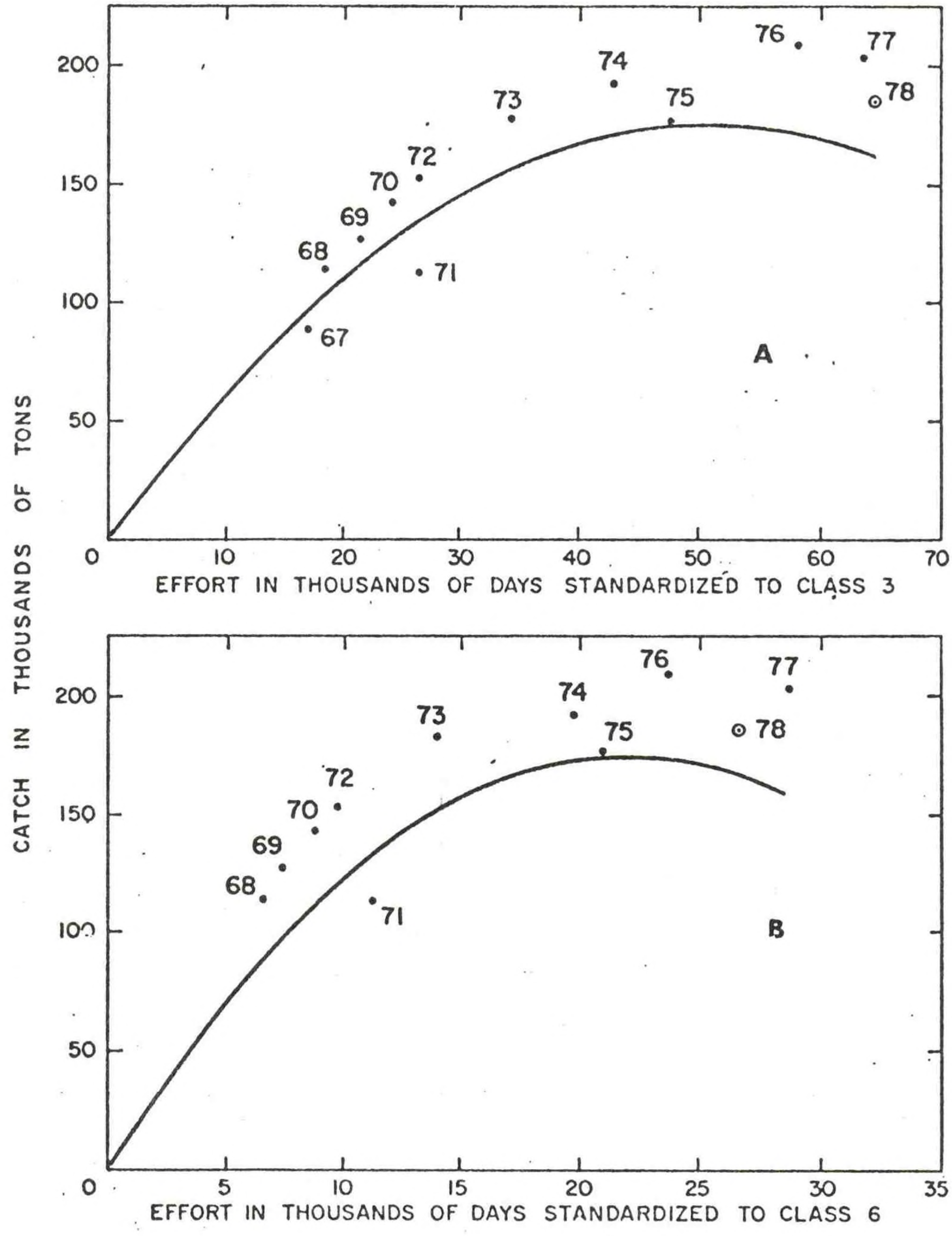

Figure 4A. Equilibrium catch curve for the yellowfin tuna fishery inside the CYRA, 1967-1978. Effort in days fishing is standardized to class 3 purse seiners.

Figure 4B. Equilibrium catch curve for the yellowfin tuna fishery inside the CYRA, 1968-1978. Effort in days fishing is standardized to class 6 purse seiners.

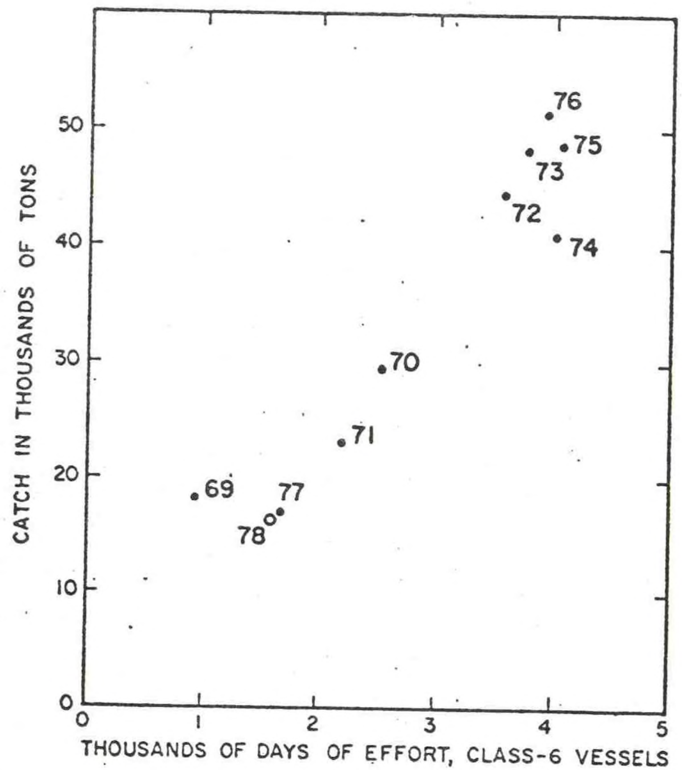

Figure 5. Relation between catch and effort for yellowfin tuna in the area outside the CYRA, 1969-1978.

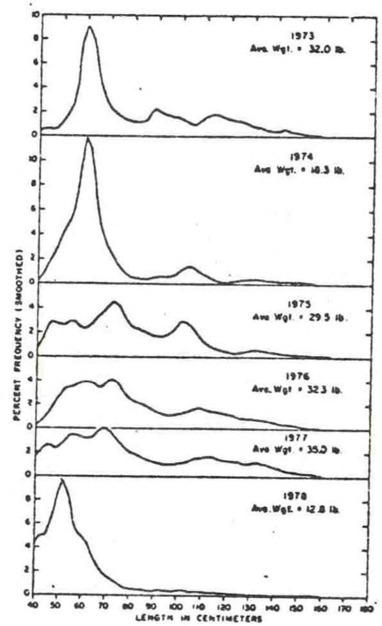

Figure 6. Length-frequency distributions of yellowfin tuna in the CYRA, 1973-1978.

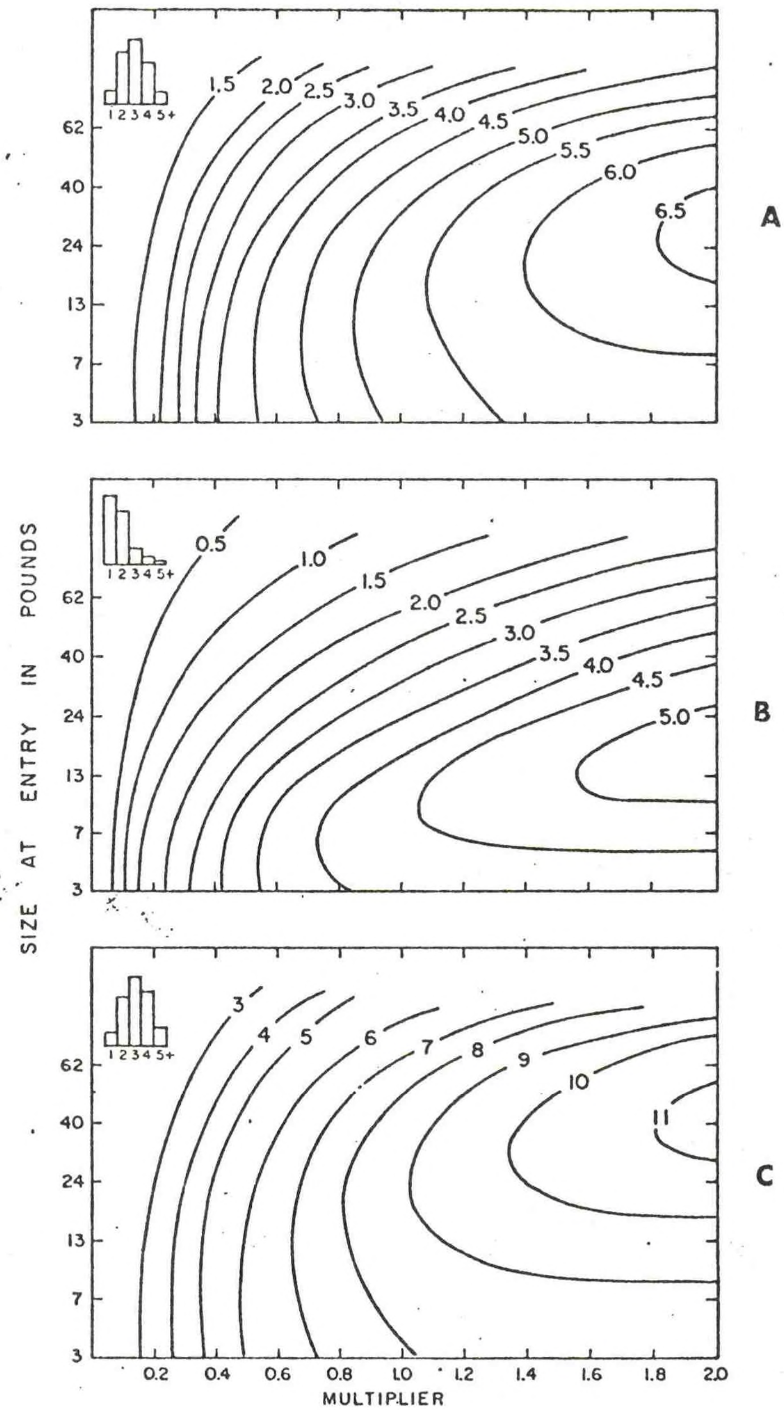

Figure 7. Yield-per-recruit isopleths for yellowfin tuna inside the CYRA; A) based on the age structure of the catch during the period 1968-1972 and natural mortality rate M=0.8, B) based on the age structure during the period 1973-1978 and M=0.8, C) based on the age structure during the period 1968-1972 and M=0.6.

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

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REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

SITUATION REPORT ON STRIPED, BLUE, AND BLACK MARLINS IN THE PACIFIC OCEAN

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August 1979

A. Description of fishery

1. Short history

The first major exploitation of the marlin resources began with the advent of the high-seas longline operations of Japan following World War II. Although the quest was for large tuna species, the gear caught all large fish, of which the marlins were a significant component. Beginning in the western Pacific, the advancing front of longline operations (Figure 1) reached long. 130°W by 1955 and the American Continents by 1965. Thereafter the fishery expanded southward (Ueyanagi 1974). Fishing effort increased from 113 million hook-days in 1955 to 335 million hook-days in 1963 and has stabilized between 247 million and 301 million hook-days since.

Longline boats of Taiwan and the Republic of Korea later followed the Japanese in fishing the high seas. The longline fleet of Taiwan, after 40 yr of coastal operations, began its high-seas venture in 1954. From a few boats that year to 42 boats in 1962 the number increased rapidly to 457 in 1971 (Huang 1974). The major part of the effort, however, has shifted from the Pacific Ocean to the Indian and Atlantic Oceans since 1968 (Table 1). Historic details of longline activities of Korea are unavailable. The longline efforts of Taiwan and Korea in the Pacific have been almost entirely in the South Pacific where almost all of their tuna are sold to two American canneries in American Samoa.

There are other fisheries which catch marlin but these are not far ranging and their catches are relatively small. A Hawaiian longline fishery, which was started in 1917 (June 1950), reached a peak of 76 boats in 1950 and has declined to 18 boats. The marlin catch of this fishery is primarily striped marlin, Tetrapturus audax, and secondarily blue marlin, Makaira nigricans. A few black marlin, M. indica, are also caught. A harpoon fishery for striped marlin has existed in Japan since ancient times (Ueyanagi 1974). The Japanese introduced the harpoon techniques to Taiwan in 1913 (Huang 1974). Sport trolling for marlins in the Pacific has its beginnings in the early years of this century. California, Australia, and New Zealand were centers at that time. In the past 30 yr, sport fishing for marlins has experienced a spurt in technology as well as popularity. Centers of activity for the various species are: Mexico, New Zealand, and California for striped marlin; Hawaii, Tahiti, and Guam for blue marlin; and Australia and Chile for black marlin.

2. Participants

The major fishers of the three species under consideration are the longline and harpoon fishermen of Japan, Taiwan, and Korea. American participants are the commercial longline fishermen of Hawaii and recreational fishermen primarily from California, Hawaii, and Guam. Other participants are recreational fishermen throughout the Pacific Basin most notably from Australia, New Zealand, and Tahiti. The number of marlin anglers is increasing in Fiji, Papua New Guinea, and Japan. Marlin fishing in the Pacific also attracts sport fishermen from all over the world.

3. Amount caught

The 1976 catches of these three species of marlins in the Pacific were: 17,032 MT (metric tons) of striped marlin; 14,813 MT of blue marlin; and 3,182 of black marlin (Suzuki and Honma[1]). An estimate of the catches by various groups of participants (Table 2) was derived from various sources of information and somewhat less than rigorous analyses. The table shows that the Japanese longliners catch the most marlins by an overwhelming margin.

4. Catch trends (All data from Suzuki and Honma see footnote 1.)

Blue marlin catches increased from 15,525 MT in 1952 to a peak of 31,344 MT in 1963 (Figure 2). Since then catches have declined irregularly to 14,813 MT in 1976. Effective fishing effort increased from 50 million hooks in 1952 to about 260 million hooks in 1963 and fluctuated around 200 million hooks from 1964 to 1975[2] (Figure 3). Catch per effort (CPUE) steadily declined from 3.0 fish/1,000 hooks in 1952 to about 0.5 fish/1,000 hooks in 1975 (Figure 3).

From 4,994 MT in 1952 striped marlin catches reached a high of 27,143 MT in 1968 (Figure 4). In 1972 the striped marlin catch dropped abruptly to 14,541 MT and has hovered about 15,000 MT since. Total effective fishing effort[3] (Figure 5) showed an increasing trend from 1952 through 1964. Since then fishing effort has fluctuated between 100 million and 200 million hooks. Catch rate (Figure 5) declined irregularly but steadfastly by approximately 50% from 1952 to 1975.

The black marlin catch (Figure 6) rose from 1,806 MT in 1952 to a high of 6,466 MT in 1956. Between 1959 and 1976 the catch has fluctuated between 2,207 and 4,066 MT. Effort and CPUE data were summarized for four Pacific areas: northwestern (Area 1), southwestern (Area 2), eastern (Area 3), and western (Area 4, a combination of Area 1 and Area 2). Effective fishing effort from 1952 to 1975 (Figure 7) has been erratic and does not show any discernible trend in Areas 1, 2, and 4. In the eastern Pacific (Area 3), where the Japanese tuna fishery commenced in 1956, effort has been on a generally increasing trend. The catch rate[4] (Figure 7) in the northwestern Pacific (Area 1) reached a peak in 1954 and declined to its lowest in 1975. In the southwest (Area 2) the catch rate reached a peak in 1955, declined to less than 4 fish/10,000 hooks in 1957, and fluctuated between 1 and 3 fish/10,000 hooks from 1958 to 1975. The catch rate in the east (Area 3) reached a peak in 1957 and declined thereafter. The western Pacific (Area 4) catch rate reflected the same trends as its constituent areas (Areas 1 and 2).

5. Ex-vessel value

The ex-vessel prices of marlin presented here are prices at the Yaizu fish market in Japan ([U.S.] National Marine Fisheries Service 1978-79) where most of the marlin is sold. The prices from January 1978 to May 1979 (Table 4) show striped marlin to be the most valuable of the three species. During that period striped marlin prices ranged from $2,316 a short ton to $4,345 a short ton. Blue marlin usually commanded a better price than black marlin. Blue marlin sold for $1,933 a short to $3,165 a short ton. Black marlin prices fluctuated between $1,638 a short ton to $2,744 a short ton.

6. Current management

The marlins are under no management scheme at present. A Preliminary Management Plan for Pacific billfishes which rather arbitrarily sets optimum yields for all the species of billfishes in the Fishery Conservation Zone is under consideration but has not been adopted.

B. Nature and degree of U.S. interest

The marlins are prized game fishes. Although the U.S. interest in marlins is primarily of a recreational nature, the commercial aspects of the marlin fishery are not to be ignored. In 1976 the sale of striped, blue, and black marlins brought $634,000 in revenue to the fishermen in Hawaii. The charter-boat industry in Hawaii has a capital investment estimated at $7.5 million, has estimated total revenues of $3.5 million, generates an employee income estimated at $1.1 million, and has net taxable income of $634,000 (draft of Billfish FMP).

Estimates of the number of boats participating in trolling for marlin are: 1,200 in California, 1,600 in Guam, and 1,800 in Hawaii.

C. Current research effort

1. Who is doing what? where?

James L. Squire at La Jolla Laboratory does a postcard inquiry of sport fishermen each year to collect information on CPUE of marlins. He also conducts a game fish tagging program which has attracted recreational fishermen in California, Mexico, Hawaii, New Zealand, and Australia to participate. Striped, black, and blue marlins have been tagged.

Heeny S. H. Yuen of the Honolulu Laboratory is working on local movement patterns of blue marlin through acoustic tracking. He is also studying the migrations of striped marlin by examining density distributions of longline records.

Jerry A. Wetherall of the Honolulu Laboratory and Misao Honma and Ziro Suzuki of the Far Seas Fisheries Research Laboratory of Japan are doing research on population dynamics and stock assessments of marlins in the Pacific.

Age determination studies are being done for blue marlin by Robert Humphreys of the Honolulu Laboratory.

D. Inventory of data

1. Location

Catch and effort statistics of longline operations are collected by the governments of Japan, Taiwan, and Korea. Longline data have been published annually by Japan since 1962 and by Taiwan since 1967. The Korean data are not regularly published. Unpublished data have been made available by the Far Seas Fisheries Research Laboratory of Japan, R. T. Yang of the National Taiwan University, and B. Y. Kim of the Fishery Resources and Development Agency of the Republic of Korea.

Sport fishing catch records are kept by many fishing clubs and tournaments. The clubs and tournaments, however, are scattered throughout the Pacific. Their records represent some unknown portion of the total catch.

2. Content

The longline data of Japan and Taiwan consist of the date, the number of fish caught by species, the position, and the number of hooks fished.

The data received from Korea were catch summaries by species for 1971-78 and catch and effort by 5° squares for 1975 and 1976. The sport fishing data would differ with different organizations but would most likely have the date, species, and weight.

3. Quality

There is no reason to believe that the commercial or sport fishing data are other than accurate and reliable. The data sets have certain shortcomings. The longline data do not have the weights of individual fish. The sport data do not have a measure of effort. With data from tournaments it is sometimes possible to approximate the fishing effort.

E. Status of stocks[5]

1. Methodology

Stock assessments were based on CPUE and effort trends and production model analysis (Fox 1975).

2. Accuracy

The accuracy of the results depended upon how well the data conformed to the major assumptions of the model production analysis. The extent to which the assumptions were violated is not known. One assumption is that the CPUE is proportional to average stock abundance and that the proportion is constant over the period of analysis. Changes in the construction or deployment of the longline gear, shifts in fishing strategy or target species, and changes in availability of the fish to the gear are some of the factors which may alter the ratio of CPUE to average abundance. In the analyses these variables could not be considered because of the lack of information. Another basic assumption is that the data refer to a single stock of the species. The stock structures of the striped, blue, and black marlins are unknown. Analysis proceeded with various assumed stock structures. The accuracy of the analyses depend on how well the assumed stock structures conformed with reality.

3. Evaluation of stocks

Based on the assumption that the blue marlin in the Pacific consists of a single oceanwide stock, production model analysis resulted in a MSY (maximum sustainable yield) estimate of 22,000 MT (Figure 8), which is associated with an effective fishing effort equal to about 50% of the 1975 total effective effort. Taken together with the steadily decreasing CPUE with increasing fishing effort, the blue marlin stock is judged to be overfished (see text footnote 2).

When a single, oceanwide stock is assumed for the striped marlin, the MSY estimate is 24,000 MT at an optimum effective effort of 3.4 million hooks/5° square (Figure 9) when compared with the 1964-75 catches of 14,500-27,100 MT at an average effective effort of 1.5-2.25 million hooks/5° square, the MSY estimate infers a striped marlin population that is not being overexploited. When the striped marlin population is assumed to be two stocks, a North Pacific stock and a South Pacific stock, the results of production model analysis indicate a perplexing picture for the North Pacific stock and a South Pacific stock that is being fished at about optimum level. The catches in the South Pacific of the last 3 yr of data, 1973-75, however, were far below the equilibrium yield curve. Further research is needed to determine the reason for the low catches before an accurate interpretation of the results can be made. In the case of the North Pacific stock, the MSY estimate was 70,000 MT at an optimum effective effort of 13.2 million hooks/5° square (see text footnote 3). This effort seems unreasonably high in light of the maximum of 1.5 million hooks/5° square fished to date.

Because of uncertainties in the total catch data and the stock structure of black marlin, a meaningful evaluation of the stocks of black marlin is not feasible.

f. Problem areas and program needs to solve problems

1. Research

With all three species the population assessments were based on incomplete catch and effort data. As a result the assessments need improvement, particularly with black marlin. Yield per recruit and cohort analyses would contribute more definitive assessments of the populations. For these analyses size at age relationships need to be confirmed for blue and striped marlins and need to be obtained for black marlin. Also needed are estimates of population parameters, e.g., natural and fishing mortality rates, recruitment rates. Another problem related to population assessment is the lack of knowledge on the stock structures of these species. Apparently it may be possible to circumvent the need for precise stock identification. One of the recommendations of the Billfish Stock Assessment Workshop was to use simulation studies to evaluate the sensitivity of stock assessments to various stock structure hypotheses on the striped marlin to determine the need for a stock identification program. Should such studies prove to be effective for striped marlins, they should be considered for the blue marlin and black marlin as well.

2. Data

Improved catch and effort statistics for commercial longline fishing are needed. Catch and effort statistics are needed from the recreational fishing area. Data on size and sex composition are required to estimate population parameters. Depending on the results of simulation studies mentioned earlier, data either on migrations or stock identification may be needed to clarify the stock structure of these species. The data needs are more urgent for the blue marlin because of its apparent overfished condition.

3. Management

Restrictive regulations may be needed to manage the blue marlin resource. None is presently needed for striped marlin. There is uncertainty about the need for management of the black marlin.

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TEXT FOOTNOTES

[1]Suzuki, Z., and M. Honma. 1977. Stock assessment of billfishe in the Pacific. Prepared for the Billfish Stock Assessment Workshop, Pacific Resources, Honolulu, Hawaii, 5-14 December 1977. BSAW/WP4, 12 p. + tables and figures.

[2]Yuen, H. S. H., and P. M. Miyake. 1978. Rapporteurs' report, blue marlin, Makaira nigricans, p. 13-20. In R. S. Shomura (editor), Summary report of the Billfish Stock Assessment Workshop, Pacific Resources, Honolulu, Hawaii, 5-14 December 1977.

[3]Bartoo, N. W., and S. Ueyanagi. 1978. Rapporteurs' report, striped marlin, Tetrapturus audax, p. 21-31. In R. S. Shomura (editor), Summary report of the Billfish Stock Assessment Workshop, Pacific Resources, Honolulu, Hawaii, 5-14 December 1977.

[4]Wetherall, J. A., and R. T. Yang. 1978. Rapporteurs' report, black marlin, Makaira indica, p. 56-63. In R. S. Shomura (editor), Summary report of the Billfish Stock Assessment Workshop, Pacific Resources, Honolulu, Hawaii, 5-14 December 1977.

[5]Shomura, R. S. (editor). 1978. Summary report of the Billfish Stock Assessment Workshop, Pacific Resources, Honolulu, Hawaii, 5-14 December 1977, 63 p.

Table 1.--Distribution of fishing efforts of Taiwan deep-sea longline fleet, 1967-71. (From Huang 1974.)

Year	Number of vessels	Fishing trips			
		Total	Pacific	Indian	Atlantic
1967	254	570	380	169	21
1968	333	1,007	359	467	181
1969	396	1,158	298	576	284
1970	418	1,258	435	539	284
1971	457	[1]1,182	495	409	278

[1]Estimated.

Table 2.--Amount of marlin caught (metric tons) by various groups.

Group	Striped marlin	Blue marlin	Black marlin
Longline			
Japan	11,760	12,980	2,670
Korea	83	656	330
Taiwan	60	628	90
Hawaii	34	8	
Harpoon			
Japan	3,000		
Taiwan	2,000		
Troll			
Hawaii	28	541	95
California	47		
New Zealand	20		
Australia			?

Table 3.--Total Pacific catch (metric tons) of marlin by species, 1952-76.

Year	Striped marlin	Blue marlin	Black marlin
1952	4,994	15,525	1,806
1953	3,789	17,250	3,188
1954	7,256	10,519	5,370
1955	7,075	24,190	5,379
1956	7,724	18,770	6,466
1957	7,150	23,500	6,376
1958	8,999	22,106	4,548
1959	8,986	20,275	3,081
1960	7,362	18,155	2,721
1961	10,084	26,581	3,170
1962	13,685	30,743	4,066
1963	16,944	31,344	3,180
1964	23,480	23,233	2,805
1965	24,017	18,585	4,039
1966	20,967	18,588	3,729
1967	22,050	17,233	2,836
1968	27,143	15,283	3,547
1969	21,706	17,427	2,546
1970	24,221	20,115	2,207
1971	24,264	13,342	2,674
1972	14,541	15,300	3,424
1973	15,407	17,285	3,720
1974	14,669	15,594	3,048
1975	16,279	12,546	2,796
1976	17,032	14,813	3,132

Table 4.--Ex-vessel marlin prices (U.S. dollars per short ton) in Japan, January 1978-May 1979.

	Striped marlin	Blue marlin	Black marlin
1978			
January	3,482	2,009	2,605
February	2,823	2,326	2,070
March	3,452	2,299	2,025
April	2,722	2,515	2,082
May	2,614	2,112	1,929
June	2,462	1,991	2,090
July	4,345	2,122	2,272
August	2,507	2,275	1,638
September	2,903	2,039	1,943
October	2,856	2,412	2,055
November	3,981	3,165	2,202
December	2,698	2,323	1,934
1979			
January	4,141	1,933	2,744
February	4,046	2,027	2,059
March	4,095	2,510	1,871
April	2,316	2,658	1,730
May	2,489	2,626	1,818

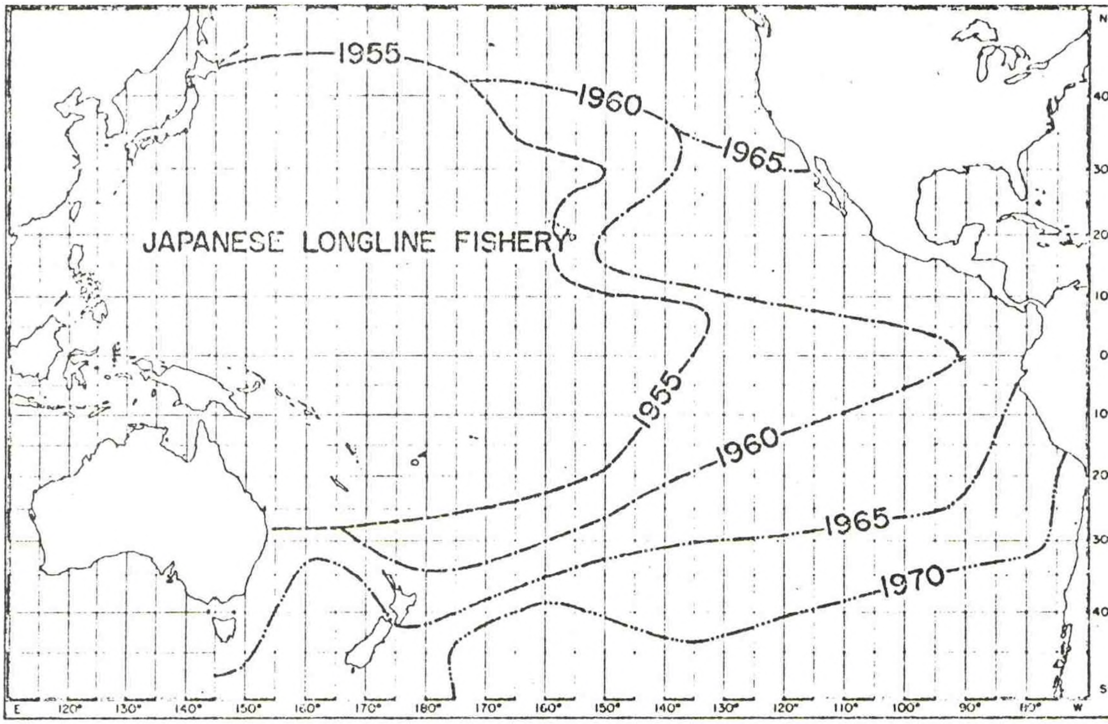

Figure 1.--Expansion of Japanese longline fishing in the Pacific Ocean at 5-yr intervals.

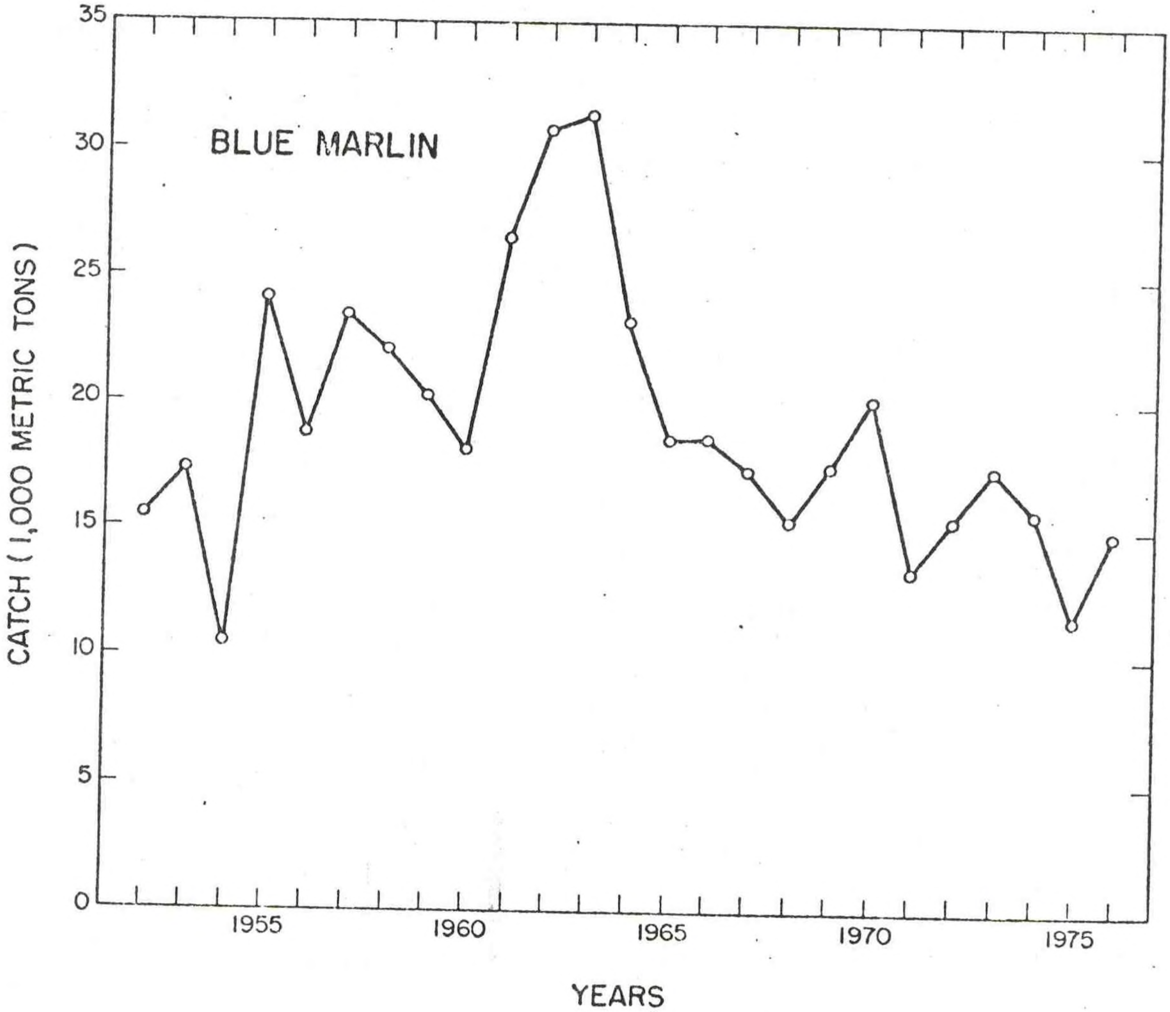

Figure 2.--Pacific catch of blue marlin.

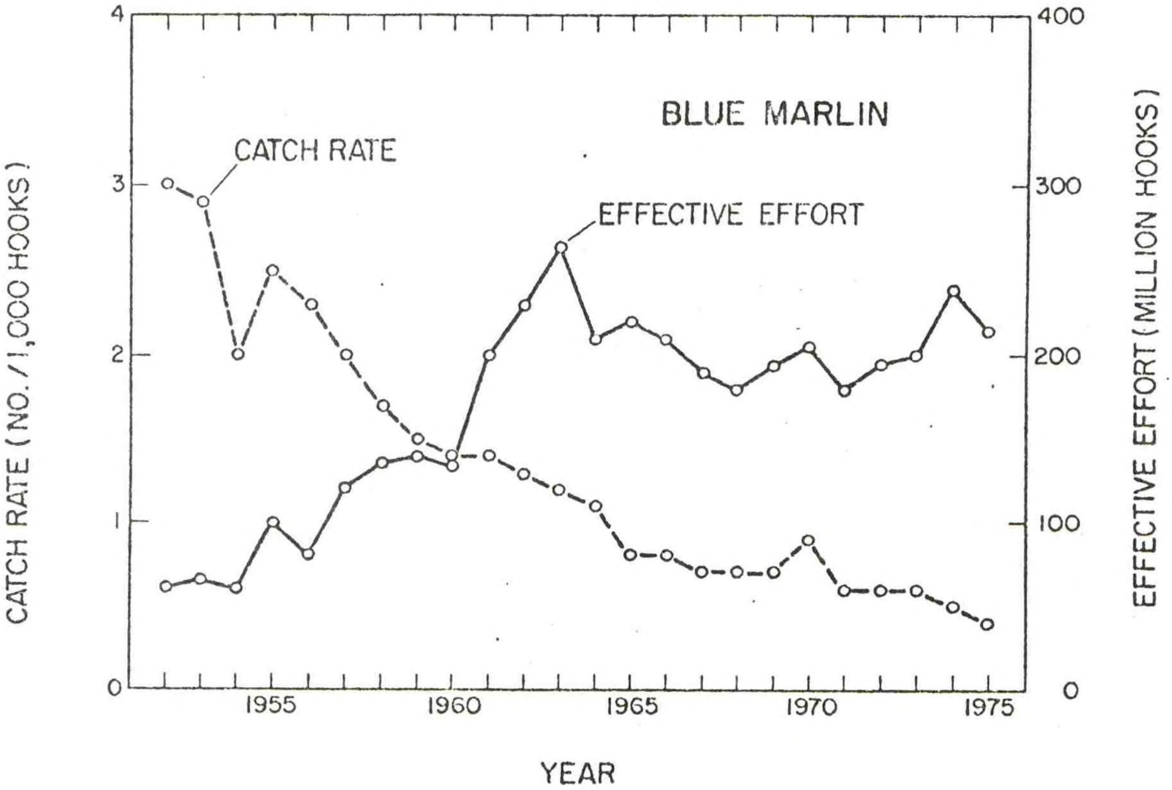

Figure 3.--Catch rate and effective fishing effort for blue marlin in the Pacific Ocean. (From Suzuki and Honma see text footnote 1.)

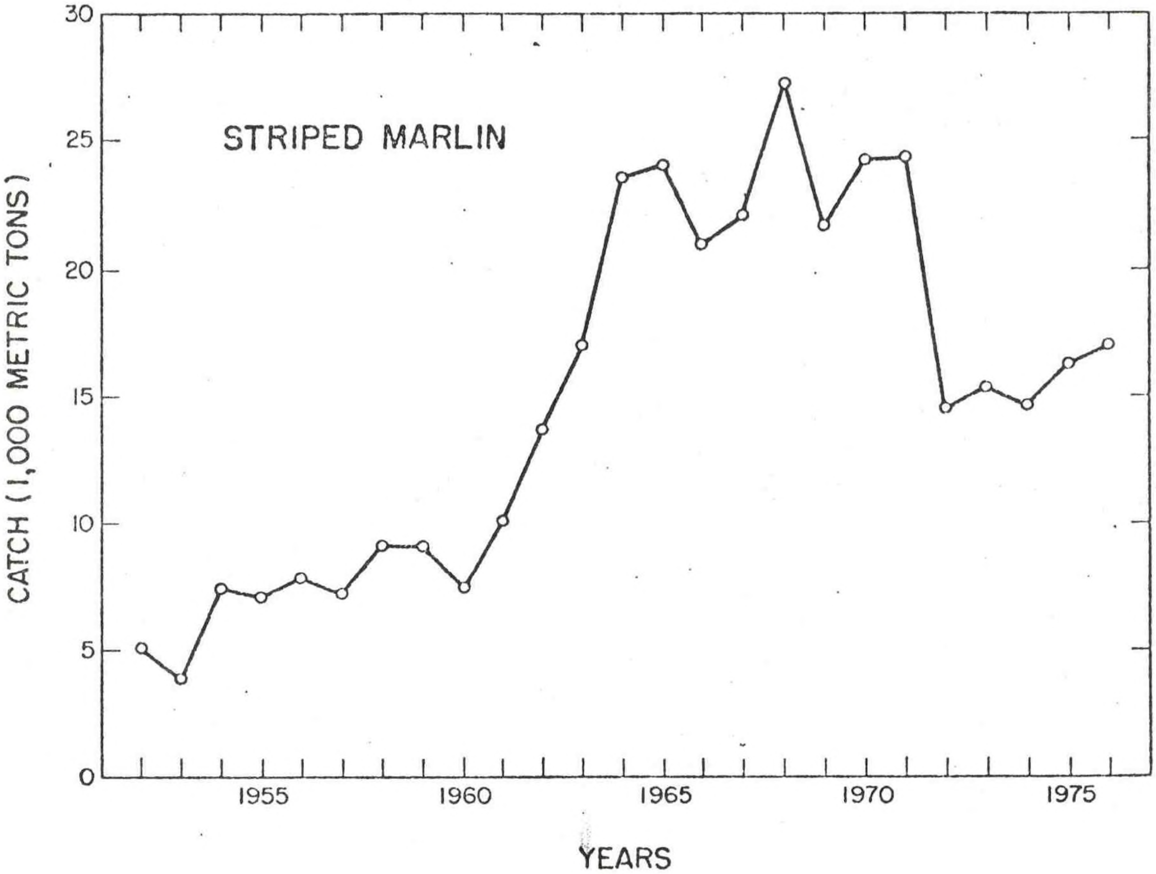

Figure 4.--Pacific catch of striped marlin.

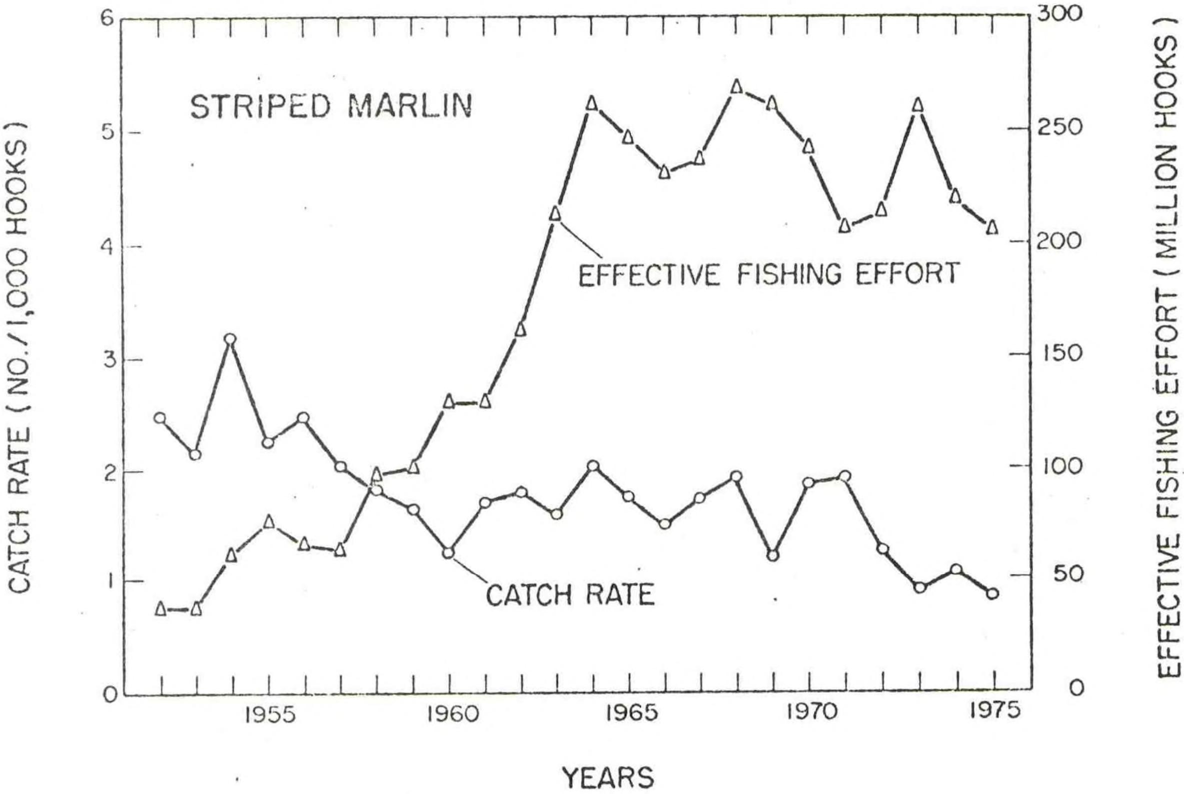

Figure 5.--Catch rates and effective fishing effort for striped marlin in the Pacific Ocean. (From Bartoo and Ueyanagi see text footnote 3.)

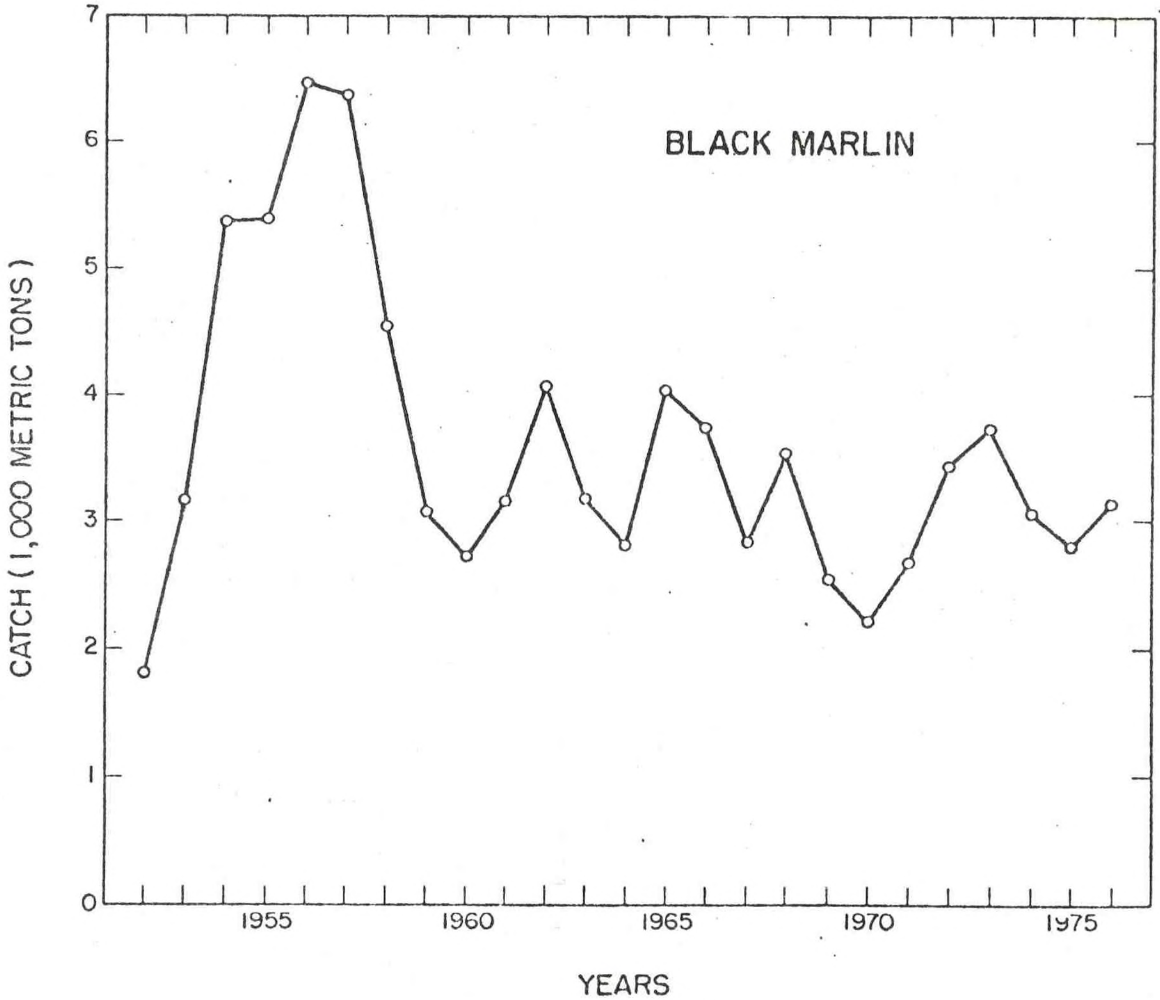

Figure 6.--Pacific catch of black marlin.

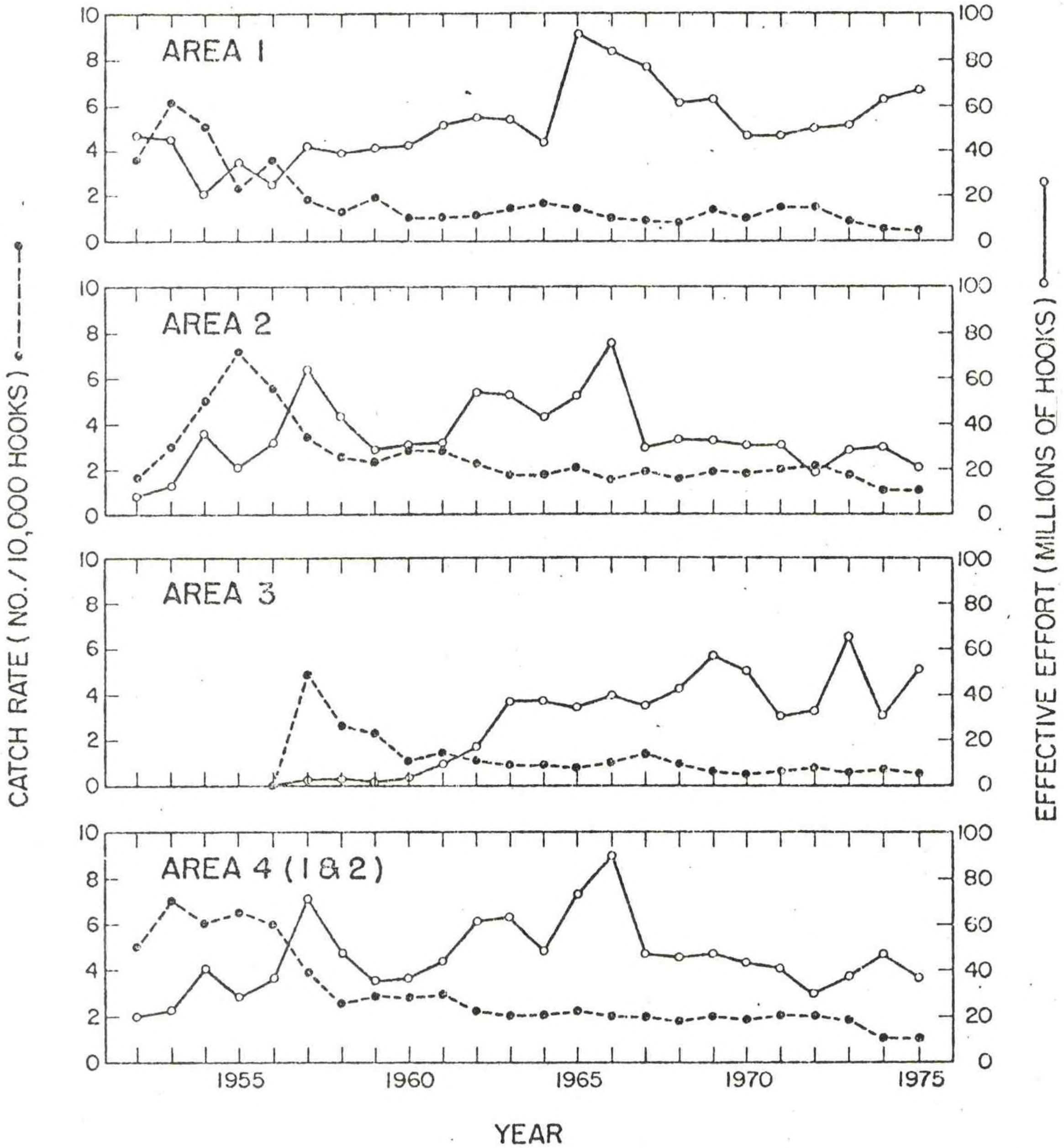

Figure 7.--Catch rates and effective fishing effort for black marlin in the Pacific Ocean. (From Wetherall and Yang see text footnote 4.)

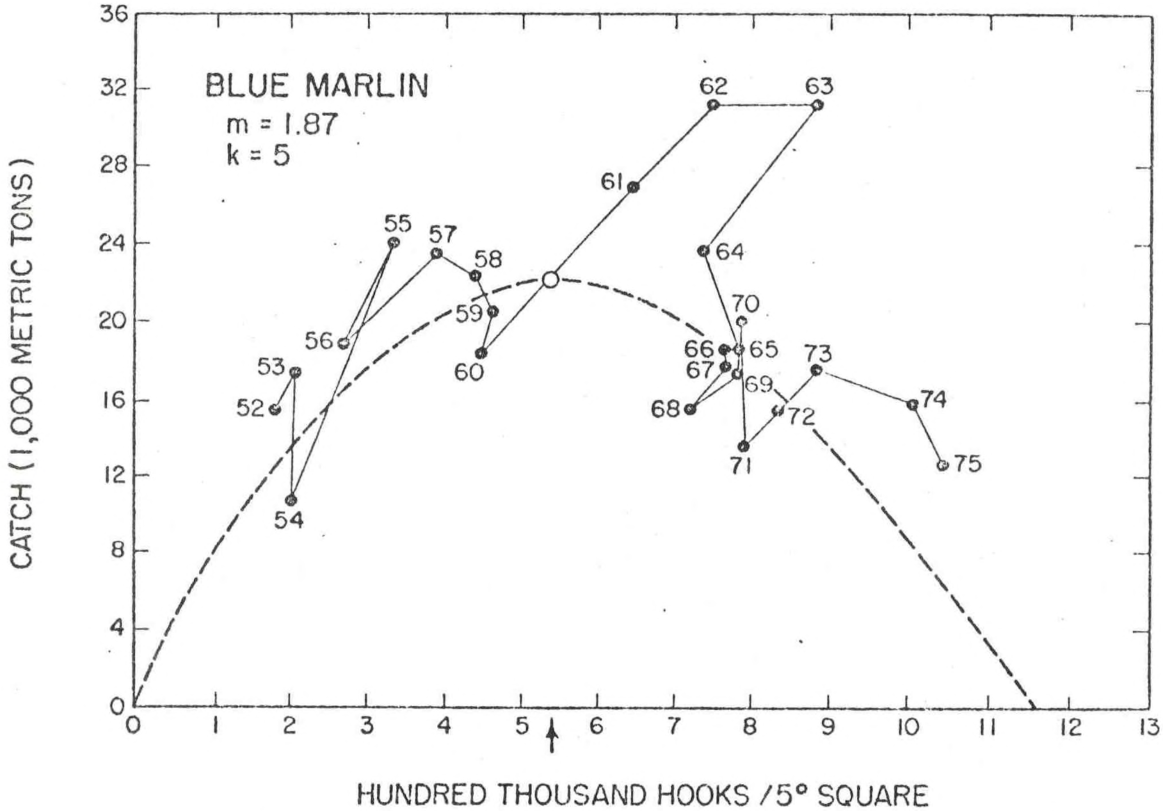

Figure 8.--Relation between catch of blue marlin and effective fishing effort. The equilibrium yield curve is based on the production model. (From Yuen and Miyake see text footnote 2.)

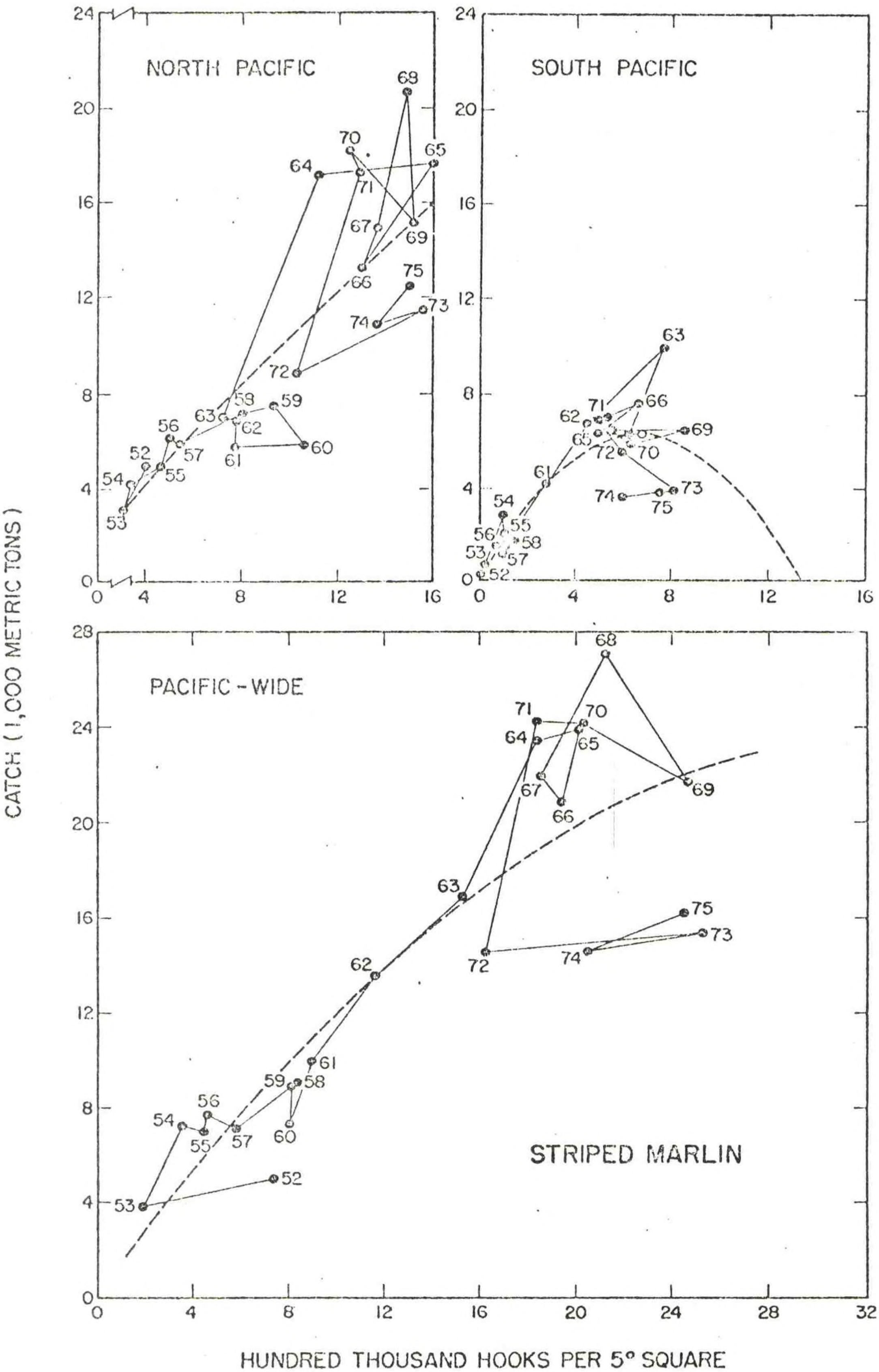

Figure 9.--Production models for hypothesized striped marlin stocks in the Pacific Ocean. (From Bartoo and Ueyanagi see text footnote 3.)

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):

Situation Report

Swordfish (Pacific Ocean)

SWFC Tuna Research Program Planning Workshop

September 11-13, 1979

San Clemente, California

A. Description of Fishery

A1. History - Swordfish (Xiphias gladius) is distributed in the tropical and temperate waters of the Pacific, Atlantic and Inidan Oceans. Commercial fishing areas are to be found in the northwestern Pacific off the Pacific coast of the United States and Mexico. They are fished also off Ecuador, Peru, New Zealand, Australia, about the Indo-Pacific islands off the southeast coast of Asia and the islands of Taiwan and Japan, in the Atlantic off the east coast of the United States and Canada, off southern Brazil, in the Gulf of Guinea, and in several areas of the Indian Ocean. Limits of commercial distribution are about 50^{0} north to 35^{0} south in the Pacific, to latitude 45^{0} north to 40^{0}-45^{0} south in the Atlantic and to latitude 45^{0} south in the Indian Ocean. This species is more abundant in coastal waters, but distribution is scattered and continuous in tropical and sub-tropical open ocean areas as evidenced by longline catch rate data (Figure 1).

Swordfish, in addition to other species of billfishes, have been recorded from archological sites in Japan and the harpoon has been used to catch swordfish in this area since ancient times. In recent times the introduction of the longline method for capture of tunas has resulted in this type of gear being the major method of swordfish capture. Longline gear, if modified and used specifically for the catching of swordfish has the capability of catching large quantities and this method currently produces most of the world's catch.

Other methods are used, the most common being the harpoon and gill nets. Incidental catches of swordfish are sometimes made with purse seines, and other gill nets being fished for species other than billfish. The rod-and-reel method is used by sport anglers to sometimes catch surface fining fish. They are taken off the southeastern United States using subsurface lighted lures.

A2. Participants - The countries catching substantial amounts of swordfish in the Pacific are the countries that have large longline fleet operations such as Japan, Korea, and Taiwan. About 18% of the total longline catch of tunas and billfish is billfish. Striped marlin and swordfish each account for 30% of the billfish catch, blue and black marlin 25% and sailfish 14% (see Figures 2 and 3).

The Japanese harpoon and gill net fishery lands about 3,000 tons of billfish (striped marlin/swordfish) from coastal waters about Sanriku (northeastern Honshu), around Izu Island and in the east China Sea.

Within United States waters, there exists a commercial harpoon and longline fishery and a minor rod-and-reel sport fishery for swordfish. The major area of harpoon fishing in United States Pacific waters is off southern California, a minor amount is taken off central California. Southern California has the largest domestic catch of swordfish of any United States area in the Pacific. Off the Hawaiian Islands a small amount of swordfish is taken by the domestic longline fleet (est. 4.4 MT/yr.).

A summary of the major participants in the Pacific and fishing methods is as follows:

United States - harpoon (California), longline (Hawaii), rod-and-reel sport (California, minor in catch).

Mexico, Costa Rica, Ecuador and Peru - coastal handline fishery, developing longline fishery through joint ventures with western Pacific countries.

Japan - Pacific wide longline fishery, coastal harpoon and drift-gill net fishery.

Taiwan - Pacific-wide longline fishery and coastal longline and harpoon fishery.

Korea - Pacific-wide longline fishery.

A3. Amount caught - Japan produces approximately 55% of the total world swordfish catch, with Taiwan, Peru and Italy each landing 1,000 to 5,000 tons each.

The total Pacific swordfish catch (MT) is given in Table 1 has ranged annually from 12,500 to 26,500 MT and current catches average about 13,000 (MT). Swordfish catches in the Pacific area given by country in Table 2.

Within Unites States' waters (to 200 n.m.) a commercial and sport fishery exists for swordfish by U.S. and Japanese and other foreign nationals. A summary of swordfish average catches, and foreign catch prior to any restrictions imposed by the FCMA of 1976, is given in Table 3.

In 1970 the Food and Drug Administration issued a guideline on the amount of mercury that could be present in fishery products (0.5 ppm.). These guidelines resulted from epidemics of poisoning in Japan by fish contaminated by an alkylmercury compound, monomethylmercury. The guidelines when established resulted in a disruption of swordfish marketing in the U.S. and Canada and the effects in fishing operations were felt worldwide by the major exporters of swordfish such as Japan. The catch statistics given in Tables 1 and 2 must be evaluated in relation to the effects of the guidelines on mercury on the consumption of swordfish in the U.S. Since the guidelines were enforced by the FDA on imports and interstate transport, but not on intrastate possession, the California swordfish fishery operated during this period with an expanded market.

In 1979 the FDA relaxed its guideline limit to 1.0 ppm and imported fish again has become available to the U.S. market.

The major U.S. swordfish fishery is the harpoon fishery off California. This harpoon fishery (only type of legal commercial fishing gear) substantially increased its catch during the 1970's, and Figure 4 gives the California catch (1918-1978) in MT. The largest catch was recorded in 1978 (1,609 MT) and is 12.4% of the 1971-1976 Pacific-wide annual average.

A4. Catch trends - The total annual Pacific catch of swordfish increased from 11,300 MT in 1952 to a high of 24,300 MT in 1961 (Table 1). The catch since has fluctuated between 10,000 to 19,000 MT. The enforcement of FDA mercury guidelines in the U.S. and Canada is reflected in the catch starting in 1971. However, total Pacific catches have increased in recent years (1976) without the U.S. and Canadian market for imported swordfish. With the lifting of the FDA limits an increase in market will be available for foreign swordfish, and may result in increaed catches, by the foreign longline fleet.

A5. Ex-vessel value - The ex-vessel value of swordfish is highly variable dependent on the type of market (fresh or frozen). In the United States on the fresh market the ex-vessel price will range from \$1.35 to \$3.50 per pound depending upon supply and demand. The average ex-vessel price is near \$2.00 per pound in Californa fishery. Assuming this price, for the amount of catch recorded in 1978 (may be a substantial underestimate) the ex-vessel value was about 7.0 million dollars. Ex-vessel prices of longline caught frozen swordfish in Japan is reported (7/79) to be 569 yen per kg. or \$1.19 per pound (US). Assuming the Japanese catch were sold at this price (iced local fish may demand a higher price) and the fish auction price reduced by 10% to give an ex-vessel value, the value of the Japanese Pacific catch based on July 1979 prices for frozen fish market is about 36 million U.S. dollars (swordfish @ 569 yen/kg or \$2,622/MT)

A6. Current Management

Resource Management - none.

Fishery Management - The State of California (C.F. & G. Commission) has a number of restrictive regulations which inhibit the further development of the swordfish fishery.

None for Hawaii.

B. U.S. Interest

The public demand for swordfish exceeds the United States supply even in years of high catch. The swordfish fishery supports a substantial small-boat commercial fleet in southern California. In 1978 a total of 806 swordfish permits were issued by C.F. & G. to commercial fishing license holders. The number of boats involved in the California fishery is about 400 as data from logbooks indicate about half the commercial permit holders will fish. To this must be added the commercial fish processing, wholesale, and retail segment of the fishery. The exact amount of its value in employment and income is unknown.

There is considerable interest in and some fishing for swordfish by rod-and-reel recreational fishery, however, the major effort is targeted on striped marlin with swordfish as an incidental catch.

The commercial production of swordfish could be increased substantially during seasons of average or better availability. However, the fishery is presently under the management of the State of California, Fish and Game Commission, and this Commission prefers to limit technological advancement. The size of the Hawaii domestic commercial longline fishery is small and the catch of swordfish is incidental to the catch of tuna and other species of billfish.

C. Current Research Effort

A small amount of stock assessment work is being conducted in Japan (Far Seas Research Laboratory, Shimizu, Japan) relative to stocks of swordfish in the world oceans. At the present time, only a very limited amount of effort is being given to swordfish biological research and stock assessment in the U.S. A program is now underway in Florida to increase research studies on the Atlantic swordfish by the University of Miami (Sea Grant), State of Florida, with the cooperation of NMFS/SEFC. The amount of biological research being conducted at other educational institutions is minimal.

Swordfish catches are being sampled off California by an at-sea sampling program by NMFS in cooperation with the Pacific Marine

Fisheries Commission and C.F. & G. No major research programs on swordfish are known for the northwestern coast of South America, Central America and Mexico, or at other locations in the Pacific. Research that would better define the biological parameters needed for management has not been done.

D. Inventory of data (major fisheries)

Catch Data

U.S. - California, fair may be a substantial underestimate for landings.

Hawaii - estimate fair for commercial longline.

Japan - Good catch data from longline, coastal fishery data unknown but assumed to be good.

Korea - Poor longline data through 1977, possibly less than 10-15% of longline catches covered by logbooks.

Taiwan - Fair, estimate 20-30% of longline catches covered by logbooks. Coastal harpoon fishery data is given, unknown quality.

Chile - Catches reported to F.A.O.

Peru - Catches reported to F.A.O.

Mexico - Fishing off Mexico by joint venture with Japanese (currently with 3 longliners), status of logbook data for this operation is unknown but assumed to be the same data as is unknown but assumed to be the same data as normally collected.

Other minor areas - unknown.

Effort Date

U.S. - California, good to excellent coverage logbook system for all participants (required by law) in commercial fishery. Quality is unknown for catches but believed to be a substantial underestimate.

Hawaii - no logbook system exists, estimates only.

Japan - Excellent longline effort data and coverage, 90% or better, however, effort not defined as night or day fishing or target species. Coastal and harpoon effort levels are believed not to be available.

Korea - Poor longline effort data through 1977.

Taiwan - Longline logook data, fair to poor coverage. Inshore harpoon fishery effort data believed not to be available.

Mexico - Effort data off Mexico by Japanese longliners, through spring 1977 excellent , except for lack of day/night and target species breakdown.

Chile - Unknown

Ecuador - Unknown

E. Status of Stocks

The stock structure of the swordfish population of the Pacific Ocean is not clearly known. Available data on distribution of larvae and on longline catch rates suggest that the population consists of either (1) a single, Pacific-wide stock, or (2) three separate stocks with centers of concentration in the northwestern (Area 1), southwestern (Area 2), and eastern (Area 3) regions of the Pacific Ocean (Figure 1)

Effort and Catch Rate Trends

For the total area the effort and catch rate trends are as follows:

Effort trends -

Effective fishing effort for Pacific swordfish has fluctuated between 270 million and 550 million hooks (Figure 5). The level in 1975 was about 300 million hooks.

Catch Rate trends -

The longest available time series of catch rates is for the Japanese longline fleet. Total Pacific catch rates for this fleet reached a peak of about 10 fish/10,000 hooks in 1958, declined to a low of 4 fish/10,000 hooks in 1967, and since then stabilized at about 5 fish/10,000 hooks (Figure 5).

Population Parameters

Estimates of basic, critical population parameters for swordfish for the most part, are lacking. Available estimates are given in Table 2 of the Honolulu Billfish Stock Assessment Summary Report. They include estimates of growth and mortality rates that are judged to be crude. The difficulty in obtaining reliable estimates appear to be limited by the ability to age swordfish. A reliable aging technique has not yet been developed and most population parameters rely on age-dependent data.

Stock Assessment

The condition of the swordfish stocks of the Pacific was evaluated based on different hypotheses about the stock structure of the population: hypothesis 1, a single Pacific-wide stock, and hypothesis 2, three separate stocks. Because of limited data on the stocks the evaluation was restricted primarily to the use of production model analysis.

Single Pacific-Wide Stock -

The relation of catch and effective fishing effort, assuming a single Pacific-wide stock is shown in Figure 6. The data points fall into two clusters separated by a sharp break between 1963 and 1964, which corresponds approximately to the period when the operational methods in the longline fishery changed to the productive northwestern fishing area. As indicated earlier, longline night fishing which is directed at swordfish, was the predominate manner of fishing in the northwestern region prior to the mid-1960's. Since then, fishing in that region has become more a day operation for tunas rather than a night operation for swordfish.

Production model analysis of the separate clusters of points gave no solution for the 1964-75 data series, and a maximum sustainable yield (MSY) estimate of 20,000 MT per year with 2.2 million hooks/5^{o} square for the 1952-63 series. Presumably during the 1952-63 period the fishery was more efficient in catching swordfish than during the 1964-75 period. The current (average for 1966-75) catch of about 14,100 MT produced by 1.8 million hooks/5^{o} square, indicate that the fishery does not appear to be overexploiting the stock and that the stock is in good condition.

Three Separate Stocks -

Complete data for production model analysis, assuming three stocks in the the Pacific were not available for examination. An appraisal of the condition of the stocks was therefore based on on estimates of apparent abundance from Japanese longline data for 1952-1975.

In the northwestern Pacific (Area 1, see Figure 1), the longline catches ranged from about 6,800 to 22,900 MT (Figure 7); the catch rates showed a gradual decline from about 20 fish/10,000 hooks in 1958 to 8 fish/10,000 hooks in 1971 (Figure 5). Since 1971 the catch rate gradually recovered to the current level of 12 fish/10,000 hooks in 1975.

In the southwestern Pacific (Area 2), the longline catches showed a gradually increasing trend (Figure 7); the catch rates fluctuated between 2 fish/10,000 hooks and 3 fish/10,000 hooks during the period 1952-67 (Figure 5). The rate then increased to the current level of 4 fish/10,000 hooks.

Longline catches in the eastern Pacific (Area 3) showed an increasing trend after 1960, following a period of small catches from 1952 to 1960 (Figure 7); the catch rates gradually increased from about 2 fish/10,000 hooks in 1954 to 6 fish/10,000 hooks in 1968 (Figure 5). In 1969 and 1970 the catch rates increased sharply to a record high of about 11 fish/10,000 hooks before declining to a level of about 6 fish/10,000 hooks in 1971-75.

Overall Stock Appraisal

The swordfish stocks of the Pacific Ocean appear to be healthy and capable of sustaining increaed yields with increased effort. However, should the longline fishery resort to night fishing as was the standard method of fishing in some areas prior to the mid-1960's, then the greater efficiency of the gear could result in the catch exceeding the MSY with about a 25% increase in the current levels of fishing effort.

Available techniques for stock identification are expensive to apply and not entirely reliable in producing clear results. The participants therefore recommended that different stock structure hypotheses be tested using existing fisheries data to determine their impact on assessments before any major program for stock identification of swordfish is considered.

The key to more precise stock assessments for swordfish is more reliable information on stock densities and better esitmates of population dynamics parameters. The participants recommened that methods of aging swordfish receive more research attention since this is important for estimating population dynamics parameters.

F. Program Needs/Problem Areas

Managememt

With current levels of fishing effort (about 1.8 million hooks/5^{o} square) and longline fishing predminantly during the day, the swordfish stocks are not being exploited beyond the estimated MSY of about 20,000 MT for the Pacific-wide stock. However, the fishery should be monitored closely for changes in the mode of operation, especially changes to night fishing, which could result in the stocks being exploited beyond MSY.

The California swordfish commercial fishery has socio-economic problems in that the techniques of fishing are limited leading to an inefficient fleet and lower production. The fishery is overcapitalized and the average vessel in the fleet experiences loss of over $4,000 per year. This fishery could be managed to substantially increase production. Currently the NMFS is cooperating with the Pacific Fishery Council to effect a Management Plan for the fishery, not the resource. Limited tagging off southern California has indicated that a high recovery rate (40%) for tagged fish is possible in the fishery, indicating the possibility of a high explotation rate for surface-fish in the local fishery area. The extent and size structure of the subsurface population off southern California is unknown. These problems have a bearing on the management for the California fishery.

Relative to the Pacific resources of swordfish the management of the stock or stocks can only be developed through international management. Seasonal target areas for the different species would need to be defined relative to production in numbers and the value of the catch in relation to the tuna. Longline fishing being the major method of take may be adjusted, also the coastal fisheries which at times have the potential to catch substantial numbers (such as California which could at times catch up to an estimated 20% of the Pacific catch (1975) should be participants in the international management program.

Data Needs

Foreign -

Longlining for swordfish is most effective during the night, whereas, longlining for tunas is most effective during the day. Prior to the mid-1960's, longlining in the most productive swordfish areas, especially in the northwestern Pacific, was conducted during the night. Since then this practice has decreased as the fishery has been targeting tuna.

This change in fishing practice has complicated the longline statistics which are used to measure apparent abundance of swordfish. Published statistics currently do not identify type of fishing, i.e., night and day operations or the species being targeted, and more precise stock assessments based on the longline data will require separation of the data. The participants of the International Billfish Workshop (Honolulu, 1977) therefore, recommended that the longline catch-effort statistics be separated into type (day and night) of operations.

Workshop participants recommended that size and sex data be collected from all fisheries, and catch-and-effort data be collected from the surface fisheries. These data are essential for using more sophisticated assessment techniques and for obtaining more precise management advice.

Domestic -

Catch and effort and landing data is being collected for the California swordfish fishery. Although the magnitude of the logbook coverage is 100% (by law) the data with regard to catch is suspect. In California a substantial (but unknown) amount of swordfish is sold directly to resturants, markets, etc., and does not enter the normal fishery distribution channels. Fishermen are reluctant to indicate the true catch, as the logbook records could be subject to inspection by tax authorities. A logbook system that would not identify the boat (name, CF&G number) should be considered.

If aircraft assistance were to be allowed, an extension of the currently established SWFC aerial fish monitoring program could be expanded to include three swordfish spotters pilots. These spotters could provide data for determining relative apparent abundance.

Research Needs -

Since the stock structure is not clearly known (1 Pacific-wide or 3 separate stocks possible), studies to determine the range and magnitude of migration of swordfish are required. A full range of stock identification techniques should be employed such as genetic studies, time/area catch anaylsis, and tagging to determine the degree of intermingling.

Research is needed to define;

1. Areas and seasons of spawning in the easten Pacific which are now unknown, but are believed to be in the tropical areas, during the winter or spring months. The distribution of larvae in the eastern Pacific is unknown.
2. Age and growth rates
3. Catch composition
4. Location of juvenile and young fish (15 kg)
5. Food preferences, by area and age
6. The realtion of sub-surface and surface distribution to the physical and biological environment.
7. The subsurface abundance of swordfish off California. (The fishery now only samples surface fish. Where a surface (harpoon) and subsurface (longline) fishery operates in the same area, such as the northwest Atlantic, the harpoon fishery takes larger fish (average) than the longline fishery, indicating that the smaller size groups may not be available to the surface fishery.)

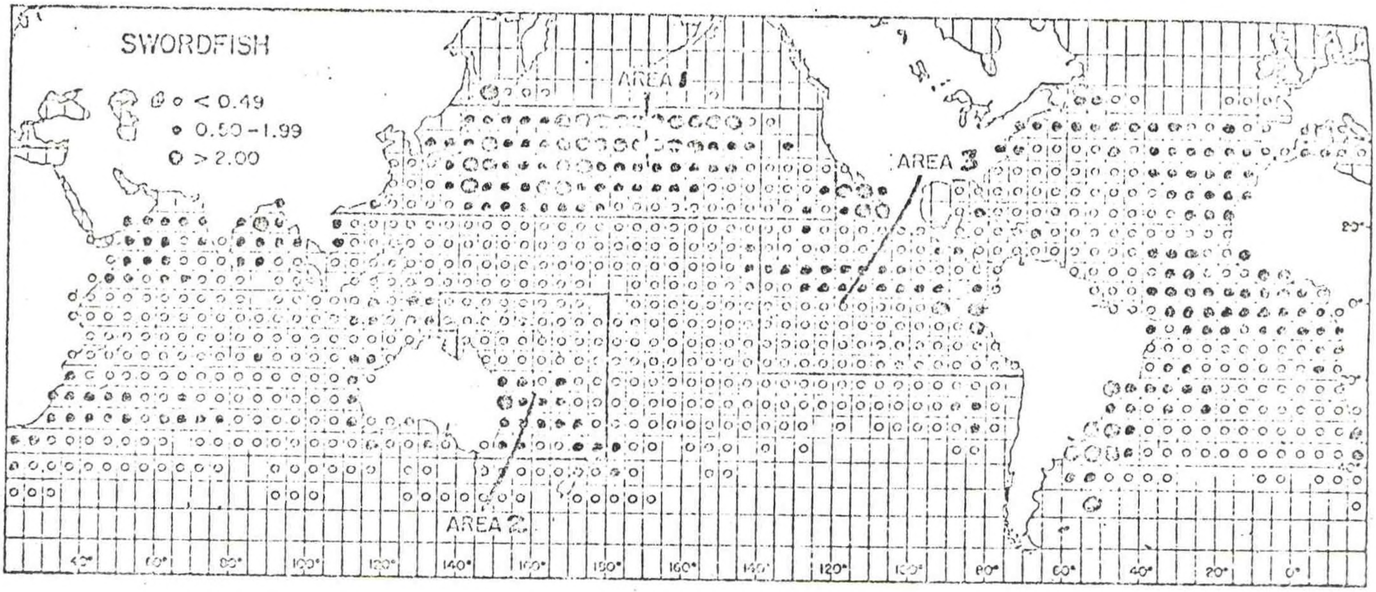

Figure 1.--Distribution of swordfish in the Pacific. The circles indicate mean catch rates (number of fish/1,000 hooks). Also shown are centers of concentration of hypothesized swordfish stocks in the Pacific.

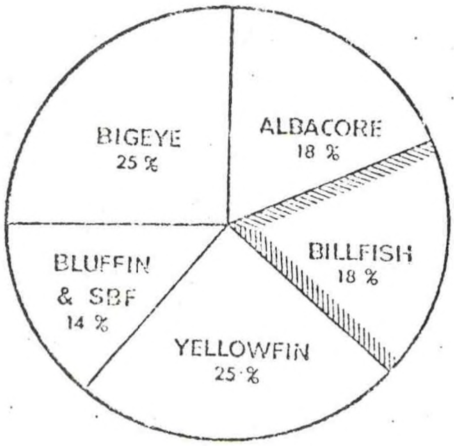

Figure 2–Average species composition of Japanese tuna fishery catches 1968-70.

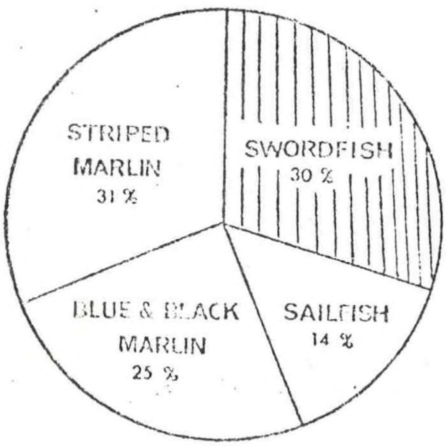

Figure 3–Species composition of billfish landings in the Japanese tuna fishery, 1968-70.

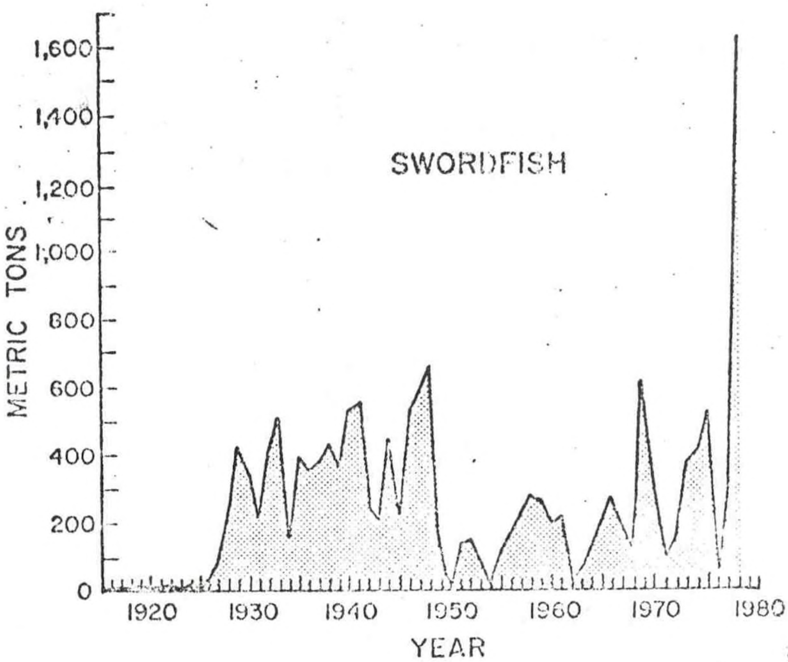

Figure 4. California landings, 1918-1978, in metric tons adjusted to round weight.

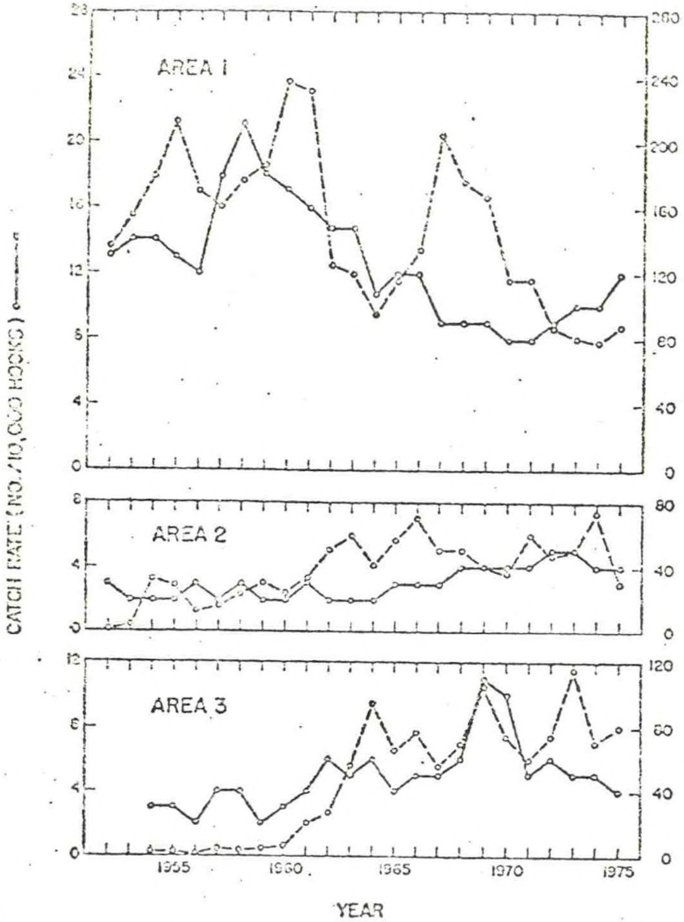

Figure 5 --Catch rates and effective fishing effort for swordfish in the Pacific.

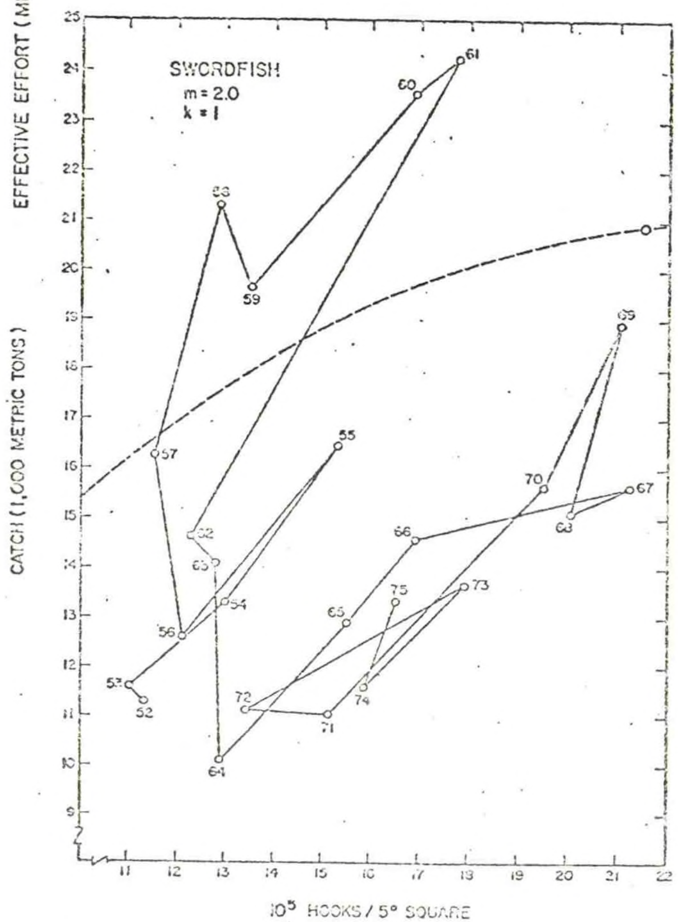

Figure 6 --Relationship of catch of swordfish and effective fishing effort. The equilibrium yield curve (Schaefer production model) is shown for data for 1952-63 only.

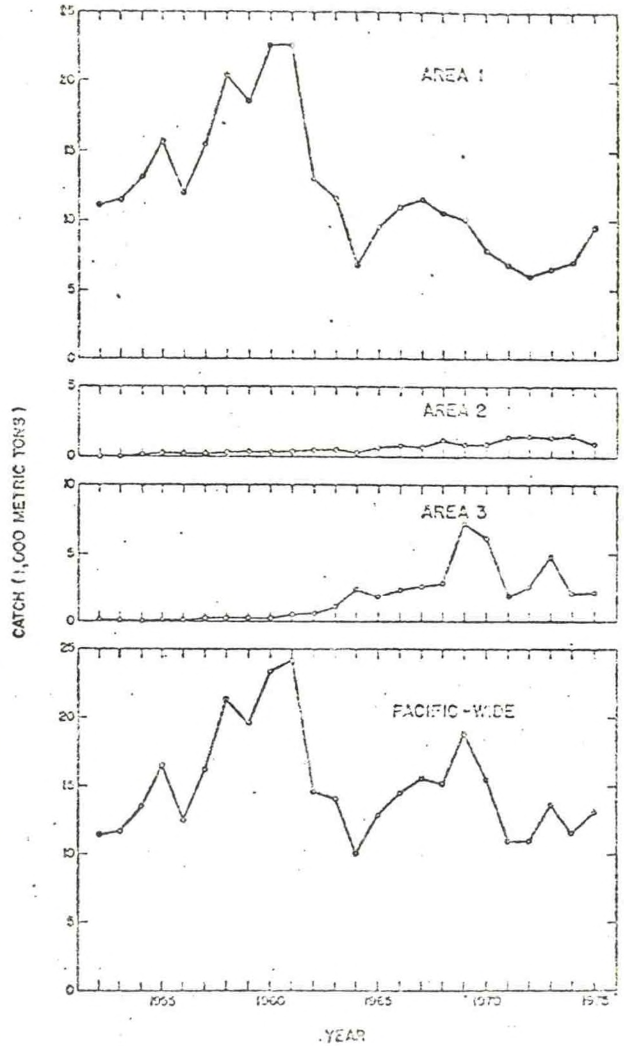

Figure 7 --Swordfish catch in the Pacific Ocean (Suzuki and Honma BSAW/WP4).

Table 1. Pacific swordfish catch (metric tons), 1952-1976

Year	MT
1952	11,339
1953	11,689
1954	13,392
1955	16,485
1956	12,584
1957	16,243
1958	21,341
1959	19,663
1960	23,409
1961	24,286
1962	14,604
1963	14,133
1964	10,112
1965	12,949
1966	14,601
1967	15,649
1968	15,230
1969	18,934
1970	16,727
1971	11,037
1972	11,029
1973	13,791
1974	11,664
1975	13,376
1976	17,190
1977	----
1978	----

Average 1952-1976 - 15,218 MT

(5 year) 1966-1970 - 15,937 MT

(5 year) 1971-1976 - 13,014 MT

Table 2. Swordfish catches (metric tons) by countries for the Pacific Ocean

Year	Japan	Taiwan	Korea	United States	Chile	Peru	Others	Total
1952	11,182			157				11,339
1953	11,604			85				11,689
1954	13,301	77		14				13,392
1955	16,220	185		80				16,485
1956	12,167	254		163				12,584
1957	15,771	250		222				16,243
1958	20,815	247		279				21,341
1959	19,136	262		265				19,663
1960	22,944	273		192				23,409
1961	23,636	432		218				24,286
1962	14,037	544		23				14,604
1963	13,775	300		58				14,133
1964	9,703	300		109				10,112
1965	11,955	300		194	200	300		12,949
1966	13,283	600	41	277	200	200		14,601
1967	13,083	838	47	181	200	1,300		15,649
1968	12,983	974	55	118	200	800	100	15,230
1969	15,612	1,023	89	610	300	1,200	100	18,934
1970	11,301	1,053	115	558	200	2,400	100	15,727
1971	9,182	1,149	115	91	200	200	100	11,037
1972	8,846	1,111	115	157	100	600	100	11,029
1973	9,644	1,269	115	363	400	1,900	100	13,791
1974	9,517	1,157	115	384	218	270	3	11,664
1975	11,274	1,099	115	512	137	158	3	13,376
1976	15,093	1,290	444	53	13	294	3	17,190
1977	----	----	---	289	---	----	---	----
1978	----	----	---	1,609	---	----	---	----

Table 3. Estimated average catch of swordfish by portion of the U.S. FCZ in MT

Location	Domestic/Foreign
Hawaii (including Midway)	4.4/111.3 MT
West Coast (off California)	225.4/ -
Guam & northern Marianas	-2/7.2
American Samoa	-/3.3
Possessions	-/28.1
AVERAGE	230/149.9 MT
TOTAL AVERAGE	380 MT

SWFC TUNA RESEARCH WORKSHOP

SAN CLEMENTE - SEPTEMBER 11-13, 1979

PRELIMINARY REVIEW OF SITUATION REPORT/RESEARCH PROBLEMS/PROGRAM NEEDS

SPECIES: ______________________________

STRENGTHS OF REVIEW OR PROPOSAL	MODIFICATIONS WHICH WOULD IMPROVE THE REVIEW OR PROPOSAL	SOURCES OF ASSISTANCE
1.	1.	
2.	2.	
3.	3.	
4.		

RESEARCH OR PROGRAMMATIC QUESTIONS THAT THE WORKSHOP SHOULD DISCUSS OR KEEP IN MIND REGARDING THIS SPECIES/STOCK.

1.

2.

3.

REMOVE, FILL-IN, AND RETURN TO D. MACKETT BEFORE SEPTEMBER 11 (SEPTEMBER 10, 1979 O.K.)

REVIEWER'S NAME (OPTIONAL):